

City of Dyersburg Water Well No. 6 Replacement



**CITY OF DYERSBURG
CITY HALL
425 WEST COURT ST
DYERSBURG, TN 38024**

CONTRACT DOCUMENTS AND SPECIFICATIONS

WATER WELL NO. 6 REPLACEMENT

CITY OF DYERSBURG

ENGINEER SEALS PAGE

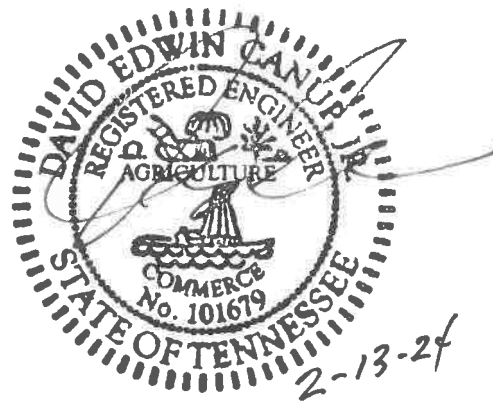
PROCESS ENGINEER



INSTRUMENTATION ENGINEER



ELECTRICAL ENGINEER



SECTION 00 01 10

TABLE OF CONTENTS

**Section
Number Section
 Title**

(VOLUME 1 OF 1)

Introductory Information

00 01 10 Table of Contents

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

Bidding Requirements and Documents

00 11 13 Advertisement for Bids
00 21 13 Instructions to Bidders
00 41 00 Bid Form
00 42 00 Funding Agency Bid Forms
00 45 13 Bidder Qualification Questionnaire
00 45 14 Subcontractor Form
00 51 00 Notice of Award
00 52 00 Construction Contract
00 55 00 Notice to Proceed
00 61 10 Bid Bond
00 61 11 Performance Bond
00 61 12 Payment Bond
00 72 00 General Conditions
00 81 00 Funding Agency Supplementary Conditions
00 83 13 Project Sign

DIVISION 01 – GENERAL REQUIREMENTS

01 00 05 Basic Requirements
01 51 00 Temporary Construction Facilities and Utilities
01 77 13 Closeout
01 99 00 Reference Forms

DIVISION 02 – EXISTING CONDITIONS

02 41 00 Demolition

DIVISION 03 – CONCRETE

Not used – refer to Drawings.

DIVISION 05 – METALS

05 05 20 Anchor Systems

DIVISION 09 – FINISHES

09 96 00 Painting and Coatings

DIVISION 10 – SPECIALTIES

10 14 20 Signage Requirements

DIVISION 11 – EQUIPMENT

11 05 13 Motors

DIVISION 26 – ELECTRICAL

26 00 00 General Electrical Requirements
26 05 19 Low-Voltage Electrical Power Conductors and Cables
26 05 26 Grounding and Bonding for Electrical Systems
26 05 29 Hangers and Supports for Electrical Systems
26 05 33 Raceways and Boxes for Electrical Systems
26 05 53 Identification for Electrical Systems
26 22 13 Low-Voltage Distribution Transformers
26 24 16 Panelboards
26 29 23 Variable Frequency Motor Controllers

DIVISION 31 – EARTHWORK

31 23 16 Excavation, Trenching, and Grading
31 23 23 Bedding, Backfilling, and Compaction
31 50 00 Sheeting and Bracing

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 31 00 Chain-Link Fences and Gates
32 90 00 Site Rehabilitation

DIVISION 33 – UTILITIES

33 01 00 Water Well Abandonment
33 11 00 Piping
33 11 13 Water Well
33 12 00 Valves
33 13 00 Testing and Disinfection of Piping and Systems

DIVISION 40 – PROCESS INTEGRATION

40 27 00 Hangers, Anchors, and Supports
40 41 13 Pipe Insulation and Heat Tracing
40 90 00 Controls and Instrumentation

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

- 43 21 06 Basic Requirements for Pumping Equipment
- 43 21 17 Vertical Turbine Pumps

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

- 46 05 00 General Requirements for Equipment

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SECTION 00 11 13

ADVERTISEMENT FOR BIDS

Bid Number: DW-PDC-2

Bid Title: City of Dyersburg Water Well No. 6 Replacement Construction Bid

Date: June 20, 2024

Sealed Bids for the **CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT** will be received by the **City of Dyersburg**, Tennessee, at the **Public Works Building, 435 Highway 51 Bypass South, Dyersburg, TN 38025-1358** until 10:00 A.M. Local Time, Thursday, July 11, 2024 and then at said place publicly opened and read aloud.

The work to be done consists of: demolition and plugging of existing Water Well No. 6 and the replacement of said well including piping, valves, electrical, instrumentation, site work and all associated appurtenances.

This project is being supported with the American Rescue Plan Act, Coronavirus State and Local Recovery Fund grant funding. Therefore, certain restrictions and other federal requirements attach to this opportunity.

City of Dyersburg hereby notifies all bidders that it will affirmatively insure that in any contract entered into pursuant to this advertisement will be afforded full opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, sex, or national origin in consideration for an award. City of Dyersburg is an Equal Opportunity Employer. Any contract that uses federal funds to pay for construction work is a "federally assisted construction contract" and must include the equal opportunity clause found in 2 C.F.R. Part 200, unless otherwise stated in 41 C.F.R. Part 60. We encourage all small and minority owned firms and women's business enterprises to participate. No bidder may withdraw his bid within (60) days after the actual date of the opening thereof.

The Copeland "Anti-Kickback" Act is also applicable, which prohibits workers on construction contracts from giving up wages that they are owed. Contractor's name must not appear on Sam.gov debarment list.

Bid Documents will be available on Thursday, June 20, 2024 at 12:00pm and will be sent electronically to interested Contractors upon request. Contact Clark Coleman at (901) 233-0256 or cccoleman@ssr-inc.com to request a set of electronic contract documents. Only entities obtaining Contract Documents through the Issuing Office shall be considered a Biddings Document Holder for purposes of qualifying for the Bid. Bids received from those entities not classified as Biddings Document Holders shall not be opened. The date that the Bidding Documents are transmitted by the Issuing Office will be considered the Bidder's date of receipt of the Bidding Documents. Neither Owner nor Engineer will be responsible for full or partial sets of Bidding Documents, including Addenda if any, obtained from sources other than the Issuing Office.

A non-mandatory Pre-Bid Conference will be held on Tuesday, July 2, 2024 at 10:00 a.m. local time at the Public Works Building located at 435 Highway 51 Bypass South, Dyersburg, TN 38025.

The Owner reserves the right to waive any informality and to reject any or all bids. In Order to qualify, a Prime Contractor must currently hold a current contractor's license in the State of Tennessee.

No bid will be opened unless the outside of the sealed envelope containing the bid provides the following information: The Contractor's license number, the date of the license's expiration, and a quotation of that part of his license classification applying to the bid. In the case of joint ventures, this information must be provided by each party submitting the bid.

All Bids must be made out on the Bid Form bound in with the bid manual. This Bid Form must not be detached from the bid manual.

With his bid, each Bidder must deposit security in the amount of five percent (5%) of the amount of the bid, subject to the conditions stated in the Instruction to Bidders. A Performance Bond and Labor and Material Payment Bond each in the amount of one hundred percent (100%) of the Contract Sum will be required of the successful Bidder.

No Bidder may withdraw his bid within sixty (60) days after the actual date of the opening thereof.

Tiffany Heard P.E.
City Engineer
City of Dyersburg

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SECTION 00 21 13

INSTRUCTIONS TO BIDDERS

1. DEFINED TERMS

Terms used in these Instructions for Bidders are defined in the EJCDC C-700 Standard General Conditions of the Construction Contract. The term "Successful Bidder" means the lowest, qualified, responsible Bidder to whom the Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award.

2. COPIES OF BIDDING DOCUMENTS

- 2.1. Complete sets of the Bidding Documents in the number and for the deposit sum, if any, stated in the Advertisement or Invitation may be obtained from Engineer (unless another issuing office is designated in the Advertisement or Invitation to Bid).
- 2.2. Complete sets of Bidding Documents shall be used in preparing Bids; neither Owner nor Engineer assume any responsibility for errors or misinterpretations resulting from the use of the incomplete sets of Bidding Documents.
- 2.3. Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

3. QUALIFICATIONS OF BIDDERS

To demonstrate qualifications to perform the Work, each Bidder must be prepared to submit within five days of Owner's request written evidence, such as financial data, previous experience, and evidence of authority to conduct business in the jurisdiction where the Project is located. Each Bid must contain evidence of Bidder's qualification to do business in the state where the Project is located or covenant to obtain such qualification prior to award of the contract.

4. EXAMINATION OF CONTRACT DOCUMENTS AND SITE

- 4.1. Before submitting a Bid, each Bidder must: (a) examine the Contract Documents thoroughly; (b) visit the site to familiarize himself with local conditions that may in any manner affect cost, progress, or performance of the Work; (c) familiarize himself with federal, state, and local laws, ordinances, rules, and regulations that may in any manner affect cost, progress, or performance of the Work; and (d) study and carefully correlate Bidder's observations with the Contract Documents.
- 4.2. On request, Owner will provide each Bidder access to the site to conduct such investigations and tests as each Bidder deems necessary for submission of his Bid.
- 4.3. The lands upon which the Work is to be performed, rights-of-way for access thereto and other lands designated for use by Contractor in performing the Work are identified in the Supplementary Conditions, General Requirements, or Drawings.

5. NON-MANDATORY PRE-BID CONFERENCE

A non-mandatory Pre-Bid Conference will be held at the date, time, and location stipulated in the Advertisement for Bids. Representatives of Owner and Engineer will be present to discuss the Project. Attendance requirements shall be as stipulated in the Advertisement for Bids and as stipulated herein. Bidders are encouraged to attend and participate in the conference. Bids received from those not attending the Pre-Bid Conference will remain unopened. Engineer will transmit to all prospective Bidders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

6. INTERPRETATIONS

All questions about the meaning or intent of the Contract Documents shall be submitted to Engineer in writing. Replies will be issued by Addendum mailed or delivered to all parties recorded by Engineer as having received the Bidding Documents. Questions received less than ten days prior to the date for opening of Bids will not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7. BID SECURITY

- 7.1. Bid Security shall be made payable to Owner, in an amount of five (5) percent of the Bidder's maximum Bid price and in the form of a certified or bank check or a Bid Bond (on form attached, if a form is prescribed) issued by a Surety meeting the requirements of the General Conditions.
- 7.2. The Bid Security of the Successful Bidder will be retained until such Bidder has executed the Agreement and furnished the required Contract Security, whereupon it will be returned; if the successful Bidder fails to execute and deliver the Agreement and furnish the required Contract Security within 15 days of the Notice of Award, Owner may annul the Notice of Award and the Bid Security of that Bidder will be forfeited. The Bid Security of any Bidder whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of the seventh day after the "effective date of the Agreement" (which term is defined in the General Conditions) by Owner to Contractor and the required Contract Security is furnished or the sixty-first day after the Bid opening. Bid Security of other Bidders will be returned within seven days of the Bid opening.

8. CONTRACT TIME

The number of days within which, or the date by which, the Work is to be completed (the Contract Time) is set forth in the Bid Form and will be included in the Agreement.

9. LIQUIDATED DAMAGES

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

10. SUBSTITUTE MATERIAL AND EQUIPMENT

The Contract, if awarded, will be on the basis of material and equipment described in the Drawings or specified in the Specifications without consideration of possible substitute or "or-equal" items. When it is indicated in the Drawings or specified in the Specifications that a substitute or "or-equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the "effective date of the Agreement." The procedure for submittal of any such application by Contractor and consideration by Engineer is set forth in the General Conditions which may be supplemented in the Supplementary Conditions.

11. SUBCONTRACTORS, ETC.

11.1. If the Supplementary Conditions require the identity of certain Subcontractors and other persons or organizations to be submitted to Owner in advance of the Notice of Award, the apparent Successful Bidder, and any other Bidder so requested, will within seven days after the day of the Bid opening submit to Owner a list of all Subcontractors and other persons or organizations (including those who are to furnish the principal items of material and equipment) proposed for those portions of the Work as to which such identification is so required. Such list shall be accompanied by an experience statement with pertinent information as to similar projects and other evidence of qualification for each such Subcontractor, person, and organization if requested by the Owner. If Owner or Engineer after due investigation has reasonable objection to any proposed Subcontractor, other person or organization, either may before giving the Notice of Award request the apparent Successful Bidder to submit an acceptable substitute without an increase in Bid price. If the apparent Successful Bidder declines to make any such substitution, the contract shall not be awarded to such Bidder, but his declining to make any such substitution will not constitute grounds for sacrificing his Bid Security. Any Subcontractor, other person or organization so listed and to whom Owner or Engineer does not make written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer.

11.2. No contractor shall be required to employ any Subcontractor, other person or organization against whom he has reasonable objection.

12. BID FORM

- 12.1. The Bid Form is attached hereto; additional copies may be obtained from Engineer.
- 12.2. Bid Forms must be completed in ink or by typewriter.
- 12.3. Bids by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown below the signature.
- 12.4. Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the signature.
- 12.5. All names must be typed or printed below the signature.
- 12.6. The Bid shall contain an acknowledgement of receipt of all Addenda (the numbers of which shall be filled in on the Bid Form).
- 12.7. The address to which communications regarding the Bid are to be directed must be shown.

13. SUBMISSION OF BIDS

- 13.1. Bids shall be submitted at the time and place indicated in the Invitation to Bid and shall be included in an opaque sealed envelope, marked:

Project title.

Bidder's name and address.

Bidder's Tennessee Contractors License Number. Bidder's License Expiration Date.

Bidder's License Classification. Contract for which Bid is submitted.

- 13.2. Bids must be accompanied by the Bid Security and other required documents. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face thereof.

14. MODIFICATION AND WITHDRAWAL OF BIDS

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

15. OPENING OF BIDS

Bids will be opened publicly and will be read aloud. An abstract of the amounts of the base Bids and major alternates (if any) will be made available after the opening of Bids.

16. BIDS TO REMAIN OPEN

All Bids shall remain open for sixty days after the day of the Bid opening, but Owner may, in his sole discretion, release any Bid and return the Bid Security prior to that date.

17. AWARD OF CONTRACT

- 17.1. Owner reserves the right to reject any and all Bids, to waive any and all irregularities and to negotiate contract terms with the Successful Bidder, and the right to disregard all nonconforming, non-responsive, or conditional bids. Discrepancies between words and figures will be resolved in favor of words. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.
- 17.2. In evaluating Bids, Owner shall consider the qualification of the Bidders, whether or not the Bids comply with the prescribed requirements, and alternates and unit prices if requested in the Bid forms. It is the Owner's intent to accept alternates (if any accepted) in the order in which they are listed in the Bid form, but Owner may accept them in any order or combination.
- 17.3. Owner may consider the qualifications and experience of Subcontractor and other persons and organizations (including those who are to furnish the principal items of material or equipment) proposed for those portions of the Work as to which the identity of Subcontractors and other persons and organizations must be submitted as provided in the Supplementary Conditions. Operating costs, maintenance considerations, performance data, and guarantees of materials and equipment may also be considered by Owner.

- 17.4. Owner may conduct such investigations as he deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications, and financial ability of the Bidders, proposed Subcontractors, and other persons and organizations to do the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.
- 17.5. Owner reserves the right to reject the Bid of any Bidder who does not pass any such evaluation to Owner's satisfaction.
- 17.6. If the contract is to be awarded, it will be awarded to the lowest bidder whose evaluation by Owner indicates to Owner that the award will be in the best interests of the Project.
- 17.7. If the contract is to be awarded, Owner will give the Successful Bidder a Notice of Award within sixty days after the day of the Bid opening.

18. PERFORMANCE AND OTHER BONDS

Provide all bonds as detailed in the Advertisement for Bids.

19. SIGNING OF AGREEMENT

When Owner gives a Notice of Award to the Successful Bidder, it will be accompanied by at least three unsigned counterparts of the Agreement and all other Contract Documents. Within fifteen days thereafter, Contractor shall sign and deliver at least three counterparts of the Agreement to Owner with all other Contract Documents attached. Within ten days thereafter, Owner will deliver all fully signed counterparts to Engineer. Engineer will identify those portions of the Contract Documents not fully signed by Owner and Contractor and such identification shall be binding on all parties.

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SECTION 00 41 00

BID FORM

Bid of:

(Name of Bidder)

(Address of Bidder)

organized and existing under the laws of the State of _____ and doing business as (indicate: "a corporation", "a partnership", "an individual", a "limited liability company" or otherwise, as applicable).

To: City of Dyersburg -Owner
Public Works Building
435 Highway 51 Bypass South
Dyersburg, TN 38025-1358

In compliance with your ADVERTISEMENT FOR BIDS, BIDDER hereby proposes to furnish all necessary labor, machinery, tools, apparatus, materials, equipment, services, and other necessary supplies in strict accordance with the terms and conditions of the plans, specifications and CONTRACT DOCUMENTS within the number of consecutive calendar days and at the prices set forth below for the construction of:

Project: CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT

By submitting this BID, BIDDER certifies that this BID has been arrived at independently without consultation, communication, or agreement as to any matter relating to this BID with any other BIDDER or with any other competitor.

BIDDER agrees, upon receipt of the NOTICE OF AWARD accompanied by the CONSTRUCTION CONTRACT and all required attachments, to cause same to be properly executed and returned to the CITY OF DYERSBURG within fifteen (15) days thereafter. BIDDER further agrees, upon receipt of the NOTICE TO PROCEED, (i) to commence work on the PROJECT not later than the last date stated in the Notice to Proceed as to which the BIDDER may commence to proceed, (ii) to achieve Substantial Completion of the PROJECT within TWO HUNDRED FORTY (240) calendar days after such date, otherwise, to pay the CITY OF DYERSBURG as liquidated damages a sum as set forth in the Tennessee Department of Transportation Supplemental Specification Section 108.07 (based on Contract price) for each consecutive calendar day thereafter as provided in the GENERAL PROVISIONS; and (iii) to complete all Punch List items within thirty (30) consecutive calendar days after the date of Substantial Completion, as such date is determined by the CITY.

BIDDER agrees to perform all work described in the CONTRACT DOCUMENTS for the following unit price(s):

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization and bonding, maximum five percent (5%) of bid.	1	LS	\$ _____	\$ _____
2	Water well construction including casing, screen, gravel pack, and grout as specified.	1	LS	\$ _____	\$ _____
3	Water well development.	1	LS	\$ _____	\$ _____
4	Water well testing (per 33 11 13 - 3.10).	1	LS	\$ _____	\$ _____
5	Chemical and bacteriological sampling and testing on water well.	1	LS	\$ _____	\$ _____
6	Televising new water well, with associated report.	1	LS	\$ _____	\$ _____
7	Construct water well foundation.	1	LS	\$ _____	\$ _____
8	Disinfect completed water well.	1	LS	\$ _____	\$ _____
9	Provide and install 14" x 1.69" threaded, coated, column assembly for water well pump	175	VF	\$ _____	\$ _____
10	Provide and install 2500-gpm vertical turbine pump bowl assembly for the water well with enclosed impellers and stainless steel collets, including all shop testing.	1	LS	\$ _____	\$ _____
11	Provide and install 150 HP motor for water well.	1	LS	\$ _____	\$ _____
12	Provide fabricated discharge head including misc. items and gaskets and any necessary modifications and or adjustments to connect to above ground piping.	1	LS	\$ _____	\$ _____

13	Natural Frequency Testing and Field Testing for Vibration, Noise, and Natural Frequency.	1	LS	\$ _____	\$ _____
14	New water well piping and valves.	1	LS	\$ _____	\$ _____
15	Protective coatings.	1	LS	\$ _____	\$ _____
16	Electrical and Instrumentation and Controls	1	LS	\$ _____	\$ _____
17	Site work including site drainage, grading, seeding, restoration, gravel road, and site fencing.	1	LS	\$ _____	\$ _____
18	Plug, abandon, and demolition of existing Water Well No. 6.	1	LS	\$ _____	\$ _____
19	Equipment Start Up and Performance Testing.	1	LS	\$ _____	\$ _____

Alternate Bid Items

Bidder agrees to provide the following Alternative items for the price stated. The stated price shall include labor, materials, and services required to provide the specified item, including overhead and profit. The Total Base Bid shall not include cost of alternates.

Alternate Bid Items		
Item No.	Description	Item Total
1	In lieu of threaded, coated, water well column (Unit Price Item No. 9), provide 304 stainless steel, 0.375 wall, threaded and coupled column pipe. (Add) (Deduct) _____ (in words)	(\$ _____) (in figures)
2	In lieu of coated cast iron bowls (Unit Price Item No. 10), provide ductile iron bowls with fusion coating (interior and exterior). (Add) (Deduct) _____ (in words)	(\$ _____) (in figures)
3	In lieu of coated cast iron bowls (Unit Price Item No. 10), provide stainless steel bowls. (Add) (Deduct) _____ (in words)	(\$ _____) (in figures)
Bidder shall identify for each Alternate Bid Items whether item is additive or deductive by neatly and clearly circling either "Add" or "Deduct" before price of each bid item.		

BID FORM

TOTAL BID PRICE (Sum Total of Items 1 thru 19), (show amount in both words and figures):

_____ and ____/100ths Dollars

\$ _____

Unit Prices have been computed in accordance with Paragraph 11.03.B of the General Conditions.

Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Bid items will be based on actual quantities, determined as provided in the Contract Documents

Submitted by:

Authorized signature: _____ Date: _____

Name and title: _____
(Type or print)

On behalf of: _____
(Name of Bidder)

Bidder's address: _____

(Please give Street and Mailing address if different)

Bidder's Telephone Number: _____

Bidder's Fax Number: _____

Bidder's contact's email address: _____

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SECTION 00 42 00

FUNDING AGENCY BID FORMS

Owner anticipates receiving financial assistance through Treasury American Rescue Plan Act (ARPA) State and Local Fiscal Recovery Funds (SLFRF) to aid in financing the Project. The Owner anticipates receiving this funding through the State Water Infrastructure Grants (SWIG) program, run by Tennessee Department of Environment and Conservation (TDEC). Bidders, Contractor and Subcontractors shall comply with the following requirements herein.

The funding agency forms including within this Section shall be included with Bid Documents. These forms are as follows:

1. BYRD Anti-Lobbying Amendment Certification
2. Iran Divestment Act Certification
3. Debarment Certification
4. Non-Boycott of Israel Certification
5. MWBE Certification
6. Certification by Proposed Prime or Subcontractor Regarding Equal Employment Opportunity
7. Statement Of Compliance Certificate Regarding Illegal Immigrants

Successful Bidder shall be subject to additional funding agency requirements, as listed in Contract Documents.

BYRD ANTI-LOBBYING AMENDMENT CERTIFICATION

Contractors who apply or bid for an award of \$100,000 or more shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, officer or employee of Congress, or an employee of a Member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 U.S.C. § 1352.

Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient who in turn will forward the certification(s) to the awarding agency.

APPENDIX A, 44 C.F.R. PART 18 – CERTIFICATION REGARDING LOBBYING – REQUIRED FOR CONTRACTS OVER \$100,000 *Certification for Contracts, Grants, Loans, and Cooperative Agreements*

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

The Contractor certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Contractor understands and agrees that the provisions of 31 U.S.C. Chap. 38, Administrative Remedies for False Claims and Statements, apply to this certification and disclosure, if any.

Signature

Date

Printed Name

Title

Name of Firm/Company



STATE OF TENNESSEE
IRAN DIVESTMENT ACT CERTIFICATION

SUBJECT CONTRACT NUMBER(S):	
CONTRACTOR LEGAL ENTITY NAME:	
EDISON SUPPLIER IDENTIFICATION NUMBER:	

The Iran Divestment Act, Tenn. Code Ann. § 12-12-101 et. seq. requires a person that attempts to contract with the state, including a contract renewal or assumption, to certify at the time the bid is submitted or the contract is entered into, renewed, or assigned, that the person or the assignee is not identified on a list created pursuant to § 12-12-106.

Currently, the list is available online at the following website: <https://www.tn.gov/generalservices/procurement/central-procurement-office--cpo-/library-/public-information-library.html>

The Contractor, identified above, certifies by signature below that it is not included on the list of persons created pursuant to Tenn. Code Ann. § 12-12-106 of the Iran Divestment Act.

CONTRACTOR SIGNATURE

NOTICE: This certification MUST be signed by an individual with legal capacity to contractually bind the Contractor.

PRINTED NAME AND TITLE OF SIGNATORY

DATE

**CERTIFICATION REGARDING DEBARMENT, SUSPENSION AND OTHER
RESPONSIBILITY MATTERS**

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

- (1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
- (2) 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;
- (3) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (b) of this certification; and
- (4) 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.

- I certify to the above statements and have attached a screenshot from sam.gov indicating this.
- I am unable to certify to the above statements. Explanation is attached.

Signature

Date

Printed Name

Title

Name of Firm/Company

NON-BOYCOTT OF ISRAEL REQUIREMENTS

The Bidder certifies that it is not currently engaged in, and will not for the duration of the contract engage in, a boycott of Israel as defined by Tenn. Code Ann. § 12-4-119. This provision shall not apply to contracts with a total value of less than two hundred fifty thousand dollars (\$250,000) or to contractors with less than ten (10) employees.

According to the law, a boycott of Israel means engaging in refusals to deal, terminating business activities, or other commercial actions that are intended to limit commercial relations with Israel, or companies doing business in or with Israel or authorized by, licensed by, or organized under the laws of the State of Israel to do business, or persons or entities doing business in Israel, when such actions are taken:

- 1) In compliance with, or adherence to, calls for a boycott of Israel, or
- 2) In a manner that discriminates on the basis of nationality, national origin, religion, or other unreasonable basis, and is not based on a valid business reason. Tenn. Code Ann. § 12-4-119.

The Contractor certifies that it is not currently engaged in, and covenants that it will not, for the duration of the Contract, engage in a Boycott of Israel, as that term is defined in Tenn. Code Ann. § 12-4-119.

Signature

Date

Printed Name

Title

Name of Firm/Company

USE OF MINORITY/WOMEN SUBCONTRACTORS

This certification is required for the contractor to demonstrate that when subcontractors are to be used on this project, an attempt will be made to utilize women/minority owned firms.

Documentation must be on file to show who has been contacted.

- I certify that every attempt was made to utilize female/minority contractors on this project.
- I am unable to certify to the above statements. Explanation is attached.

Signature

Date

Printed Name

Title

Name of Firm/Company

**CERTIFICATION BY PROPOSED PRIME OR SUBCONTRACTOR REGARDING
EQUAL EMPLOYMENT OPPORTUNITY**

Name of Prime Contractor: _____

INSTRUCTIONS

This certification is required pursuant to Executive Order 11246, Part II, Section 203 (b), 30 F.R. 12319-25). Any bidder or prospective contractor, or any of their proposed subcontractors, shall state as an initial part of the bid or negotiations of the contract whether it has participated in any previous contract or subcontract subject to the equal opportunity clause; and, if so, whether it has filed all compliance reports due under applicable instructions.

Where the certification indicated that the prime or subcontractor has not filed a compliance report due under applicable instruction, such contractor shall be required to submit a compliance report.

CONTRACTOR'S CERTIFICATION

Contractor's Name: _____

Address: _____

1. Bidder has participated in a previous contract or subcontract subject to the Equal Opportunity Clause.
Yes No

2. Compliance Reports were required to be filed in connection with such contract or subcontract.
Yes No

If yes, state what reports were filed and with what agency.

3. Bidder has filed all compliance reports due under applicable instructions, including SF100.
Yes No

4. If answer to Item 3 is NO, please explain in detail on reverse side of this certification.

Certification: The information above is true and complete to the best of my knowledge and belief. (A willfully false statement is punishable by law-U.S. Code, Title 18, Section 1001.)

Signature

Date

Printed Name

Title

STATEMENT OF COMPLIANCE CERTIFICATE REGARDING ILLEGAL IMMIGRANTS

Each Contractor bidding shall fill in and sign the following:

This is to certify that _____
Have fully complied with all the requirements of Chapter No. 878 (House Bill No. 111 and Senate Bill No. 411) which serves to amend Tennessee Code Annotated Title 12, Chapter 4, Part I, attached herein for reference.

All Bidders for construction services on this project shall be required to submit an affidavit (by executing this compliance document) as part of their bid that attests that such Bidder shall comply with requirements of Chapter no. 878.

Signed: _____

State of _____

County of _____

Personally appeared before me, _____ the undersigned Notary Public, _____, the within named bargainer, with whom I am personally acquainted, and known to me to be the President / Owner / Partner (as applicable) of the _____, Corporation, Partnership, Sole Proprietorship (as applicable) and acknowledged to me that he executed the foregoing document for the purposed recited therein.

Sworn to and subscribed before me a Notary Public for the above state and county, on

This _____ day of _____, 20_____.

Notary Public

My Commission Expires

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SECTION 00 45 13

BIDDER QUALIFICATION QUESTIONNAIRE

By completion of this statement, as a minimum, all potential Bidders are required to submit evidence satisfactory to Owner that potential Bidder meets the following requirements.

1. Minimum of five (5) years of experience in successful execution of work of similar magnitude.
2. Successful completion of at least five (5) projects of similar nature and of comparable complexity.

Owner reserves the right to deny any potential Bidder which in Owner's opinion fails to meet the above requirements.

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The potential Bidder may submit any additional information he desires.

1. Legal Name of Organization _____
2. Permanent main office address _____

3. When organized _____
4. If a corporation, where incorporated _____
5. Present bonding capacity \$ _____
6. Contactor License No. _____
7. How many years have you been engaged in a contracting business under your present firm or trade name under which you propose to execute this Contract?

8. Contracts on hand: (Complete schedule at the end of this section.)
9. General character of work performed by your company:

10. Has your organization or your officers, if previously with another business entity, ever failed to complete any work awarded to you or been released from a bid? Yes _____ No _____
If so, where, when and why?

11. Has your organization ever filed any lawsuits against your owner or requested mediation or arbitration with your owner with regard to any construction contract (lawsuits/mediation/arbitration with suppliers, subcontractors, or other entities is not within the scope of this question)? Yes _____ No _____
If so, where, when and why?

12. Are there any judgments, claims, arbitration proceedings or suits pending or outstanding against your organization or any of your officers? Yes _____ No _____
If so, where, when and why?

13. Has your organization ever defaulted or had a bond called on a contract awarded to you? Yes _____ No _____
If so, where, when and why?

14. Has your organization ever been assessed liquidated damages on a contract awarded to you? Yes _____ No _____
If so, where, why, when and how much?

15. Has your organization ever been debarred or disqualified (other than through pre-qualification procedures) from performing work within any jurisdiction in the United States? Yes _____ No _____
If so, where, when and why?

16. List at least five (5) representative projects completed in the last five (5) by your company that are similar in size and scope to this project. (Complete schedule at the end of this section.)

17. List work experience of your company with the Owner's Full Name.

18. List your major equipment available for this contract (Complete schedule at the end of this section.)

19. Background and experience of the principal members of your organization, including officers.

20. List Project Manager, Project Engineers (if to be used) and Jobsite Superintendent(s) who will be assigned to this project if you are awarded the job. Include position or title, education and professional qualifications, number of years with your organization and identify by Project Name to which project listed in the Current Projects and Representative Projects Schedules they were assigned. Provide a brief narrative of the project assignment.

21. Will you, upon request, fill out a detailed financial statement and furnish any other information that may be required by the Local Public Agency? Yes _____ No _____

22. Do you have, or can you procure the necessary personnel, equipment, facilities and financial resources to immediately undertake and satisfactorily complete the work contemplated in this Contract? Yes _____ No _____

CURRENT PROJECTS

NAME, LOCATION AND DESCRIPTION OF PROJECT	OWNER	DESIGN ENGINEER	DATE COMPLETED	CONTRACT PRICE	\$ OF CONTRACT SELF PERFORMED	LIST OF KEY PERSONNEL ON PROJECT (NAME AND TITLE)	OWNER REFERENCE/CONTACT (INCLUDE ADDRESS, PHONE, & EMAIL)

REPRESENTATIVE PROJECTS

NAME, LOCATION AND DESCRIPTION OF PROJECT	OWNER	DESIGN ENGINEER	DATE COMPLETED	CONTRACT PRICE	\$ OF CONTRACT SELF PERFORMED	LIST OF KEY PERSONNEL ON PROJECT (NAME AND TITLE)	OWNER REFERENCE/CONTACT (INCLUDE ADDRESS, PHONE, & EMAIL)

The undersigned hereby authorizes and requests any person, firm, or corporation to furnish any information requested by the Local Public Agency in verification of the recitals comprising this Bidder's Qualifications Questionnaire.

Dated this _____ day of _____, 20____.

Name of Bidder

Signature_____

Name (print)_____

Title_____

State of _____

County of _____

_____ being duly sworn deposes and says that he is _____

_____ of _____ and that the answers to the foregoing questions and all statements therein contained are true and correct. Subscribed and sworn to before me this _____ day of _____, 20____.

Notary Public

My Commission Expires:

(Date) _____

(SEAL)

END OF SECTION

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SECTION 00 45 14

SUBCONTRACTOR FORM

LIST OF PROPOSED SUBCONTRACTORS

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

.....

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

.....

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

.....

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

.....

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

.....

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

.....

NAME:

ADDRESS:

TRADE:

SUBCONTRACT AMOUNT: \$ _____ MBE _____ YES _____ NO

LICENSE NUMBER AND EXPIRATION DATE: _____

END OF SECTION

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SECTION 00 51 00
NOTICE OF AWARD

TO: Bidder
 Bidder Address

PROJECT: **CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT.**

THE OWNER has considered the BID submitted by you for the above-described WORK in response to its Advertisement for Bids dated Month XX, 2024, and information for Bidders.

You are hereby notified that your BID has been accepted for items in the amount of

 Bid Amount (\$XX)

You are required by the Information for Bidders to execute the Contract and furnish the required Contractor's Performance Bond and Payment Bond within ten calendar days from the date of this Notice to you.

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

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

Dated this ___ day of _____, 2024.

ACCEPTANCE OF NOTICE
Receipt of the above
NOTICE OF AWARD is
hereby acknowledged

CITY OF DYERSBURG, TENNESSEE
Owner

By _____
John Holden
Title Mayor of the City of Dyersburg

By _____

this the _____ day of
_____, 20_____.

Signature: _____

Title: _____

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SECTION 00 52 00

CONSTRUCTION CONTRACT

Construction Contract made as of the _____ day of _____

Between THE CITY OF DYERSBURG (hereinafter referred to as "THE CITY") and

_____ (hereinafter referred to as "CONTRACTOR").

In consideration of their acceptance of the terms and conditions stated below, the parties agree as follows:

ARTICLE 1 - THE CONTRACT DOCUMENTS

The Contract Documents consist of this Construction Contract and the terms and conditions stated herein below; the Advertisement for Bids dated _____, attached as Exhibit A to this Contract; the Instructions for Bidders attached as Exhibit B to this Contract; the Bid Form of CONTRACTOR dated _____, attached as Exhibit C to this Contract; the Standard General Conditions and Supplemental Conditions attached collectively as Exhibit D to this Contract; the Technical Specifications, attached as Exhibit E to this Contract; the Certificate of Liability Insurance of Accord Corporation, insuring

_____, attached as Exhibit F to this Contract; Performance Bond #

_____ with _____ as surety in the amount of

_____, attached as Exhibit G to this Contract; Payment Bond #

_____ with _____ as surety in the amount of

_____, attached as Exhibit H to this contract, the Notice of Award dated

_____, attached as Exhibit I to this Contract; and the Notice to Proceed dated

_____, attached as Exhibit J to this Contract.

ARTICLE 2 - THE WORK

The work agreed to be performed by CONTRACTOR under this Contract, known as **CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT** (hereinafter "the Work") shall consist of, but is not limited to: demolition and plugging of existing Water Well No. 6 and the construction of a replacement Water Well No. 6, including piping, valves, electrical, instrumentation, site work and all associated appurtenances. The Work shall also include the furnishing of all labor and equipment necessary and required for the safe, proper and expeditious performance of the Work.

ARTICLE 3 - ENGINEER

The Dyersburg City Engineer will act as the ENGINEER in connection with the completion of the project in accordance with the Contract Documents.

ARTICLE 4 - CONTRACT TIME

As soon as practicable after the parties' execution of this Construction Contract, CONTRACTOR shall commence performance of the Work. Thereafter, CONTRACTOR shall diligently perform in order to complete the Work within two hundred (200) calendar days of the commencement of the Work. The parties acknowledge and agree that time is of the essence of this Contract.

ARTICLE 5 - CONTRACT PRICE AND PAYMENT PROCEDURES

The Contract Price is _____ . THE CITY shall make monthly progress payments to the CONTRACTOR based upon the CONTRACTOR'S Application for Payment, as approved by the ENGINEER.

ARTICLE 6 – LIQUIDATED DAMAGES

If the CONTRACTOR fails to complete the Work within the time stipulated in this Agreement, including any extensions of time for excusable delay as approved by the ENGINEER, the CONTRACTOR shall pay THE CITY liquidated damages in the amount of \$100 per day for each and every calendar day of delay, until the work is substantially Complete, as certified by the ENGINEER.

ARTICLE 7 - CHANGES IN THE WORK

THE CITY may, from time to time during the performance of the Work, order changes within the general scope of the Work. In such event, the parties may agree to an amendment of the Contract Price and/or time to compensate CONTRACTOR for additional work performed or materials furnished as a result of the change ordered in the Work.

ARTICLE 8 -TERMINATION

If CONTRACTOR shall be adjudged bankrupt or make general assignment for the benefit of creditors; or if a receiver should be appointed for CONTRACTOR or any of its property; or should CONTRACTOR persistently disregard instructions or fail to observe or perform any condition as required by the Contract, or fail to observe or perform any provision of the Contract or otherwise be guilty of a substantial violation of any provision of the Contract, then, THE CITY may, by at least five days' prior written notice to CONTRACTOR, without prejudice to any other rights or remedies available to THE CITY, terminate this Contract and CONTRACTOR's right to proceed with the Work. The above provisions are in addition to, and not in limitation of, the rights of THE CITY under the law or other provisions of this Contract.

ARTICLE 9 - ASSIGNMENT OF CONTRACT

CONTRACTOR shall not assign the whole or any part of this Contract or any monies due or to become due hereunder without THE CITY's written consent. In case CONTRACTOR

assigns all or any part of any money due or to become due under this Contract the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any monies due or to become due to CONTRACTOR, shall be subject to prior liens to all persons, firms, and corporations for services rendered or materials supplied for the performance of the Work.

ARTICLE 10 - TAXES

CONTRACTOR shall pay and be responsible for any and all applicable federal, state and local taxes assessed in connection with the furnishing of the services required by this Contract and shall indemnify and also hold THE CITY harmless therefore.

ARTICLE 11 - SAFETY AND HEALTH REGULATIONS

CONTRACTOR shall comply with all applicable labor safety and health regulations promulgated by the U.S. Department of Labor and the State of Tennessee, including without limitation the Occupational Safety and Health Act of 1970 (PL 91-596) and the Contract Work Hours and Safety Standards Act (PL 91-54). CONTRACTOR shall also grant to authorized representatives of THE CITY and the Department of Labor free access to all work areas for inspection.

ARTICLE 12 - INSURANCE

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

A. Claims under workers' or workmen's compensation, disability benefits and other similar employee benefit acts; where applicable;

B. Claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees;

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

D. Claims for damages insured by personal injury liability coverage which are sustained:
(a) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR; or (b) by any other person for any other reason;

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

F. Claims arising out of operation of Laws or Regulations for damages because of bodily injury or death of any person or for damage to property; and

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

CONTRACTOR's general liability insurance shall also include coverage for the indemnification obligation to THE CITY assumed under Article 13 hereof.

The insurance required hereby shall include the specific coverage and be written for not less than the following stated limits of liability and coverage or limits of liability and coverage required by law, whichever is greater:

Comprehensive General Liability

1. Bodily Injury (including completed operations and products liability) and Property Damage: Combined single limit of \$1,000,000.00 each occurrence and \$1,000,000.00 aggregate.

2. Property damage liability insurance will provide explosion, collapse and

underground coverage where applicable.

3. Personal injury, with employment exclusion deleted: combined single limit of \$1,000,000.00 each occurrence and aggregate.

Comprehensive Automobile Liability

Combined single limit of \$500,000.00 each occurrence.

Workers' Compensation and Employers Liability

All of the policies of insurance so required to be purchased and maintained (or the certificates or other evidence thereof) shall contain a provision or endorsement that the coverage afforded will not be cancelled, materially changed or renewal refused until at least thirty (30) days' prior written notice has been given to THE CITY by certified mail. All such insurance shall remain in effect until final payment and at all times thereafter when CONTRACTOR may be correcting, removing or replacing defective work. In addition, CONTRACTOR shall maintain such completed operations insurance for at least two years after final payment and furnish THE CITY with evidence of continuation of such insurance at final payment and one year thereafter.

ARTICLE 13 - INDEMNIFICATION

CONTRACTOR shall indemnify and hold harmless THE CITY, its agents and employees, from and against all claims, damages, losses and expenses, including attorneys' fees, arising out of or resulting from the performance of the Work, provided that any such claim, damage, loss or expense: (a) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property, and (b) is proximately caused by the negligent act or omission of CONTRACTOR, its subcontractors, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

ARTICLE 14 – NOTICES

All notices, demands, requests, instructions, approvals and claims issued or presented by either party to the other hereunder shall be in writing. All such written notices and communications shall be sufficiently given if sent by registered or certified mail, postage prepaid, addressed to the respective parties as follows:

If to THE CITY, then to:

Ms. Tiffany Heard, PE
City Engineer
City of Dyersburg
P.O. Box 1358
Dyersburg, Tennessee 38025-1358
(731) 288-2587

If to CONTRACTOR, then to:

ARTICLE 15 - MISCELLANEOUS PROVISIONS

A CONTRACTOR warrants that it is duly and lawfully qualified to conduct business in the State of Tennessee.

B This Contract sets forth the entire agreement and understanding of the parties in respect of the transactions contemplated hereby and supersedes all prior agreements, communications and understandings relating to the subject matter hereof.

C THE CITY and the CONTRACTOR each binds himself, his partners, successors, assigns, and legal representatives to the other party hereto in respect of all covenants, agreements and obligations contained in the Contract Documents.

D This Contract shall not be amended or modified except by written instrument duly executed by both parties.

E If there is any conflict between this Agreement and the General Conditions, or any other document incorporated herein by reference, the terms of this Agreement shall control.

(The remainder of this page is intentionally left blank)

IN WITNESS WHEREOF, the parties have executed this Construction Contract on the day and date first above said.

THE CITY OF DYERSBURG

By: _____
John Holden, Mayor

CONTRACTOR

By: _____

STATE OF TENNESSEE

COUNTY OF DYER

PERSONALLY, APPEARED BEFORE ME, the undersigned Notary Public for County and State aforesaid, being duly commissioned and qualified, JOHN HOLDEN, with whom I am personally acquainted and who acknowledged himself to be the Mayor of the CITY OF DYERSBURG, a municipal corporation, and that he as such Mayor, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing the name of the corporation by himself as such Mayor.

WITNESS MY HAND AND NOTARIAL SEAL of office in Dyersburg, Dyer County, Tennessee, this __ day of _____, 2024.

Notary Public

My Commission Expires:

STATE OF TENNESSEE

COUNTY OF DYER

PERSONALLY, APPEARED BEFORE ME, the undersigned Notary Public for County and State aforesaid, being duly commissioned and qualified,

, with whom I am personally acquainted and who acknowledged himself to be the Partner of the

_____, a (*limited liability*) corporation, and that he as such Partner, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing the name of the corporation by himself as such Partner.

WITNESS MY HAND AND NOTARIAL SEAL of office in Dyersburg, Dyer County, Tennessee, this__day of_____, 2024.

Notary Public

My Commission Expires:

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SECTION 00 55 00

NOTICE TO PROCEED

TO: _____ Contactor _____

_____ Contractor Address _____

PROJECT: **CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT**

You are hereby notified to commence work in accordance with the CONSTRUCTION CONTRACT dated _____, 2024, on or before _____, 2024, you are to complete the WORK within consecutive calendar days thereafter. The date of completion of all WORK is therefore _____, 2024.

ACCEPTANCE OF NOTICE

City of Dyersburg, Tennessee
Owner

Receipt of the above
NOTICE TO PROCEED is
Hereby acknowledged by

By _____
John Holden

Title: Mayor of the City of Dyersburg

this is the _____ day of

_____, 2024

By _____

Title

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SECTION 00 61 10

BID BOND

KNOWN ALL MEN BY THESE PRESENTS, that we, the undersigned, as CONTRACTOR, and _____ as Surety, are hereby held and firmly bound unto _____ as OWNER in the penal sum of payment of which, well and truly made, we hereby jointly and severally bind ourselves, successors, and assigns.

Signed, this _____ day of _____, 20_____.

The Condition of the above obligation is such that whereas the principal has submitted to _____ a certain BID, attached hereto and hereby made a part hereof to enter into a contract in writing, for the NOW, THEREFORE,

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

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

IN WITNESS WHEREOF, the CONTRACTOR and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

CONTRACTOR

By _____

Witness _____

Title _____

Surety

By _____

Witness _____

Title _____

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

Note: Bond may be declared invalid if not accompanied by Power of Attorney.

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SECTION 00 61 11

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, that

(Name of Contractor)

(Address of Contractor)

a _____, hereinafter called CONTRACTOR,
(Corporation, Partnership, Individual, or Joint Venture)

and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto the City of Dyersburg, hereinafter called OWNER, in the penal sum of _____ Dollars \$(_____) in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the CONTRACTOR has entered into a certain contract with the OWNER, dated the _____ day of _____, 2024, a copy of which is hereto attached and made a part of here of for the construction of: **CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT.**

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

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

PROVIDED, FURTHER, that no final settlement between the OWNER and the CONTRACTOR shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in _____
(number)

counterparts, each one of which shall be deemed an original, this the _____ day of _____, 2024.

ATTEST:

(Contractor) Secretary
(SEAL)

Contractor

By _____

Title _____

Address _____

Witness to Contractor

Address

Surety By

Attorney-in-fact

Address _____

Witness to Surety

Address

Note: Date of BOND must not be prior to date of Contract. If CONTRACTOR is Partnership all partners should execute BOND.

BOND is not valid unless accompanied by Power of Attorney.

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

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SECTION 00 61 12

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that

(Name of Contractor)

(Address of Contractor)

a _____, hereinafter called
CONTRACTOR, (Corporation, Partnership, Individual, or Joint Venture)

and _____ (Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto the City of Dyersburg, 435 Highway 51 Bypass South 38025-1358 hereinafter called OWNER, in the penal sum of Dollars, \$(_____) in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the CONTRACTOR has entered into a certain contract with the OWNER, dated the _____ day of _____, 2024, a copy of which is hereto attached and made a part of here for the construction of: CITY OF DYERSBURG WATER WELL NO. 6 REPLACEMENT.

NOW, THEREFORE, if the CONTRACTOR shall promptly make payment to all persons, firms, Subcontractors, and corporations furnishing materials for or performing labor in the prosecution of the Work provided for in such contract, and any authorized extension or modification thereof, including all amounts due to material, lubricants, oil, gasoline, coal and coke, repairs on machinery, equipment, and tools, consumed or used in connection with the construction of such Work, and all insurance premiums on said Work, and for all labor, performed in such Work whether by Subcontractor or otherwise, then this obligation shall be void; otherwise to remain in full force and effect.

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

PROVIDED, FURTHER, that no final settlement between the OWNER and the CONTRACTOR shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in counterparts, each one of which shall be deemed an original, this the _____ day of _____, 2024.

ATTEST:

(Contractor) Secretary

(SEAL)

Witness to Contractor

Address

Witness to Surety

Address

Contractor

By _____

Title _____

Address _____

Surety

By _____

Attorney-in-fact

Address _____

Note: Date of BOND must not be prior to date of Contract. If CONTRACTOR is Partnership all partners should execute BOND.

BOND is not valid unless accompanied by Power of Attorney.

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

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**STANDARD GENERAL CONDITIONS OF THE
CONSTRUCTION CONTRACT
TABLE OF CONTENTS**

	Page
Article 1 – Definitions and Terminology	1
1.1 Defined Terms	1
1.2 Terminology.....	5
Article 2 – Preliminary Matters	6
2.1 Delivery of Bonds and Evidence of Insurance	6
2.2 Copies of Documents	6
2.3 Commencement of Contract Times; Notice to Proceed	6
2.4 Starting the Work.....	6
2.5 Before Starting Construction	7
2.6 Preconstruction Conference; Designation of Authorized Representatives	7
2.7 Initial Acceptance of Schedules.....	7
Article 3 – Contract Documents : Intent, Amending, Reuse	8
3.1 Intent	8
3.2 Reference Standards.....	8
3.3 Reporting and Resolving Discrepancies	8
3.4 Amending and Supplementing Contract Documents.....	9
3.5 Reuse of Documents	9
3.6 Electronic Data.....	10
Article 4 – Availability of Lands; Subsurface and Physical Conditions; Hazardous Environmental Conditions; Reference Points	10
4.1 Availability of Lands	10
4.2 Subsurface and Physical Conditions.....	11
4.3 Differing Subsurface or Physical Conditions	11
4.4 Underground Facilities.....	12
4.5 Reference Points	13
4.6 Hazardous Environmental Condition at Site.....	14
Article 5 – Bonds and Insurance	15
5.1 Performance, Payment, and Other Bonds	15
5.2 Licensed Sureties and Insurers.....	16
5.3 Certificates of Insurance	16
5.4 Contractor’s Insurance	16
5.5 Owner’s Liability Insurance	18
5.6 Property Insurance	18
5.7 Waiver of Rights	19
5.8 Receipt and Application of Insurance Proceeds	20
5.9 Acceptance of Bonds and Insurance; Option to Replace.....	20
5.10 Partial Utilization, Acknowledgment of Property Insurer	21

Article 6 – Contractor’s Responsibilities	21
6.1 Supervision and Superintendence	21
6.2 Labor; Working Hours	21
6.3 Services, Materials, and Equipment.....	22
6.4 Progress Schedule	22
6.5 Substitutes and “Or-Equals”	22
6.6 Concerning Subcontractors, Suppliers, and Others	25
6.7 Patent Fees and Royalties	26
6.8 Permits	26
6.9 Laws and Regulations	27
6.10 Taxes	27
6.11 Use of Site and Other Areas.....	27
6.12 Record Documents.....	28
6.13 Safety and Protection	28
6.14 Safety Representative.....	29
6.15 Hazard Communication Programs	29
6.16 Emergencies	29
6.17 Shop Drawings and Samples	30
6.18 Continuing the Work.....	31
6.19 Contractor’s General Warranty and Guarantee.....	31
6.20 Indemnification	32
6.21 Delegation of Professional Design Services	33
 Article 7 – Other Work at the Site	 34
7.1 Related Work at Site	34
7.2 Coordination	34
7.3 Legal Relationships.....	35
 Article 8 – Owner’s Responsibilities	 35
8.1 Communications to Contractor	35
8.2 Replacement of Engineer	35
8.3 Furnish Data.....	35
8.4 Pay When Due	35
8.5 Lands and Easements; Reports and Tests	35
8.6 Insurance	35
8.7 Change Orders	35
8.8 Inspections, Tests, and Approvals	36
8.9 Limitations on Owner’s Responsibilities.....	36
8.10 Undisclosed Hazardous Environmental Condition.....	36
8.11 Evidence of Financial Arrangements.....	36
8.12 Compliance with Safety Program	36
 Article 9 – Engineer’s Status During Construction	 36
9.1 Owner’s Representative	36
9.2 Visits to Site	36
9.3 Project Representative	37

9.4	Authorized Variations in Work.....	37
9.5	Rejecting Defective Work.....	37
9.6	Shop Drawings, Change Orders and Payments	37
9.7	Determinations for Unit Price Work.....	38
9.8	Decisions on Requirements of Contract Documents and Acceptability of Work	38
9.9	Limitations on Engineer’s Authority and Responsibilities.....	38
9.10	Compliance with Safety Program	39
Article 10 – Changes in the Work; Claims		39
101	Authorized Changes in the Work.....	39
102	Unauthorized Changes in the Work.....	39
103	Execution of Change Orders.....	39
104	Notification to Surety.....	40
105	Claims	40
Article 11 – Cost of the Work; Allowances; Unit Price Work		41
11.1	Cost of the Work.....	41
11.2	Allowances.....	43
11.3	Unit Price Work	44
Article 12 – Change of Contract Price; Change of Contract Times		45
12.1	Change of Contract Price	45
12.2	Change of Contract Times	46
12.3	Delays	46
Article 13 – Tests and Inspections; Correction, Removal or Acceptance of Defective Work		47
13.1	Notice of Defects	47
13.2	Access to Work.....	47
13.3	Tests and Inspections	47
13.4	Uncovering Work.....	48
13.5	Owner May Stop the Work.....	48
13.6	Correction or Removal of Defective Work.....	48
13.7	Correction Period.....	49
13.8	Acceptance of Defective Work.....	50
13.9	Owner May Correct Defective Work.....	50
Article 14 – Payments to Contractor and Completion		51
14.1	Schedule of Values	51
14.2	Progress Payments	51
14.3	Contractor’s Warranty of Title.....	53
14.4	Substantial Completion.....	53
14.5	Partial Utilization	54
14.6	Final Inspection.....	55
14.7	Final Payment	55
14.8	Final Completion Delayed	56
14.9	Waiver of Claims	56

Article 15 – Suspension of Work and Termination	57
15.1 Owner May Suspend Work.....	57
15.2 Owner May Terminate for Cause	57
15.3 Owner May Terminate For Convenience	58
15.4 Contractor May Stop Work or Terminate.....	58
Article 16 – Dispute Resolution.....	59
16.01 Methods and Procedures	59
Article 17 – Miscellaneous	59
17.1 Giving Notice.....	59
17.2 Computation of Times	60
17.3 Cumulative Remedies	60
17.4 Survival of Obligations	60
17.5 Controlling Law	60
17.6 Headings	60

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.1 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.
 3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Asbestos*—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.
 5. *Bid*—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 6. *Bidder*—The individual or entity who submits a Bid directly to Owner.
 7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).
 8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.
 9. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.
 10. *Claim*—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.
 11. *Contract*—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.
13. *Contract Price*—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).
14. *Contract Times*—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.
15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.
16. *Cost of the Work*—See Paragraph 11.01 for definition.
17. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.
18. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
19. *Engineer*—The individual or entity named as such in the Agreement.
20. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.
21. *General Requirements*—Sections of Division 1 of the Specifications.
22. *Hazardous Environmental Condition*—The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.
23. *Hazardous Waste*—The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.
24. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
25. *Liens*—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.
26. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.
28. *Notice to Proceed*—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.
29. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.
30. *PCBs*—Polychlorinated biphenyls.
31. *Petroleum*—Petroleum, including crude oil or any fraction thereof which liquid at standard conditions of temperature and pressure is (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.
32. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor’s plan to accomplish the Work within the Contract Times.
33. *Project*—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.
34. *Project Manual*—The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.
35. *Radioactive Material*—Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.
36. *Resident Project Representative*—The authorized representative of Engineer who may be assigned to the Site or any part thereof.
37. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
38. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.
39. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
40. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

41. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.
42. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.
43. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.
44. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.
45. *Successful Bidder*—The Bidder submitting a responsive Bid to whom Owner makes an award.
46. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.
47. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.
48. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
49. *Unit Price Work*—Work to be paid for on the basis of unit prices.
50. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.
51. *Work Change Directive*—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies that occur at Work

Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.2 *Terminology*

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives:*

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

C. *Day:*

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

D. *Defective:*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents; or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

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

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

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.
- F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.1 Delivery of Bonds and Evidence of Insurance

- A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.
- B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.2 Copies of Documents

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

2.3 Commencement of Contract Times; Notice to Proceed

- A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.4 Starting the Work

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

2.5 *Before Starting Construction*

- A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:
1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;
 2. a preliminary Schedule of Submittals; and
 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.6 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.
- B. At this conference Owner and Contractor 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 individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.7 *Initial Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.
1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and

substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS : INTENT, AMENDING, REUSE

3.1 *Intent*

- A. The Contract Documents are complementary; what is required by one is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.
- C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.2 *Reference Standards*

- A. Standards, Specifications, Codes, Laws, and Regulations
 - 1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
 - 2. No provision of any such standard, specification, manual, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.3 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

- 1. *Contractor's Review of Contract Documents Before Starting Work:* Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

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

B. *Resolving Discrepancies:*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:
 - a. the provisions of any standard, specification, manual, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference in the Contract Documents); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.4 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.
- B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:
 1. A Field Order;
 2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or
 3. Engineer's written interpretation or clarification.

3.5 *Reuse of Documents*

- A. Contractor and any Subcontractor or Supplier shall not:
 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions; or

2. reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.6 *Electronic Data*

- A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.
- B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.
- C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

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

4.1 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.
- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and
2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the “technical data” contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such “technical data” is identified in the Supplementary Conditions. Except for such reliance on such “technical data,” Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions, or information.

4.3 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

1. is of such a nature as to establish that any “technical data” on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or
2. is of such a nature as to require a change in the Contract Documents; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such

condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

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

C. *Possible Price and Times Adjustments*:

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and
 - b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:
 - a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or
 - b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or
 - c. Contractor failed to give the written notice as required by Paragraph 4.03.A.
3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.4 *Underground Facilities*

A. *Shown or Indicated*: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and
2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. reviewing and checking all such information and data;
 - b. locating all Underground Facilities shown or indicated in the Contract Documents;
 - c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and
 - d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. Not Shown or Indicated:

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.5 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property

monuments by professionally qualified personnel.

4.6 *Hazardous Environmental Condition at Site*

- A. *Reports and Drawings:* The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.
- B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the “technical data” contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such “technical data” is identified in the Supplementary Conditions. Except for such reliance on such “technical data,” Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or
 2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or
 3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.
- D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.
- E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered written notice to Contractor: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in

Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim as provided in Paragraph 10.05. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

- F. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- G. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- H. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 – BONDS AND INSURANCE

5.1 Performance, Payment, and Other Bonds

- A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

- B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the list of “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as “Acceptable Reinsuring Companies” as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual’s authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.
- C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.2 *Licensed Sureties and Insurers*

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

5.3 *Certificates of Insurance*

- A. Contractor shall deliver to Owner, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.
- B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.
- C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor’s obligation to maintain such insurance.
- D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.
- E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor’s liability under the indemnities granted to Owner in the Contract Documents.

5.4 *Contractor’s Insurance*

- A. Contractor shall purchase and maintain such insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which

may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;
2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;
3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;
4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:
 - a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or
 - b. by any other person for any other reason;
5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and
6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

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

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;
2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;
3. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;
4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and

the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

5. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and
6. include completed operations coverage:
 - a. Such insurance shall remain in effect for two years after final payment.
 - b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.5 *Owner's Liability Insurance*

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

5.6 *Property Insurance*

- A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:
 1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;
 2. be written on a Builder's Risk "all-risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.
 3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);
 4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;
 6. include testing and startup; and
 7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued.
- B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.
- C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.
- D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.
- E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under this Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.7 *Waiver of Rights*

- A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting

from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

- B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:
 - 1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
 - 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.
- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them.

5.8 *Receipt and Application of Insurance Proceeds*

- A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the loss payees, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.
- B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

5.9 *Acceptance of Bonds and Insurance; Option to Replace*

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

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.1 *Supervision and Superintendence*

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

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

6.2 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or

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

6.3 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.
- B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.4 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.
 - 1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.
 - 2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.5 *Substitutes and "Or-Equals"*

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.
 - a. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and

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

- 1) in the exercise of reasonable judgment Engineer determines that:
 - 2) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 3) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and
 - 4) it has a proven record of performance and availability of responsive service.
- b. Contractor certifies that, if approved and incorporated into the Work:
- 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items:*

- a. If in Engineer’s sole discretion an item of material or equipment proposed by Contractor does not qualify as an “or-equal” item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.
- b. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.
- c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.
- d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
 - 1) shall certify that the proposed substitute item will:
 - a) perform adequately the functions and achieve the results called for by the general design,
 - b) be similar in substance to that specified, and

- c) be suited to the same use as that specified;
 - 2) will state:
 - a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time,
 - b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
 - c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;
 - 3) will identify:
 - a) all variations of the proposed substitute item from that specified, and
 - b) available engineering, sales, maintenance, repair, and replacement services; and
 - 4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.
- B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.
- C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.
- D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- E. *Engineer's Cost Reimbursement:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the

provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

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

6.6 *Concerning Subcontractors, Suppliers, and Others*

- A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.
- B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.
- C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:
1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor
 2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.
- D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.
- E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.
- F. The divisions and sections of the Specifications and the identifications of any Drawings

shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

- G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract

Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.7 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.
- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.8 *Permits*

- A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.9 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.
- C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

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

6.11 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas:*

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.
2. Should any claim be made by any such owner or occupant because of the performance

of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.
- B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.
- C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.
- D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
 1. all persons on the Site or who may be affected by the Work;
 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.
 - C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.
 - D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.
 - E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
 - F. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

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

6.15 *Hazard Communication Programs*

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

6.16 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the

Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

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

1. *Shop Drawings:*

- a. Submit number of copies specified in the General Requirements.
- b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples:*

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

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Submittal Procedures:*

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

- a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
- b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
- c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

- d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

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

6.19 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 - 1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 - 2. normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
 - 1. observations by Engineer;
 - 2. recommendation by Engineer or payment by Owner of any progress or final payment;
 - 3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 - 4. use or occupancy of the Work or any part thereof by Owner;
 - 5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;
 - 6. any inspection, test, or approval by others; or
 - 7. any correction of defective Work by Owner.

6.20 *Indemnification*

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

members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

- C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:
 - 1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
 - 2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.
- B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.
- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.
- D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.
- E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 – OTHER WORK AT THE SITE

7.1 *Related Work at Site*

- A. Owner may perform other work related to the Project at the Site with Owner's employees, or through other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:
1. written notice thereof will be given to Contractor prior to starting any such other work; and
 2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.
- B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.
- C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.2 *Coordination*

- A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:
1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;
 2. the specific matters to be covered by such authority and responsibility will be itemized; and
 3. the extent of such authority and responsibilities will be provided.

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

7.3 *Legal Relationships*

- A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.
- B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's wrongful actions or inactions.
- C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's wrongful action or inactions.

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.1 *Communications to Contractor*

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

8.2 *Replacement of Engineer*

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

8.3 *Furnish Data*

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

8.4 *Pay When Due*

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

8.5 *Lands and Easements; Reports and Tests*

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

8.6 *Insurance*

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

8.7 *Change Orders*

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

8.8 *Inspections, Tests, and Approvals*

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

8.9 *Limitations on Owner's Responsibilities*

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

8.10 *Undisclosed Hazardous Environmental Condition*

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

8.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents.

8.12 *Compliance with Safety Program*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.1 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents.

9.2 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a

greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.3 *Project Representative*

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

9.4 *Authorized Variations in Work*

- A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.5 *Rejecting Defective Work*

- A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.6 *Shop Drawings, Change Orders and Payments*

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

and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

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

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

9.7 *Determinations for Unit Price Work*

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

9.8 *Decisions on Requirements of Contract Documents and Acceptability of Work*

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

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

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

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

9.9 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for

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

- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.
- E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.10 *Compliance with Safety Program*

- A. While at the Site, Engineer's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.1 *Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).
- B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.2 *Unauthorized Changes in the Work*

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

10.3 *Execution of Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders recommended by

Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;
2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and
3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.4 *Notification to Surety*

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

10.5 *Claims*

- A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.
- B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).
- C. *Engineer's Action:* Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take

one of the following actions in writing:

1. deny the Claim in whole or in part;
 2. approve the Claim; or
 3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.
- D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.
- E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.
- F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.1 *Cost of the Work*

- A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.
 2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner

deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
 - c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
 - d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
 - e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
 - f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable.

Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

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

- 1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.
- 2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
- 3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
- 4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
- 5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.

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

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

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

11.3 *Unit Price Work*

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:
 - 1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
 - 2. there is no corresponding adjustment with respect to any other item of Work; and
 - 3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of

any such increase or decrease.

ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.1 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:
 1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or
 2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or
 3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).
- C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:
 1. a mutually acceptable fixed fee; or
 2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;
 - b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;
 - c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;
 - d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4,

11.01.A.5, and 11.01.B;

- e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
- f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.2 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.3 *Delays*

- A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.
- B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.
- D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects,

attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

- E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.1 Notice of Defects

- A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.2 Access to Work

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

13.3 Tests and Inspections

- A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:
 - 1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;
 - 2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and
 - 3. as otherwise specifically provided in the Contract Documents.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's

acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

- E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.
- F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.4 *Uncovering Work*

- A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.
- B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.
- C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.
- D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.5 *Owner May Stop the Work*

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

13.6 *Correction or Removal of Defective Work*

- A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).
- B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.7 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. repair such defective land or areas; or
 - 2. correct such defective Work; or
 - 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.
- C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
- E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute

for, or a waiver of, the provisions of any applicable statute of limitation or repose.

13.8 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.9 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct, or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.
- C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.1 Schedule of Values

- A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.2 Progress Payments

A. Applications for Payments:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. Review of Applications:

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the

accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

- a. the Work has progressed to the point indicated; the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and any other qualifications stated in the recommendation); and
 - b. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
- a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
- a. to supervise, direct, or control the Work, or
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:
- a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

- b. the Contract Price has been reduced by Change Orders;
- c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or
- d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due:*

- 1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. *Reduction in Payment:*

- 1. Owner may refuse to make payment of the full amount recommended by Engineer because:
 - a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;
 - b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
 - c. there are other items entitling Owner to a set-off against the amount recommended; or
 - d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.
- 2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.
- 3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

14.3 *Contractor's Warranty of Title*

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

14.4 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.
- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.
- E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.5 *Partial Utilization*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:
 - 1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.6 *Final Inspection*

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

14.7 *Final Payment*

A. *Application for Payment:*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.
2. The final Application for Payment shall be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;
 - b. consent of the surety, if any, to final payment;
 - c. a list of all Claims against Owner that Contractor believes are unsettled; and
 - d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit

of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. Engineer's Review of Application and Acceptance:

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due:

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.8 *Final Completion Delayed*

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

14.9 *Waiver of Claims*

- A. The making and acceptance of final payment will constitute:
 1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to

Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.1 *Owner May Suspend Work*

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.2 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will justify termination for cause:
 1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);
 2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;
 3. Contractor's repeated disregard of the authority of Engineer; or
 4. Contractor's violation in any substantial way of any provisions of the Contract Documents.
- B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:
 1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);
 2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and
 3. complete the Work as Owner may deem expedient.

C.If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the

Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

- D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.
- E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.
- F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

15.3 *Owner May Terminate For Convenience*

- A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;
 - 3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and
 - 4. reasonable expenses directly attributable to termination.
- B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.4 *Contractor May Stop Work or Terminate*

- B. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90

consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

- C. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.1 Methods and Procedures

- A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.
- B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.
- C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:
1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or
 2. agrees with the other party to submit the Claim to another dispute resolution process; or
 3. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.1 Giving Notice

- A. Whenever any provision of the Contract Documents requires the giving of written notice,

it will be deemed to have been validly given if:

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or
2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.2 *Computation of Times*

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

17.3 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.4 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.5 *Controlling Law*

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

17.6 *Headings*

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

SECTION 00 81 00

FUNDING AGENCY SUPPLEMENTARY CONDITIONS

Owner anticipates receiving financial assistance through Treasury American Rescue Plan Act (ARPA) State and Local Fiscal Recovery Funds (SLFRF) to aid in financing the Project. The Owner anticipates receiving this funding through the State Water Infrastructure Grants (SWIG) program, run by Tennessee Department of Environment and Conservation (TDEC). As such, Contractor and all Subcontractors shall comply with all funding agency supplementary conditions listed herein.

ARTICLE 1 - EQUAL EMPLOYMENT OPPORTUNITY

- (1) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
- (2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.
- (3) The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.
- (4) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- (5) The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- (6) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

SECTION 00 81 00

FUNDING AGENCY SUPPLEMENTARY CONDITIONS

Owner anticipates receiving financial assistance through Treasury American Rescue Plan Act (ARPA) State and Local Fiscal Recovery Funds (SLFRF) to aid in financing the Project. The Owner anticipates receiving this funding through the State Water Infrastructure Grants (SWIG) program, run by Tennessee Department of Environment and Conservation (TDEC). As such, Contractor and all Subcontractors shall comply with all funding agency supplementary conditions listed herein.

ARTICLE 1 - EQUAL EMPLOYMENT OPPORTUNITY

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

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

(3) The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

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

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

(6) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

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

(8) The contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (8) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance:

Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

The applicant further agrees that it will be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally assisted construction work: Provided, that if the applicant so participating is a State or local government, the above equal opportunity clause is not applicable to any agency, instrumentality or subdivision of such government which does not participate in work on or under the contract.

The applicant agrees that it will assist and cooperate actively with the administering agency and the Secretary of Labor in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and the rules, regulations, and relevant orders of the Secretary of Labor, that it will furnish the administering agency and the Secretary of Labor such information as they may require for the supervision of such compliance, and that it will otherwise assist the administering agency in the discharge of the agency's primary responsibility for securing compliance.

The applicant further agrees that it will refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, Government contracts and federally assisted construction contracts pursuant to the Executive Order and will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the administering agency or the Secretary of Labor pursuant to Part II, Subpart D of the Executive Order. In addition, the applicant agrees that if it fails or refuses to comply with these undertakings, the administering agency may take any or all of the following actions: Cancel, terminate, or suspend in whole or in part this grant (contract, loan, insurance, guarantee); refrain from extending any further assistance to the applicant under the program with respect to which the failure or refund occurred until satisfactory assurance of future compliance has been received from such applicant; and refer the case to the Department of Justice for appropriate legal proceedings.

ARTICLE 2 - CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

(1) **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.

(2) **Violation; liability for unpaid wages; liquidated damages.** In the event of any violation of the clause set forth in paragraph (1) of this section 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 paragraph (1) of this section, in the t \$27 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 paragraph (1) of this section.

(3) **Withholding for unpaid wages and liquidated damages.** The Contractor 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 contractor, 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 paragraph (2) of this section.

(4) **Subcontracts.** The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1) through (4) of this section 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 paragraphs (1) through (4) of this section.

ARTICLE 3 - CLEAN AIR ACT

(1) The contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act, as amended, 42 U.S.C. § 7401 et seq.

(2) The contractor agrees to report each violation to the Owner and understands and agrees that the Owner will, in turn, report each violation as required to assure notification to Treasury, and the appropriate Environmental Protection Agency Regional Office.

(3) The contractor agrees to include these requirements in each subcontract exceeding \$150,000.

ARTICLE 4 - DEBARMENT AND SUSPENSION

(1) This contract is a covered transaction for purposes of 2 C.F.R. pt. 180 and 2 C.F.R. pt. 3000. As such, the contractor is required to verify that none of the contractor's principals (defined at 2 C.F.R. § 180.995) or its affiliates (defined at 2 C.F.R. § 180.905) are excluded (defined at 2 C.F.R. § 180.940) or disqualified (defined at 2 C.F.R. § 180.935).

(2) The contractor must comply with 2 C.F.R. pt. 180, subpart C and 2 C.F.R. pt. 3000, subpart C, and must include a requirement to comply with these regulations in any lower tier covered transaction it enters into.

(3) This certification is a material representation of fact relied upon by Owner. If it is later determined that the contractor did not comply with 2 C.F.R. pt. 180, subpart C and 2 C.F.R. pt. 3000, subpart C, in addition to remedies available, the Federal Government may pursue available remedies, including but not limited to suspension and/or debarment.

(4) The bidder or proposer agrees to comply with the requirements of 2 C.F.R. pt. 180, subpart C and 2 C.F.R. pt. 3000, subpart C while this offer is valid and throughout the period of any contract that may arise from this offer. The bidder or proposer further agrees to include a provision requiring such compliance in its lower tier covered transactions.

ARTICLE 5 - BYRD ANTI-LOBBYING AMENDMENT

(1) Contractors who apply or bid for an award of \$100,000 or more shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, officer or employee of Congress, or an employee of a Member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 U.S.C. § 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient who in turn will forward the certification(s) to the awarding agency.

ARTICLE 6 - FEDERAL WATER POLLUTION CONTROL ACT

(1) The contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq.

(2) The contractor agrees to report each violation to the Owner and understands and agrees that the Owner will, in turn, report each violation as required to assure notification to Treasury, and the appropriate Environmental Protection Agency Regional Office.

(3) The contractor agrees to include these requirements in each subcontract exceeding \$150,000.

ARTICLE 7 - PROCUREMENT OF RECOVERED MATERIALS

(1) In the performance of this contract, the Contractor shall make maximum use of products containing recovered materials that are EPA-designated items unless the product cannot be acquired competitively within a timeframe providing for compliance with the contract performance schedule; meeting contract performance requirements; or at a reasonable price.

(2) The Contractor also agrees to comply with all other applicable requirements of Section 6002 of the Solid Waste Disposal Act.

ARTICLE 8 - DOMESTIC PREFERENCE

- (1) As appropriate, and to the extent consistent with law, the contractor should, to the greatest extent practicable, provide a preference for the purchase, acquisition, or use of goods, products, or materials produced in the United States. This includes, but is not limited to iron, aluminum, steel, cement, and other manufactured products.
- (2) Produced in the United States means, for iron and steel products, that all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States. Manufactured products mean items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber.
- (3) Please note that this requirement is solely a domestic preference, and it only applies to the extent appropriate and practical. This project is **not** subject to Build America Buy America (BABA) requirements **nor** American Iron and Steel (AIS) requirements.

ARTICLE 9 - ACCESS TO RECORDS

- (1) The Contractor agrees to provide (insert name of state agency or local or Indian tribal government), (insert name of recipient), Treasury, the Comptroller General of the United States, or any of their authorized representatives access to any books, documents, papers, and records of the Contractor which are directly pertinent to this contract for the purposes of making audits, examinations, excerpts, and transcriptions.
- (2) The Contractor agrees to permit any of the foregoing parties to reproduce by any means whatsoever or to copy excerpts and transcriptions as reasonably needed.
- (3) The Contractor agrees to provide the Treasury or authorized representatives access to construction or other work sites pertaining to the work being completed under the contract.

ARTICLE 10 - FEDERAL LAW, REGULATIONS, AND EXECUTIVE ORDERS

- (1) This is an acknowledgement that Treasury ARP SLFRF financial assistance will be used to fund all or a portion of the contract. The contractor will comply with all applicable Federal law, regulations, executive orders, Treasury policies, procedures, and directives.

ARTICLE 11 - FALSE CLAIMS ACT

- (1) The Contractor acknowledges that 31 U.S.C. Chap. 38 (Administrative Remedies for False Claims and Statements) applies to the Contractor's actions pertaining to this contract.

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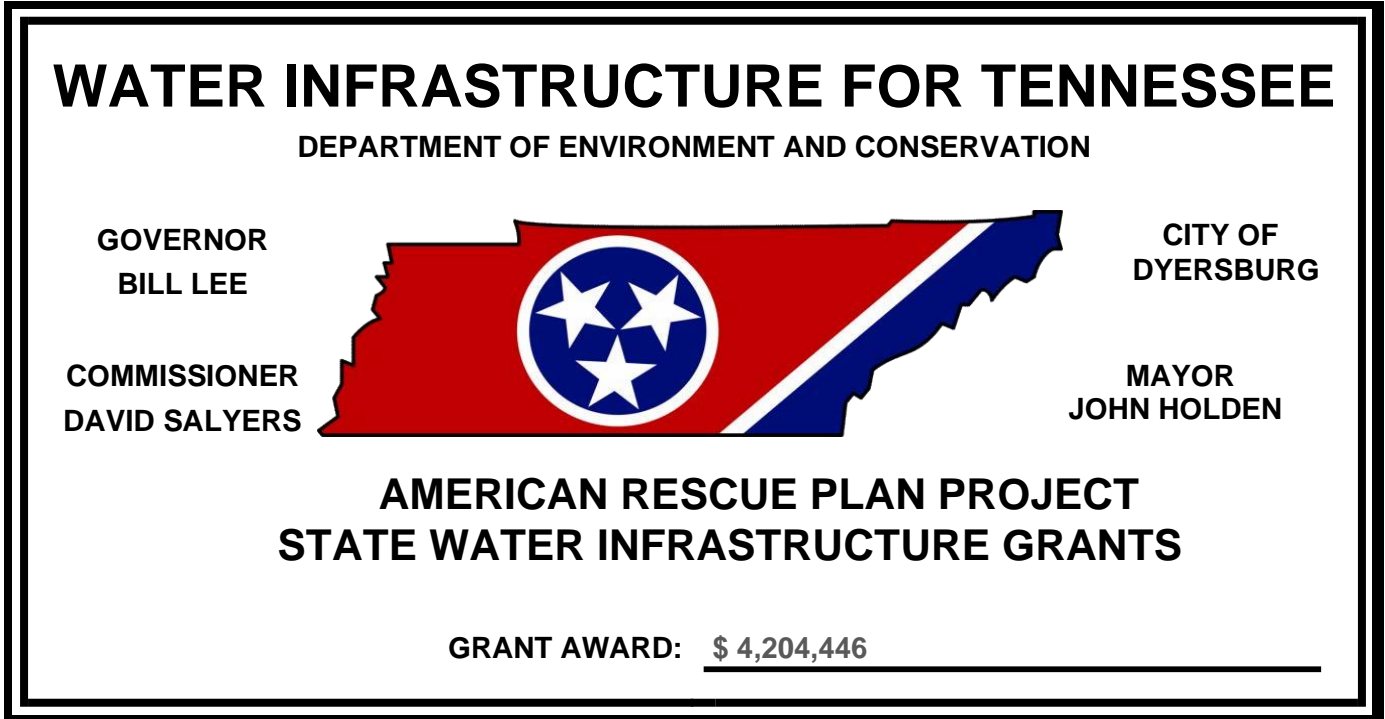
SECTION 00 83 13

PROJECT SIGN

STATE WATER INFRASTRUCTURE GRANTS: IDENTIFICATION SIGN

All plans and specifications for each project approved shall contain provisions for requiring the general contractor to provide identification signs. The signs shall conform to the following basic features:

1. The following diagram shall be used as a design:



2. The sign shall be a 4'0" X 8'0" sheet of exterior grade plywood and shall be built so as to remain erected during the entire construction phase of the project.
3. The background of both sides shall be white. The lettering shall be black and shall be large enough to take advantage of the full size of the plywood. The stars shall be white set on a blue field and surrounded by a white ring placed inside a state map in red with a stripe of white and blue on the right side. The sign shall be bordered by a one-inch blue stripe.

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SECTION 01 00 05
BASIC REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Summary of Work.
2. Coordination.
3. Hangers, Supports, and Restraints
4. Openings, Chases, Sleeves, Inserts, Etc.
5. Field Engineering.
6. Schedule of Values.
7. Payment Procedures.
8. Preconstruction Conference.
9. Progress Meetings.
10. Change Order Procedures.
11. Allowances, Alternates, and Guaranteed Prices.
12. Submittals.
13. Construction Photographs.
14. Quality Control.
15. Laboratory Testing Services.
16. Materials and Equipment.
17. Product Options and Substitutions.
18. Starting of Systems.

B. Related documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY OF WORK

A. Work Covered by Contract Documents.

1. Intent of these Contract Documents is for Work described herein to be complete in every detail for purposes designated and Contractor to provide everything necessary for such Work, notwithstanding any omission in Contract Documents. Work not specifically identified on Drawings or in Specifications but necessary to accomplish work, and to provide equipment complete in all details and every respect and ready for operation and functionality described in these Contract Documents, shall be performed as specified and as required. All parts of Contract Documents, including all drawings and all specification sections, apply to Contractor and all subcontractors on project.
2. Work to be performed under this Contract shall consist of following major work items:
 - a. Demolition and plugging of existing Water Well No. 6
 - b. Construction of replacement Water Well No. 6 including all necessary piping, valves, electrical, instrumentation and controls and appurtenances to provide a functioning system.
3. All work shall conform to requirements of these Contract Documents, any applicable codes, and regulations, and norms of industry, whichever is more stringent.

B. Work Hours.

1. Contractor shall, in general, confine his work to between 7:00 AM and 6:00 PM Monday through Friday. Any work outside these stipulated times, including work on Saturdays, Sundays and Holidays must be approved by Owner at least five (5) days in advance of such work.

C. Contractor Use of Premises and Responsibilities.

1. Contractor shall confine his operations to such portions of property of Owner, and to rights-of-way or easements acquired for work as shown. Private property adjacent to work shall not be entered upon or used by Contractor for any purpose whatsoever without written consent of owner thereof. Contractor shall provide at his expense for all additional lands required for temporary construction facilities, storage of materials and equipment or access to work not otherwise provided by Owner.
2. Contractor shall assume full responsibility for protection and safekeeping of products, materials, supplies, and equipment under this Contract; and all injury or damage to same from whatever cause, shall be made good at Contractor's expense before final payment is made.
3. Contractor shall maintain premises in a safe condition, free from human hazard, and provide proper facilities to allow access by his workers and those of his subcontractors, Owner, Engineer, and their agents and other employees, and all in compliance with applicable regulations, including OSHA.
4. Contractor shall be solely responsible for means, manpower, methods, techniques, sequences and procedures of construction, including those related to safety.
5. No extra payment shall be made for any labor, materials, tools, equipment or temporary facilities required during construction of facilities. All costs therefore shall be considered to have been included in price bid of Proposal.
6. All color choices shall be submitted to Engineer for selection.
7. Contractor shall keep himself fully informed of all laws, municipal ordinances, and regulations in any manner affecting those engaged or employed in work, or materials

used in work, or in any way affecting conduct of work, and of all orders, decrees and instructions of bodies or tribunals having any jurisdiction or authority over same.

- a. If any discrepancy or inconsistency should be discovered in Contract Documents in relation to any such permits, laws, ordinances, regulations, orders, decrees, or instructions, he shall forthwith report same in writing to Owner and Engineer.
8. Contractor shall at all times maintain a drug-free and alcohol-free workplace.
 9. Contractor shall conduct necessary background checks on any person employed by Contractor to ensure that they are legally allowed to work in this Country and that their background does not present or constitute a reasonable threat to security of Owner's facilities prior to allowing them access to work site. Contractor shall require all subcontractors and all other personnel not under direct control of Contractor to conduct similar background checks of their employees prior to allowing them access to work site. Contractor shall provide evidence of such background checks at request of Owner.
 10. Contractor shall comply with all security measures currently in place by Owner or instituted by Owner during course of work at no additional cost to Owner. Contractor shall familiarize himself with all of Owner's security procedures to ensure they are followed at all times while work is conducted.
 11. Coordination.
 - a. All dimensions shall be checked and all structural and finish conditions investigated and Contractor shall coordinate his work with these conditions and provide such offsets, brackets, rises, drops, transitions, alternate routings, and other necessary accessories as may be required to provide a complete operating system. Immediately upon discovery of any discrepancy in Drawings or Specifications, or points of conflict therein, Contractor shall notify Engineer. Engineer shall clarify such discrepancy in writing prior to progress of work beyond point of concern.
 - b. Contractor and all his subcontractors shall be responsible for reviewing all of Contract Documents, including those drawings and specification sections, related to work to be provided by his subcontractors for his responsibilities and that of his subcontractors. Failure by Contractor or his subcontractors to fully review Contract Documents in their entirety shall not entitle Contractor or his subcontractors to additional compensation.
 - c. Contractor is responsible for proper coordination of his work and his subcontractor's work, to prevent interference with operation of facility and to assure that owner is made aware in advance of proposed construction activities.
 - d. Where work of any subcontractor shall be installed in close proximity to work of other subcontractors, or where there is evidence that work of any subcontractor shall interfere with work of other subcontractors, Contractor shall work out space allocations to make a satisfactory adjustment.
 - e. Contractor shall prepare composite working coordination drawings and sections at a suitable scale, not less than 1/4 inch equals 1 foot, clearly showing how work is to be installed in relation to work of others. If Contractor permits any work to be installed before coordinating with various subcontractors; or so as to cause interference with work of other subcontractors, he shall make necessary changes in work to correct condition without extra cost to Owner.
 - 1) Coordination drawings shall include, but not be limited to, pipe laying schedules, pipe fabrication, support and restraint details, pipe, duct and conduit routings, equipment layout and mounting details, concrete placing schedules,

reinforcing steel details, structural steel fabrication and erection details, etc. Intent of these Contract Documents is for Contractor to provide complete and operable equipment whether or not any specific component is shown or specified.

- f. Contractor shall arrange that each subcontractor determines location, size and arrangement of all chases and openings and shall establish clearances in concealed spaces required for proper installation of its work and shall see that such are provided.

D. Limits of Work Area.

1. Conduct operations so as not to interfere with operation of Owner's facilities. Any interference, such as excavations, that could impact ability to operate Owner's facilities or receive materials at facilities shall be coordinated with Owner and Engineer at least seven (7) days in advance of any work commencing. Contractor shall not operate any of Owner's facilities.

E. Construction Permits and Inspection Fees and Other Fees.

1. Contractor shall obtain and pay for necessary construction permits from those authorities or agencies having jurisdiction over land areas, utilities or structures which are located within Contract Limits and which shall be occupied, encountered, used, or temporarily interrupted by Contractor's operations. All fees, including any fees related to obtaining any of permits, shall be paid for by Contractor, including but not limited to, building permits, electrical permits, sign permits, office trailer and construction trailer permits, plumbing and mechanical permits, blasting permits, excavation and grading permits, and permits for any road cutting.
2. When construction permits are accompanied by regulations or requirements issued by a particular authority or agency, it shall be Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to his operations on this project. Any costs associated with additional field supervision by authorities or agencies shall be Contractor's responsibility.
3. Contractor shall pay all necessary inspection fees related to Work to those agencies having jurisdiction over work.
4. In all cases, for all permits, whether applied for by Owner or Contractor, Contractor shall be responsible for payment of all required fees, charges, maintenance, bonds, insurance, and penalties or fines for non-compliance, associated with all required permits.
5. Additional fees, such as those required to establish utility accounts, or any other fee required to be paid as part of this project shall be borne by Contractor at no additional cost to Owner. Contractor shall be fully responsible for identifying all fees that may be incurred from agencies, companies, or authorities having jurisdiction over Work.

F. Work Sequence.

1. Work Plan.
 - a. Contractor shall develop and submit for review in accordance with this Section no more than 10 days after effective date of agreement a written work plan for sequencing of work that:
 - 1) Identifies tasks of construction in an orderly and logical sequence along with schedule/duration of each task that completes work within allowable contract time.

- a) Tasks shall outline specific means and methods to be used by Contractor that are unique, abnormal for intended work, or in any way deviate from stipulated requirements of Contract Documents.
- 2) Demonstrates ability to keep Owner's existing facilities operational and ability to protect existing facilities from contamination of any sort.
- 3) Identifies tasks (and order in which they shall be performed) that shall require temporary interruption of service or shutdown of any portion of Owner's facilities. Description shall include how an orderly removal of relevant facilities from service shall occur and how those services shall be brought back on-line with no interruption to Owner's operations.
- 4) Identifies time frame for such interruptions of services.
- 5) Establishes contingency plan for return of system to service in a timely fashion should problems be encountered completing that task.
- b. Contractor shall be solely responsible for means, manpower, methods, techniques, sequences and procedures of construction and for coordinating construction and installation of all materials and equipment shown or described in Contract Drawings and Specifications in accordance with Contract Documents, and subject to approval of Engineer and Owner. However, following sequence is offered to identify that certain proposed facilities must be constructed in an order which permits commissioning of certain unit processes before others may be decommissioned, renovated, or demolished. This sequence is only a guideline and is not to be considered complete and a formal sequence shall be prepared by Contractor. Contractor may proceed concurrently with work on multiple systems. Contractor is responsible for coordinating parallel work items with Engineer so as to expedite progress while minimizing interference with operations of Owner's facilities.

G. Weather Delays.

- 1. Weather and neglect of utility owner or other contractors shall not be deemed a consideration for change in Contract Price or for extension of contract time.

1.03 EQUIPMENT AND HOUSEKEEPING PADS

- A. All process, mechanical, heating and ventilating and air conditioning, fire suppression, plumbing, electrical, and instrumentation and control equipment shall be provided with a housekeeping pad whether shown on Contract Drawings or not, unless Contract Drawings explicitly state that pads are not to be provided or equipment is to be wall-mounted. Unless otherwise shown on Contract Drawings, equipment pads and housekeeping pads shall be constructed of reinforced concrete and shall be 8 inches larger than footprint of equipment. Unless otherwise shown on Contract Documents or required by equipment manufacturer, pads shall be no less than 4 inches high. Contractor shall coordinate all pad dimensions, locations, and equipment anchor requirements described in Contract Documents with equipment suppliers and manufacturers and subcontractors and confirm all aspects of pad construction prior to pad fabrication and placement. Cost to repair or correct pads of incorrect size shall be borne solely by Contractor at no additional expense to Owner. Lack of pads being shown on Contract Drawings shall not be grounds by Contractor for a modification in Contract amount or Contract schedule.

1.04 HANGERS, SUPPORTS, AND RESTRAINTS

- A. Contractor shall be responsible for designing, engineering, and providing suitable hangers, supports and restraints for all piping and equipment provided under Contract, whether shown on Contract Drawings or not. All hangers, supports and restraints shall be furnished and

installed in accordance with all applicable codes and standards and in accordance with these Contract Documents. All hardware shall be specifically designed for application intended and shall be of a materials or finish which shall prevent corrosion in in-service atmosphere in which it is located. Shop Drawing information on proposed hangers, supports and restraints, whether manufactured, or fabricated, shall be provided.

1.05 OPENINGS, CHASES, SLEEVES, INSERTS, ETC.

- A. Contractor shall provide all openings, chases, etc., in his work to fit his own work and that of other subcontractors. All such openings or chases shown on Contract Drawings, or reasonably implied thereby, or as confirmed or modified by shop drawings approved by Engineer, or shown on manufacturer's erection drawings, shall be provided by Contractor.

1.06 FIELD ENGINEERING

- A. Control datum for survey work is that provided by Engineer. Datum shall be provided prior to start of construction.
- B. Contractor shall provide three control points at each work site.
- C. Contractor shall provide field engineering services as follows:
 - 1. Provide construction surveys as necessary to construct work in accordance with lines, grades, and elevations shown on Contract Drawings.
 - 2. Protect all control and reference points. Accurately replace any such point which is damaged or moved at no additional cost to Owner.
 - a. All benchmarks used by Contractor, whether provided by Contractor or by Owner or Engineer shall be identified on final record documents.
 - 3. Provide correct lines, grades, locations and elevations for construction of all Project components.
 - 4. Provide correct information for preparation of Project record documents.
 - 5. At completion of project, Contractor shall submit certification that locations and elevations of Work are in conformance with Contract Documents and indicate any substantive deviations.
 - 6. At completion of project, Contractor shall submit site drawings with certification that locations and elevations of Work are in conformance with Contract Documents and indicate any substantive deviations.

1.07 SCHEDULE OF VALUES

- A. Type Schedule on AIA G702 (cover page) and G703 (continuation sheets).
- B. Identify each line item of Schedule by number and title of Specifications Sections.
- C. Cost of shop drawing preparation and submittal shall be included in price of each piece of equipment or material. Shop drawings shall not be paid as a separate payment item, unless otherwise indicated in individual specification section.
- D. Submit one (1) pdf of Schedule of Values. Assemble so that form and content is acceptable to Engineer.

- E. Schedule of Values shall be approved by Engineer prior to submission of first payment application.
- F. When Engineer requires substantiating information, submit data justifying line item amounts in question.

1.08 PAYMENT PROCEDURES

- A. Payment application cover and continuation sheets shall be similar to AIA Form G702 (cover) and G703 (continuation sheets) and approved by Engineer.
- B. Application shall include invoices or receipts for stored material for which payment is requested and other information that may be requested by Engineer.
- C. Approved Schedule of Values shall be used to list items on Applications for Payment.
- D. Retainage shall be withheld from stored materials, unit price items, allowances, as well as completed work at rate indicated in Agreement, or if not included in agreement at a rate of 5 percent.
- E. Submit one (1) pdf of Application for Payment to Engineer, each with original signatures.
- F. Payment Period: Monthly.
- G. No payment application shall be reviewed by Engineer unless Record Drawings are up to date, Progress Schedule has been approved and is up-to-date at time of payment submittal, required photographs submitted, List of Submittals is up-to-date and copy submitted with payment application, and List of Operations and Maintenance Manuals is up-to-date in and copy submitted with payment application.

1.09 PRECONSTRUCTION CONFERENCE

- A. Engineer shall schedule a pre-construction conference after date of Notice to Award.
- B. Attendance – Owner, Engineer, Contractor and his superintendent (and major subcontractors that Contractor deems appropriate), and others required by Owner and Engineer.
- C. Agenda:
 - 1. Designation of responsible personnel of Owner, Contractor, and Engineer.
 - 2. Submittal of executed bonds and insurance certificates.
 - 3. Distribution of contract documents (and State approved documents as applicable).
 - 4. Notice to proceed and construction schedule.
 - 5. Permits.
 - 6. Existing and subsurface conditions.
 - 7. Submittal of:
 - a. List of subcontractors.
 - b. List of products.
 - c. Schedule of values.

- d. Schedule of shop drawing, product data, and sample submittals.
 - e. Schedule of operations and maintenance manual submittals.
 - f. Progress schedule.
 - g. Erosion and sediment control plan.
 - h. Spill prevention plan.
 - i. Storm water pollution prevention plan (SWPPP).
 - j. Work Plan/Sequence of Construction.
 - k. Project Sign Rendering.
 - l. List of unspecified equipment, components, accessories, or connections.
 - m. List of required dates for selection and purchase of allowance related items.
 - n. Draft training schedule.
 - o. Samples for color selections.
 - p. Photographs.
8. Procedures and processing of:
- a. Lines of communication.
 - b. Emergency communications.
 - c. Discrepancies.
 - d. Progress meetings.
 - e. Field decisions.
 - f. Submittals including Shop Drawings.
 - g. Substitutions and proposal requests.
 - h. Applications for payment.
 - i. Change orders.
 - j. Operation and maintenance manuals.
 - k. Record documents and drawings.
 - l. Contract closeout procedures.
 - m. Claims.
9. Testing Laboratory - scheduling activities and procedures for testing.
10. Requirements of regulatory agencies.

11. Use of premises by Owner and Contractor, including chemical deliveries, and Owner's occupancy.
 12. Temporary facilities, utilities, and controls to be provided by Owner and by Contractor.
 13. Maintenance of vehicular traffic detours, flagmen, etc.
 14. Periodic cleanup of site, housekeeping procedures, and security.
 15. Notification of utilities' owners.
 16. Requirements for startup of equipment and plant startup.
 17. Review and acceptance of equipment put into service during construction period.
 18. Survey and building layout.
 19. Site mobilization.
 20. Other issues.
- D. Engineer shall record minutes and distribute copies after meeting to participants. Contractor shall distribute copies to his subcontractors and other parties not in attendance who are affected by decisions made.

1.10 PROGRESS MEETINGS

- A. Engineer shall schedule and administer progress meetings throughout progress of Work at maximum monthly intervals.
- B. Location of meetings: Owner's office or other convenient location as determined by Engineer.
- C. Engineer shall prepare meeting agenda with copies for participants, preside at meetings, record highlights, and distribute copies of highlights to meeting attendees.
- D. Distribution of meeting highlights by Engineer shall include e-mailing one (1) copy of highlights.
- E. Contractor shall distribute copies of highlights to those who did not attend meeting and who are affected by decisions made at meeting, including any subcontractors.
- F. Attendance Required: Owner, Engineer and other professional consultants he deems appropriate, Contractor and his job superintendent, major Subcontractors and suppliers as appropriate to agenda topics for each meeting, and others as appropriate to agenda topics. Contractor shall be responsible for ensuring that representatives of contractors, subcontractors and suppliers attending meetings are qualified and authorized to act on behalf of entity each represents.
- G. Agenda:
 1. Attendee Sign-in Sheet.
 2. Review and approval of highlights of previous meeting.
 3. Review of work progress since last meeting.
 4. Review and maintenance of progress schedule.

5. Planned work progress before next meeting.
6. Field observations, problems and decisions.
7. Identification of problems which may impede planned progress and measures to regain project schedule.
8. Special Inspections and Testing.
9. Review of submittals schedule and status of submittals.
10. Review of requests for information and status of requests.
11. Review of field drawings.
12. Construction photographs.
13. Review of fabrication and delivery schedules.
14. Status of modifications and change orders and effects on schedule and coordination.
15. Coordination of process interruptions.
16. Other business relating to Work.
17. Schedule of next meeting.

H. Contractor shall supply to each attendee of each progress meeting following:

1. Written summary of work performed since last progress meeting.
2. Updated project schedule reflecting completed work, revised dates for future work, and any changes to substantial and final completion dates.
3. Documentation indicating number of days ahead of or behind schedule. If behind schedule, include proposed methods of regaining schedule.
4. Brief summary of major work to be performed between present meeting and next progress meeting, including any anticipated interruptions to Owner's facilities.

1.11 CHANGE ORDER PROCEDURES

- A. Change Order Forms: AIA Document G701 or similar Engineer approved form. Provide supporting documentation as may be requested by Engineer.
 1. Requests for change in contract sum and/or contract time shall include origin and date of claim, dates and times work was performed, and by whom, time records and wage rates paid, and receipts and invoices for products, equipment and subcontracts, similarly documented.
- B. Lump Sum Change Order – Content of Change Orders shall be based on either Engineer Proposal Request or Notice of Change and Contractor's lump sum quotation or Contractor's request for a Change Order as approved by Engineer.
- C. Unit Price Change Order – For contract unit prices and quantities, and for adjustment prices, Change Order shall be executed on a fixed unit price basis. For unit costs or quantities of units of Work that are not predetermined, execute Work under a Work Change Directive as

directed by Owner. Changes in Contract Price or Contract Time shall be computed as specified for Cost of Work Change Order.

- D. Time and Material Change Order – Maintain detailed records of work done on Time and Material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in Work. At completion of change, submit itemized account and supporting data, within time limits in Conditions of Contract. Engineer shall determine change allowable in Contract Sum and Contract Time as provided in Conditions of Contract.
- E. Requests for changes to contract time shall only be acceptable for those items shown to be on critical path of project completion as shown on most recent project schedule provided by Contractor prior to Contractor advising Engineer of change or Engineer determining such a change is necessary, whichever comes first. Those items not on critical path, although adjustments to contract sum may be acceptable, shall not be permitted to adjust contract time.
 - 1. For any request for change in contract time, as part of submission of documents supporting change to be provided to Engineer, Contractor shall provide schedule, or portion thereof, clearly showing that respective change is on critical path and that such schedule existed prior to determination that such change to Work is necessary. Failure to provide such documentation shall result in change being deemed to result in no change to contract time.
 - 2. Responsibility of fully demonstrating that proposed change is on critical path to satisfaction of Owner and Engineer shall be Contractor's alone.

1.12 ALLOWANCES, ALTERNATES, AND GUARANTEED PRICES

- A. Contingency Allowances.
 - 1. All allowances shall be included in Total Base Bid Price submitted by Contractor.
 - 2. Costs Included in Allowances:
 - a. Contingency Allowances – Allowances include costs of materials and equipment (less applicable trade discounts); applicable taxes; product delivery to site and handling at site, including unloading, uncrating, and storage; protection of Products from elements and from damage; labor for installation and finishing; and overhead and profit.
 - 3. Engineer Responsibilities – consult with Contractor for consideration and selection of Products, suppliers and installers; select Products in consultation with Owner and transmit decision to Contractor; and prepare change order.
 - 4. Contractor Responsibilities:
 - a. Within 30 calendar days of Notice to Proceed, notify Engineer of date when final selection and purchase of each product or system described by an allowance must be completed in order to avoid delay in performance of Work.
 - b. Assist Engineer in selection of products, suppliers and installers.
 - c. Obtain proposals from suppliers and installers and offer recommendations.
 - d. On notification of selection by Engineer, execute purchase agreement with designated supplier and installer.
 - e. Arrange for and process shop drawings, product data, and samples. Arrange for and coordinate delivery of each product or system. Contractor is responsible for delivery

schedule even if there is an equipment manufacturer proposal in bid documents that includes a delivery schedule. Changes to bid proposal schedule due not constitute grounds for a change in contract time period.

- f. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.
 - g. Provide copies of all paid purchase orders to Engineer, including invoices, receipts, or other satisfactory evidence of actual amounts paid for installation of utility services by utility companies.
5. Differences between allowance amounts and actual costs shall be adjusted by Change Order prior to final payment.
 6. Allowances Schedule:
 - a. Contingency Allowances:
 - 1) Cash Allowance for Construction Contingencies:
 - a) No construction contingency shall be provided within the project contract.

B. Alternates.

1. Alternates quoted on Bid Forms shall be reviewed and accepted or rejected at Owner's option. Accepted Alternates shall be identified in Schedule of Bid Items as referenced by Owner Contractor Agreement Notice of Award.
2. Coordinate related Work and modify surrounding Work as required. Dimensions and locations shown on Drawings for equipment and accessories are based on base bid equipment. Any change in dimensions or location of equipment or accessories or type of accessories required to accommodate alternate manufacturers and models shall be at Contractor's expense.
3. All costs associated with modifying design and construction of building, structural, piping, electrical, mechanical, plumbing and instrumentation systems and all other aspects of project required to accommodate alternate manufacturers and models shall be responsibility of Contractor.

1.13 SUBMITTALS

A. General.

1. Purpose of submittals is to demonstrate that Contractor understands and shall conform to intent of Contract Documents.
2. Engineer's review of submittals shall not be for purpose of determining accuracy or completeness of details such as quantities, dimensions, materials, catalog numbers, or similar data for compliance with Contract Documents, or for substantiating instructions for installation or performance of materials, equipment, or systems, all of which remain sole responsibility of Contractor.
 - a. Engineer's review does not constitute approval of any safety precautions taken or not taken by Contractor nor means and methods or field construction criteria employed or not employed by Contractor.
3. Engineer's review is only to check general conformity with Contract Documents.

4. Contractor's submission of submittals to Owner/Engineer or Engineer's/Owner's review of said submittals shall not in any way relieve Contractor of responsibility for full compliance with Contract Documents and Contractor's responsibility for any deviations or variations from requirements of Contract Documents or other errors contained or implied in submittals or any omissions from submittals.
- B. Email all submittals to Engineer.
 - C. Consecutively number all submittals. Every submittal and re-submittal shall be accompanied with a letter of transmittal with Contractor's signature or initials that itemizes all data transmitted as well as identifies Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and Specification Section number, as appropriate.
 - D. Contractor and all his subcontractors shall review and coordinate all submittals, as well as field verify all measurements, quantities, field construction criteria, performance criteria, manufacturer's catalog numbers, and compliance of submittal with requirements of Contract Documents, prior to transmittal to Engineer. Any comments from Contractor or subcontractor as well as any deviations between submittal and contract documents shall be provided to Engineer in writing at time of submittal.
 - E. Revise and resubmit submittals as required. Identify all changes made since previous submittal.
 - F. Distribute copies of all reviewed (even if not accepted) and accepted submittals, including shop drawings, product data, samples, and Operations and Maintenance Manuals, which bear Engineer's stamp, to job site files, Record Documents file, subcontractors, suppliers, other affected contractors, concerned parties, and other entities requiring information. Instruct anyone receiving said submittals to promptly report any inability to comply with provisions.
 - G. Do not fabricate products or begin work which requires submittals until return of submittal with Engineer's acceptance.
 - H. Owner shall not be obligated to accept or pay for any materials or equipment furnished in absence of a required shop drawing submittal or in absence of addressing any comments concerning said shop drawings.
 - I. After acceptance of submittals, items shall be provided exactly as described in submittal, inclusive of any comments.
 1. In event that a manufacturer changes design of an item subsequent to its acceptance via a submittal, Contractor providing said item shall bear all additional costs incurred by Owner or other contractors.
 - J. Engineer shall review original submittal and one re-submittal of any equipment at cost to Owner. Any subsequent re-submittals shall be reviewed at expense of Contractor, cost of which shall be deducted by Owner from Contract amount.
 - K. Construction Progress Schedules.
 1. Submit preliminary progress schedule in duplicate within 10 calendar days after effective date of Agreement for Engineer review.
 2. Submit finalized progress schedule at least 10 calendar days before submission of first Application for Payment.
 3. Submit revised schedules at each progress meeting, identifying changes since previous version.

4. Prepare computer-generated network analysis diagram using critical path method, generally as outlined in Associated General Contractors of America (AGC) publication "Use of CPM in Construction A Manual for General Contractors and Construction Industry."
5. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration. Diagram shall be divided into calendar months.
6. Indicate estimated percentage of completion for each item of Work at each progress meeting and update accordingly. Submission of updated progress schedules of each monthly progress meeting shall be necessary for processing monthly payments.
7. Indicate submittal dates for all required shop drawings, product data, samples, and anticipated product delivery dates, including those furnished by Owner and under Allowances.
8. As a minimum, progress schedules shall include at least one task for each Specification Section and each major division of Project General Requirements.

L. Initial Submittals.

1. In addition to Progress Schedule, Contractor shall also submit following by stipulated deadlines:
 - a. Within 10 calendar days after effective date of Agreement:
 - 1) Detailed Work Plan including intended Sequence of Construction in accordance with this Section.
 - 2) Schedule of Values.
 - b. Within 15 calendar days after effective date of Agreement:
 - 1) All requests for substitutions including comparative literature.
 - c. Within 30 calendar days of Notice of Award, Contractor shall submit following:
 - 1) Rendering of project sign in conformance with Section 01 00 05.
 - 2) Before beginning any on-site construction (including mobilization), submit insurance certificates.
 - 3) Before beginning any on-site construction (including mobilization), submit erosion and sediment control plan, spill prevention plan, and storm water pollution prevention plan in conformance with Section 01 00 05 and State of Tennessee regulations.
 - 4) List from each equipment manufacturer required to provide a performance affidavit of any equipment, components, accessories, or connections which are required for a complete operating system but are not shown or described in Contract Documents.
 - d. Within 30 calendar days of Notice to Proceed, Contractor shall submit following:
 - 1) List of dates when final selection and purchase of each product or system described by an allowance must be completed in order to avoid delay in performance of Work.

- 2) Draft training schedule.
 - 3) Name of proposed reputable independent testing laboratory to perform services to be provided by Contractor.
 - 4) List of all shop drawings, product data, and samples to be submitted with respective specification or drawing number and proposed dates of submittal to Engineer. List shall be updated prior to each monthly progress payment with actual submittal dates and revised proposed dates and submitted with payment application.
- e. Within 60 calendar days of Notice to Proceed, Contractor shall submit following:
- 1) Samples for selection of colors.
 - 2) List of all operations and maintenance manuals to be submitted with respective specification or drawing number and proposed dates of submittal to Engineer. List shall be updated prior to each monthly progress payment with actual submittal dates and revised proposed dates and submitted with payment application.

M. Shop Drawings.

1. Shop drawing submittals shall include all descriptive data, performance characteristics, material specifications, spare parts list, drawings, piping diagrams, wiring schematics, and shall be complete and accurate to indicate item-by-item compliance with Contract Documents. Shop drawing submittals shall be coordinated, assembled, and submitted in groupings to facilitate checking related items. Contractor shall provide additional information as may be required by Engineer.
2. General Submission Requirements.
 - a. A copy of this specification section and other sections as may be required by individual specification sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark (✓) shall denote full compliance with a paragraph as a whole. A check mark shall denote full compliance with related sections in their entirety. If deviations from specifications are indicated, and therefore requested by Contractor, each deviation shall be underlined and denoted by a number in margin to right of identified paragraph, referenced to a detailed written explanation of reasons for requesting deviation. Engineer shall be final authority for determining acceptability of requested deviations. Remaining portions of paragraph not underlined shall signify compliance on part of Contractor with specifications. Failure to include a copy of marked up specification section(s), along with justification(s) for any requested deviations to specification requirements, with submittal shall be sufficient cause for rejection of entire submittal with no further consideration.
 - b. A copy of contract document control diagrams, process and instrumentation diagrams, mechanical layout drawings, and other relevant documents relating to submitted equipment, with addendum updates that apply to equipment in this section, marked to show specific changes necessary for equipment proposed in submittal. If no changes are required, drawing or drawings shall be marked "no changes required". Failure to include copies of relevant drawings with submittal shall be cause for rejection of entire submittal with no further review.
 - c. Drawings showing plan, elevation, appropriate cross sections of equipment being provided and anchor bolt locations when applicable.

- d. Complete engineering data including, but not limited to, all pertinent engineering calculations, descriptive data, material specifications, equipment weights, loads imparted on supporting structures, piping diagrams, instrumentation diagrams, and wiring diagrams, as appropriate, to support design of equipment being provided.
 - e. Paint system data where applicable.
 - f. Pump performance curves in accordance with Section 43 21 05 where applicable.
 - g. Motor test data and all other information necessary to show compliance with Section 11 05 13 where applicable.
3. Identify field dimensions. Show relation to adjacent or critical features, work or products.
 4. Submit pdf to Engineer.
 5. Submittals shall bear Contractor's stamp, signed or initialed to each submittal certifying that review, verification of Products required, field dimensions, adjacent construction Work, installation requirements, and coordination of information, is in accordance with requirements of Work and complies with Contract Documents. Submittals without Contractor's stamp shall not be reviewed and shall be returned to Contractor for proper resubmission.

N. Product Data.

1. Submit in conformance with this Section and requirements for Shop Drawings, above.
2. Submit pdf to Engineer.
3. Mark each copy to identify pertinent products, models, options, and other data, referenced to specification number and article number. Supplement or modify manufacturers' standard data, drawings, and diagrams, to provide information unique and specifically applicable to this Project. Delete or otherwise cross out information not pertinent or applicable to submittal. Provide additional information as may be required by Engineer.
4. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
5. Provide manufacturer's preparation, assembly and installation instructions as specified in this Section and individual sections of these contract documents.

O. Samples and Field Samples.

1. Submit samples to illustrate functional and aesthetic characteristics of Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
2. Submit samples of finishes from full range of manufacturers' standard colors selected textures and patterns for Engineer's selection, except when more restrictive requirements are specified, in which case custom colors, textures, patterns, or finishes shall be provided for review.

1.14 CONSTRUCTION PHOTOGRAPHS

A. Photography.

1. Provide digital photographs of site and construction throughout progress of work.
2. Deliver digital files monthly with each Application for Payment on flash drive. Catalog and index in chronological sequence; provide table of contents.
 - a. Provide two (2) flash drives, one for Owner and one for Engineer.
3. Digital image shall include date and time stamp.
4. Photograph filename shall identify subject and orientation of view (for example, "Sedimentation Tank Foundation, looking north").
5. All digital photographs shall be provided on flash drives in .jpg format.
6. Contractor shall pay costs for specified photography and flash drives. Parties requiring additional photography or prints shall pay Contractor directly for additional work.
7. Contractor shall have entity performing photography and videos provide a release to Owner at end of project that all photos and videos shall become property of Owner and that Owner is entitled to unrestricted use of said videos and photographs for any purpose and in any manner Owner chooses.
8. Contractor shall also have entity performing photography and videos provide a release to Owner at end of project that none of photos and videos taken shall be used in any manner whatsoever by entity nor shall any copies/originals of said photographs or videos be provided by entity to anyone else but Owner without express written permission of Owner in advance of such use or before providing said copies/originals.

B. Digital Photographs (non-aerial).

1. Full color.
2. Film – digital. Digital imagery shall be 10 mega-pixel or better quality.

1.15 QUALITY CONTROL

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in sequence.
- C. Verify that field measurements are as indicated on shop drawings or as instructed by manufacturer.
- D. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- E. Comply with specified standards as a minimum quality for Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- F. Perform work by persons qualified to produce workmanship of specified quality.
- G. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

- H. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- I. References and Standards.
 - 1. Conform to reference standard by date of issue current on date for receiving bids, except where a specific date is established by code. Where referred to in these Contract Documents, published regulations, specifications, codes, or standards shall be followed or complied with as if they were incorporated herein in their entirety, as applicable to Work of these Contract Documents and to extent that they do not conflict with specific requirements contained in these Contract Documents.
 - 2. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
 - 3. No provision of any standard, specification, manual, code, or instruction shall be effective to change duties and responsibilities of Owner, Contractor, Engineer, or any of their subcontractors, nor shall these be effective to assign to Owner, Contractor, Engineer, or any of their subcontractors, or any of their consultants, agents, employees any duty or authority to supervise or direct providing or performance of Work or any duty or authority to undertake responsibility inconsistent with any provisions of Contract Documents.
- J. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- K. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- L. Adjust products to appropriate dimensions; position before securing products in place.

1.16 LABORATORY TESTING SERVICES

- A. Selection and Payment.
 - 1. Contractor shall employ and pay for services of an independent testing laboratory to perform following inspection and testing:
 - a. Concrete consistency, air content, compressive test cylinder casting and compression testing specified on Drawings.
 - b. Sieve analysis and proctor tests of proposed backfill material (except that Contractor shall conduct initial testing to determine suitability as described on Drawings.
 - c. Compaction testing.
 - d. Other specified geotechnical tests, such as pile load tests.
 - e. Steel inspections including visual inspection of welds, weld testing, visual inspection of bolts, and determination of metal type and gauge thickness.
 - f. Other tests as ordered by Engineer not due to deficiencies of Contractor or his subcontractors.
 - 2. Contractor shall furnish required labor, facilities, tools, equipment, compressed air, water and electric power, and as necessary a reputable independent testing laboratory, to conduct following tests:

- a. Hydrostatic and/or pressure tests on installed utilities, process piping, valves, air piping, tanks, and structures in accordance with individual Sections of Specifications.
 - b. Disinfection of water lines, process piping, and related facilities and collect necessary samples to be provided to Owner for analysis to verify proper disinfection in accordance with individual Specification Sections.
 - c. All startup, field, performance, and other tests required to verify compliance with Contract Documents of equipment and materials of a manufacturer, fabricator, supplier, or distributor incorporated into work or proposed to be incorporated into work or required for pre-approval prior to purchase as described in individual specifications and this Section.
 - d. Testing and analysis of materials for pre-installation approval such as concrete mix designs, sieve and proctor tests of proposed granular fill materials, and paving materials.
 - e. Any specialized testing of manufactured materials or equipment, such as pipe certifications, steel certifications, pump certifications, etc. shall be provided by Contractor or manufacturer of material or equipment.
 - f. Other tests as ordered by Engineer due to deficiencies of Contractor or his subcontractors.
 - g. Contractor shall pay all costs associated with hydrostatic/pressure tests, disinfection sampling, and equipment startup, field, performance, and other testing and equipment testing described in Divisions 21, 22, 23, 26, 28, 33, and 40.
 - h. Contractor shall employ and pay for services of an independent testing laboratory to perform all other testing not specifically defined in this Section to be provided by Owner but required to be performed by Contract Documents.
 - i. Contractor shall submit results of all testing to Engineer within seven days of receiving results. Submittals shall conform to this Section.
3. Should Contractor employ any laboratory to conduct testing required to be performed by Contractor, laboratory shall be acceptable to Owner and Engineer. Submit name of laboratory to Engineer at least no later than 30 days after Notice to Proceed.
 - a. Employment of a testing laboratory shall in no way relieve Contractor of obligation to perform work in accordance with requirements of Contract Documents.
 4. Owner shall provide name of laboratory employed by Owner to Contractor at least 14 days prior to any services being required. Contractor shall inform Owner and Engineer at least 30 days prior to first time when Owner's laboratory needs to provide services.
 5. Contractor shall be responsible for coordinating required testing with laboratory employed by Owner.
 6. Testing, transporting, and storage of material to be tested shall conform to applicable standards of care for industry.
 7. Contractor shall not employ same laboratory as one chosen by Owner for this project for any testing conducted by Contractor.

B. Laboratory Reports.

1. After each inspection and test, Testing Laboratory shall promptly submit one copy of laboratory report to Engineer, resident project representative (RPR), Owner, and Contractor. If test results indicate failure to conform to specified requirements, Testing Laboratory shall immediately transmit results to Engineer, RPR, and Contractor via facsimile or electronic mail. Submit reports within 7 days of performing tests. Report shall include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of field tester or inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and Specifications Section.
 - f. Location in Project.
 - g. Type of inspection or test.
 - h. Date of test.
 - i. Results of tests and any observations made during sampling or testing.
 - j. Degree of compliance with Contract Documents.
2. Reports shall also indicate that materials were tested in accordance with applicable edition of applicable Building Code and Specifications, and shall state whether materials passed or failed to meet those requirements. Engineer may select items and determine how they shall be selected. In no case shall vendor select items to be tested.

C. Contractor Responsibilities.

1. Deliver to laboratory at designated location, adequate samples of materials proposed for use which require testing, together with proposed mix designs.
2. Cooperate with laboratory personnel, and provide access to Work.
3. Provide equipment, tools, storage, and assistance necessary for proper sampling and testing and as may be requested by laboratory, Engineer, or Owner.
4. Provide incidental labor and facilities to provide access to work to be tested, to obtain and handle samples at site, or at source of products to be tested, to facilitate tests and inspections, and for storage and curing of test samples.
5. Notify Engineer and/or resident project representative, Owner, and laboratory 72 hours prior to expected time for operations requiring testing and inspection services, including concrete.
6. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's own use.
7. Retesting required because of non-conformance to specified requirements shall be performed by same independent firm(s) which performed initial tests and inspections, whether employed by Owner or Contractor.

8. Payment for any required retesting shall be by Contractor with no change to contract price regardless of whether initial testing was paid for by Owner or Contractor.
9. Contractor shall be responsible for, and shall pay for:
 - a. Additional testing expenses resulting from Contractor's failure to advise Engineer and independent firm 72 hours in advance of operations.
 - b. Additional testing expenses resulting from changes in Contractor's schedule after independent firm has been notified that testing is required, canceled or modified.
 - c. Expenses and delays resulting in Work from Contractor's failure to provide adequate notice to Owner or Engineer of upcoming work requiring field testing and resulting inability to arrange for testing to accommodate Contractor's schedule and subsequent deferment or rescheduling necessary until required testing services are available. Contractor shall make no claim for damages or delay as a result of any such deferral or rescheduling.

1.17 MATERIAL AND EQUIPMENT

- A. Related Sections – specification sections listed under “related sections”, “related documents”, or other similar headings, of individual specification sections shall be an integral part of those specification sections and Contractor shall be responsible for providing those related sections to equipment manufacturers and for complying with all requirements described therein.
- B. Performance Affidavits.
 1. Contractor shall submit manufacturer's Performance Affidavits for equipment to be furnished as indicated in individual equipment specification section and in accordance with this Section.
 2. By these affidavits, each manufacturer must certify to Contractor and Owner, jointly, that he has examined Contract Documents and that equipment, apparatus or process he offers to furnish shall meet in every way performance requirements set forth or implied in Contract Documents. Equipment design, manufacturing, and assembly specifications are an integral part of performance affidavit. Contractor must transmit to Engineer three (3) copies of affidavit given him by manufacturer or supplier along with initial Shop Drawing submittals. Performance Affidavit must be signed by an officer of basic corporation, partnership or company manufacturing equipment and witnessed by a notary public. Shop Drawings, if required, shall not be reviewed prior to receipt of an acceptable Performance Affidavit, which shall have following format:

Addressed to: (Contractor) and Location of Project

Reference: (Project Name)

Text: “ _____ (Manufacturer's Name) _____ has examined Contract Documents and hereby certifies that _____ (Product) _____ described in Section(s) _____ of Contract Documents:

- a. Product meets in every way performance requirements and design specifications set for in Contract Documents.
- b. Contract documents show and/or describe all equipment, components, accessories, and connections necessary for a complete operating system.

- c. Manufacturer shall provide within 30 days after date of Notice of Award a list of any equipment, components, accessories, or connections which are required for a complete operating system but are not shown or described in Contract Documents.
- d. Manufacturer has unitary responsibility over product including components not of his manufacture that are within manufacturer's scope of supply."

Signature: Corporate officers shall be Vice President, or higher (unless statement authorizing signature is attached).

Notary: Signature(s) must be notarized.

C. Manufacturer's Certificates.

1. When specified in individual Specification Sections or as required by this Section, submit manufacturer's certificate to Engineer for review, in quantities specified for Product Data. Manufacturer's certificates are not required when a Performance Affidavit is required.
2. Certify that all materials used in work comply with all specified provisions or exceed said provisions. Submit supporting reference data, affidavits, and certifications as appropriate. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer. Certification shall not be construed as relieving Contractor from responsibility to furnish satisfactory materials if, after tests are performed on selected samples, material is found not to meet specified requirements.
3. Show on each certification name and location of work, name and address of Contractor, quantity and date or dates of shipment or delivery to which certificate applies, and name of manufacturing or fabricating company. Certification shall be in form of a letter or company - standard forms containing all required data. Certificates shall be signed by an officer of manufacturing or fabricating company.
4. In addition to above information, all laboratory test reports submitted with certificate of compliance shall show date or dates of testing, specified requirements for which testing was performed, and results of test or tests.

D. Transportation and Handling.

1. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete. Allow time for inspection prior to installation.
2. Coordinate deliveries to avoid conflict with work, conditions at site, work of subcontractors, work of Owner, and availability of personnel and handling equipment.
3. Transport and handle materials and equipment in accordance with manufacturer's instructions and by methods to avoid Product damage; deliver in undamaged condition in manufacturer's original unopened containers or packaging, dry, with identifying labels intact and legible. Labels shall clearly identify contents and net weight of container.
 - a. Where delivery in original manufacturer packaging is not practical, provide cover and shielding for all items with protective materials to keep them from being damaged.
4. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Ship equipment, material, and spare parts complete, except where partial disassembly is required by transportation regulations, or for protection of components.

5. All equipment shall be suitably boxed, crated, or otherwise protected during transportation.
6. Promptly inspect shipments at time of delivery to ensure that materials and equipment comply with project specifications, requirements and shop drawings, quantities are correct, and products are undamaged. Equipment and materials damaged or not meeting project requirements shall be immediately returned for replacement or repair by manufacturer. Contractor shall not be permitted to make repairs. Notify Engineer or any products received in damaged conditions or not meeting project requirements. No damaged products or products not meeting project requirements shall be installed. Owner and Engineer, in conjunction with equipment manufacturer, shall decide if equipment shall be repaired or replaced.
7. Provide equipment and personnel to handle materials and equipment by methods to prevent soiling, disfigurement, or damage. Protect sensitive equipment and finishes against impact, abrasion, and other damage.
8. Lifting and handling drawings and instructions furnished by manufacturer or supplier shall be strictly followed. Slings and chains shall be padded as required to prevent damage to protective coatings and finishes.
9. Items such as nonmetallic pipe, nonmetallic conduit, etc. shall be handled using nonmetallic slings or straps.
10. Pack all spare parts in separate containers bearing labels clearly designating contents and equipment for which they are intended.
11. Deliver spare parts at same time and primary equipment. Contractor shall deliver all spare parts to Owner prior to Substantial Completion.
12. Prior to delivery to site of any material listed as toxic or hazardous, Contractor shall submit to Owner one (1) copy of Material Safety Data Sheet (MSDS) for material. In addition, one (1) copy of MSDS for each item of material shall be prominently posted on outside of storage area in a manner which protects sheets from weather.

E. Storage and Protection.

1. Store and protect materials and equipment from loss or damage in accordance with manufacturer's instructions.
2. Store with seals and labels intact and legible.
3. Provide equipment and personnel to store materials and equipment by methods to prevent soiling, disfigurement, or damage.
4. During interval between delivery of equipment to site and installation, all equipment whether new or pre-existing Owner equipment being relocated, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.
5. Finished iron or steel surfaces not required to be painted, such as flange faces, shall be properly protected to prevent rust, corrosion and damage.
6. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust

damage. Connect and operate continuously space heaters furnished in electrical equipment.

7. Unless specified otherwise in individual equipment or material specification, equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing sealed enclosure.
8. Cover materials and equipment subject to deterioration with impervious sheet covering. Tarps and other coverings shall be supported above stored equipment or materials on wooden strips to provide ventilation under cover and minimize condensation. Outdoor supports shall be sloped to prevent ponding of water.
9. Contractor shall be responsible for providing satisfactory storage facilities which are acceptable to Engineer. In event that satisfactory facilities cannot be provided on site, satisfactory warehouse, acceptable to Engineer, shall be provided by Contractor for such time until equipment, materials, and products can be accommodated at site.
10. Equipment, materials, and products which are stored in a satisfactory warehouse acceptable to Engineer shall be eligible for progress payments as though they had been delivered to job site.
11. Store loose granular materials on solid, flat surfaces in a well-drained area. Prevent mixing with foreign matter.
12. Provide lubricants and perform initial lubrication and all subsequent lubrication until Substantial Completion. Lubricants and lubrication shall be in accordance with equipment manufacturer's instructions.
13. Limit size and maintain stockpiles of construction materials in such a manner that they shall not block existing drainage or be hazardous to pedestrian or vehicular traffic in any way. Limitation relative to stockpiling of construction materials shall be controlled by Owner and Engineer. In event Contractor fails to satisfactorily modify his operations relative to stockpiling of construction materials upon order of Owner or Engineer, all Work except clean-up operations shall be stopped, and remain stopped, until order of Owner or Engineer has been complied with.
14. Unless otherwise permitted in writing by Engineer, building products and materials such as cement, grout, plaster, gypsum board, particleboard, resilient flooring, acoustical tile, paneling, finish lumber, insulation, wiring, etc., shall be stored indoors in a dry location. Building products such as rough lumber, plywood, concrete block, and structural tile may be stored outdoors under a properly secured waterproof covering.
15. Mechanical, electrical, and plumbing equipment shall not be staged or stored outdoors unless equipment intended for outdoor use.
16. All piping and ducts shall be stored to keep them free of dirt and debris.
17. Protect plumbing fixtures and brass- or chromium-plated trim, valves, and piping from damage. Cover fixtures during work of finishing trades.
18. Cover factory finished equipment during work of finishing trades, such as fan coils, fin tubes, etc.
19. Protect cooling and/or heating coils with temporary filter media during construction.

20. Arrange storage of materials and equipment to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
 21. Contractor shall be responsible for maintenance and protection of all equipment, materials, and products placed in storage and shall bear all costs of storage, preparation for transportation, transportation, re-handling, and preparation for installation.
 22. See individual sections for special requirements.
 23. Evidence of damage from water or other contaminants shall be cause for rejection.
 24. Materials and equipment shall be delivered and stored in such a manner as to not block access to public or private property, disrupt Owner's access for operation or maintenance of his facility or interfere with safety access or equipment.
 25. Unless stated otherwise in these Contract Documents, Owner has no indoor space available for storage of material or equipment.
 26. Location of Contractor's on-site storage facilities shall be coordinated with Owner. Contractor shall be responsible for unloading and moving materials and equipment and shall not assume that Owner has equipment available for that purpose.
 27. Contractor shall maintain all storage areas, and any other area where materials are being used, in a safe, orderly, neat and clean condition. Materials shall be kept in their original containers until ready for immediate use and shall be segregated. Containers shall be kept covered and only approved containers shall be used for storage, transport, mixing or cleaning. Empty containers shall be disposed of off-site on a regular basis. Cleaning materials and dirty rags shall not be permitted to accumulate on site or in storage areas.
- F. Noise Criteria – Unless otherwise specified, noise levels for all operating equipment shall not exceed 90 dB at 5 feet from equipment and 75 dB at 50 feet from equipment when measured on A scale of a calibrated sound level meter at slow response and 70 dB when measured from adjacent property line(s). Noise criteria shall be met without use of special external barriers or enclosures.
- G. Equipment Installation.
1. Contractor shall field verify all dimensions and elevations and shall notify Engineer of any specific differences.
 2. Install all equipment strictly in accordance with recommendations of manufacturer and in accordance with these Contract Documents. Notify Engineer in writing of any conflicts between Contract Documents and manufacturer documentation, requirements, or recommendations before proceeding with work.
 3. Provide all necessary equipment (including temporary equipment, measuring devices, etc.), materials (including temporary materials, lubricants, chemicals, etc.) and labor necessary for initial system startup, testing, and operation. Grades of oil and grease for all equipment shall be in accordance with recommendations of equipment manufacturer. Contractor shall account for fact that many of other plant systems may or may not be online when equipment is started up and tested
 4. Contractor shall be responsible for ensuring that all equipment is rigidly and accurately anchored into position. Contractor shall be responsible for providing all necessary foundation bolts, plates, nuts, washers, and other fasteners not provided by equipment manufacturer.

5. Equipment manufacturer shall provide Contractor with engineering and technical support related to specified equipment, and participate in commissioning, startup, testing, and training of Owner's personnel as required by Contract Documents and as necessary to allow Contractor to provide a complete and operable system. Refer to other portions of this Section and individual equipment specification sections for additional details and requirements.
6. Provide jointly to Owner and Engineer, in accordance with this Section, a complete Equipment Start-up Report and Certification form found in Section 01 99 00 executed by equipment manufacturer or their approved representative stating that equipment has been properly installed, tested to their satisfaction, that all final adjustments required have been made, and equipment shall be warranted as required by individual equipment specification requirements.

H. Field Tests.

1. Preliminary and final field tests shall all be done in presence of Engineer and equipment manufacturer or their approved representative.
2. All testing instruments and gauges necessary for conducting tests shall be furnished by Contractor. Installed instruments and gauges shall be used whenever possible if calibrated and approved for purpose. Calibrate all installed instruments and gauges and attach a cloth tag showing date of calibration. Portable test equipment used in field testing shall be calibrated in presence of Engineer or suitable written evidence attesting to accuracy of equipment shall be submitted.
3. All equipment shall be tested before it is covered or insulated. All accessory equipment which may be damaged by conditions during test shall be isolated or otherwise protected.
4. Preliminary Field Tests: Preliminary tests shall be made after installation of equipment. Contractor shall furnish all labor, materials and instruments to perform all preliminary field tests of equipment. Make all changes, adjustments and replacements required to comply with requirements of Contract Documents. Demonstrate that:
 - a. Equipment is properly installed in location and orientation specified these specifications or shown on Drawings.
 - b. Units are in proper alignment.
 - c. Equipment is prepared for operation in strict accordance with Contract Documents and with manufacturer's recommendations.
5. Final Acceptance Tests: Perform final tests prior to startup. Provide services of manufacturer's representative if required by Schedule of Equipment Testing and Manufacturer's Services or in individual equipment specification section. Unless otherwise specified in detailed equipment specifications, Contractor shall furnish all labor, materials, water, air, oil, power, fuel, chemicals, test equipment, and other items required to conduct field tests, including any retests. Furnish equipment and instruments, including pressure gauges and flow meters, necessary for all acceptance tests even if that equipment is not part of final installation. Schedule final acceptance test to consist of following checks as a minimum:
 - a. That equipment is properly installed, lubricated, adjusted and aligned.
 - b. That equipment meets all specified performance requirements in every detail and performs its intended function without any unusual vibration, noise or other signs of possible malfunction, such as overloading or overheating of any parts.

- c. Perform motor field tests as specified in Section 11 05 13. Tests shall verify that all no time while equipment was tested under specified performance requirements that motors were overloaded.
 - d. Where equipment is capable of operation in more than one mode or equipment performs more than one function, each operational mode or function shall be checked for proper performance.
 - e. All controls, both mechanical and electrical, shall be checked individually for proper connection and operation.
 - f. That there are no mechanical defects in any of parts.
 - g. All field tests shall be conducted with clean water from public water supply system. Contractor shall provide all temporary flow measurement devices as necessary to achieve accurate measurement of pumped flow during field tests.
 - h. Units can pass size of solids specified and type of liquid for which units are to be used.
- 6. Promptly adjust, repair, modify, or replace any components of system which fail to meet all specified requirements at no additional cost to Owner. Retest entire system after adjustments, repairs, modifications, and replacements have been made. Repeat adjustment/repair/modification/replacement and testing procedure until all issues are resolved and system operates in full compliance with Contract Documents and equipment manufacturer's specifications and requirements and results are acceptable to Engineer. All such work shall be at Contractor's expense. Owner and Engineer shall review and approve of any modifications proposed by Contractor necessary to correct any issues prior to work commencing.
 - 7. All testing and all adjustments, repairs, modifications, or replacements necessary to bring equipment into compliance with Contract Documents shall be at Contractor's expense.
 - 8. If Contractor fails to make these correction, or if improved equipment again fails to meet guarantees or specified requirements, Owner, notwithstanding his having made partial payment for work and materials which have entered into manufacture of said equipment, may reject said equipment and order Contractor to remove it from premises at Contractor's expense.

1.18 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Contractor's Options.

- 1. Products Specified by Reference Standards or by Description Only: Select a product meeting those standards or description.
- 2. Products Specified by Naming One or More Manufacturers with a provision of substitution. Select a specified product or submit a request for substitution for a manufacturer not specifically named.
- 3. Products Specified by Naming Several Manufacturers: Select product of a named manufacturer meeting specifications.
- 4. Product specified by naming only one manufacturer: Provide product specified.

B. Limitations of Substitutions.

1. Submit requests for substitutions within 15 days after effective date of Owner-Contractor Agreement, and prior to issuance of subcontracts or purchase orders. Requests made after this stipulated period shall not be considered; Contractor shall provide specified products. Requests made prior to Bid Opening date shall not be considered unless stated otherwise in product detailed specification section.
2. Requests for substitutions after stipulated time period shall only be considered in case of product unavailability or other conditions beyond control of Contractor. Contractor shall submit written evidence of product unavailability or other conditions with request for substitution.
3. Substitutions shall not be considered when indicated on shop drawings or product data submittals without separate formal request, regardless of whether request is made by prime Contractor or any subcontractors, or when acceptance shall require substantial revision of Contract Documents.
4. Do not order or install substitute products without written acceptance.
5. Only one request for substitution for each product shall be considered. When substitution is not accepted, provide specified product.
6. Engineer shall determine acceptability of substitutions.

C. Contractor's Representation.

1. In making request for substitution, Contractor represents:
 - a. He has personally investigated proposed product or method, and determined that it is equal to or superior in all respects, including performance requirements, basic function, and quality, to that specified or credit or addition offered represents a fair or superior difference in value.
 - b. He shall provide same warranty for substituted product as for product or method specified, unless substitution has a superior warranty.
 - c. He shall coordinate installation of accepted substitution into Work, making such changes as may be required for Work to be complete in all respects with no additional cost to Owner.
 - d. He waives all claims for additional costs or time extension related to substitution which may subsequently become apparent.
 - e. Cost data is complete and includes all related cost under his contract.
 - f. He shall reimburse Owner costs incurred by Owner for review and any subsequent redesign services by Engineer, including Engineer's revisions to Contract Documents, and Engineer's assistance in connection with review by authorities when re-approval is required, if Engineer determines that item of material or equipment proposed by Contractor is a substitute item.
 - g. Proposed substitution does not affect dimensions shown on Drawings.
 - h. Any fees and royalties associated with proposed substitution shall be paid by Contractor.
 - i. Maintenance and service parts shall be locally available for proposed substitution.
 - j. Proposed substitution shall have no effect on applicable codes.

D. Requests for Substitutions.

1. All submittals shall comply with this Section.
2. Submit digitally request for substitution to Engineer for review and approval.
3. Limit each request to one product. Requests concerning more than one product shall be rejected and not reviewed.
4. Submit request that contains complete data substantiating compliance of proposed substitution with Contract Documents. Submittals shall include, as appropriate, following information on proposed substitution:
 - a. Complete dimensional information and technical data, including drawings, samples, and laboratory tests.
 - b. Complete information on changes to drawings, specifications, and other elements of work which proposed substitution shall require for its proper installation
 - c. Complete side-by-side comparison of qualities of proposed substitution with that specified. Comparison shall definitively show that substitution is at a minimum equivalent to or superior in terms of quality, performance, and appearance than specified product. Samples and other substantiating data shall be provided for review. Clearly mark manufacturer's literature to indicate equality in performance. Differences in quality of materials and construction shall be indicated and justified. Failure to provide side-by-side comparison shall result in substitution being rejected without review.
 - d. Effect on construction schedule.
 - e. Cost data comparing proposed substitution with product specified. Provide an itemized estimate of all costs or credits that shall result directly or indirectly from acceptance of proposed substitution.
 - f. Any required license fees or royalties.
 - g. Availability of maintenance service, and source of replacement materials.
 - h. List of names, locations, and telephone numbers of three (3) similar projects on which proposed product was used, date of installation, Engineer's name and telephone number, and Owner's name and telephone number.
5. Identify product by Specifications section number. Provide manufacturer's name and address, trade name of product, and model or catalog number. List fabricators and suppliers as appropriate.
6. Attach shop drawing and other product data as specified herein.
7. Engineer shall review requests for substitutions with reasonable promptness, and notify Contractor, in writing, of decision to accept or reject requested substitution. Failure to object to a listed item shall not constitute a waiver of requirements of Contract Documents.

1.19 STARTING OF SYSTEMS

A. System Startup.

1. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
2. Verify that tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
3. Verify that wiring and support components for equipment are complete and tested.
4. Execute startup under supervision of responsible manufacturer's representative in accordance with manufacturers' instructions.
5. Verification that all final acceptance tests have been performed.
6. Verification that all piping and valves have been properly tested, disinfected as necessary, and labeled in accordance with appropriate sections of Specifications.
7. Verification that all safety equipment is installed and fully functional.
8. Verification that all indicating and annunciating systems are installed and fully functional.
9. Verification that all utilities are operable.
10. Verification that all equipment Operations and Maintenance Instruction manuals are available to Owner. Startup shall not commence until approved manuals have been provided to Owner.
11. 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.
12. Equipment manufacturer and Contractor shall make adjustments to equipment and related appurtenances at Contractor's expense until equipment meets or exceeds specified requirements with test data to confirm compliance. If adjustments cannot be made to allow equipment to meet specified requirements, provide written explanation for why equipment that fails to meet specified requirements.
13. Complete training, instruction, and demonstrations to Owner's personnel.
14. Submit a written report with all test data, including failed testing, in accordance with this Section indicating that equipment or system has been properly installed and is functioning correctly. Submit completed "Equipment Startup Report and Certification" form found in Section 01 99 00 for each piece of equipment.

B. Demonstration and Instructions.

1. Complete demonstrations to and instructions of Owner's personnel before commencing Equipment Startup Period.
2. Coordinate demonstration and instruction schedule with Engineer and Owner for various equipment and systems.
3. Demonstrate operation and maintenance of Products to Owner's personnel prior to date of Substantial Completion.

4. Demonstrate project equipment by a qualified manufacturer's representative who is knowledgeable about Project.
5. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
6. Demonstrate start up, operation, control, adjustment, trouble shooting, servicing, maintenance, and shutdown of each item of equipment.
7. Amount of time required for instruction on each item of equipment and system, as well as any specialized instruction, is that specified in individual sections.
8. For each demonstration and instruction session, execute "Training Attendance Record" form found in Section 01 99 00 and provide pdf to Engineer in conformance with this Section.

C. Services of Manufacturers Representative.

1. Unless stated otherwise in individual specification sections, arrange for equipment manufacturer to furnish services of a certified and qualified representative of manufacturer to provide services described herein and elsewhere in these Contract Documents. Representative shall be a direct full-time employee of manufacturer. Manufacturer shall obtain written approval of Engineer prior to using anyone as a representative that is not a direct, full-time employee of manufacturer.
2. Factory representatives shall arrive at site with all tools, instruments, equipment, documentation or other materials necessary to perform required services.
3. Duration of visits is described in individual specification sections. Where no specific duration of visit is listed, length of time shall be such to allow equipment representative ample time to follow requirements outlined in this Section and individual technical section covering particular equipment item. Times indicated in schedule shall be actual on-site time performing indicated tasks. Travel time and time spent at site if not properly prepared or equipped to perform required service shall not be charged against allotted on-site time. If manufacturer does not fully utilize allotted time for representative, manufacturer shall provide a credit to Owner for those unused services or schedule a return of a representative for unused time during period or periods after Substantial Completion agreeable to Owner.
4. Within 30 days of Notice to Proceed, Contractor shall submit a detailed schedule of training to be performed by manufacturer's representatives in accordance with specifications for Owner's and Engineer's review. Training schedule shall identify equipment on which training needs to take place, and training dates, times, and personnel involved.
5. All training shall be performed so as to occur between 7:00 a.m. to 3:00 p.m. Eight hours of on-site service time from manufacturer's representative shall constitute one day of service. Dates and times for training shall be coordinated with Owner in advance and shall be performed on dates and at times convenient for Owner's personnel to be present.
6. Training schedule shall be updated monthly by Contractor.
7. Upon completion of training on each piece of equipment, complete Equipment Training Certification form found in Section 01 99 00.
8. Installation Service – Check and certify installation, recommend or make adjustments and change calibrations for optimum performance and supervise initial operation and field

testing of equipment. Supervise correction of any defective or faulty work before and after acceptance by Owner.

9. Final acceptance – Supervise equipment startup, field testing, final acceptance testing, and performance testing in accordance with this Section. Services shall include, as necessary, on-site presence of a qualified PLC programmer to assist in any required changes in equipment controls programming.
10. Instructions – Instruct Owner’s operating and maintenance personnel in operation and proper maintenance and repairs of equipment. A written report by representative covering instructions given shall be sent to Owner, Engineer and Contractor.
11. Certification of Equipment Compliance – Submit written certification jointly to Owner, Engineer and Contractor that equipment supplied or manufactured by their organization has been installed and tested to their satisfaction, and that all final adjustments thereto have been made. Certification shall include date of final acceptance field test, as well as a listing of all persons present during tests.

D. Materials, Supplies, and Utilities.

1. Special tools for maintenance and minor repairs, spare parts, etc. shall be furnished in accordance with other sections of Specifications. Contractor’s mechanics shall have adequate tools on hand to supplement requirements of this Section.
2. All electric and other utilities required during startup and initial operation, until issuance of Certificate of Substantial Completion, shall be provided by Contractor.
3. All consumables, including chemicals, fuel oil, parts, etc. related to any of systems to be started shall be supplied by Contractor at his cost until equipment has been successfully started, all required documentation supplied to Engineer and approved, and a Certificate of Substantial Completion issued.

E. Equipment Performance Period.

1. Unless otherwise specified in Contract Documents, each and every item of equipment shall be operated in service without failure for a "performance period" of fourteen (14) calendar days, as a condition for substantial completion. For items of equipment which are part of a system, all items of equipment in system, must undergo performance period simultaneously.
 - a. Performance period may not commence until following have been completed:
 - 1) All process tankage and piping has been leak tested with clean water. Leak testing is required for new systems as well as modified existing systems unless otherwise noted.
 - 2) Equipment manufacturers have certified installation and provided startup reports describing equipment operates as intended and in full conformance with Contract Documents;
 - 3) All controls, alarms, and telemetry are operational;
 - 4) All equipment wiring, piping, etc. have been labeled;
 - 5) All safety equipment is installed and fully functional;
 - 6) All equipment-related operations and maintenance manuals have been reviewed and accepted by Engineer in accordance with this Section; and

- 7) All equipment training for Owner's personnel has been completed in accordance with this Section and individual equipment sections.
- b. Equipment and systems shall operate continuously without failure to perform or interruption due to equipment malfunction of any kind for entire performance period to be considered acceptable. For equipment, such as pumps, that may normally cycle on and off while in service, or equipment which is only utilized for parts of a day in normal service, performance period is overall in-service time, including normal off cycles.
 - c. If an item of equipment fails for any reason during performance period, or fails to perform in accordance with specifications during performance period, performance period shall start over from "zero" upon Contractor correcting issue(s).
 - d. Contractor shall be responsible for all operation and preventive, routine and corrective maintenance of equipment during performance period, including responding to any alarms or failures during both normal working and non-working hours, 24 hours per day, seven days per week.
 - 1) If an item of equipment or a system develops a problem or fails during performance period, Contractor shall immediately respond, troubleshoot and correct issue(s) or switch to a backup.
 - 2) Contractor shall provide a legible, detailed, daily maintenance and operation log for all operating equipment, from time equipment is operational until Substantial Completion. Documented data shall include date, equipment description, model number, serial number, hours of operation, and maintenance schedule. Logs shall be made available for Owners and Engineers review.
 - 3) If, in opinion of Owner and Engineer, Contractor fails to respond in a timely and effective manner, and if such failure may damage other equipment or facility or adversely affect treatment process or service to public, Owner's personnel may respond and take necessary corrective action. Cost to Owner of any such response and action shall be deducted from monies otherwise due Contractor.
 - 4) Owner shall not be obligated to respond, and such response or non-response by Owner shall not relieve Contractor from liability for damage to public or private property caused by an equipment failure during performance period, or for making permanent repairs or corrections to failed equipment. Contractor shall not have nor make any claim against Owner for actual or alleged damages to equipment, facility or public or private property due to Owner's response or action or failure to respond or act.
 - 5) Cost of utilities consumed during performance period shall be borne by Owner. Disposal of process related material, such as residuals or sludge, collected or generated during performance period shall be by Owner. Fuel, lubricants parts and chemicals used during performance period shall be provided by Contractor, unless otherwise specified or agreed to in advance.
2. Equipment Performance Testing.
 - a. One criteria for successful completion of Equipment Performance Period for all systems shall be demonstration by Contractor that equipment is capable of meeting following test criteria:
 - 1) All equipment shall demonstrate that they meet or exceed design criteria as specified in their individual specification sections.

- b. Cost of all testing associated with this Equipment Performance Period until successful completion shall be borne by Contractor. Contractor shall be responsible for providing all necessary test equipment, including consumables and equipment not available at facility, to verify compliance with specified test criteria.
 - 1) Testing shall be performed by Contractor's personnel under direct supervision of Owner's personnel.
- 3. During Equipment Performance Period, Contractor shall operate equipment in various modes or combinations as described below. This work shall include, when practical, simulation of extreme conditions so as to check response of control devices, bypass functions, standby power generators, pumping cycles, etc.
 - a. Process Variations:
 - 1) With and without use of Water Well No. 7
 - 2) With and without use of Water Well No. 9.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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SECTION 01 51 00

TEMPORARY CONSTRUCTION FACILITIES AND UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Mobilization.
2. Construction Work Area.
3. Material Storage Areas.
4. Equipment Storage Area.
5. Temporary Sanitary Facilities.
6. Temporary Fence.
7. Access Roads.
8. Parking.
9. Maintenance of Traffic.
10. Progress Cleaning.
11. Temporary Buildings.
12. Removal of Temporary Facilities and Utilities.
13. Responsibility for Temporary Facilities and Utilities.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 32 90 00 – Site Rehabilitation

1.02 MOBILIZATION

A. Mobilization shall include, but not be limited to, these principal items:

1. Obtaining required permits.
2. Moving field offices and equipment required for first month of operation onto Site.
3. Installing temporary construction power, wiring and lighting facilities.
4. Providing onsite communication facilities, include telephones and internet where specified.

5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations and governing agencies.
 6. Arranging for and erection of Contractor's storage and staging area.
 7. Posting OSHA required notices and establishing safety programs and procedures.
 8. Post funding agency required notices.
 9. Having Contractor's superintendent at Site full time.
- B. Use area indicated on Drawings, or if not shown on Drawings, coordinate area to be used with Owner.

1.03 CONSTRUCTION WORK AREA

- A. Contractor shall limit his operations, storage of equipment and materials, and parking of his employees to areas designated on Contract Drawings and as directed by Engineer.
- B. Contractor shall maintain work area in a manner that shall not obstruct operations or traffic flow of existing facilities nor interfere with existing facilities operations. Where operations require trenching across access roads, Contractor shall provide temporary roads as required to prevent disruption of access. Contractor shall proceed with his work in an orderly manner, maintaining construction site free of debris and unnecessary equipment or materials.
- C. Contractor shall limit his construction operations to work area shown on Contract Drawings. Temporary Contractor work office and storage buildings, equipment and material storage areas, and parking for employees shall be limited to Construction Staging and Equipment Storage Areas described below, except as otherwise approved by Owner and Engineer.
- D. Temporary gravel surfacing and maintaining of access roads and building, storage, and parking areas, within designated staging and storage areas, shall be furnished by Contractor.
- E. Any connections made by Contractor to any utility systems shall be in accordance with all applicable codes and standards, shall be arranged to prevent disruption or damage to facility or hazard to personnel and shall be approved by Owner in advance. Any fees, including permit fees, associated with any utility connections shall be at expense of Contractor.
- F. Contractor shall be responsible for providing and maintaining all temporary facilities necessary for proper, safe and efficient performance of work and for safety, health and welfare of personnel.
- G. Existing Owner facilities may be used, except as otherwise stipulated herein, only if agreed to by Owner. Contractor shall assume in his bid that all temporary facilities shall be provided and maintained by Contractor at no additional expense to Owner. Any of Owner's facilities used by Contractor to provide temporary services shall be cleaned or restored by Contractor to satisfaction of Owner prior to substantial completion at no additional expense to Owner.

1.04 MATERIAL STORAGE AREAS

- A. Contractor is solely responsible for safety and security of material storage area. Temporary fencing shall be constructed at Contractor's expense.
- B. Use of any area other than designated area for material storage must be approved by Owner and Engineer.
- C. If on-site storage areas are inadequate for Contractor's operation, Contractor shall be responsible for finding additional storage areas off-site at no additional cost to Owner.

1.05 EQUIPMENT STORAGE AREA

- A. Contractor shall erect or provide, as approved by Engineer, temporary storage facilities as required for protection of mechanical and electrical equipment and materials as recommended by manufacturers of such equipment and materials. Storage facilities shall be within construction and/or material storage areas described above. Storage facilities shall be provided with such environmental control systems that meet recommendations of manufacturers of all equipment and materials stored. Facilities shall be of sufficient size and so arranged or partitioned to provide security for their contents and ready access for inspection and inventory. At or near completion of work under this Contract, and as directed by Owner and Engineer, temporary storage facilities shall be dismantled, removed from site, and remain property of Contractor.
- B. Combustible materials (paints, solvents, fuels, etc.) shall be stored in a well-ventilated facility removed from other facilities and buildings.
- C. If on-site storage areas are inadequate for Contractor's operation, Contractor shall be responsible for finding additional storage areas off-site at no additional cost to Owner.

1.06 TEMPORARY SANITARY SERVICES

- A. Contractor shall provide and maintain sanitary facilities and enclosures for his employees, employees of subcontractors, and employees of Engineer during construction period. Facilities shall comply with regulations of local and state health departments and other applicable regulations and ordinances.
- B. Facilities shall be provided at time of mobilization.
- C. Waste from portable sanitary facilities located in construction offices shall be connected to existing sewer system. If not connected, Contractor shall keep sanitary tanks pumped.
- D. Waste contents shall be removed and disposed of in satisfactory manner by Contractor as occasion requires.
- E. Contractor's plans for handling all sanitary wastes shall be approved by Engineer.
- F. Contractor shall pay for all materials, equipment, installation, and maintenance of temporary sanitary facilities.
- G. Contractor shall remove facilities from site at end of construction.
- H. Contractor shall enforce sanitary regulations amongst employees and take precautions against infectious diseases as deemed necessary. Isolate infected employee(s) and arrange for immediate removal of such person(s) from site.
- I. Use of Owner's facilities during construction is not permitted.

1.07 TEMPORARY FENCE

- A. If during course of work it is necessary to remove or disturb any existing site fence or part thereof, Contractor shall provide and maintain a suitable temporary fence at his own expense.
- B. Contractor shall provide additional fencing as necessary to protect work and prevent unauthorized access to work areas and to delineate construction areas from public usage areas for safety purposes.

1. Contractor shall provide a 6-foot high fence around construction site; equip with vehicular gates with locks. Necessary posts and supports shall be provided to maintain fence in vertical position without sagging.
2. Construction - Commercial grade chain link fence.
3. Fence shall be in place, complete and secured, prior to adjacent construction activity and shall be maintained throughout work. Fence shall be removed when adjacent work has been completed.
4. If Owner's security fence is disturbed, original fence or similar new fence of same height and design shall be installed at end of each work day until original fence is permanently repaired to satisfaction of Owner and Engineer.

C. Refer to Section 01 00 05 for additional controls and other requirements for fencing.

1.08 ACCESS ROADS

- A. Designated existing on-site roads may be used for construction traffic.
- B. Contractor shall provide and maintain temporary access roads to project site as follows:
 1. Construct roads on Owner's property or along designated rights-of-way to connect public thorough fare(s) with construction area.
 2. Extend and relocate roads as work progress requires. Provide detours as necessary for unimpeded traffic flow.
 3. Roads shall be free for use by all personnel involved in project, and be adequate for transportation of persons, materials, equipment and products to construction area.
 4. Maintain roads in serviceable condition, free of obstructions, potholes, ponded water, debris, accumulated snow and ice, until completion of project or until permanent access roads are installed.
 5. When no longer required, remove roads and restore areas to original site conditions.

1.09 PARKING

- A. Contractor shall arrange and coordinate with Owner and Engineer for surface parking areas to accommodate all construction personnel involved with project on Owner's property.
- B. When Owner's site space is not adequate, Contractor shall provide additional off-site parking at no additional cost to Owner.
- C. No parking shall be allowed in areas of Owner's property not specifically designated by Owner for such purpose.
- D. Designate one parking space for Engineer and identify same with appropriate signs for space.
- E. All staging and parking areas utilized during construction shall be restored in accordance with Section 32 90 00.

1.10 MAINTENANCE OF TRAFFIC

- A. Contractor shall maintain and regulate traffic within Contract Limits in accordance with all applicable state, county, and local regulations.
- B. Conduct operations so as to maintain and protect access for vehicular and pedestrian traffic to and from properties adjoining or adjacent to those streets and roads affected by construction activities, and to subject public to a minimum of delay and inconvenience.
- C. Erect suitable signs, barricades, railings, etc., including warning lights, to alert traveling public. Danger lights shall be provided by Contractor as required. Provide trained watchmen and flagmen as necessary to maintain and regulate traffic. Provide detours, temporary roadways and walkways or other facilities as required by owner of roadway on which travel may be obstructed as a result of Work.
- D. Plan operations so that access to any dwelling, building or hospital is assured in case of fire or other emergency. Review with and obtain approval from local fire and police departments and other local emergency services regarding anticipated detours and obstructions to traffic flow which could hinder passage of fire apparatus, ambulance or otherwise.
- E. Notify police, fire, and other emergency services, local departments of public works, and school dispatchers prior to each day's work if operations shall disrupt traffic in any way.
- F. Not more than one block nor more than one cross-street intersection may be torn up, obstructed or closed to travel at one time without permission of Owner.
- G. When normal route of vehicular access to any property must be temporarily obstructed, notify affected property owner at least 24 hours in advance of intended operations at location. Route shall subsequently be re-opened not later than one day following start of construction at that location, unless special arrangements have been made with property owner. Vehicular access to hospitals, fire and police departments must be provided at all times.
 - 1. If required by property owner, Contractor shall provide alternate means of access, at no additional cost to Owner or property owner.
- H. Contractor shall keep roads clear of materials and debris to fullest extent possible due to construction activities.

1.11 PROGRESS CLEANING

- A. Contractor shall maintain areas free of waste materials, debris, and rubbish. Maintain site and structures in a clean and orderly condition, as follows:
 - 1. Remove debris and rubbish from pipe chases, plenums, attics, crawlspaces, and other closed or remote spaces, prior to enclosing space.
 - 2. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
 - 3. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off site.
 - 4. Prior to removal, rubbish shall be placed and stored in approved containers, such as "dumpsters," provided by Contractor. Owner's facilities shall not be used.
 - 5. On-site burning shall be permitted only with a local permit and then only with permission of Owner. Burying of rubbish shall not be permitted.

- B. Contractor and subcontractors shall store unused tools and equipment at his yard or base of operations.
- C. Roads adjacent to work sites shall be kept clean of mud, dirt, and debris from construction operations. Contractor shall, on a daily basis as necessary, clean adjacent roads of debris and as ordered by Owner and other authorities having jurisdiction over roads.

1.12 TEMPORARY BUILDINGS

- A. Exterior Enclosures
 - 1. Contractor shall provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self closing hardware and locks.

1.13 REMOVAL OF TEMPORARY FACILITIES AND UTILITIES

- A. At such time or times that any temporary construction facilities and utilities are not longer required for work, Contractor shall notify Owner and Engineer of his intent and schedule for removal of temporary facilities and utilities and obtain Owner's and Engineer's written approval before removing same. As approved, Contractor shall remove temporary facilities and utilities from site as his property and leave site in such condition as specified in Section 32 90 00, as directed by Owner and Engineer, and/or as shown on Contract Drawings.
- B. Site shall be left in a condition that shall restore original drainage, be evenly graded, and be left with an appearance equal to, or better than, before temporary facilities or utilities installed.
- C. Remove all temporary gravel surfaced areas, construction debris and rocks constructed under this Contract, within designated staging areas for temporary buildings, storage, and parking areas, except as approved by Owner and Engineer. Any rock larger than 2 inches in any dimension shall be removed. Entire area shall be covered with a minimum of 4 inches of topsoil. Area shall have seed and straw in accordance with Section 32 90 00. All temporary power, water, sewer and data facilities shall be removed.
- D. All temporary facilities and utilities shall be removed and restoration complete prior to Final Application for Payment at latest.

1.14 RESPONSIBILITY FOR TEMPORARY FACILITIES AND UTILITIES

- A. In accepting Contract, Contractor assumes full responsibility for sufficiency and safety of all temporary structures, facilities, utilities, or work and for any damage which may result from their failure or their improper construction, maintenance or operation and shall indemnify and save harmless Owner and Engineer from all claims, suits or actions and damages or costs of every description arising by reason of failure to comply with above provisions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 77 13

CLOSEOUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Contract Closeout.
2. Cleaning and Restoration.
3. Project Record Documents.
4. Operation and Maintenance Data.
5. Warranties and Bonds.
6. Spare Parts and Maintenance Materials.

B. Related documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 26 – Electrical
3. Division 33 - Utilities
4. Division 40 – Process Integration

1.02 CONTRACT CLOSEOUT

A. Substantial Completion:

1. When Contractor considers Work is substantially complete submit written certification that following are complete and Work is ready for a walkthrough inspection by Owner and Engineer.
 - a. Final cleanup has been completed.
 - b. Contract Documents have been reviewed.
 - c. Work has been inspected by Contractor for compliance with Contract Documents.
 - d. Work has been completed in accordance with Contract Documents and ready for inspection by Owner and Engineer.
 - e. Equipment and systems have been started up, tested, adjusted and balanced, as applicable, and are fully operational.
 - f. Equipment operational period, if required, has been successfully completed.
 - g. Operation of systems has been demonstrated to Owner's personnel.

- h. Certifications that any outstanding work can be entirely complete within 60 days of request for substantial completion.
 - i. All permits from local authorities have been provided to Engineer.
 - j. All temporary facilities have been removed from project site.
2. Contractor shall provide list of any items that need to be completed or corrected at time of certification and reasons for being incomplete.
3. Before Certificate of Substantial Completion is issued, submit to Engineer following or demonstrate to satisfaction of Owner and Engineer that following are in place and functioning reliably in accordance with Contract Documents:
- a. All manufacturer performance affidavits.
 - b. All manufacturer equipment certifications.
 - c. All equipment, structural, piping, mechanical, electrical, and all project components requiring testing has been completed and test data and reports issued to Engineer.
 - d. All lab test reports.
 - e. Manufacturer's certified installation and startup reports.
 - f. Control, alarm, and telemetry systems.
 - g. Painting, including inspection by paint manufacturer in accordance with Section 09 96 00 and labeling in accordance with 10 41 20 and Division 26.
 - h. Final cleaning in accordance with this Section.
 - i. Acceptable means have been provided for safe and efficient access to equipment by Owner's personnel for operation and maintenance, and all required environmental and housekeeping facilities are available (e.g., weather protection, ventilation, heat, light, water for washdown, alarms, platforms, ladders, etc.).
 - j. Record drawings and documents and electrical interconnection data. Provide Record Documents Certification form found in Section 01 99 00 with submittal.
 - k. Equipment operations and maintenance manuals in accordance with this Section.
 - l. Owner's training.
 - m. Spare parts, tools, special tools, and accessories including all spare parts transfer forms.
 - n. Equipment performance periods have been completed.
 - o. All warranties and bonds, including those for specific equipment and systems. Refer to other portions of this Section.
 - p. Contractor's notarized warranty letter, indicating that Contractor guarantees work for one year and provides a one-year warranty to Owner from Date of Substantial Completion for all Work.
 - q. Code inspection reports.

- r. Electrical inspection reports.
 - s. Temporary utilities have been terminated and payments for those services have been satisfied.
 - t. All items salvaged for Owner's future use during demolition have been turned over to Owner.
 - u. All other submittals as required by Contract Documents prior to Substantial Completion.
 - v. Certification that all work items previously itemized to Contractor, whether verbally or in writing prior to issuance of a Punch List, have been completed in their entirety.
 - w. All releases enabling Owner full and unrestricted use of Work and access to all services and utilities.
 - x. Copy of all construction photographs as required by Section 01 00 05.
 - y. Successful equipment startups as described in Section 01 00 05.
 - z. All materials consumed during startup, including spare parts, air filters, grease, oil, etc. have been replaced.
 - aa. Certificate of Property Restoration from each property owner whose land was disturbed during Work. Use form included in Section 01 99 00.
 - bb. Photograph and video release in accordance with Section 01 00 05.
 - cc. All door keys and codes have been turned over Owner.
4. Upon request from Contractor, Owner and Engineer shall proceed with initial walkthrough inspection or advise Contractor in writing of items to be completed before an initial walkthrough inspection shall be made.
 5. Upon initial walkthrough inspection, should Engineer and Owner determine that Work is not substantially complete; Contractor shall be promptly notified in writing listing observed deficiencies.
 6. When deficiencies have been remedied in conformance with General Conditions, Contractor shall submit a second written notice of substantial completion to Engineer.
 7. When Engineer and Owner find Work is substantially complete, Engineer shall prepare a Certificate of Substantial Completion in accordance with provisions of General Conditions, including a Punch List of items to be completed.
 8. Punch List issued as part of Substantial Completion shall list deficient items along with an estimated value to correct items. Value of retainage after Substantial Completion shall be no less than twice estimated value to correct Punch List items.
 9. All warranties and guarantees required by Contract Documents shall commence on Date of Substantial Completion as granted by Owner.

B. Final Acceptance:

1. When Contractor considers Work is complete, submit written certification that:

- a. All deficient Work identified during walkthrough inspection(s) and any subsequent observed deficiencies have been corrected. Use Engineer-prepared Punch List of incomplete or deficient items indicating that each item has been completed. Add to Punch List any items discovered after Certificate of Substantial Completion certificate was issued.
 - b. Work is completed in its entirety and in compliance with Contract Documents and ready for Final Inspection.
2. Contractor shall include copies of all final change order requests with certification of final completion.
 3. Should Engineer and Owner consider that Work is incomplete or defective, Contractor shall be promptly notified in writing, listing observed deficiencies.
 4. When deficiencies have been remedied in accordance with General Conditions, send a second written notice of final completion.
 5. When Engineer and Owner find that Work is acceptable under Contract Documents, Engineer shall issue a Notice of Final Acceptance of Work and consider Application for Final Payment.
 6. All warranties and guarantees required by Contract Documents shall commence on Date of Final Acceptance as granted by Owner.

C. Re-inspection Fees:

1. Should status of completion of Work require re-inspection by Engineer (including his professional consultants) due to failure of Work to comply with Contractor's claims on initial final inspection, Owner shall deduct amount of Engineer's compensation (including that of his professional consultants) for re-inspection services from Final Payment to Contractor.

D. Application for Final Payment.

1. Submit final Application for Payment in accordance with procedures and requirements stated in Conditions of Contract. Final payment shall include all change orders.
2. If required, Engineer shall prepare a final Change Order, reflecting approved adjustments to Contract Sum not previously made by Change Orders.
3. Final Application for Payment shall be accompanied by following documents:
 - a. Contractor's notarized warranty letter, indicating that Contractor guarantees Work for one year from date of Final Acceptance.
 - b. Letter from Contractor certifying that all documents called for in Contract Documents have been supplied to Owner and Engineer.
 - c. Contractor's letter certifying that all materials used in installation and construction of Work comply with Contract Documents.
 - d. Contractor's Affidavit of Payment of Debts and Claims, indicating that Contractor has paid or otherwise satisfied all obligations to suppliers, vendors, laborers, and subcontractors (AIA Document G706).

- e. Contractor's Affidavit of Release of Liens, indicating Contractor and his subcontractors and suppliers release Owner from any liens associated with project (AIA Document G706A).
- f. Affidavit of Release of Liens from every subcontractor and materials supplier, indicating that they release Owner from any liens associated with project (AIA Document G706A).
- g. Waiver of Lien from Contractor and every one of his subcontractors and materials suppliers indicating that once they receive final payment, they waive all their rights to any future liens concerning Work and release any current liens that might be pending.
- h. Statement by Contractor's surety that Performance Bond, Labor and Material Payment Bond, and all other bonds related to project shall remain in force for guarantee period.
- i. Consent of Surety Company to Final Payment (AIA G707).
- j. Renewal Certificates of Insurance showing that Contractor's insurance shall remain in force for two years after final payment.
- k. Evidence of compliance with requirements of governing authorities.
- l. Certification that locations and elevations of Work are in conformance with Contract Documents and indicate any substantive deviations per Section 01 00 05.
- m. All construction photographs not previously turned over to Engineer.
- n. Releases from permitting authorities that all restoration and permit requirements have been satisfactorily completed.
- o. Releases from permitting authorities and property owners shall comply with following:
 - 1) Furnish Engineer written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within Owner's construction right-of-way.
 - 2) In event Contractor is unable to secure written releases:
 - a) Inform Engineer of reasons.
 - b) Owner or its representatives shall examine Site, and Owner shall direct Contractor to complete Work that may be necessary to satisfy terms of side agreement or special easement.
 - c) Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
 - d) When Owner is satisfied that Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that

Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

1.03 CLEANING AND RESTORATION

- A. Execute final cleaning prior to Substantial Completion walkthrough inspection.
- B. Contractor shall leave project site in a condition that is equal to pre-construction condition or better. Acceptance of site shall be compared to photos, videos, and Owner's acceptance of site.
- C. Buildings and Facilities:
 - 1. Employ experienced workmen or professional cleaners for final cleaning.
 - 2. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process shall not fall on wet, newly painted surfaces.
 - 3. Vacuum clean interior building areas when ready to receive finish painting and continue vacuum cleaning on an as-needed basis until building is ready for substantial completion or occupancy.
 - 4. Vacuum and dust inside of cabinets.
 - 5. Clean all lighting fixtures and electrical equipment.
 - 6. Wash and polish all metal surfaces.
 - 7. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces and of concealed spaces.
 - 8. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces; polish surfaces so designated to shine finish.
 - 9. Repair, patch, and touch up marred surfaces to specified finish to match adjacent surfaces for all surfaces marked, soiled, scratched, dented, or otherwise damaged. Surfaces shall include all surfaces installed during Work and surfaces existing before Work but damaged during Work. Damage to finished surfaces shall be repaired to Owner's satisfaction prior to substantial completion.
 - 10. Clean interior and exterior glass.
 - 11. Dust all interior surfaces.
 - 12. Finished floors shall be thoroughly cleaned, sealed, and given a final coat of wax.
 - 13. Clean screens on air intake vents.
 - 14. Replace filters of operating equipment and clean ducts, blowers, and coils of ventilation units operated during construction.
 - 15. Clean debris from roofs, gutters, downspouts, and drainage systems.
 - 16. All exposed piping shall be free of dust or dirt.

17. Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver over such materials and equipment in a bright, clean, polished and new-appearing condition. Use cleaning materials appropriate for surface and material being cleaned.

D. Site Cleanup:

1. Broom clean paved surfaces affected by Work; rake clean other surfaces of grounds.
2. Remove all grease and oil stains on pavement and sidewalks caused by Contractor's equipment.
3. Contractor shall remove from site all plant, material, tools and equipment belonging to him, and leave site with an appearance acceptable to Engineer and Owner.
4. Site shall be free of rocks, stones or pebbles. All disturbed and reseeded areas shall be raked with a rock rake and shall be raked completely in two different directions. All rocks to be removed from site.
5. Any landscape feature scarred or damaged by Contractor's equipment or operations shall be restored as nearly as possible to its original condition at Contractor's expense. Engineer shall decide what method of restoration shall be used.
6. Post-Construction Cleanup or Obliteration
 - a. Contractor shall obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, or any other vestiges of construction.
7. For pipelines, storm sewers, catch basins, manholes, and all building floor drains, prior to their activation or at conclusion of project, Contractor shall thoroughly clean all of new pipes by flushing with water for fluid lines, or compressed air for gas lines. Debris cleaned from lines shall be removed from lowest access point. Water for flushing shall be provided per Section 33 13 00 by Owner. Compressed air shall be provided by Contractor.
8. Refer to Section 32 90 00 for additional details.
9. Restore all parking and staging areas in accordance with this Section and Section 32 90 00.

E. Submittals.

1. Submit completed "Certificate of Property Restoration" form found in Section 01 99 00 for every property damaged during construction executed by each property owner.

F. In event Contractor is required to return to project for warranty work or punch list items, cleaning of area shall be required and shall be cleaned to level that Owner received project.

G. Painting of all equipment shall be performed and Contractor shall paint in accordance with Section 09 96 00 of these specifications. Touch-up painting shall include surface preparation, priming, and finish coats. Spot painting shall not be allowed.

1.04 PROJECT RECORD DOCUMENTS

- A. Records documents shall fully and completely illustrate all work as finally constructed.
- B. In addition to requirements in General Conditions, maintain at site for Owner, one record copy of:

1. Contract drawings.
2. Specifications (Project Manual).
3. Addenda.
4. Reviewed shop drawings, product data and samples.
5. Change orders and other modifications to Contract including Engineer's Field Orders.
6. Testing reports.
7. Field test records.
8. Inspection certificates.
9. Manufacturer's certificates.
10. Fixed equipment manuals.
11. Equipment training certificate.
12. Equipment start-up certificate.
13. Guarantee documentation form.
14. Spare parts transfer form.

C. Recording information.

1. Record information for all disciplines on one (1) set of documents.
2. Make entries within 24 hours after receipt of information that a change in Work has occurred.
3. Legibly mark in red ink or pencil to show all changes in, or directly associated with, Work. Changes shall be so recorded to be suitable for re-production. Keep entire set of drawings current on day-to-day basis.
4. Changes shall be so recorded to be suitable for re-production. Ensure that entries are complete and accurate, enabling future reference by Owner.
5. Record information concurrently with construction progress. Do not conceal any work until required information is recorded. For any concealed items, including all buried, imbedded, or concealed piping or conduit including fixtures, fittings, valves, and accessories, measure location to visible and accessible features of structure.

D. Contract Drawings: Neatly and legibly mark each item to indicate actual construction. Following list shall not be considered an all inclusive list.

1. Indicate any changes to project component locations or elevations.
2. Indicate any additions to deletions of project components.
3. Indicate any relocation of project components from what is shown on Contract Drawings.
4. Denote any area where any existing utility was repaired, replaced or relocated. Show correct location if plan location was incorrect.

5. Note and accurately locate all existing underground utilities encountered during construction, whether shown on Drawings or not.
6. Indicate measured horizontal and vertical locations of all underground utilities, valves, etc. referenced to building exterior lines.
7. Show direction of flow of pipe and depth of piping underground.
8. Include details not on original Contract Drawings.
9. Note change in materials, such as pipe materials, and sizes.
10. Update schematics, schedules, and diagrams.
11. Provide references to related shop drawings and modifications.
12. Show changes in topographical contours of finished earth surfaces.
13. Update detail sheets with details actually used. Add and delete details to reflect actual details utilized.
14. Changes due to changed field conditions.
15. Changes made by Owner or Engineer regardless of whether such changes have been described or noted in other documents such as field orders, change orders, etc.
16. Show correct elevations for inverts and manhole tops: inverts to nearest hundredth and tops to nearest tenth.
17. Specifically for electrical work:
 - a. Accurately record final routing of all ductbanks and handhole locations including dimensions from buildings or other fixed objects as reference points.
 - b. Show actual locations of grounding electrodes.
 - c. Revise motor control center elevation views as required.
 - d. Show branch circuit arrangements on a typed legend for panelboards provided under this Project. Correct existing field legends where modifications are made to existing panelboards.
18. Show distance of pipeline location off edge of pavement at 100 foot intervals.
19. Show corrected stationing and horizontal location dimension for all piping and structures.
20. For Water and Force Main Construction:
 - a. Show unusual connections to existing mains in detail. (Schematic, where necessary).
 - b. Show correct horizontal alignment and grade, including centerline elevations for all mains installed to grade.
 - c. Show correct stationing of tees, bends (horizontal and vertical), valves, air release valves, blow-off chambers.

- d. Show perpendicular distances from hydrant to water main and from hydrant to valve. If connection to water main is by a parallel or over main tee, so indicate this on Record Drawings.
 - e. Show perpendicular distances from valves and other underground accessories to visible and accessible aboveground permanent structures.
- E. Updating of record documents shall be a condition of payment. If Contractor fails to keep copies of record documents up to date at frequency stipulated above, Engineer and Owner shall be authorized to withhold payment until record documents are fully up to date. Engineer and Owner shall be permitted to review record documents as frequently as deemed necessary to ascertain status of record documents, but in no case less than on a monthly basis prior to each progress meeting.
- F. In addition to above requirements, Contractor shall throughout project have record measurement surveys performed as conditions warrant. These surveys shall include rim elevations of all installed new manholes and structures, invert elevation of pipes at manholes and structures, and length of all new pipe as measured between centers of manholes or structures, as well as angles between centerlines of pipes and tie distances, from all utility frames and covers installed by Contractor to a minimum of three fixed objects, with sketches and notes, as appropriate. All measurements shall be made to nearest 0.01 foot.
- G. Project Manual: Neatly and legibly mark each item with felt tip marking pens to record actual construction, including:
 - 1. Changes made by Addenda, Amendments, Modifications, Change Orders, and Field Orders.
 - 2. Manufacturer, trade name and catalog number of each product and item actually installed.
- H. Submittal.
 - 1. Submit at least one copy of record documents to Engineer for review at least 30 days prior to application for Substantial Completion. Deliver documents under provisions of this Section.
 - 2. At request for Substantial Completion, deliver Record Documents and samples under provisions of this Section. Final payment shall not be made until Record Documents are deemed satisfactory by Engineer.
 - 3. Record Documents must include Certification form included in Section 01 99 00.
 - 4. Transmit with cover letter in duplicate, listing:
 - a. Date.
 - b. Project title and number.
 - c. Contractor's name, address and telephone number.
 - d. Title and number of each Record Document.
 - e. Certification that each document submitted is complete and accurate.
 - f. Signature of Contractor or his authorized representative.
 - 5. Engineer may request that Contractor expand on changes noted on Record Documents.

1.05 OPERATION AND MAINTENANCE DATA

A. General Requirements.

1. All equipment, devices or materials furnished by Contractor as a part of work shall be accompanied by all information, instructions and data necessary for proper and complete care, operation, maintenance and repair of equipment, device or material by Owner's personnel. Required information, instructions and data shall be prepared and compiled by manufacturer of equipment, device or material.
2. In addition to any specific requirements of other sections of these Contract Documents, equipment manuals shall be required for any and all items containing moving parts, electric or electronic wiring or components, pneumatic or hydraulic devices or components, or requiring regular or special maintenance, cleaning or lubrication. In addition to major items of equipment, this requirement for submission of equipment manuals is intended to also apply to such items as locksets, door, gate and window hardware, finishes, carpeting and upholstery, furniture, electrical and lighting system components, fixtures and accessories, HVAC system components, fixtures and accessories, valves, piping system components, fixtures and accessories, plumbing system components, fixtures and accessories, etc.
3. Where any item of equipment includes components or subassemblies manufactured by other than equipment manufacturer, all pertinent information for subassemblies shall be included in equipment manual prepared and compiled by equipment manufacturer.
4. Information contained in equipment manual which is not applicable to specified item furnished under this Contract shall be clearly lined out or obliterated.

B. Submittal Procedures.

1. When specified in individual specification Sections or in Section 01 05 00, submit manufacturers' printed operation and maintenance instructions for equipment and systems supplied for this project in conformance with this Section and Section 01 05 00.
2. Submit one (1) copy of preliminary drafts of manuals in specified format. Engineer shall review draft and return one (1) copy with comments. All draft manuals shall be delivered to Engineer prior to payment of more than 60 percent of contract value as described in original submitted Schedule of Values and not as modified by subsequent change orders.
3. If preliminary manual is returned with a status of "resubmit requested information", a revised draft manual is not required to be submitted. If preliminary manual is returned with a status of "amend and resubmit", Contractor shall submit one (1) copy of revised manuals in specified format addressing all of Engineer's comments prior to submittal. Engineer shall review draft and retain copy and shall only return comments concerning revised manual to Contractor. All revised draft manuals shall be delivered to Engineer prior to payment of more than 70 percent of contract value as described in original submitted Schedule of Values and not as modified by subsequent change orders.
4. System startups shall not commence until all draft operation and maintenance manuals have been reviewed and accepted, with exception of field startup reports and other details that cannot be incorporated into manuals until after startup. Draft manuals shall be available during system startups.
5. After system startups have been completed and all required reports and other documentation has been submitted and accepted by Engineer, submit one (1) review copy of near-final operations and maintenance manual to Engineer for review and approval. Manual shall be returned to Contractor with any comments needing to be addressed.

6. Once Contractor has satisfactorily addressed all remaining Engineer's comments concerning manuals, Contractor shall provide one (1) finalized hard copy of each manual to Engineer addressing all previous submittal comments. Contractor shall also provide manuals in Adobe Portable Document Format (PDF) format on flash drives. Contractor shall supply four (4) flash drives. Each flash drive shall have a directory structural that clearly delineates each equipment name and appropriate specification section. Each flash drive shall be supplied with protective plastic sheet envelope with loops for attachment to binder rings.
7. Finalized manuals shall be accepted prior to Substantial Completion.
8. After review and acceptance by Engineer of draft and finalized manuals, distribute copies in accordance with this Section and Section 01 05 00. Provide copies for required record documents described in this Section.
9. Contractor shall allow Engineer an average of 45 days of review time for all operation and maintenance submittals and Contractor shall incorporate this time into his work schedule. Submittal review time shall not be considered grounds for a Contract time extension unless overall average for all operational and maintenance submittals exceeds 45 days, even if review time for any single submittal exceeds 45 days.
10. With each submittal for each manual, provide a completed "Operations and Maintenance Manual Checklist" form found in Section 01 99 00.

C. Format.

1. Prepare data in form of an instructional manual.
2. Binders: Shall be commercial heavy-duty quality 3-ring binders for 8-1/2 inch by 11-inch pages with hardback, durable cleanable plastic covers, D-size maximum ring size. When multiple binders are used, correlate data into related consistent groupings. Binders shall be identical for all manuals.
3. Cover: Shall identify each volume with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS." List title of Project, and identify subject matter of contents. When multiple volumes are provided for same system, indicate volume number and total number of volumes.
4. Arrange content by system under Section numbers and sequence of Table of Contents of this Project Manual.
5. Internally subdivide binder contents with permanent page dividers, logically organized by product or major component as described below; with tab titling clearly typed under reinforced laminated plastic tabs.
6. Text: Manufacturer's printed data, or neatly typewritten data on 20 lb. paper.
7. Drawings: Provide with reinforced punched binder tab and bind in with text. Fold larger drawings to size of text pages.
8. Folded Drawings and Small Items: Provide in heavy-duty three-ring plastic pockets inserted into binder. Pockets shall be of appropriate size for binder sizes provided.

D. Contents, Each Volume.

1. Table of contents:
 - a. Title of product.

- b. Name, address and telephone number of Engineer with names of responsible parties.
 - c. Name, address and telephone number of Contractor with names of responsible parties.
 - d. A schedule of products and systems, indexed to content of volume.
 - e. If multiple volumes are provided for equipment or system, table of contents shall provide identical listings indicating contents of every volume within each volume with clear indication of which contents are in each manual.
2. For each product or system, list names, addresses and telephone numbers of subcontractors, manufacturers, suppliers, and manufacturer's local service representative, include local source of supplies and replacement parts.
 3. Product data: Mark each sheet to clearly identify products and component parts, and data applicable to installation. Delete or otherwise cross-out non-applicable information.
 4. Drawings: Supplement product data with drawings as necessary to clearly illustrate relations of component parts of equipment and systems, and to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
 5. Typed text: As required to supplement product data. Provide a logical sequence of instructions for each procedure incorporating manufacturer's instructions specified in Section 01 00 05.
 6. Approved Shop Drawings: Incorporate all approved shop drawings regarding any system components in their entirety into manuals. Shop drawings shall adequately describe interrelationship between all system components.
 7. Start-Up Instructions: Provide manufacturer delivery, storage, preparation, assembly, erection, installation; start up, adjusting, balancing, and finishing instructions as specified in Section 01 00 05 for each system component. These instructions shall be part of operations and maintenance manuals regardless of whether they were submitted for review under Section 01 00 05.
 8. Care and cleaning of all finishes. Where applicable, list of paints used with color and other pertinent data.
 9. Conflicts: Identify any conflicts between manufacturer's instructions and Contract Documents.
 10. Certifications: Provide copies of any manufacturer certifications provided under Sections 01 00 05 and 01 99 00 and 11 05 13.
 11. Performance affidavit.
 12. Reports: Provide copies of any manufacturer field startup reports including air and water balance reports, training reports and other testing data and reports.
 13. Warranties and bonds: Provide copies of all documentation.

E. Manual for Equipment and Systems.

1. Each item of equipment and each system: Include description of unit or system, and list all component parts. Include function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of all replaceable parts. Operation and

maintenance instructions for individual components should be included; however, written instructions, drawings, and schematics must cover complete system, not just specific components.

2. Design criteria: Provide detailed list of all significant design criteria.
3. General arrangement drawings and general arrangement detail drawings, as required.
4. Erection drawings, as required.
5. A complete bill of materials for all equipment, including weights.
6. Parts List: Provide complete parts lists and parts diagrams for all equipment, including motors and drive units, showing manufacturer's identification numbers for each part.
7. Process and Instrumentation Diagrams (P&ID) specifically reflecting components and equipment provided for this project and as modified in field during installation.
8. Electrical and Control Schematics: Provide wiring diagrams and schematics, elementary control diagrams, and one-line diagrams. Provide panelboard circuit directories including electrical service characteristics, controls and communications. Include as-installed color coded wiring diagrams. Include labeled terminations. Schematics shall be project specific and reflect actual equipment installed including all modifications made in field. Provide interconnection data or diagrams for factory-wired components.
9. Operating procedures: Include erection, installation, start-up, break-in, and routine normal operating instructions and sequence. Include regulation, adjustments, control, stopping, dust-down, and emergency instructions. Include summer, winter, and any special operating instructions. Include any relevant technical bulletins and diagrams.
10. Maintenance procedures: Include preventative and routine procedures and guide for trouble-shooting, disassembly instructions, and alignment, adjusting, balancing and checking instructions for all system components.
11. Major overhaul or repair procedures including diagrams, measurements, clearances, tolerances, adjustment settings, alignment and calibration procedures, torque specs, etc.
12. Provide list of all original manufacturer's spare parts provided and spare parts available and other items supplied with equipment or system identified by name and by manufacturer part number. Include manufacturer's current prices and recommended quantities to be maintained in storage.
13. Provide a servicing and lubrication schedule and list of lubricants required. List lubricants by name and manufacturer part number.
14. Include manufacturer's printed operating and maintenance instructions.
15. Include following from controls manufacturer:
 - a. Sequence of operation.
 - b. As-installed control diagrams.
16. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
17. Provide list of special tools required for operation and maintenance of equipment.

18. Maintenance schedule: At end of each equipment section, provide a detailed maintenance schedule clearly itemizing tasks that should be performed and their frequency. Schedule shall include:
 - a. List and frequency of maintenance activities, other than lubrication.
 - b. List of lubrication frequency and application points.
 - c. List of approved lubricant types (weight or grade and recommended manufacturers) and method of application.
19. Motor and Drive List: List of all motors and drives provided with details of significant design criteria.
20. Additional requirements: As specified in individual Specifications Sections.
21. Provide a listing in Table of Contents for design data, with a tabbed fly sheet and space for inserting data.

1.06 WARRANTIES AND BONDS

- A. All warranties and bonds shall commence on Date of Substantial Completion unless acceptance is delayed beyond this date in which case warranty and bonds shall start on date of acceptance.
- B. General Warranty.
 1. Contractor shall warrant all equipment, materials, products, and workmanship provided by Contractor under these Contract Documents for a period of 12 months after date of Substantial Completion of Work by Owner.
 2. If, during warranty period; (i) any equipment, materials, or products furnished and/or installed by Contractor are found to be defective in service by reason of Contractor's faulty process, structural and/or mechanical design or specifications, or (ii) any equipment, materials, or products furnished and/or installed by Contractor are found to be defective by reason of defects in material or workmanship or by their failure to meet fully requirements of Contract Documents; Contractor shall, within 15 days, after receipt of written notice from Owner, repair or cause to be repaired such defective equipment, materials or products, or replace such defective equipment, materials or products to full satisfaction of Owner.
 3. In event of multiple equipment failures of major consequence prior to expiration of 1-year warranty described herein, affected equipment shall be disassembled, inspected, and modified or replaced as necessary to prevent further occurrences. All related components that may have been damaged or rendered non-serviceable as a consequence of equipment failure shall be replaced. A new 12-month warranty against defective or deficient design, workmanship, and materials shall commence on day that item of equipment is reassembled and placed back into operation. As used herein, multiple equipment failures shall be interpreted to mean two or more successive failures of same kind in same item of equipment or failures of same kind in two or more items of equipment. Major equipment failures may include, but are not limited to, cracked or broken housings, piping, or vessels, excessive deflections, bent or broken shafts or structural members, broken or chipped gear teeth, overheating, premature bearing failure, excessive wear, or excessive leakage around seals. Equipment failures which are directly and clearly traceable to operator abuse, such as operating equipment in conflict with published operating procedures, or improper maintenance, such as substitution of unauthorized replacement parts, use of incorrect lubricants or chemicals, flagrant over- or under-lubrication, and use of maintenance procedures not conforming with published maintenance instructions, shall

be exempted from scope of 1-year warranty. Should multiple equipment failures occur in a given item or type of equipment, all equipment of same size and type shall be disassembled, inspected, modified or replaced, as necessary, and re-warranted for 1 year.

4. Contractor shall, at his own expense, furnish all labor, materials, tools and equipment required and shall make such repairs and removals or shall perform such work or reconstruction as may be made necessary by any structural or functional defect or failure resulting from neglect, faulty workmanship or faulty materials, in any part of Work performed by him. Such repair shall also include refilling of trenches, excavations or embankments which show settlement or erosion after backfilling or placement.
5. Except as noted on Drawings or as specified, all structures such as embankments and fences shall be returned to their original condition prior to completion of contract. Any and all damage to any facility not designated for removal, resulting from Contractor's operations, shall be promptly repaired by Contractor at no cost to Owner.
6. In event Contractor fails to proceed to remedy defects of which he has been notified within 15 days of date of such notice, Owner reserves right to cause required materials to be procured and work to be done, as described in Contract Documents, and to hold Contractor and sureties on his bond liable for cost and expense thereof.
7. In case of an emergency where, in opinion of Engineer, delay could cause serious loss or damage, corrections or replacement may be made prior to or concurrent with notice being sent to Contractor. All expenses in connection with such corrections or replacement, including costs for professional services, shall be charged to Contractor.
8. Neither foregoing paragraphs nor any provision in Contract Documents, nor any special guarantee time limit implies any limitation of Contractor's liability with law of place of construction.

C. Special Warranties and Bonds.

1. Special warranties above and beyond general 1-year guarantee by Contractor are indicated in each individual specification sections. Special warranties, including equipment warranties from equipment manufacturers, shall cover same circumstances as general warranty except as further clarified below and in each individual specification section.
2. Warranties shall be acceptable only from equipment manufacturer. Warranties from suppliers or installers shall not be acceptable.
3. Warranties shall be executed by principles of company providing warranty and shall contain raised seal of that company.
4. Equipment warranties and support shall cover all components of each specified system described in individual specification sections and all other system components provided by equipment manufacturer regardless of manufacture or source.
5. Equipment manufacturer shall, at his own expense, furnish all labor, materials, tools and equipment required and shall make such repairs and removals or shall perform such work or reconstruction as may be made necessary by any structural or functional defect or failure resulting from faulty workmanship or faulty materials in any part of Work provided or supplied by him.
6. Preparation of Submittals.
 - a. Obtain warranties and bonds, executed in duplicate and executed by principles of company providing warranty and shall contain raised seal of that company. Leave

date of beginning of time of warranty blank until Date of Substantial Completion or other specified date is determined.

- b. Verify that documents are in proper form, contain full information, and are notarized.
 - c. Co-execute submittals when required.
 - d. Owner shall be named as beneficiary.
 - e. Warranty period shall commence at Date of Substantial Completion.
 - f. Retain warranties and bonds until time specified for submittal.
 - g. Warranties and guarantees shall be in accordance with General Conditions. Requirements may be added to or modified in individual Specification Sections.
 - h. By supplying a product under contract, manufacturer and Contractor jointly agree that all manufacturers' warranties, expressed or implied, pass through Contractor to Owner. This warranty obligation starts on date specified above and survives any inspection by, delivery to, acceptance by or payment by Owner or Contractor for goods furnished by manufacturer. Further, this warrants that equipment designed, manufactured and/or used meets all applicable federal, state and local laws, rules and regulations, including applicable OSHA standards. This requirement does not change or limit requirements for performance affidavits described in Section 01 05 00.
7. All warranties shall be submitted prior to Date of Substantial Completion, or for items of work when acceptance is delayed beyond date of Substantial Completion, submit within 10 days after acceptance, listing date of acceptance as beginning of warranty period.

1.07 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Submit Spare Parts Transfer Form found in Section 01 99 00 for all parts provided to Owner in accordance with Section 01 00 05.
- B. Prepare detailed listing of spare parts required, including quantity, supplier name, and specification section.
- C. Delivery, storage, and maintenance of spare parts shall be in accordance with Section 01 00 05.
- D. Provide quantities of products, spare parts, maintenance tools and maintenance materials specified in individual Sections to be provided to Owner, in addition to that required for completion of Work. Verify that these items were transferred to Owner prior to request for Substantial Completion.
- E. Spare parts shall be identical to those installed in Work. Include quantities in original purchase from supplier of manufacturer to avoid variations in manufacture.
- F. Use of Spare Parts.
 - 1. Spare parts are for Owner's sole use after guarantee/warranty period is over. Spare parts shall not be utilized by Contractor, equipment manufacturer, or any other party except Owner to accomplish repair, maintenance, or replacement work before or during guarantee/warranty period without written permission of Owner.

- a. Any spare parts agreed by Owner to be used during guarantee/warranty period shall be replaced immediately by Contractor or equipment manufacturer at no additional cost to Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 99 00
REFERENCE FORMS

PART 1 GENERAL

1.01 SUMMARY

A. Related Documents:

1. Following forms listed below and included herein are referenced from other sections in Contract Documents.
 - a. Change Control Form.
 - b. Equipment Start-up Report and Certification.
 - c. Equipment Training Certification.
 - d. Training Attendance Record.
 - e. Operation and Maintenance Manual Checklist.
 - f. Warranty Documentation Form.
 - g. Spare Parts Transfer Form.
 - h. Submittal Label.
 - i. Concrete Pre-placement Checklist.
 - j. Record Documents Certification.
 - k. Motor Testing Summary Sheet.
 - l. Piping Disinfection Summary Sheet.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)



CHANGE CONTROL FORM NO.

Date Issued:		Project:	
Project No.:		Contractor:	
This Document is a: <input type="checkbox"/> Request for Proposal <input type="checkbox"/> Field Order <input type="checkbox"/> Work Change Directive <input type="checkbox"/> Contractor Change Request			
Description of Change <i>(attach necessary supporting documentation):</i>			
Initiated By: <input type="checkbox"/> Contractor <input type="checkbox"/> Engineer <input type="checkbox"/> Owner <input type="checkbox"/> Resident Project Representative			
Drawing(s) Reference:		Spec. Reference:	
RFI Reference:		Date of RFI:	
Attachments:			
REQUEST FOR PROPOSAL/CHANGE REQUEST			
We propose to perform the Work or make the Claim described above for the following change in Contract Cost and Contract Times:			
<input type="checkbox"/> No Change in Contract Amount is Required		<input type="checkbox"/> A Change in Contract Amount is Required:	
<input type="checkbox"/> No Change in Contract Time is required		<input type="checkbox"/> A Change in Contract Time is Required:	
WORK CHANGE DIRECTIVE			
You are directed to proceed to make the changes to the Work described in this Work Change Directive. Any change in Contract Price or Contract Time will be determined in accordance with the General Conditions.			
FIELD ORDER			
This Field Order issued in accordance with the General Conditions for minor changes in the Work without changes in the Contract Price or Contract Time. If you consider that a change in Contract Price or Contract Times is required, notify the Engineer immediately and before proceeding with the proposed Work.			
AUTHORIZING SIGNATURES			
ENGINEER:	CONTRACTOR:	OWNER:	RESIDENT PROJECT REPRESENTATIVE:
_____	_____	_____	_____
_____	_____	_____	_____
(print name)	(print name)	(print name)	(print name)
Date: _____	Date: _____	Date: _____	Date: _____



EQUIPMENT START-UP REPORT AND CERTIFICATION

Date: _____
Owner: _____
Contract No.: _____
SSR Project No.: _____

Manual No.: _____
Submittal No.: _____
Spec. Section: _____
Submittal Description: _____
Equipment Serial No.: _____

I, _____, an authorized representative of
_____, hereby certify that above-mentioned piece of
equipment/system:

- Has been properly installed and aligned;
- Has been accurately calibrated and adjusted;
- Has been lubricated in accordance with manufacturer's recommendations;
- Is free from any undue stress imposed by connection piping or anchor bolts;
- Operation and maintenance manuals for above-mentioned piece of equipment have been delivered to Owner;
- Has been operated under all process variations listed in Section 01 88 23 and 01 88 26, if applicable.
- Has been operated under full load conditions and performed satisfactorily without leaks, excessive vibration, abnormal noise, and in complete conformance with Specifications.
- Is a follow-up visit required (Yes / No) If so, when _____.

Recommendations made by Manufacturer's Service Representative:

If applicable, please attach a copy of manufacturer's start-up report along with recorded test data.

Owner Representative Signature

Manufacturer Representative Signature

Date

Date

Contractor Representative Signature

Engineer Representative Signature

Date

Date



**EQUIPMENT TRAINING
CERTIFICATION**

Date: _____
Owner: _____
Contract No.: _____
SSR Project No.: _____

Manual No.: _____
Submittal No.: _____
Spec. Section: _____
Submittal Description: _____
Equipment Serial No.: _____

I, _____, an authorized representative of
_____, hereby certify that training for above-mentioned
piece of equipment/system:

- Has been properly performed;
- Owner fully understands operation of equipment;
- Owner understands and can modify controls associated with equipment;
- Operation and maintenance manuals for above-mentioned piece of equipment have been delivered to Owner, and;
- If specified, a flash drive with video/audio of training session was made and a copy has been forwarded to Owner.

Attach a copy of Equipment Start-up Report and Training Attendance sheet to this Training Certification.

Owner Representative Signature

Manufacturer Representative Signature

Date

Date

Contractor Representative Signature

Engineer Representative Signature

Date

Date



TRAINING ATTENDANCE RECORD

Date: _____ Manual No.: _____
 Owner: _____ Submittal No.: _____
 Contract No.: _____ Spec. Section: _____
 SSR Project No.: _____ Equip. Description: _____
 _____ Equip. Serial No.: _____

Attendees

Name (please print)	Signature	Representing	Tools Received
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
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			<input type="checkbox"/>



OPERATION AND MAINTENANCE MANUAL CHECKLIST

Date: _____
 Owner: _____
 Contract No.: _____
 SSR Project No.: _____

Manual No.: _____
 Submittal No.: _____
 Spec. Section: _____
 Submittal Description: _____

Checklist	Contractor		Engineer	
	Satisfactory	N/A	Accept	Deficient
Table of contents				
Table of contents (included at front of multiple volumes, if applicable)				
Title page (incl. title of equipment; name, address, telephone, and responsible party for Engineer and Contractor)				
Schedule of products and systems, if applicable				
Subcontractor information, if applicable				
Manufacturer information				
Local representative/supplier information				
Nearest service center information				
Local source of supplies and replacement parts				
Equipment model number				
Equipment serial number				
Product/equipment data with non-applicable information deleted/crossed-out				
Design criteria, performance curves, engineering data, motor data, and schematics provided for each piece of equipment				
For building products, provide product data, catalog numbers, color, texture, composition, technical bulletins, necessary re-ordering information, etc.				
Bill of material for all equipment, including weights				
Supplemental drawings provided (e.g., general arrangement), if necessary				
Installation instructions				
Erection drawings, if necessary				
Start-up and shutdown procedures				
Safety precautions/instructions				
Normal operations instructions, including logical sequence of operation and limiting conditions				
Emergency operations instructions				
Special operating instructions (e.g., cold and warm weather operation), if applicable				
Lubrication data (trade names of lubricants) and schedule				
Care and cleaning of all materials finishes, if applicable				

Checklist	Contractor		Engineer	
	Satisfactory	N/A	Accept	Deficient
Preventative and routine maintenance and care data, including disassembly and alignment/calibration and balancing/checking, and schedules				
Troubleshooting guides				
Maintenance and repair procedures, including major overhauls, and schedules				
Removal and replacement instructions				
Spare parts and supply lists (include part manufacturer and number and recommended quantities; denote wear items, and long delivery time items)				
List of special tools required for maintenance, if applicable				
Detailed parts list with exploded view				
Electrical and control schematics (e.g., wiring diagrams/schematics, one-line diagrams, panelboard circuit directories, as applicable)				
Process and instrumentation diagrams (P&IDs), if necessary				
Sequence(s) of operation, if necessary				
Valve schedule with tag numbers and valve functions keyed to P&IDs				
Warranty information (also bond information, if applicable)				
Copy of equipment performance affidavit or equipment certification, if applicable				
Final approved shop drawings included in back of manual				
Identify any conflicts between information in O&M manual(s) and Contract Documents				
Testing equipment and special tools information				
Factory shop testing results				
Field test results and reports, including any air or water balance reports, and data collected during startup				
Equipment installation/startup certification				
Operator instruction/training certification (including attendance sheet)				
Motor test report(s), if applicable				
Additional information required by specific equipment/product specification section, if any				

Note: This manual submittal is a final submittal and should include all corrections to submittal package. Information in this submittal should be site specific and include complete descriptions of furnished equipment.

Contractor's Signature



WARRANTY DOCUMENTATION FORM

Owner: _____

Page _____ of _____

Contact Name: _____

Date _____

Contract No.: _____

SSR Project No.: _____

System, Equipment, or Area ID	Start Date	End Date	Contact	Company	Phone



**SPARE PARTS
TRANSFER FORM**

Owner: _____
 Contact Name: _____
 Contract No.: _____

Page _____ of _____
 SSR Project No.: _____

System, Equip, or Area ID	Container/Item No.	Description	Reviewed by	Date	Received by	Date

Notes:

1. Owner personnel shall initial Received by column indicated that spare parts were received from Contractor.
2. RPR personnel shall initial Review by column indicating that spare parts were provided in accordance with Contract Documents.

 Contractor Signature

 Engineer Signature

 Date

 Date

SUBMITTAL LABEL

Project Name:	SSR Project No.:
Date:	Submittal No.:
To:	From:
Subcontractor/Supplier:	Product:
	Manufacturer:
Drawing Ref.:	Spec. Ref.:

REVIEW STAMPS

Contractor	Engineer

Contractor's Certification

I certify that I have reviewed attached shop drawings and to best of my knowledge and belief, that review, verification of products and materials required, field dimensions, adjacent construction Work, installation requirements, and coordination of information, is in accordance with requirements of Work and complies with Contract Documents, with following exceptions (explain or list any and all known exceptions; attach separate piece of paper if necessary).

- 1.
- 2.
- 3.

By: _____
 (Authorized Signature)

CONCRETE PRE-PLACEMENT CHECKLIST

Project Name

Notification to Owner/Manager of Scheduled Placement (minimum 48 hours in advance)

Person Notified: _____ Date: _____ Time: _____

Date Scheduled for Placement: _____

Time Scheduled for Placement: _____ AM/PM

Estimated Quantity of Concrete to be Placed: _____ Cu. Yds.

Planning Information

Location: Water Containment Structure Building Foundation Other: _____

Placement Type: Mud Mat Slab Wall Grade Beam Topping Other: _____

Additional Description: _____

Required "A"-General Use "B"-Water Contact "C"-Topping "CF"-Topping "D"-Mud Mat/Fill "E"-Sidewalk/Curb
Mix:

Maximum W/C Ratio: 0.44 0.42 0.44 0.50 0.42

Finish Requirements: _____

Curing Procedure/Type or Method: _____

Special Requirements: _____

Weather Protection: _____

Pre-Placement Inspection (Check all that apply and have been verified as ready)

Imbeds in Place:	Electrical	Mechanical	Plumbing	Sleeves				
Floor Drain Elevations Set:	Elevations _____							
Form Work:	Plumb/Square/Tolerances	Form Ties in Place	Ties – Correct Quantity	Dimensions Correct				
Anchor Bolts:	Thread Protection	Thread Protection	Layout	Spacing				
Water Stop:	Installed	Straight	Fastened/Supported	Welded				
Key Ways:	In Place	Straight	Fastened/Supported					
Re-Bar:	In Place	Connect Spacing	Correct Cover	Support				
Equipment On-Hand:	Pump (1 or 2)	Hoses	Vibrator	Floats	Protection	Coring	Heat	Other: _____

Additional Remarks: _____

Acknowledgements (All listed parties must initial or sign as indicated)

Construction Layout: _____ (Contractor Surveyor Initials)
 Rebar Installation: _____ (Concrete Rebar Foreman Initials)
 Forms and Embeds/Inserts: _____ (Concrete Forms Foreman Initials)
 Placement Foreman: _____ (Concrete Placement Foreman Initials)
 CPC Form Completion: _____ (RPR Initials)

Contractor Signature: _____ Date: _____

RECORD DOCUMENTS CERTIFICATION

_____, CONTRACTOR on _____
(Contractor)

(Project title per Contract Documents)

hereby certifies that enclosed Record Documents show all changes made during construction and have been compiled in accordance with Section 01 77 13 of Contract Documents.

ATTACHMENTS:

- 1. Contract drawings.
- 2. Specifications (Project Manual).
- 3. Addenda.
- 4. Reviewed shop drawings.
- 5. Requests for information.
- 6. Field orders
- 7. Work change directives.
- 8. Change orders.
- 9. Field test records.
- 10. Inspection certificates.
- 11. Manufacturer's certificates.
- 12. Fixed equipment manuals.
- 13. Equipment training certificate.
- 14. Equipment start-up certificate.
- 15. Warranty documentation form.
- 16. Spare parts transfer form.

CONTRACTOR _____ (SEAL)
(Name of sole ownership, corporation or partnership)

(Signature of Authorized Representative) (SEAL)

(Affix corporate seal here)

Title: _____

ATTEST:

Name _____
(Please Type)

Title _____

Note: Attest for a corporation must be by corporate secretary; for a partnership by another partner; for an individual by a Notary.

MOTOR TESTING SUMMARY SHEET

PROJECT INFORMATION

Job No.: _____ Location: _____
Project: _____ Contractor: _____
Contractor's Representative: _____ Observed by: _____

GENERAL EQUIPMENT INFORMATION

Equipment Description: _____ Equipment No.: _____
Equipment Location: _____
Drawing Numbers: _____
MCC/Panel No.: _____ Section/CKT. No.: _____
Control CKT. No.: _____

NAMEPLATE DATA

Motor Manufacturer: _____ HP: _____ RPM: _____ S.F.: _____
Voltage: _____ Phase: _____ F.L. Amp: _____ KVA Code: _____ Deg. Rise: _____
Serial No.: _____ Other: _____
Locked Rotor KVA: _____ Efficiency: _____

PRESTART CHECKS

	Date
Lubrication Checked (Motor and Driven Equipment)	_____
Motor Rotates Freely	_____
Overload Heater Size/Setting: _____ (located at starter)	_____
Control Circuit Tested	_____
Breaker Size (Frame Size/Trip Element Rating): _____	_____
Motor Insulation Resistance (Megger)	_____
Test Volts: _____ (500V for up to 250V motors and 1000V for up to 600V motors); Test Duration - 1 minute	
Phase A to Gnd: _____ Phase B to Gnd: _____ Phase C to Gnd: _____	
Phase A to B: _____ Phase B to C: _____ Phase C to A: _____	

(over)

MOTOR TESTING SUMMARY SHEET (CONT.)

UNCOUPLED DATA

(Provide this only when motor is shipped, uncoupled. Do not uncouple motor from drive to test.)

Bus Voltage:_____ Inrush Current:_____ Amps:_____ Sec Run in Time:_____

Average Running Current: A:_____ B:_____ C:_____ Rotation*:_____

RPM:_____

Performed by:_____ Date:_____

Approved by (test engineer):_____ Date:_____

COUPLED DATA

Bus Voltage:_____ Inrush Current:_____ Amps:_____ Sec Run in Time:_____

Average Running Current: A:_____ B:_____ C:_____ Rotation*:_____

RPM:_____ System Lineup/Conditions:_____

Test Equipment Control Nos.:_____

Remarks:_____

Performed by:_____ Date:_____

Approved by (test engineer):_____ Date:_____

*As viewed from motor outboard end.

PIPING DISINFECTION SUMMARY SHEET

Job No.: _____ Location: _____

Project: _____

Contractor: _____

Contractor's Representative: _____ Observed by: _____

Date: _____ Weather: _____ Temperature: _____

Section Tested: _____ ft. of _____-inch diameter pipe

Discharge Rate (gal/min): _____ Application of _____% hypochlorite solution @ gal/min

_____ mg/l initial total chlorine residual @ end of line at _____ (time)

_____ mg/l initial total chlorine residual @ end of 24 hours at _____ (time)

Method of measuring chlorine residual: _____

Line flushed at _____ gal/min for _____ hours _____ minutes on _____ (date)

Bacteria sample collected at: _____ (location) at _____ date/time)

Bacteria sample results _____ meet _____ do not meet state and/or county drinking water standards for total coliform.

Line Ready for Service on _____ (date) _____ (time)

Line Put into Service on _____ (date) _____ (time)

<p>WITNESS: OWNER/ENGINEER _____</p> <p>Name _____</p> <p>Title _____</p> <p>Signature _____</p>	<p>WITNESS: CONTRACTOR _____</p> <p>Name _____</p> <p>Title _____</p> <p>Signature _____</p>
---	---

END OF SECTION

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SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Work Included:

1. Demolition and removal of equipment, pipes, sections, and components of existing Well No. 6 as indicated on drawings, except such items that are designated to remain. If composed of stainless steel, the existing well shaft is to be salvaged.
2. Demolition and removal of existing concrete retaining wall as shown in drawings.
3. Demolition and removal of site-related construction.
4. Disconnections and removing all existing utility lines and appurtenances as indicated on drawings or required to accomplish work except those designated or required to remain.
5. Protection of all structures or objects that are designated or required to remain so as to avoid damage of any kind.
6. Protection and storage of all material designated or required to be relocated or reused so as to avoid damage of any kind.
7. Temporary relocation of dog park fencing as limits indicate on drawings.
8. Scope of demolition shall be what is required to accomplish work as described in Contract Documents. For purposes of bidding, base value of demolition work on condition of site on day of pre-bid meeting.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 09 96 00 – Painting and Coatings
3. Section 31 23 23 – Bedding, Backfill and Compaction
4. Section 32 90 00 – Site Restoration

1.02 DEFINITIONS

- A. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof and disposal of materials.
- B. Removal: Dismantling and removal of equipment or material items or any part thereof and disposal of materials.
- C. Modify: Provide all necessary material and labor to modify an existing item to condition indicated or specified.

- D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make equipment fully functional, to new location identified on Drawings.
- E. Renovation: Altering a facility or one or more facility components in any way.
- F. Salvage: Remove and deliver, to specified location(s), equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 00 05.
- B. Submit proposed demolition plan together with any necessary diagrams and/or drawings, taking into account Owner's continuing occupancy and sequence of construction of project.
- C. Demolition plan shall include following:
 - 1. Demolition, removal, and disposition of items identified in this Section.
 - 2. Disposal locations of removed items.
 - 3. Relocation of salvageable items.
 - 4. Temporary storage of items to be reused
 - 5. Time lines and sequences of operations.
 - 6. Location of temporary barricades, fences, and signs.
 - 7. Provisions for disposal of any hazardous materials (if any).

1.04 PROJECT RECORD DRAWINGS AND PHOTOGRAPHS

- A. Submit under provisions of Sections 01 00 05.
- B. Accurately record actual locations of capped utilities and subsurface obstructions.
- C. Furnish services of commercial photographer to produce such photographs in accordance with Section 01 00 05 of those items designated by Owner and Engineer, prior to their scheduled demolition, removal, or relocation.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for demolition of structures, protection of adjacent structures, dust control, runoff control, and disposal of materials.
- B. Obtain required permits from authorities.
- C. Notify affected utility companies before starting demolition operations and comply with their requirements.
- D. Do not close or obstruct roadways, sidewalks, hydrants, parking areas, or public access areas without required permits.

- E. Conform to applicable regulatory procedures if a hazardous environmental condition is encountered at site or if hazardous material disposal is required.

1.06 HAZARDOUS ENVIRONMENTAL CONDITIONS

- A. If an unknown unforeseeable hazardous environmental condition is encountered at site, or if Contractor or anyone for whom Contractor is responsible creates a hazardous environmental condition, immediately:
 - 1. Secure or otherwise isolate such condition;
 - 2. Stop all Work in connection with such condition and in any area affected thereby; and
 - 3. Notify Owner and Engineer (and promptly thereafter confirm such notice in writing).
- B. Resume Work in connection with such condition or in any affected area only after Owner has obtained any required permits related thereto and delivered to Contractor a written notice specifying under what special conditions Work may be resumed safely.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Provide fill material in accordance with Section 31 23 23.

PART 3 EXECUTION

3.01 PREPARATION

- A. Thirty (30) days prior to performing any demolition, there shall be a coordination meeting between Contractor, Owner, and Engineer to discuss Contractor's Demolition Plan and related procedures. Items to be discussed shall be, but not limited to, dust control, sequence of work, removal of material, protection of existing equipment, access and egress of material, materials to be reused or salvaged by Owner, etc. Demolition procedures must be coordinated with Owner's operating personnel and operations, and adjusted accordingly, if necessary. Following coordination meeting, begin demolition operations after obtaining written authorization to proceed from Owner.
- B. Notify Owner and Engineer at least 48 hours in advance of intended start of demolition operations in each affected area.
- C. Provide, erect, and maintain temporary barriers, signs, and security devices as required to secure site and to avoid disruption to vehicular and pedestrian traffic.
- D. Protect existing structures, equipment, appurtenances, architectural features, and materials which are not to be demolished. Prevent movement or settlement of adjacent structures.
- E. Protect existing site-related items such as pavements, walkways, parking areas, curbs, aprons, and landscaping features which are not to be demolished.
- F. Protect existing electrical; heating, ventilating, and air conditioning; and plumbing systems, including related components, which are not to be demolished.
- G. Mark location of underground utilities.

3.02 PERSONNEL AND EQUIPMENT

- A. Provide skilled operators and labor.
- B. Provide suitable and adequate equipment and tools for performing required work in a safe and orderly manner.

3.03 GENERAL DEMOLITION REQUIREMENTS

- A. Demolish items shown on Contract Drawings, as well as all other items necessary to accomplish Work in accordance with this Section.
- B. Confine demolition operations within contract limits and only to those areas designated for demolition on Contract Drawings.
- C. Conduct operations to minimize interference with adjacent and occupied building areas. Maintain protected egress and access at all times.
- D. Contractor shall be responsible for ensuring that demolition activities do not hinder Owner's operations. Pipelines, electrical service, drains, process equipment, etc. required for normal operation shall be protected.
- E. Cease operations immediately if adjacent structures appear to be in danger. Notify Engineer. Do not resume operations until directed.
- F. All materials to be demolished shall become property of Contractor and be disposed of by Contractor off-site in an approved area. Do not dispose of items to be reused or salvaged for Owner's future use. Care shall be taken not to damage items to be reused or salvaged by Owner for future use.
 - 1. All materials removed from old construction and all materials or articles of value found in excavation or on site of work shall be brought to attention of Owner and Engineer, and if so ordered by Owner, shall be property of Owner, and shall be carefully preserved for future use. If not claimed by Owner, such material or articles shall be removed and disposed of by Contractor at his own expense.
- G. Dispose of rubble and non-metallic scrap at an approved disposal site.
- H. Dispose of designated hazardous materials in accordance with nature of material, required handling and disposal procedures, regulatory requirements, and applicable permits.

3.04 GENERAL DEMOLITION OPERATIONS

- A. Break up and remove slabs-on-grade, pavements, curbs, aprons, etc., and related items in designated areas.
- B. Break up and remove foundation walls, footings, etc., including any below-grade concrete slabs, to a point at least 3 feet below grade. Structures less than 5 feet in depth shall be removed entirely.
- C. Break up and remove concrete structures and tanks, including walls, piers, base slabs, cover slabs, etc. to avoid water retention in future.
- D. Empty and remove buried tanks, meter pits, and associated piping.
- E. Backfill, compact, and rough grade areas excavated, including cavities created by removal of demolished items, in accordance with Section 31 23 23 using fill material specified in PART 2.

- F. Disconnect and cap and identify utilities within demolition areas.
- G. Remove designated buried sewer and storm drain piping systems, capping with concrete plugs those segments to be abandoned, and provide temporary capping of those segments to be reused.
- H. Disconnect and remove designated process piping systems, including valves and fittings; provide temporary capping of those segments of system to be reused. Plug openings in walls and floors where utilities are removed.
- I. Detach, dismantle, and remove metal components of process equipment from designated tanks, including miscellaneous metal work items associated with access to and operation of such equipment.
- J. Carefully disconnect support, protect, and remove designated equipment to be reused on Project or salvaged for Owner's future use.
- K. All removed materials and equipment designated for reuse on Project, or designated to be salvaged for Owner's future use, shall be stored at locations chosen by Contractor and shall be protected from damage and from deterioration by weather. All salvaged items to be reused by Owner shall be turned over to Owner prior to substantial completion.
- L. Remove and dispose of demolished materials as work progresses. Do not burn materials; do not bury materials unless otherwise specified.
- M. Patch and refinish existing visible surfaces which are to remain in accordance with Section 01 31 13, and otherwise restore adjacent surfaces.
- N. Paint designated metal surfaces and reinforcing steel exposed by demolition operations, in accordance with Section 09 96 00.
- O. Paint exposed reinforcing steel that is parallel to wall, slab, etc. in accordance with Section 09 96 00.
- P. Exposed reinforcing steel and anchor bolts that is perpendicular to wall, slab, etc. shall be core drilled 1/2-inch minimum and hole patched in accordance with Section 03 01 40.
- Q. Remove temporary barricades, partitions, signs, etc.
- R. Remove and dispose of residual materials such as grit, sludge, debris, trash, and other scrap in an offsite location.
- S. Upon completion of demolition operations, leave areas in a clean condition.
- T. Dispose of all material to be removed, rubbish and debris, off site in an approved location in accordance with local, state, and Federal requirements, this section, and Section 31 11 00.

3.05 ABANDONMENT OF UTILITIES

- A. Removal of all pipe, valves and fitting inside and outside as indicated shall be removed. Piping, valves and fittings shall be disposed of by Contractor.
- B. Remove existing utilities to be abandoned within limits of trench excavation, or impinging on trench limits.
- C. Abandoned manholes and water valve casings shall be backfilled to grade with approved trench backfill material.

- D. Frames, covers, grates, water valve casing, sections of water piping, hydrants (including standpipe and boot) valves and other items to be abandoned shall, if ordered by Owner, be salvaged for re-use and be delivered to Owner's property yard.
- E. All piping shall be removed to five (5) feet beyond building line. Piping 6 inches in diameter or less shall be capped or plugged. All piping 8 inches or larger shall be filled with flowable fill. At connection points with existing pipe remaining in service, abandoned piping shall be capped or plugged with restrained fitting or concrete plug.

3.06 SALVAGE AND TITLE TO MATERIALS

- A. All items designated to be removed or demolished shall become property of Contractor.
- B. Title to equipment and materials resulting from demolition or renovation is vested in Contractor upon approval by Engineer of Contractor's Demolition Plan, and resulting authorization by Engineer to begin demolition or renovation.

3.07 DISPOSITION OF MATERIAL

- A. Do not remove equipment and materials without approval of Contractor's Demolition Plan by Engineer.
- B. Remove salvaged items designated as property of Owner in a manner to prevent damage.
- C. Owner shall not be responsible for condition or loss of, or damage to, property scheduled to become Contractor's property after Engineer's authorization to begin demolition. Materials and equipment shall not be viewed by prospective purchasers or sold on site.

3.08 RESTORATION

- A. After completion of demolition activities, site shall be fully restored per requirements of Section 32 90 00. Supplemental top soil may be required to allow planting of grass over demolished structures. This cost shall be included in price for demolition work.

END OF SECTION

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SECTION 05 05 20
ANCHOR SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Anchor bolts cast in concrete.
 - 2. Anchors, including expansion, sleeve, and adhesive type.
- B. Related Documents:
 - 1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.

1.02 SUBMITTALS

- A. Product data sheets for each system.
- B. ICBO or ICC-ES Evaluation and Acceptance Report for adhesive anchors, wedge anchors, undercut anchors or any anchoring system other than cast-in-place. If ICBO or ICC-ES has not evaluated proposed anchor system, Engineer may review test data from other sources, but is under no obligation to accept that data or system.

PART 2 PRODUCTS

2.01 ANCHOR BOLTS CAST IN CONCRETE

- A. Headed type, unless otherwise shown on Drawings.
- B. Material type and protective coating as shown in Fastener Schedule at end of this section.
- C. Comply with ASTM F1554 for carbon steel, hot-dipped galvanized per ASTM A153, and ASTM F593 Type 316, stainless steel anchor bolts.
- D. Use F1554 Grade 75 steel, hot-dipped galvanized per ASTM A153.

2.02 ANCHOR BOLT SLEEVES

- A. Plastic:
 - 1. Single unit construction with corrugated sleeve.
 - 2. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
 - 3. Material: High density polyethylene.
 - 4. Manufacturer: Sinco Products, Inc., Middletown, CT, (800) 243-6753.

B. Fabricated Steel: ASTM A36/A36M.

2.03 CONCRETE AND MASONRY DRILLED ANCHORS

A. General Requirements:

1. As shown in Fastener Schedule at end of this section.
2. Use only those products listed below that is available in Type 316 stainless steel.

B. Expansion Anchors:

1. Manufacturers:
 - a. Hilti Corporation, Kwik-Bolt 3 Anchor.
 - b. ITW Ramset/Red Head, Trubolt Wedge Anchor.
 - c. Simpson Strong Tie Co., Inc., Wedge-all Anchor.
 - d. Or approved equal.
2. Comply with Federal Specification FF-S-325 Group II, Type 4, Class I.
3. Minimum Embedment: 6 inches, unless otherwise shown on Drawings.

C. Sleeve Anchors:

1. Manufacturers:
 - a. Hilti Corporation, Sleeve Anchor.
 - b. ITW Ramset/Red Head, Dynabolt Sleeve Anchor.
 - c. Simpson Strong Tie Co., Inc., Sleeve-all Anchor.
 - d. Or approved equal.
2. Comply with Federal Specification FF-S-325 Group II, Type 3, Class 3.

D. Adhesive Anchors:

1. Manufacturers:
 - a. Hilti, Inc.; HIT Doweling Anchor System, HIT HY 150.
 - b. ITW Ramset/Red Head, Epcon System, Ceramic 6 Epoxy.
 - c. Simpson Strong Tie Co., Inc., ET Epoxy Tie Adhesive.
 - d. Or approved equal.
2. Injection Gel:
 - a. Two component structural epoxy.
 - b. Comply with ASTM C881.

3. Screen Tubes:
 - a. Use with hollow base materials.
 - b. Stainless steel screen.
 4. Anchor:
 - a. All-thread ASTM F593 stainless steel.
 - b. Threaded rods shall be of A307, A36, or A325 steel, zinc plated for interior applications and hot dip galvanized per ASTM A153 for exterior applications. Where indicated on Drawings "St. Stl.", threaded rods shall be Type 316 stainless steel.
 - c. Diameter as shown on Drawings.
 5. Minimum Embedment: 6 inches, unless otherwise shown on Drawings.
- E. Drop-in Anchors:
1. Self-drilling anchors, snap-off or flush type.
 2. Non-drilling Anchors: Flush type for use with bolt, or stud type with projecting threaded stud.
 3. Manufacturers and Products:
 - a. ITW Ramset/Red Head; Multi-Set II Drop-In and Self Drill Anchor.
 - b. Hilti, Inc.; Hilti HDI Drop-In Anchor.
 - c. Powers Rawl; Steel Drop-In Anchor.
 - d. Simpson Strong-Tie Co., Inc.; Drop-In Anchor.
- F. Undercut Anchors:
1. Manufacturers and Products:
 - a. Covert Operations, Inc.; DUC Undercut Anchor.
 - b. Hilti, Inc.; HDA Undercut Anchor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's instructions.

3.02 ANCHOR BOLTS CAST IN CONCRETE

- A. Accurately locate and hold anchor bolts in place with templates at time concrete is placed.
- B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt. Sleeve shall have an internal diameter not less than 3 times bolt diameter and shall be not less than 10 bolt diameters long.

- C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.
- D. After anchor bolts have been embedded, their threads shall be protected by grease and nuts installed.

3.03 CONCRETE AND MASONRY DRILLED ANCHORS

- A. Begin installation only after concrete to receive anchors has attained design strength.
- B. Install in accordance with manufacturer’s instructions.
- C. Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer’s instructions or shown otherwise on Drawings:

Anchor Type	Min. Embedment (bolt diameters)	Min. Edge Distance (bolt diameters)	Min. Spacing (bolt diameters)
Expansion	9	6	12
Sleeve	4	6	12
Undercut	9	12	16
Adhesive	9	9	13.5

- D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air.
- E. For undercut anchors, use special undercutting drill bit and rotary hammer drill and apply final torque as recommended by anchor manufacturer.
- F. When embedded steel or rebar is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify Engineer for direction on how to proceed.
- G. Expansion and Undercut Anchors:
 1. Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is extremely unlikely. Overhead applications (such as pipe supports) in conditions listed above are not allowed.
 2. Anchor diameter and grade of steel shall be per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.
 3. All installation recommendations by anchor system manufacturer shall be followed carefully, including maximum hole diameter.
 4. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.
 5. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.
- H. Adhesive Anchors:
 1. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.

2. Use shall be limited to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, to chlorine gas, or to machine or diesel oils, is extremely unlikely.
 3. Anchor diameter and grade of steel shall be per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.
 4. Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is extremely unlikely. Overhead applications (such as pipe supports) because of above concerns shall be disallowed.
 5. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.
 6. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry where required by manufacturer's instructions.
 7. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.
 8. Do not disturb anchor during recommended curing time.
 9. Do not exceed maximum torque as specified in manufacturer's instructions.
 10. All installation recommendations by anchor system manufacturer shall be followed carefully, including maximum hole diameter.
- I. Prestressed Concrete: Do not use drilled-in anchors in prestressed or posttensioned concrete members without Engineer's prior approval unless specifically shown on Drawings.

3.04 ANCHORS

- A. Use expansion anchors in precast or cast-in-place concrete.
- B. Use adhesive anchors where shown on Drawings.

3.05 ANCHOR SCHEDULE

- A. Unless indicated otherwise on Drawings, provide anchors as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Equipment Bases		
Submerged, Exterior, Interior Wet, and Corrosive Areas	ASTM F593 Type 316 stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 96 00

- A. Refer to Section 01 00 05 for definitions of area classifications.

END OF SECTION

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SECTION 09 96 00
PAINTING AND COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Surface preparation, field and shop application of paints and coatings.
2. Color coding and labeling of pipe and conduits.
3. Coordination of shop and field painting.
4. Chemical resistant finish.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 03 – Concrete.
3. Section 10 14 20 – Signage Requirements.
4. Division 26 – Electrical.
5. Division 40 – Process Integration.

1.02 REFERENCES

Reference	Title
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Products
ANSI/ASC Z9.4	Abrasive-Blasting Operations – Ventilation and Safe Practices for Fixed Location Enclosures
ASTM D16	Standard Terminology for Paint-Related Coatings, Materials, and Applications
ASTM D522	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings (Method A, Conical Mandrel)
ASTM D870	Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
ASTM D1014	Standard Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates
ASTM D1653	Standard Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM D2200	Standard Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to Effects of Rapid Deformation (Impact)
ASTM D3359	Standard Test Methods for Measuring Adhesion by Tape Test
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test

Reference	Title
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4060	Standard Test Method for Abrasion Resistance of Organic Coatings by Taber Abraser
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by Plastic Sheet Method
ASTM D4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D4585	Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D6386	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM D7243	Standard Guide for Measuring Saturated Hydraulic Conductivity of Paper Industry Sludges
ASTM E337	Standard Test Method for Measuring Humidity with a Psychrometer (Measurement of Wet- and Dry-Bulb Temperatures)
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM G85	Standard Practice for Modified Salt Spray (Fog) Testing
ASTM G154	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
ASTM G210	Standard Practice for Operating the Severe Wastewater Analysis Testing Apparatus
ICRI Technical Guideline 310.2 (formerly No. 03732)	Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers, and Polymer Overlays
NACE	All standards, guidance, and recommendations of
NACE Coating Inspector Program (CIP)	NACE International (formerly "National Association of Corrosion Engineers") – CIP certification program
NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings I Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NSF International	ANSI/NSF Standard 61
OSHA 1910.144	Safety Color Code for Marking Physical Hazards
OSHA 1915.35	Painting
SSPC	All standards, guidance, and recommendations of
SSPC PA2	Determining Compliance to Required DFT
SSPC-Volumes 1 and II	SSPC: Society for Protective Coatings –Painting Manual and Systems and Specifications
SSPC-SP1	Solvent Cleaning

Reference	Title
SSPC-SP2	Hand Tool Cleaning
SSPC-SP3	Power Tool Cleaning
SSPC-SP5	White Metal Blast Cleaning
SSPC-SP6	Commercial Blast Cleaning
SSPC-SP7	Brush-Off Blast Cleaning
SSPC-SP10	Near-White Metal Blast Cleaning
SSPC-SP11	Power Tool Cleaning to Bare Metal
SSPC-SP12	Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating
SSPC-SP13	Surface Preparation of Concrete
SSPC-SP16	Brush-Off Blast Cleaning of Galvanized Steel, Stainless Steel and Non-Ferrous Metals

1.03 DEFINITIONS

- A. Conform to ASTM D16 for interpretation of terms used in this section, unless otherwise specified.
- B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

1.04 SUBMITTALS

- A. Submit in accordance with Sections 01 33 00.
- B. All field painting shall be by an approved painting subcontractor with a successful experience record of painting on projects of similar size and type. Submit painting experience record of proposed subcontractor/Contractor for approval.
- C. Manufacturer's recommended test procedure for determining moisture content in concrete prior to application of coating.
- D. Product Data:
 1. For each primer and finish coating, Contractor shall furnish a Material Safety Data Sheet (MSDS).
 2. For each primer and finish coating, Contractor shall provide Manufacturer's application instructions which shall include following:
 - a. Surface preparation recommendations.
 - b. Primer type, where required.
 - c. Maximum dry and wet mil thickness per coat.
 - d. Minimum and maximum curing time between coats, including atmospheric conditions for each.
 - e. Curing time before submergence in liquid.
 - f. Thinner to be used with each paint.

- g. Ventilation requirements.
 - h. Minimum atmospheric conditions during which paint shall be applied.
 - i. Allowable application methods.
 - j. Maximum allowable moisture content.
 - k. Maximum storage life.
- E. Submit a complete schedule of paint systems and surface preparations proposed.
1. List all interior and exterior surfaces and all major equipment to be painted.
 2. Schedule is to reflect approved manufacturer's recommendations. Schedule shall include certification that a qualified manufacturer's representative has reviewed and approved schedule. Qualified manufacturer's representative shall hold current NACE certification as a Coating Inspector, Protective Coatings Specialist, or Materials Selection/Design Specialist.
 3. As a minimum, schedule shall itemize each painted item or surface and shall contain following information in tabular format:
 - a. Type of surface preparation (note whether shop or field preparation). Contractor shall maintain Mylar test tape results (ASTM D4417) used to verify surface preparation blast profiles for examination by Engineer and Paint Manufacturer.
 - b. Paint system (generic name).
 - c. Prime coat (product, number of coats, dry mil thickness per coat, square feet coverage per gallon).
 - d. Intermediate coat, if required (product, number of coats, dry mil thickness per coat, square feet coverage per gallon).
 - e. Finish coat (product, number of coats, color, dry mil thickness per coat, square feet coverage per gallon).
 - f. Critical drying or re-coat times.
 - g. Quantity of coating to be shipped.
 - h. Painting status at time of installation.
 - i. Remarks (any special treatment or application requirements, etc.).
 - j. Discuss any special maintenance procedures or requirements as well as any special methods required for repairing surfaces.
 4. Schedule shall follow sample format attached to end of this section. It shall also contain name of paint manufacturer and name, address, and telephone number of manufacturer's representative. Schedule shall be in conformance with criteria of Tables A-1, A-2, and A-3 and schedules contained in architectural/structural drawings. Manufacturer's recommended dry mil thickness shall be incorporated into schedule. Schedule shall be submitted to Engineer as soon as possible following award of Contract so that approved schedule may be used to identify colors and to specify shop paint systems for fabricated equipment.

5. A Finish Schedule is provided as Table A-2. Requirements of Finish Schedule shall govern if they exceed requirements of Table A-1 or of these specifications. Finish Schedule is provided only as a guide for Contractor. There may be additional items and surfaces which require painting in accordance with these specifications.
- F. Submit color chips for selection. Color names and/or numbers shall be identified according to appropriate color chart published by manufacturer.
- G. Certification: Provide certification from Manufacturer(s) that products meet or exceed Specifications.
- H. Warranty: Provide complete description of warranty to be provided.
- I. General.
 1. Prior to application of coatings, submit letter(s) from paint manufacturer's technical representative identifying application personnel who have satisfactorily completed training or a letter from manufacturer stating that personnel who shall perform work are approved by manufacturer without need for further or additional training.
 2. Submit specified reports when work is underway.
 3. Submit manufacturer Coating System Inspection Checklists for coating work for each specific area and structure.
 4. Paint manufacturer's technical representative final report.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame and smoke rating requirements for finishes.
- B. All chemicals, substances, and materials added to or brought in contact with water in or intended to be used in a public water system or used for purpose of treating, conditioning, altering, or modifying characteristics of such water shall be shown by either manufacturer, distributor, or purveyor to be non-toxic and harmless to humans when used in accordance with formulation and concentration as specified by manufacturer, and shall conform with American National Standards Institute/National Sanitation Foundation (ANSI/NSF) standard 60 or 61 the, Tennessee Department of Environment and Conservation and Underwriter Laboratories (UL). Any organization certified by American National Standards Institute may certify in writing that a product conforms to these standards. Contractor shall submit evidence of approval for all applicable materials.
- C. All materials used on this project, whether shop applied by equipment manufacturer or field applied by Contractor, shall comply with all current federal, state and local Clean Air Act-related regulations. It shall be responsibility of equipment manufacturer to comply with laws in effect at their painting facilities. Where laws or regulations prohibit field applications of any scheduled paint product, Contractor shall submit for Engineer's approval, an alternate product of similar performance characteristics which complies with those laws. If approved, those products shall be provided at no additional cost to Owner.

1.06 ENVIRONMENTAL CONDITIONS

- A. Coatings shall be applied during good painting weather. Air and temperatures shall be within limits prescribed by manufacture for coating being applied and work areas shall be reasonably free of airborne dust at time of application and while coating is drying.
- B. If conditions specified in this Section are more stringent than those specified by manufacturer, conditions in these Contract Documents shall control.

- C. Weather:
 - 1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with Manufacturer's instructions.
 - 2. Ambient Temperature: Minimum of 50 degrees F for interior or exterior, unless required otherwise by Manufacturer.
 - 3. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
 - 4. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with Manufacturer's instructions.
 - 5. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
 - 6. Wind: Do not spray coatings if wind velocity is above manufacturer's limit.
- D. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D102.
- E. All materials specified herein shall meet current VOC Regulations in effect for State of Tennessee.
- F. Dust and Contaminants:
 - 1. Schedule coating work to avoid excessive dust and airborne contaminants.
 - 2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

1.07 INSPECTION BY CONTRACTOR

- A. Contractor shall examine all surfaces to be coated and report any defects. Failure to report defects, or to ascertain that reported defects have been corrected, shall result in Contractor being responsible for defective work resulting therefrom.
- B. All inspections, as applicable, shall be in accordance with the Contract Documents and SSPC PA2 and all other relevant SSPC and NACE standards, requirements, and recommendations. Differences between Contract Documents and indicated standards shall be resolved in favor of more stringent standard.

1.08 QUALITY ASSURANCE

- A. Work shall be done by competent, experienced workmen qualified in application of coatings specified for use.
- B. Manufacturer's Qualifications:
 - 1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.
 - 2. Able to demonstrate successful performance on comparable projects.
 - 3. Single Source Responsibility: Coatings and coating application accessories shall be products of a single manufacturer.
- C. Applicator's Qualifications:

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this work.
 2. Applicator's Personnel: Employ persons trained for application of specified coatings.
- D. Paint Sample: Contractor shall obtain Engineer's review of first finished room, space, area, item, or portion of work of each surface type and color specified. First room, space, area, item, or portion of work which is acceptable to Engineer shall serve as project standard for all surfaces of similar type and color. Where spray application is utilized, area to be reviewed shall not be smaller than 100 square feet.
- E. Manufacturer's Representative during Painting Operations: An authorized Manufacturer's representative shall be present at start-up and weekly during painting operations. Such representative shall instruct and observe Contractors and Applicators work and shall, at completion of work, certify in writing to Engineer that Manufacturer's application recommendations have been adhered to. Cost of this work shall be borne by Contractor.
- F. Quality Control Requirements.
1. Contractor is responsible for workmanship and quality of coating system installation. Inspections by any party shall not relieve or limit Contractor's responsibilities.
 2. Contractor's methods shall conform to requirements of this specification and standards referenced in this Section. Changes in coating system installation requirements shall be allowed only with written acceptance of Engineer before work commences.
 3. Only personnel who are trained by paint manufacturer's technical representative specifically for this contract or who are approved by manufacturer specifically for this contract shall be allowed to perform coating system installation specified in this Section.
 4. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.
 5. For repairs, Contractor shall provide same products, or products recommended by manufacturer, as used for original coating.
 6. Contractor shall identify points of access for inspection by Owner and Engineer. Contractor shall provide ventilation, ingress and egress, and other means necessary for personnel to safely access work areas.
 7. Contractor shall conduct work so that coating system is installed as specified and shall inspect work continually to ensure that coating system is installed as specified. Coating system work that does not conform to specifications or is otherwise not acceptable shall be corrected as specified.
 8. Contractor shall complete Coating System Inspection Checklist at end of this Section for all coating system installations for each area and structure. Follow sequential steps required for proper coating system installation as specified and as listed in Coating System Inspection Checklist. For each portion of work, install coating system and complete signoffs as specified prior to proceeding with next step. After completing each step as indicated on Coating System Inspection Checklist, Contractor, applicable coatings manufacturer, and Applicator shall sign checklist indicating that work has been installed and inspected as specified.
 9. Contractor shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to coating system installation.

G. Inspection at Hold Points.

1. Contractor shall conduct inspections at Hold Points during coating system installation and record results from those inspections on Coating System Inspection Checklist. Contractor shall coordinate such Hold Points with Owner and Engineer such that Owner, Engineer, and applicable coating manufacturer may observe Contractor's inspections on a scheduled basis. Contractor shall provide Engineer a minimum of two (2) hours of notice prior to conducting Hold Point Inspections. Hold Points shall be as follows:
 - a. Environment and Site Conditions – Prior to commencing an activity associated with coating system installation, Contractor shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. Acceptability of weather and/or environmental conditions within structure shall be determined by requirements specified by manufacturer of coating system being used.
 - b. Conditions Prior to Surface Preparation – Prior to commencing surface preparation, Contractor shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from surface.
 - c. Monitoring of Surface Preparation – Spot checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, compressed air used for surface preparation or blow down cleaning shall be checked to confirm it is free from oil and moisture.
 - d. Post Surface Preparation – Upon completion of surface preparation, Contractor shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09 96 00 and in manufacturer's written instructions.
 - e. Monitoring of Coatings Application – Contractor shall inspect, measure, and record wet film thickness and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as application work proceeds.
 - f. Post Application Inspection – Contractor shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness and other problems as may be observed.
 - g. Post Cure Evaluation – Contractor shall measure and inspect overall dry film thickness (DFT). Contractor shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on type of project and specific requirements in this Section 09 96 00 and/or in manufacturer's written instructions.
 - 1) Standards for such testing, including frequency and calibration of test instruments, shall be in accordance with this Section, other section of the Contract Documents, and SSPC PA2. Any differences between the Contract Documents and SSPC PA2 shall be resolved in favor of the more stringent standard.
 - h. Follow-up to Corrective Actions and Final Inspection – Contractor shall measure and re-inspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

H. Responsibilities of paint manufacturer's technical representative.

1. General:

- a. Contractor shall retain or obtain services of paint manufacturer's technical representative to be on site to perform Contractor and applicator training and to routinely inspect and verify in writing that application personnel have successfully performed surface preparation, filler/surface application, coating system application, and quality control inspections in accordance with this Section and to warrantable level of quality. This must include checking required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking wet and dry film thickness of coating systems), proper cure of coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. This inspection is in addition to inspection performed by Contractor in accordance with this Section 09 96 00.
2. Coating System Installation Training:
 - a. Provide a minimum of 8 hours of classroom and off-site training for application and supervisory personnel (both those of Contractor and Applicator). Provide training to a minimum of two supervisory personnel from Applicator and one supervisor from Contractor. Alternatively, paint manufacturer's technical representative shall provide a written letter from manufacturer stating that application personnel (listed by name) who shall perform coating work are approved by manufacturer without further or additional training.
 - b. One paint manufacturer's technical representative can provide training for up to fourteen application personnel and three supervisory personnel at one time. Training shall include following as a minimum:
 - 1) A detailed explanation of mixing, application, curing, and termination details.
 - 2) Hands-on demonstration of how to mix and apply coating systems.
 - 3) A detailed explanation of ambient condition requirements (temperature and humidity) and surface preparation requirements for application of coating system as well as a detailed explanation of re-coat times, cure times, and related ambient condition requirements.
 - 4) When training is performed, paint manufacturer's technical representative shall provide a written letter stating that training was satisfactorily completed by personnel listed by name in letter.
3. Coating System Inspection:
 - a. While on site to routinely inspect and verify, paint manufacturer's technical representative shall perform following activities to confirm acceptability and conformance with specifications:
 - 1) Inspect ambient conditions during various coating system installation at hold points for conformance with specified requirements.
 - 2) Inspect surface preparation of substrates where coating system shall terminate or shall be applied for conformance to specified application criteria.
 - 3) Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).
 - 4) Inspect application of filler/surface materials for concrete and masonry substrates.

- 5) Inspect application of primers and finish coats including wet and dry film thickness of coatings.
 - 6) Inspect coating systems for cure.
 - 7) Review adhesion testing of cured coating systems for conformance to specified criteria.
 - 8) Review coating system continuity testing for conformance to specified criteria.
 - 9) Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
 - 10) Conduct a final review of completed coating system installation for conformance to specifications.
 - 11) Prepare and submit a site visit report following each site visit that documents acceptability of coating work in accordance with manufacturer's recommendations.
4. Final Report:
- a. Upon completion of coating work for project, paint manufacturer's technical representative shall prepare a final report. That report shall summarize daily test data, observations, drawings, and photographs in a report. Include substrate conditions, ambient conditions, and application procedures, observed during paint manufacturer's technical representative's site visits. Include a statement that completed work was performed in accordance with requirements of this Section 09 96 00 and manufacturer's recommendations.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Conform to Section 01 00 05.
- B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
 1. Coating or material name.
 2. Manufacturer name, address, and trademark.
 3. Color name and number.
 4. Batch or lot number.
 5. Date of manufacture.
 6. Mixing and thinning instructions.
 7. Recommendations for protective measures against toxicity.
- C. Storage:
 1. Store materials in a clean dry area and within temperature range in accordance with Manufacturer's instructions.
 2. Keep containers sealed until ready for use.

3. Do not use materials beyond Manufacturer's shelf life limits.
 4. Store materials for three days prior to installation in area of installation to achieve temperature stability.
- D. Handling: Protect materials during handling and application to prevent damage or contamination.

1.10 TESTING EQUIPMENT

- A. Contractor shall furnish and make available to Engineer following items of testing equipment for use in determining if requirements of this section are being satisfied. Specified items of equipment shall be available for Engineer's use at all times when field painting or surface preparation is in progress.
1. Wet film gauge.
 2. Surface thermometer.
 3. Testex Press-O-Film replica tape and spring micrometer.
 4. Set of National Association of Corrosion Engineers (NACE) visual standards.
 5. Holiday (pinhole) detector (low voltage).
 - a. For coatings where a single layer or total thickness of all layers exceeds 20 mils, use a high voltage test per NACE SP0188 in lieu of standard low-voltage test.
 6. Sling-psychrometer.
 7. Tooke gauge.

1.11 EXTRA STOCK

- A. Upon completion of painting, all unused paint shall be removed from project site. Furnish Owner with color formulations for each color or product used to allow Owner to match colors in future.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Paint and paint products shall be as designated for following uses and as manufactured by following:
1. Industrial: Materials shall be as manufactured by Tnemec Company, Inc., Sherwin-Williams Company, or Carboline. No "or equals" shall be permitted.
- B. Products for each specified function and system shall be of a single manufacturer. Prime and finish coats from different manufacturers shall not be accepted.
- C. Where thinning is necessary, only products of particular manufacturer furnishing paint shall be used and all such thinning shall be done in strict accordance with manufacturer's instructions.
- D. Colors, where not specified, shall be as selected by Owner and Engineer.
- E. Pipe and conduit labels: Refer to Section 10 14 20.

2.02 MATERIALS

- A. All materials delivered to job site shall be in original sealed and labeled containers provided by paint Manufacturer.
- B. Paint – Refer to Table A-1, Paint System Schedule.
- C. All paint materials shall be certified Lead Free.
- D. Pipe and Conduit Labels:
 - 1. Refer to Section 10 14 20.

2.03 CHEMICAL RESISTANT FINISHES

- A. Following shall pertain only to chemical resistant finishes (Systems C-8 and C-9).
 - 1. Coated surfaces shall withstand continuous immersion in chemicals listed at end of this Article.
 - 2. Finish system shall be as specified in Paint System Schedule except as modified herein.
 - 3. Total system shall result in a leak-proof primary containment lining, free of cracks and leaks.
 - a. Any filler required to fill bug holes shall be applied to substrate prior to priming of surface.
 - b. For System C-8 (concrete and masonry surfaces), special attention shall be applied to structural joints and field conditions. Total system shall contain a minimum 1.5 oz. per square yard fiberglass chopped strand reinforced mat cloth system on all horizontal and vertical surfaces and cant on all inside 90-degree angles. Cants shall be a minimum of 1 inch by 1 inch.
 - 1) Saturant coat shall initially “wet out” mat. Afterwards, mat shall be completely saturated with saturant coat. Mat shall be completely hidden by saturant coat.
 - 2) Prior to application of any coats beyond mat and saturant coat, all areas that have received fiberglass mat reinforcement shall be sanded to ensure fiberglass is embedded below surface of saturant coat.
 - c. Mat system is not required for System C-9.
 - 4. For System C-8, coatings shall extend over floor, pump pads, tanks pads, on vertical surfaces of containment areas, and to extent described herein and shown on Contract Drawings. For System C-9, all metallic surfaces within containment areas and other areas as specifically shown or described in Contract Documents shall be coated otherwise metal surfaces shall not be coated with System C-9.
 - 5. Following is a list of chemicals that may spill and subject chemical resistant finish to continuous immersion for an indefinite time period:

Chemical	Concentration (percent)
Sodium Hypochlorite	15 (maximum)
Sodium Bisulfite	45

Chemical	Concentration (percent)
Aluminum Sulfate	48.5
Ferric Chloride	45
Polyaluminum Chloride	22
Polyacrylamide	60
Polyquarternary Amine	65

PART 3 EXECUTION

3.01 GENERAL

A. Adhesion Confirmation.

1. Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) shop applied prime coat adheres to substrate, and (2) specified field coatings adhere to shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.

3.02 EXAMINATION

- A. Verify that surfaces are ready for application of materials in accordance with product manufacturer's instructions.
- B. Examine surfaces scheduled to be finished prior to commencement of Work. Report any condition that may potentially affect proper application.
- C. Paint manufacturer shall provide onsite representative to review all installation procedures and review surface preparation prior to any paint being applied.
- D. Measure moisture content of surfaces using appropriate method as instructed by coating manufacturer. Do not apply finishes unless moisture content of surfaces is below coating manufacturer's acceptable maximums.
- E. Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) shop applied prime coat adheres to substrate, and (2) specified field coatings adhere to shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.
- F. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated during Paint Removal Operations.

3.03 TESTING OF PAINT ON EXISTING SURFACE FINISH

- A. Where paint is to be applied over existing finished surface, apply a test application.

- B. Allow test application to dry overnight. If wrinkling or lifting occurs after overnight drying, application of new paint over existing finished surface shall not be allowed. With approval of Engineer, use one of following alternatives:
 - 1. Remove existing coating and apply complete system as described in Finish Schedule.
 - 2. Apply intermediate barrier coat material that is compatible with both existing finish and new topcoat and shall ensure bonding of new paint to existing surface finish.
 - 3. Substitute a different coating material that is compatible with and shall adhere to existing surface finish.
- C. Cost of test application shall be borne by Contractor.

3.04 EQUIPMENT FINISHES

- A. Surface preparation, shop painting and field painting and other pertinent detailed painting of all equipment shall be in accordance with this Section and individual specification sections.
 - 1. If equipment has received manufacturer's factory-applied coatings that fully comply with this Section including those for quantity, thickness, and color, Contractor shall be responsible for obtaining touch up paint from equipment manufacturer in correct color and any other special materials required by manufacturer to make necessary field repairs to factory-applied finish should said finish be marred or damaged. Alternate touch materials may be accepted only when a complete field coat is to be applied and when alternate materials are approved by both equipment manufacturer and field coat manufacturer.
 - 2. If equipment has received a manufacturer's standard factory finish which does not conform to this Section with respect to quantity, thickness, and/or color, Contractor shall apply necessary field coat(s), including tie coat if necessary, to meet requirements of this Section. Contractor is responsible for ensuring compatibility of factory-applied and field paint systems.
 - 3. If equipment has received only a factory-applied prime coat, Contractor shall be responsible for removing prime coat in accordance with this Section before applying all required field coats, which shall comply with this Section.
 - 4. If equipment does not have a prime coat applied, as a minimum, surfaces shall be protected from corrosion by applying a rust inhibitor or other acceptable means of protection. Contractor shall be responsible field preparing and coating these surfaces, when required, in accordance with this Section.
 - 5. Contractor shall be responsible for reviewing with equipment manufacturer prior to bid what type of factory-applied coating(s), if any, shall be applied to equipment prior to shipment. Contractor shall be responsible for providing required field-applied coatings in order to fully comply with this Section and individual equipment specification sections at no additional cost to Owner.

3.05 SURFACE PREPARATION

- A. Protection of Items Not to Be Painted:
 - 1. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing. Mask nameplates, descriptive data on pumps, motors and other equipment. Removed item shall be reinstalled by workmen skilled in trades involved.

2. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
 3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
 4. Mask openings in motors to prevent paint and other materials from entering.
 5. Protect surfaces adjacent to or downwind of Work area from overspray.
- B. All surfaces to be painted shall be prepared with objective of obtaining a clean and dry surface free from dust, rust, scale and all foreign matter. No painting shall be done before surfaces meet requirements of paint manufacturer.
- C. Correct defects and clean surfaces which affect Work of this Section.
- D. Seal marks which may bleed through surface finishes with sealer as instructed by paint manufacturer.
- E. If mildew is encountered, remove by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Touch up welds, burned and abraded areas with specified primer before applying field coats.
- G. All existing painted surfaces to be painted are to be reviewed by paint manufacturer's representative to verify type of existing paint, surface preparation required and suitability of specified paint system to go over existing paint. Contractor is to notify Engineer if manufacturer's representative recommends changing specified paint system.
- H. All applicable surface preparations shall be verified using method ASTM D4417. Contractor shall maintain all Mylar tape samples for examination by Engineer or Paint Manufacturer.
- I. Steel Surface Preparation:
1. Prepare steel surfaces in accordance with Manufacturer's instructions.
 2. Fabrication Defects:
 - a. Correct steel and fabrication defects revealed by surface preparation.
 - b. Remove weld spatter and slag.
 - c. Round sharp edges and corners of welds to a smooth contour.
 - d. Smooth weld undercuts and recesses.
 - e. Grind down porous welds to pinhole-free metal.
 - f. Remove weld flux from surface.
 3. Prepare steel surfaces scheduled to receive additional SSPC preparation in accordance with Manufacturer's instructions, SSPC-SP 1 (Solvent Cleaning).
 4. Ensure surfaces are dry.
 5. Immersed or Below Grade Surfaces:

- a. Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2 (Near White Blast Cleaning).
6. Exterior Exposed or Interior Exposed Surfaces:
 - a. Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3 (Commercial Blast Cleaning).
7. Interior or Immersed Surfaces, Severe Atmospheres:
 - a. Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 5/NACE 1 (White Metal Blast Cleaning).
8. Abrasive Blast-Cleaned Surfaces:
 - a. Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.
9. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent rusting.
10. Shop Primer:
 - a. Prepare shop primer to receive field coat in accordance with Manufacturer's instructions.
 - b. For non-immersed metal surfaces, remove loose primer and rust in accordance with SSPC-SP2 (Hand Tool Cleaning) or SSPC-SP3 (Power Tool Cleaning). Clean surfaces in accordance with SSPC-SP1 (Solvent Cleaning).
 - c. Touch up damaged areas of shop primed items with compatible primer.
 - d. For metal surfaces in an immersed, vapor, or splash zone, remove shop primer and other foreign matter in accordance with SSPC-SP 10/NACE 2 (Near White Blast Cleaning).
 - e. Contractor shall be responsible for compatibility of shop primer and field coats.
- J. Galvanized Steel, Copper, and Nonferrous Metal Surface Preparation (other than aluminum):
 1. Prepare galvanized steel, copper, and nonferrous metal surfaces in accordance with Manufacturer's instructions.
 2. Visible deposits of oil, grease, or other contaminants shall be removed as required by SSPC-SP1. Sweep (Abrasive) Blasting per SSPC-SP16 to achieve a uniform anchor profile (1.0 to 2.0 mils). Galvanized surfaces must be clean, dry, and contaminant free prior to application of coatings.
 3. Ensure surfaces are dry.
 4. Remove visible oil, grease, dirt, dust, protective mill coatings, and other soluble contaminants in accordance with SSPC-SP 1 (Solvent Cleaning) followed by or Manufacturer's instructions as specified for coating system.
 5. Immersed Service:

- a. Clean surfaces in accordance with SSPC-SP7 (Brush-off Blast Cleaning) or SSPC-SP16 (Brush-Off Blast Cleaning of Galvanized Steel, Stainless Steel and Non-Ferrous Metals) depending on substrate.
6. Non-immersed Service:
- a. Non-passivated (do not use this method for epoxy coatings): Clean and etch metal per SSPC-SP1 (Solvent Cleaning). Use Clean N' Etch by Great Lakes Laboratories, Inc. or equal. Follow manufacturer's written instructions. Uniformly etch and clean surface while removing contamination and oils. Reference coating manufacturer's specific surface preparation guidelines.
 - b. Passivated (use this method for epoxy coatings): Abrasive brush blast clean per ASTM D6386, uniformly etching galvanized or aluminum surface without damaging surface to achieve an anchor profile of 1.0 to 2.0 mils. Reference coating manufacturer's specific surface preparation guidelines.
7. Remove Rust from Galvanized Steel:
- a. Remove rust from old galvanized steel in accordance with SSPC-SP2 (Hand Tool Cleaning) or SSPC-SP3 (Power Tool Cleaning).
 - b. Do not damage or remove galvanizing.
 - c. Testing: Apply 1 drop of 10-percent copper sulfate solution to treated/dried surface. If a black spot develops instantly on contact, surface has been properly prepared for painting.
8. For unknown galvanized surfaces, apply Clean N'Etch by Great Lakes Laboratories, Inc. or equal product. Then apply water to surface. If water beads or breaks on surface, surface is not ready to paint. If water sheets over surface, surface is ready to paint as passivation film and other oily soils have been removed.
9. Increase mechanical adhesion under moderate to severe conditions, such as exterior exposure or chemical environments, by abrasive blast and/or chemical cleaning.
- K. Ductile or Cast-Iron Surface Preparation:
- 1. Prepare ductile or cast-iron surfaces in accordance with Manufacturer's instructions.
 - 2. Remove coating in accordance with NAPF 500-03.
 - 3. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- L. PVC and FRP Surface Preparation:
- 1. Prepare PVC and FRP surfaces in accordance with Manufacturer's instructions.
 - 2. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
 - 3. Lightly hand sand PVC and FRP surfaces with medium grit sandpaper.
 - 4. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed to prevent removing excess material.
 - 5. Apply test sample prior to application to ensure adhesion.
- M. Insulated Pipe Surface Preparation:

1. Prepare insulated pipe surfaces in accordance with Manufacturer's instructions.
 2. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- N. Aluminum Surfaces Scheduled for Paint Finish: Clean and lightly scarify per SSPC-SP1 (Solvent Cleaning). Apply manufacturer's instructed primer immediately following cleaning.
- O. Prior Coating:
1. Old paint surfaces on concrete, ferrous metal and nonferrous metal shall be prepared by abrasive blast cleaning in accordance with proper SSPC method for service.
- P. Touchup:
1. Any abraded areas of shop or field applied coatings shall be touched up with same type of shop or field applied coating, even to extent of applying an entire coating, if necessary.
 2. Touchup coatings and surface preparations shall be in addition to and not considered as first field coat.

3.06 APPLICATION

- A. Do not apply materials until representative samples of surface preparation are reviewed and accepted by Engineer and by an authorized representative of paint manufacturer.
- B. Comply with manufacturer's instructions.
- C. Contractor shall maintain a daily epoxy coatings induction record (log) as required showing each epoxy paint mixing event in format demonstrated at end of this section. A signed copy of this log shall be turned over to Engineer's field representative before end of each working day during which epoxy coatings are mixed or applied.
- D. Do not use plumbing fixture or waste piping for mixing of paint or disposal of any refuse material. All waste shall be disposed of properly into a suitable receptacle located outside of building.
- E. Apply coatings to all surfaces with special attention to hard-to-reach areas such as between legs of back-to-back angles. Apply each coat to achieve specified dry film thickness.
- F. Do not apply finishes to surfaces that are not dry.
- G. Deficiencies in film or coating thickness shall be corrected by application of additional coat(s) of material at expense of Contractor.
- H. Apply each coat to a uniform smooth finish.
- I. Special attention shall be given to ensure that edges, corners, crevices and welds, receive a film or coating thickness equivalent to that of adjacent surfaces (i.e., stripe coat). At no time shall wet-on-wet applications be permitted. Finished surfaces shall be free from runs, drips, ridges, waves, laps, brush marks and variations in color, texture and finish.
- J. For concrete containment linings, saw cut all terminations 1/4-inch-deep and 1/4 inch wide. Install coating systems so that they fold into saw cuts.
- K. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- L. Sand surfaces lightly between coats as required to achieve required finish.

- M. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
- N. Where clear finishes are required, tint fillers to match wood. Work fillers into grain before set. Wipe excess from surface.
- O. Prime concealed surfaces of wood to be scheduled for paint finish with primer paint.
- P. Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.
- Q. Contractor shall be responsible for cleanliness of all painting operations and use covers and masking tape to protect work. Contractor shall protect not only his own work, but also all adjacent work and materials by adequate covering with drop cloths.
- R. Any unwanted paint shall be carefully removed without damage to finished paint or surface. If damage does occur, entire surface adjacent to and including damaged area shall be repainted without visible lap marks.
- S. All paint shall be applied to provide uniform color and sheen without streaks, laps, runs, sags, thin spots, missed areas, or unacceptable marks. Paint shall be applied at rate specified to achieve minimum dry mil thickness required. Additional coats of paint shall be applied, if necessary, to obtain dry film thickness specified. Primer and finish coats shall be furnished by same manufacturer to ensure compatibility.
- T. Application shall be by spraying, brushing, or rolling as recommended by Paint Manufacturer. If material has thickened or must be diluted for application by spray gun, each coat shall be built up to same film thickness achieved with undiluted brushed-on material. Where mixing or thinning is necessary, such mixing or thinning shall be done in strict accordance with manufacturer's instructions and in accordance with AWWA D102.
 - 1. Spray painting of any exterior surface is forbidden.
- U. A minimum of 24 hours drying time or as recommended in writing by manufacturer shall elapse between applications of any two coats of paint on a particular surface, unless otherwise recommended by coating manufacturer. Longer drying times may be required for abnormal conditions in concert with manufacturer's recommendations.
- V. No painting whatsoever shall be accomplished in rainy or excessively damp weather when relative humidity exceeds 85 percent, or when general air temperature cannot be maintained at 50 degrees F (10 degrees C) or above throughout entire drying period. No painting shall occur on applicable surfaces until Mylar tape samples used for test ASTM D4417 have been reviewed by Paint Manufacturer and approval for painting granted by Paint Manufacturer.
- W. Apply color coding to all new plant piping, in accordance with Table A-3, Piping Color and Label Schedule, and/or Engineer's instructions. Plant piping shall be painted solid colors unless otherwise specified.
- X. On piping designated to receive identification bands, such band shall be 6 inches wide, neatly made by masking, and spaced at intervals of 30 inches on center, regardless of diameter of pipe being painted. Use approved precut and pre-finished metal or plastic bands on piping in lieu of marked and painted bands, if approved by Engineer. PVC pipe shall be banded with colored bands in lieu of painting.
- Y. Contractor shall protect paint work from damage and barricade any areas painted until finishes have cured to prevent unauthorized entry into areas that have been painted.
- Z. Pipe Labeling:

1. Refer to Section 10 14 20.

3.07 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. All fabricated steel work and equipment delivered to job site shall receive at factory at least one shop coat of approved prime paint that is compatible with specified finish coats in concert with paint system required by these Specifications. Surface preparation prior to shop painting shall be scheduled in Table A-1. All shop painted items shall be properly packaged and stored until they are incorporated in work. Any painted surfaces that are damaged during handling, transportation, storage, or installation shall be cleaned, scraped, and patched before field painting begins so that work shall be equal to original painting at shop. Equipment or steel work that is to be assembled on site shall likewise receive a minimum of one shop coat of paint at factory. Paint and surface preparation used for shop coating shall be identified on equipment shop drawings submitted to Engineer.
- B. Where exact identity of shop primer cannot be determined, or where primer differs from that specified, Contractor shall perform blast cleaning appropriate for service, followed by specified paint system. In lieu of above, Contractor has option of shipping bare metal to job site and performing appropriate blast cleaning, followed by field prime coat of specified material immediately thereafter.
- C. Paint shop-primed equipment.
- D. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- E. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, except where items are pre-finished.
- F. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- G. Paint exposed conduit and electrical equipment occurring in finished areas.
- H. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
- I. Color-code equipment, piping, conduit, and exposed ductwork in accordance with requirements indicated. Color band and identify with flow arrows names and numbering.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.08 FIELD QUALITY CONTROL

- A. Each prepared surface and each field coat of priming and finishing paint shall be inspected by paint manufacturer as well as Engineer or his authorized representative before prime coat is applied and before each succeeding coat is applied. Contractor shall follow a system of tinting successive paint coats so that no two coats for a given surface are exactly same color. Areas to receive black protective coatings shall be tick-marked with white or actually gauged as to thickness when finished. Contractor shall request acceptance of each coat before applying next coat. Contractor shall correct work that is not acceptable and request re-inspection. Failure to obtain paint manufacturer's review of all surfaces prior to commencement of subsequent costing shall be at Contractor's sole risk and expense.

- B. Contractor shall request acceptance of prepared surface and each coat before applying next coat.
- C. Wet Film Thickness: Monitor during application of each successive coat.
- D. Dry Film Thickness: Measure thickness of each coat applied using non-destructive dry film thickness gauges. Calibrate gauges and perform thickness measurements in accordance with SSPC-PA2 except minimum DFT thicknesses shall be as specified herein. Disputes regarding coating thickness applied shall be resolved by use of a Tooke Gauge (destructive scratch gauge) to extent required. Repair damage created by destructive testing using complete coating system specified.
- E. Inspection Devices: Contractor shall possess, use, and make available for use by Owner, inspection devices in good working order for dry film thickness measurement. Furnish with inspection device, U.S. Department of Commerce, National Bureau of Standards certified thickness calibration plates to verify accuracy of dry film thickness gauges.
- F. Applicator's Services:
 - 1. Verify coatings and other materials are as specified.
 - 2. Verify surface preparation and application is as specified.
 - 3. Verify DFT of each coat and total DFT of each coating system is as specified using wet film and dry film gauges. Square feet coverage shall also be monitored to verify proper coverage rates.
 - 4. All surfaces having less dry film thickness than specified, apply additional coat(s) at no extra cost to Owner to bring thickness up to specifications.
 - 5. Structural metals in immersion service that receive a protective coating system shall be checked with a non-destructive holiday detector that shall not exceed 67-1/2 volts. All pinholes or defects shall be repaired in accordance with manufacturer's printed recommendations and then retested.
 - a. Use high-voltage holiday detection equipment as per NACE SP0188-latest revision for systems in excess of 20 mils.
 - 6. Coating Defects:
 - a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
 - b. Check for holidays on interior steel and concrete immersion surfaces using holiday detector.
 - 7. Report:
 - a. Submit daily written reports describing work performed, inspections made, and actions taken to correct nonconforming work. Daily reports shall contain, but not be limited to, following information:
 - 1) Start date and time of work in each area.
 - 2) Weather conditions.
 - 3) Date and time of application for each following coat.

- 4) Moisture content of substrate prior to each coat.
 - 5) Provisions utilized to maintain temperature and humidity of work area with Manufacturer's recommended ranges.
- b. Report nonconforming work not corrected.
 - c. Submit copies of report to Engineer and Contractor.
8. Contractor shall permit Owner's Representative and/or paint and coating manufacturer (as requested by Owner) to inspect his work for conformance to this specification. Owner reserves right to reject all work that does not comply with this specification.
- G. Manufacturer's Field Services:
1. Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems. Contractor shall not proceed with next coating or preparation step without first obtaining a review and approval of current surface condition with paint manufacturer.
- H. Prior to receiving a Certificate of Substantial Completion, Contractor shall arrange for paint manufacturer to review application of his product and shall submit his report to Engineer identifying products used and verifying that said products were properly applied and that paint systems were proper for exposure and service. Manufacturer's representative shall also certify that all coats in each system are compatible with one another.

3.09 COVERAGE

- A. Coverage given or recommended by coating manufacturer shall not relieve applicator of responsibility for obtaining a smooth, uniform, and attractive coating. Where satisfactory coverage is not obtained with specified number of coats, additional coats shall be applied at no extra cost to Owner. Each separate coating application, except for finish coat, shall have a color such that it may be identified.

3.10 CLEANING

- A. Collect waste material which may constitute a fire hazard; place in closed metal containers and remove daily from Site.
- B. Remove masking, over-spray, or drips on adjacent surfaces.
- C. Remove and dispose of all rubbish or other unsightly material, in a legal manner, leaving premises in a clean condition in accordance with Section 01 00 05.

3.11 SURFACES NOT TO BE PAINTED

- A. Following surfaces shall not be painted unless specified otherwise in Contract Documents:
 1. Stainless Steel: All surfaces.
 2. Aluminum: All surfaces, except where indicated otherwise. (Aluminum in contact with concrete shall be coated.)
 3. Exterior concrete and exterior concrete floors (except where indicated otherwise).
 4. Factory Finished Equipment: If a durable high-quality permanent finish is provided, such finish is undamaged, and colors conform to color scheme selected.

5. Glass.
6. Galvanized structural and miscellaneous steel unless otherwise indicated.
7. Gel-coated fiberglass doors.
8. Machined and polished surfaces unless otherwise indicated.
9. Non-ferrous metal surfaces unless otherwise indicated.

3.12 TABLE A-1: PAINT SYSTEM SCHEDULE

- A. Table A-1 and Equipment Finish Schedule (Table A-2) are not intended to list every structure or equipment item to be painted. All new and existing structures, equipment, and appurtenances including all items furnished under contract shall be painted by Contractor, in accordance with most applicable category from Table A-1. New and existing concrete tanks are not to be painted unless specifically identified in following tables or on Contract Drawings. No painting shall be required for existing structures and equipment which are not being modified under this contract.
- B. Paint systems of Tnemec, Sherwin-Williams, and Carboline are listed.

System/Substrate		TNEMEC	Sherwin-Williams	Carboline
SYSTEM M-2: Ferrous Metal (non-galvanized) and Ductile Iron/Cast Iron – Exterior, Non-Submerged	Surface Prep	SSPC-SP6 Commercial blast (ferrous metal). NAPF 500-03-04 with exception that <u>all</u> rust and mold coating be removed; only tightly adherent annealing oxide may remain (ductile iron).		
	Prime Coat	Series N69 Hi-Build Epoxoline II 4.0-6.0 mils	Macropoxy 646 Fast Cure Epoxy 4.0-6.0 mils	Carboguard 60 4.0-6.0 mils
	Intermediate Coat	Series N69 Hi-Build Epoxoline II 6.0-8.0 mils	Macropoxy 646 Fast Cure Epoxy 4.0-6.0 mils	Carboguard 60 4.0-6.0 mils
	Finish Coat	Series 1095 Endura-Shield 3.0-5.0 mils	Acrolon 218 2.0-4.0 mils	Carbothane 134HG 2.0-4.0 mils
	Total DFT	11.5 mils minimum	10.0 mils minimum	10.0 mils minimum
SYSTEM M-3: Ferrous Metal (non-galvanized) and Ductile Iron/Cast Iron – Submerged/In Contact With Raw and Potable Water	Surface Prep	SSPC-SP10 Near White blast (ferrous metal). NAPF 500-03-04 with exception that <u>all</u> rust and mold coating be removed; only tightly adherent annealing oxide may remain (ductile iron). Galvanized – Visible deposits of oil, grease, or other contaminants shall be removed as required by SSPC-SP1. Abrasive blasting per SSPC-SP10/NACE 2 Near-White Blast Cleaning with a minimum angular anchor profile of 3.0 mils. Surfaces must be clean, dry, and contaminant free prior to application of coatings.		
	Prime Coat	Series 20HS Pota-Pox 5.0-7.0 mils	Macropoxy 5500LT Potable Water Epoxy 5.0-7.0 mils	Carboguard 891 VOC 5.0-7.0 mils
	Intermediate Coat	Series 20HS Pota-Pox 5.0-7.0 mils	Macropoxy 5500LT Potable Water Epoxy 5.0-7.0 mils	Carboguard 891 VOC 5.0-7.0 mils
	Finish Coat	Series 20HS Pota-Pox 5.0-7.0 mils	Macropoxy 5500LT Potable Water Epoxy 5.0-7.0 mils	Carboguard 891 VOC 5.0-7.0 mils
	Total DFT	15.0 mils minimum	15.0 mils minimum	15.0 mils minimum

- C. Paint systems in contact raw or potable water shall be NSF approved without exception.
- D. PVC pipe shall be banded with colored bands in lieu of painting.
- E. Concrete floors, except those exposed to chemicals such as in containment areas, shall not be painted.
- F. For application and curing at temperatures of 35 to 50 degrees F, use alternate products as may be required by paint manufacturer for particular application environment.
- G. For conditions not listed above, Contractor shall submit proposed paint system to Engineer for review prior to purchase of paint or application of paint in field.
- H. Galvanized surfaces that are damaged only slightly during installation shall be touched up using Galv-O-WELD, or approved equal. Repair shall be in accordance with equipment manufacturer's and paint manufacturer's recommendations. Prior to painting, surfaces including any welds of slags or flux shall be cleaned by wire brushing and chipping.

3.13 TABLE A-2: FINISH SCHEDULE

Location/Description	Surface	Paint System ID	Color	Tnemec ID; Sherwin-Williams ID; Carboline ID
Exterior non-submerged motors, drives, pumps, and pump operators	Metal	M-2	Same as Process Fluid; or Same as Associated Equipment	--
Submerged motors, drives, pumps, and pump operators	Metal	M-3	Manufacturer's Standard	--
Non-submerged exterior ductile iron pipe, supports, valves, etc.	Metal	M-2	See Paint Pipe Schedule	--
Exterior PVC Pipe and Accessories	PVC	--	See Pipe Paint Schedule	Single bands 3 feet on center
Miscellaneous exterior non-submerged ferrous metal	Metal	M-2	Owner to Select	--

- A. Any color designated as "manufacturer's standard" shall indicate that equipment shall be factory painted by manufacturer in accordance with this specification section and other individual specification sections pertaining that that equipment prior to equipment being delivered to project site.
- B. All colors shall be coordinated with Owner prior to ordering.
 - 1. When colors are to be matched to other colored surfaces, an actual piece of that surface from material actually delivered to site for installation (e.g., siding) shall be used to match color. Contractor shall supply a minimum 2-inch x 2-inch sample of material to paint manufacturer to accurately match color. Color chips and material samples not derived from actual on-site material shall not be used to match colors without express permission of Owner and Engineer.

- C. Painting and coating of plumbing, HVAC, and electrical equipment shall be coordinated with Divisions 21, 22, 23, 26, and 40 specifications.
- D. Walls, base, ceilings, and floors shall be painted as scheduled for various rooms in Finish Schedule on Contract Drawings. Colors to be coordinated with Engineer and Owner prior to purchase and installation. Paint systems shall be as specified in Table A-1.
- E. Contractor shall install concrete densifier/hardener to all walking surfaces and other surfaces called to receive such treatment as soon as able based on product manufacturer's required concrete cure times before application. Any damage, staining, or other concrete defects resulting from Contractor's delay in applying densifier/hardener shall be at sole risk and expense of Contractor.
- F. All surfaces not identified in Table A-2 shall be painted in accordance with general surface descriptions and associated paint system as described in Table A-1.

3.14 TABLE A-3: PIPE AND LABEL COLOR SCHEDULE

Legend	Piping ID From Drawings	Label Color	Pipe Color	Tnemec ID	Sherwin-Williams ID	Carboline ID
Process Drain	DR	Brown	Light Brown	04BR	SW 4003	V212
Raw Water	RW	Green	Olive Green	110GN	SW 4070	V359
Vents	VENT	White	Light Gray	32GR	SW 4019	2701
Potable Water	POTW	Blue	Dark Blue	11SF	SW 4086	9112

(1) Bands shall be 6 inches wide spaced at 30-inch intervals.

- A. Label Color Requirements:
 - 1. Green with white letters
 - 2. White with black letters
 - 3. Yellow with black letters
 - 4. Brown with white letters
 - 5. Blue with white letters
 - 6. Black with white letters
 - 7. Red with white letters
 - 8. Orange with black letters
 - 9. Violet with white letters
- B. Label and paint (or band) all piping shown on heating and plumbing drawings.
- C. Multi-use pipes shall receive labels designating only their primary use.
- D. Where a dual piping system is utilized, containment pipe shall be labeled and painted as designated for chemical service outlined in schedule above. Carrier pipe does not require labeling or painting where completely contained within containment pipe.

- E. Paint all metal electrical conduits to match background. Do not paint interior PVC or PVC-coated conduit, unless noted otherwise.
- F. Do not paint stainless steel, copper, FRP, or PVC pipe, unless noted otherwise. Provide pipe labels and bands only. Band colors shall be color designated in table under “Pipe Color.”
- G. This table may not list every pipe to be painted and labeled. All piping and conduit shall be painted (or banded). Coordinate choice of color of unlisted piping with Owner and Engineer prior to painting.
- H. Pipe labels shall be in accordance with Section 10 14 20.
- I. Where pipe is insulated or is surrounded by a containment pipe, provide color bands and pipe labels on insulation or containment piping.

PAINT SCHEDULE

Interior or Exterior Surfaces to Be Painted and Major Equipment	Surface Preparation		Paint System	Prime Coat Product, No. of Coats, Dry Film Thickness, and Coverage	Intermediate Coat	Finish Coat	Painting Status	Remarks (Any Special Treatment or Application Requirements)
	Shop	Field		Color	Color	Color		

Reviewed by Paint Manufacturer Representative _____

DAILY EPOXY COATINGS INDUCTION RECORD

Date	Project	Location	Ambient Temperature (degrees F)	Mix Start Time	Induction End Time	Total Induction Time Before Use



COATING SYSTEM INSPECTION CHECKLIST

Owner: _____
 Contract No.: _____
 Owner Project No.: _____
 SSR Project No.: _____

Contractor: _____
 Coating System Manufacturer: _____
 Coating System Applicator: _____

Area or Structure: _____
 Location within Structure: _____

Coating System (e.g., M-1): _____
 Coating Type (e.g., epoxy): _____

Checklist	Reviewer	Name	Signature	Date
Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	Contractor			
	Manufacturer			
	Applicator			
Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	Contractor			
	Manufacturer			
	Applicator			
Completion of ambient condition control in structure or building area and acceptance of ventilation methods in Structure or Area.	Contractor			
	Manufacturer			
	Applicator			
Completion of Surface Preparation for Substrates to be Coated.	Contractor			
	Manufacturer			
	Applicator			
Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	Contractor			
	Manufacturer			
	Applicator			
Completion of Concrete Filler/ Surface Application to Concrete.	Contractor			
	Manufacturer			
	Applicator			



**COATING SYSTEM
INSPECTION CHECKLIST**

Checklist	Reviewer	Name	Signature	Date
Completion of Prime Coat Application.	Contractor			
	Manufacturer			
	Applicator			
Completion of Intermediate Coat Application, if applicable.	Contractor			
	Manufacturer			
	Applicator			
Completion of Finish Coat Application and of Detail Treatment at Transitions or Terminations.	Contractor			
	Manufacturer			
	Applicator			
Completion of Full and Proper Cure of Coating System.	Contractor			
	Manufacturer			
	Applicator			
Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	Contractor			
	Manufacturer			
	Applicator			
Completion of Localized Repairs to Coating System Following Testing.	Contractor			
	Manufacturer			
	Applicator			
Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and Manufacturer's Quality Requirements.	Contractor			
	Manufacturer			
	Applicator			

Owner Signature

Engineer Signature

Date

Date

END OF SECTION

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SECTION 10 14 20
SIGNAGE REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Engraved plastic and fiberglass signs.
 - 2. Process piping labels.
- B. Related Documents:
 - 1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
 - 2. Section 09 96 00 – Painting and Coatings
 - 3. Section 40 41 13 – Pipe Insulation and Heat Tracing

1.02 REQUIREMENTS

- A. Contractor shall install signs as required in this Section and as required by Federal, State, and local requirements including those of OSHA, TDOT, TDEC, and EPA.
- B. Contractor shall furnish and install all placards required for chemical, electrical and process rooms in accordance with Federal, State, and local requirements.
- C. Contractor is advised that, due to nature of this project, labels may require custom fabrication.
- D. All piping, except buried underground piping, shall be labeled as required by this Section.
- E. All signs and labels shall comply with ANSI/ASME A13.1 and ANSI Z535.1

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site under provisions of Section 01 00 05.
- B. Store and protect products under provisions of Section 01 00 05.
- C. Package signs, labeled in name groups.
- D. Store adhesive tape at ambient room temperatures.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Do not install signs when ambient temperature is below 70 degrees F. Maintain this minimum during and after installation of signs.

1.05 SUBMITTALS

- A. Contractor shall provide list of signs to be provided prior to sign purchase. List shall include listing of all equipment to be provided a sign along with designation to be assigned to each piece of equipment. Equipment designations shall follow conventions established in these Contract Documents. Equipment not having received a designation in these documents shall be clearly identified so that designation can be approved prior to sign purchase by Engineer and Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Best Manufacturing Company - Products: HC300E MP or fiberglass for room designations and Type "MP" for safety/equipment signs.
- B. Seton Nameplate Corporation, Marking Services Inc. or equal for pipe and equipment labels.

2.02 MATERIALS AND COLORS

- A. Equipment Signs - Laminated colored plastic; in blue face color. Size shall be proportional to message of 1/8-inch thick material. Signs to be 1-inch high with 1/2-inch high standard bold condensed upper case raised white letters. No border or radius corners required. Mount with stainless steel mounting hardware.
- B. Danger Signs - Laminated colored plastic; in red face color. Size shall be 10-inch by 7-inch, 10-inch by 14-inch, or 20-inch by 14-inch of 1/8-inch thick material with 1/2-inch high or larger standard bold condensed uppercase raised white letters. No border or radius corners required; attach "Danger" signs with stainless steel mounting hardware.
- C. Caution Signs - Laminated colored plastic; in yellow face color. Size shall be 10-inch by 7-inch, 10-inch by 14-inch, or 20-inch by 14-inch of 1/8-inch thick material with 1/2-inch high or larger standard bold condensed upper case raised black letters. No border or radius corners required; attach "Caution" signs with stainless steel mounting hardware.
- D. Safety Instruction Signs - Laminated colored plastic; in green face color. Size shall be 10-inch by 7-inch, 10-inch by 14-inch, or 20-inch by 14-inch of 1/8-inch thick material with upper case 1/2-inch high or larger standard bold condensed upper case raised white letters. No border or radius corners required; attach signs with stainless steel mounting hardware.
- E. Warning Signs - Laminated colored plastic; in orange face color. Size shall be 10-inch by 7-inch, 10-inch by 14-inch, or 20-inch by 14-inch of 1/8-inch thick material with 1/2-inch high or larger standard bold condensed upper case raised black letters. No border or radius corners required; attach signs with stainless steel mounting hardware.
- F. Tape Adhesive - Double sided tape with permanent adhesive; 1/16-inch vinyl foam for wall or door mounting.

2.03 PIPING LABELS

- A. All piping, including interior and exterior piping inside pipe trenches, shall receive a strap-on piping label indicating contents of pipe, flow direction, and color coded as indicated in Section 09 96 00. When no color coding is indicated, it shall conform to ASME 13.1 otherwise coordinate color with Engineer prior to purchase and installation of labels. Only labeling exception shall be for buried underground piping.

- B. Pipe labels shall be factory fabricated, flexible, semi-rigid plastic, pre-formed to fit around pipe or pipe covering.
- C. Label size shall be minimum 6-inch by 12-inch size or size to fit lettering, engraved plastic with stainless steel spring straps.
- D. Apply identification labels to all types and sections of piping, as outlined herein and in Section 09 96 00. Such labels shall be in form of plain block lettering giving name of pipe content is full and showing direction of flow by arrows. All lettering shall have an overall height in inches, in accordance with following table:

Diameter of Pipe or Pipe Covering	Minimum Width of Color Field	Height of Lettering
3/8 to 5/8 inches	3	1/4 inch
3/4 to 1 inches	8	1/2 inch
1-1/8 to 2-3/8 inches	8	3/4 inch
2-1/2 to 7-7/8 inches	12	1-1/4 inches
8 to 10 inches	24	2-1/2 inches
Over 10 inches	32	3-1/2 inches

- E. Labels shall be installed so as to be visible from floor area.
- F. Piping labels shall be located as follows:
 1. Adjacent to each valve, fitting, and flange (except at pump suction and discharge connections where labels are required on headers only).
 2. Adjacent to all changes in direction, both horizontal and vertical, and all branches.
 3. On both sides of all wall, floor, and ceiling penetrations.
 4. Maximum distance between labels shall be 10 feet on all non potable water, chemical piping, and on all chlorine solution lines with a minimum of two labels in each room, gallery, or tunnel. Maximum distance between labels on all other piping runs shall be 15 feet. Exception shall be labeling of piping inside pipe trenches, in which case maximum distance between labels shall be 4 feet.
- G. Identification lettering shall be located midway between color coding bands where possible and shall be properly inclined to pipe axis to facilitate easy reading. In event lettering and arrow identifications are required for piping less than 3/8 inch in diameter, Contractor shall furnish and attach approved color coded tags where instructed by Engineer.
- H. Labels shall be provided by Seton Nameplate Corporation, EMED Company, Inc., Marking Services Inc., or equal.

2.04 VALVE TAGS AND SCHEDULE

- A. Provide valve tags for all valves.
- B. Tags shall be made from a plastic laminate of heavy plastic with an eyelet in corner and shall indicate valve number and fluid in pipe.

- C. Tags shall be fastened to each valve with a Type 316 stainless steel chain. For buried valves, tags shall be fastened to concrete mowing pad, valve box, or some other conspicuous manner near valves.
- D. Tags to be made by Seton Name Plate Company, New Haven, Connecticut; W.H. Brady Company; or equal.
- E. If not included on Drawings, a valve schedule shall be provided by Contractor listing all valve numbers, valve function, and location.
 - 1. Buried valves shall be included in valve directory with a description of their functions and locations even though they shall not have a valve tag.

2.05 EQUIPMENT LABELS

- A. Labels shall be semi-rigid plastic identification markers meeting all applicable ANSI and OSHA standards.
- B. All process equipment, including pumps, valves, mixers, scales, instruments, etc. as well as all mechanical, plumbing, and electrical equipment including pumps, air handling units, heaters, panels, etc. shall have laminated colored fiberglass or thermoplastic signs in blue face color. Size shall be proportional to message and of 1/8-inch thick material. Signs shall have 1/2-inch high standard bold condensed upper case raised white letters. No borders or radius corners required. Equipment signs shall show equipment designation (name, numbers/letters) as shown on Contract Drawings and as specified herein.
- C. For equipment to receive labels that are not designated in Contract Documents, Contractor shall coordinate labeling with Engineer prior to purchase and installation of labels.
- D. Acceptable manufacturers: Seton Nameplate Corporation, Marking Services Inc. or equal.
- E. Nameplates shall be located in conspicuous located directly on equipment. Coordinate location with Engineer prior to placement.
- F. Labels shall be removable (non pressure sensitive) after attachment to equipment. If equipment does not allow for direct attachment of label to equipment, use Type 316 stainless steel or non-corrosive rings to attach tags to equipment.

2.06 SPARE PARTS

- A. Provide one (1) spare sign and label for each type used.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install signs after surfaces are finished, in locations indicated or as directed.

- C. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.
- D. Center sign on door, level.
- E. Clean and polish.

3.03 SCHEDULE

- A. Provide “NON-POTABLE WATER – DO NOT DRINK” danger color signs at following locations:
 - 1. Hose bibs.
- B. “CAUTION – EQUIPMENT STARTS AUTOMATICALLY” caution color signs to be provided at following equipment:
 - 1. All pumps.
- C. “DANGER – CONFINED SPACE” signs to be furnished as required by OSHA requirements.
- D. “DANGER – 480 VOLTS” danger color signs at following locations:
 - 1. 480V junction boxes.
 - 2. All MCCs and switchgear.
 - 3. Electrical Room entrance door(s).
- E. Equipment Labels specified above.
- F. Pipe Labels specified above.
- G. All Operated Chain-Link Cantilever slide gates are required to have Gate Warning Placards fully visible to approach on both sides of gate per UL-325.

END OF SECTION

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SECTION 11 05 13

MOTORS

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. This Section includes basic requirements for factory- and field-installed motors.
2. See individual Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
3. All electric motors supplied under these Contract Documents shall conform to this specification as minimum requirements.
4. Rating of motors offered shall in no case be less than horsepower required in Contract Documents.
5. Motor efficiency shall be a prime consideration in selection of all motors. Unless otherwise specified in individual equipment specifications, motors shall meet Motor Efficiency requirements specified herein.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 09 96 00 – Painting and Coatings
3. Division 26 – Electrical
4. Division 40 – Process Integration
5. All other sections where motors are specified or required.

1.02 REFERENCES

A. Design, manufacturer and test motors, controllers and components in accordance with latest edition of following standards:

1. NEMA - National Manufacturers Association Standards.
2. ANSI/NEMA MG 1 - Motors and Generators.
3. NFPA 70 - National Electrical Code.
4. IEEE Standard 112, Test Method "B".
5. IEEE Standard 519-1992.
6. NEMA - ICS-3-303.
7. IEEE Standard 444 (ANSI C34.3).

8. Energy Policy Act of 1992 (EP Act).
- B. Provide equipment and material with UL or ETL listing, in accordance with requirements of authorities having jurisdiction of Work and suitable for its intended use.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Contract Documents including Section 01 00 05.
- B. Product Data for Field-Installed Motors: For each type and size of motor, provide name of manufacturer, nameplate data and ratings per NEMA MG-1; service factor, type of enclosure, motor rpm (full load), maximum temperature rise, nominal efficiency, guaranteed minimum efficiency at 50, 75, and 100 percent full load, minimum power factor at 50, 75, and 100 percent, shipping, installed, and operating weights; enclosure type and mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; information on coatings or finishes, and name of equipment to be driven.
- C. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include following:
 1. Each installed unit's type and details.
 2. Nameplate legends.
 3. Motor outline, dimensions and weight.
 4. Manufacturer's descriptive information of motor features.
 5. Diagrams of power, signal, and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.
 6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
 7. Bearing type, lubrication and life.
 8. Space heater voltage and watts.
 9. Description, ratings, and wiring diagram of motor thermal protection.
 10. Motor sound power level in accordance with NEMA MG 1.
 11. Maximum brake horsepower required by equipment driven by motor.
 12. Name of equipment to be driven.
- D. Include motor submittals with related equipment. Submittals for motors only without related equipment shall not be reviewed.
- E. Factory Tests:
 1. Manufacturer's factory motor Prototype Tests per IEEE Standard 112 Appendix A on motors through 250 horsepower shall be submitted as Product Data for motor, actual factory tests for motors is not required:
 - a. Winding resistance in ohms and converted to 25 degrees C.
 - b. Resistive Unbalance and Quarter Voltage Impedance, as applicable.

- c. Locked-Rotor current (Single phase).
 - d. High Potential.
 - e. No-Load Excitation (volts, amperes, RPM).
 - f. Bearing vibration check. Vibration testing shall be with motor assembled and in accordance with NEMA MG-1.
 - g. Efficiency, Power Factor, Current at 115 percent, 100 percent, 75 percent, 50 percent, and no load.
- F. Field quality-control test reports.
 - G. For all inverter duty motors: Manufacturer's certification that motor is compatible with variable frequency drive to be used.
 - H. Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.05 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices and features that comply with following:
 - 1. Compatible with following:
 - a. Magnetic controllers.
 - b. Multi-speed controllers.
 - c. Reduced-voltage controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- D. Motors shall be rated for type of environment that they shall be installed in accordance with Room and Area Classifications described in Section 01 00 05. Contractor shall be responsible for ensuring that correctly rated motors are installed in all designated environments.

1.06 SHOP TESTS

- A. Perform motor shop tests in accordance with IEEE Code for polyphase induction machines. Use NEMA report-of-test forms and submit results to Engineer, in five copies, for his approval.
- B. Test each motor and submit report; for power factor and efficiency at 50, 75 and 100 percent of its rated horsepower; for insulation resistance and dielectric strength; for heating; and for compliance with all specific performance requirements.
- C. For motors less than 50 HP, provide guaranteed performance data based on previous testing of motor design. For motors of 50 HP or larger, make complete tests of each motor and furnish certified test data sheets.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. NIDEC Motor Corporation - US Motors.
- B. General Electric, Inc.
- C. ABB (Baldor Electric Company)
- D. Or approved equal.

2.02 MOTOR REQUIREMENTS

- A. All electric motors shall conform to ANSI Standards for Rotating Electrical Machinery (Designation C50) and to NEMA Standards MG-1 for Motors and Generators (NEMA Standard Publication latest revision) and to NEC, Article 430.
- B. Motor requirements apply to factory- and field-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for motor are specified in another Section.
 - 2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
- C. Motors shall be capable of supplying maximum rated horsepower and rpm at conditions and within ranges required per equipment manufacturers. Motors shall be capable of withstanding all forces, which may be imposed during course of normal operation of equipment.

2.03 MOTOR CHARACTERISTICS

- A. Furnish with adequate ratings to accelerate and drive connected equipment under all normal operating conditions without exceeding nameplate ratings.
- B. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
 - 1. Finish: Provide rust-resisting prime coat. Finish coat shall be either field applied by Contractor or factory applied in shop in accordance with Section 09 96 00. Contractor shall coordinate with motor manufacturer to ensure cumulative layers of coatings do not interfere with proper heat transfer from motor.

- C. Motors 1/2 HP and Larger: Three phase 230/460 volt unless otherwise specified.
- D. Motors Smaller Than 1/2 HP: Single phase, 120 volt unless otherwise specified
- E. Motors indicated on Contract Drawings and/or specified in specifications as non-230/460 volt shall be specially wound for voltage indicated and/or specified.
- F. Dual-rated motors (i.e., 208/230 volts) are not acceptable for operation on 208 volts.
- G. Resistance Temperature Detectors (RTDs).
 - 1. Motors for constant speed application 100 hp and larger and motors for adjustable speed application 60 hp and larger shall be provided with RTDs.
 - 2. Resistance Temperature Detectors (RTDs).
 - a. RTDs shall be 100 ohm platinum and be of a 3-wire or 4-wire design. Use of lesser wire designs shall not be permitted.
 - b. Repeatability shall be within 0.05 percent.
 - c. A minimum of two RTDs shall be provided for each stator phase.
 - d. RTDs shall be in intimate contact with winding conductors.
 - e. Epoxy-potted, solid state RTD control module mounted in NEMA 4 box on motor by motor manufacturer.
 - 1) Box shall be rated as explosion-proof for those motors located in hazardous areas or other areas requiring explosion-proof equipment in accordance with NFPA 820.
 - f. Individual RTD circuits factory-wired to control module.
 - g. Control module rated for 120 volts ac power supply.
 - h. Control module automatically reset contact for external use rated 120 volts ac, 5 amps minimum, and opening on abnormally high winding temperature. Manual reset shall be provided at motor controller.
 - 1) RTDs shall be wired by Contractor to a motor protection relay to display RTD measured temperature, and provide alarm and trip points.
- H. Space Heaters: Provide space heaters on all exterior motors regardless of size to prevent condensation inside motor enclosure after motor shutdown and to maintain temperature of winding at not less than 5 degrees C above outside ambient temperature with a relative humidity of 90 percent.
 - 1. Heaters shall be 120 V, single-phase with leads terminating at the motor starter control transformer. Contractor shall provide necessary breaker(s), conduit, and wire for heaters whether shown on Contract Drawings or not.
 - a. Heaters shall be wired by Contractor utilizing terminal strips in controls (motor starters or VFDs or other devices). Contractor shall be responsible for providing activating relay, protective fuse, and appropriately sized control power transformer.
 - b. Heaters shall be wired to operate whenever motor is not running.

- I. Frequency Rating: 60 Hz.
- J. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- K. Power Supply Variations: Motors shall operate successfully under running conditions at rated load with plus or minus 10 percent of rated voltage with rated frequency or plus or minus 5 percent of rated frequency with rated voltage at rated load; and at rated load with a combined variation in voltage and frequency not more than 10 percent above or below rated voltage and frequency provided that frequency variation does not exceed 5 percent.
- L. Service Factor: 1.15 for open drip-proof motors; 1.15 for totally enclosed motors; 1.0 for motors with non-sinusoidal voltage source (inverter drive).
- M. Duty: Continuous duty at ambient temperature of 105 degrees F and at altitude of 3300 feet above sea level.
- N. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- O. Enclosure and Winding Insulation:
 - 1. Minimum Class F unless noted otherwise in Contract Documents.
 - 2. Unclassified Indoor Areas: TEFC, Standard insulation.
 - 3. Wet Indoor Areas: TEFC, Encapsulated windings.
 - 4. Outdoor Areas (unless corrosive or explosive areas): TEFC, Encapsulated windings.
 - 5. Corrosive Areas: TEFC, Severe/Chemical duty.
 - 6. Class I, Division 1 Areas: Explosion Proof, Approved for Class I, Division 1 locations.
 - 7. Class II, Division 1 Areas: Explosion Proof, Approved for Class II, Division 1 locations.
 - 8. Class I or Class II, Division 2 Areas: Explosion Proof, Approved for Division 1 locations or TEFC with maximum external frame temperature compatible with gas or dust in area (extra dip and bake for moisture), encapsulated windings.
 - 9. Encapsulated Windings - Where specified, an additional "dip and bake" shall not be acceptable. Encapsulation shall be Contour Mold Everseal by U.S. Motors; Costum Polyseal by General Electric; or equal.
 - 10. Open drip-proof motors shall not be permitted.
- P. Motor Power Factors:
 - 1. Minimum of 90 percent.
 - 2. Motors with power factors less than 90 percent shall have power factor correction capacitors, switched integrally with motors (unless otherwise required by either motor or starter manufacturer), which shall bring power factor up to a minimum of 90 percent.
 - 3. When capacitors are used with solid-state starters, capacitors shall be connected to load side of a bypass contactor via an additional contactor switched with bypass. Connection

of capacitor shall be in accordance with starter manufacturer's requirements. Contactor shall be sized for 125 percent of capacitor full load current.

4. Furnish and install, at no additional cost to Owner, capacitors and provide all necessary wiring to connect them to motor terminals or motor controller terminals.
 - a. Properly size fused switch or circuit breaker to serve as a disconnect for capacitor.
5. Capacitor and Disconnect Enclosure:

Area Classification	NEMA Type Enclosure
Unclassified Indoor	NEMA 12, wall mounted
Wet Indoor	NEMA 4X, wall mounted
Outdoor	NEMA 4X, wall mounted, pad mounted, or stand mounted
Corrosive	NEMA 4X, wall mounted (disconnect only, locate capacitor outside corrosive area)
Hazardous	NEMA 7, wall mounted (disconnect only; located capacitor outside explosive area)

6. Size capacitors so they do not increase self-excitation voltage above motor nameplate rating.
 7. Do not use capacitors on motors controlled by variable frequency drives.
 8. When used with solid-state starters, energize only after bypass or full speed bypass contactor is energized. Verify with starter manufacturer their connection requirements and follow them.
- Q. Lifting Eyes: Motors weighing more than 50 pounds shall be fitted with at least one lifting eye and motors over 150 pounds shall be fitted with two lifting eyes.
- R. Conduit Box: Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.
- S. Vertical Hollowshaft Motors:
1. Where specified, design vertical hollowshaft motors to carry motors, pumps, and associated equipment's full thrust. Equip motors with oil lubricated spherical roller thrust bearings and lower grease lubricated radial guide bearings. Provide motors with visual oil level indicators and sufficient oil to fill motor.
 2. Vertical Adjustment - By means of a lockable nut at top of shaft.
 3. Non-Reversing Ratchets - Provide ball bearing style ratchet system where specified in individual equipment specifications and where suitable for continuous operation at any speed between 50 percent and 100 percent of rated speed. Use of pin-style ratchet systems, or other types of systems, shall not be acceptable.
- T. Namesplates – Stainless steel in accordance with latest version of MG 1-10.38.
- U. Two speed motors:
1. Motors 1/2 HP and Larger - Two windings unless otherwise noted.

- 2. Motors less than 1/2 HP shall be permitted with single windings.
- 3. Speeds of motors shall be as specified. Two-speed motors shall be tested at higher speed
- V. Contractor shall provide multi-speed (multiple windings or consequent poles - single winding, wound rotor, etc.) where required as specified in individual equipment specifications.
- W. Motors used with belt drives shall have grease slingers on sheave end and sliding bases to provide for belt take-up.
- X. Hazardous or Explosive-Proof Areas:
 - 1. All areas noted as hazardous or explosion-proof (as defined in latest edition of National Electrical Code) shall have all work done in accordance with requirements of National Electrical Code (NEC) for that particular "class" and "division" and all equipment enclosures (for motors, starters, switches, capacitors, etc.), fittings, conduits and appurtenances shall be of a type approved for area.
 - 2. Unless otherwise shown, all hazardous or explosion-proof areas shall be Class I, Division 1 (Groups C and D); locations and all equipment enclosures, fittings, conduits and appurtenances shall be NEMA Type 7 and approved for use in Class I, Division 1, Groups C and D atmospheres.
 - 3. All wiring in these areas shall be done in accordance with applicable NEC provisions.
- Y. Use applicable paragraphs of NEMA MG 1-12.42 in making design selections.
- Z. Other Design Requirements:
 - 1. Motors on belt driven equipment shall have slide rails with adjusting screws for belt tension adjustment. Motors exposed to weather shall be weather protected.
 - 2. Provide motors with drive shafts long enough to extend completely through belt sheaves when sheaves are properly aligned or balanced.

2.04 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium, as defined in NEMA MG 1.
- C. Stator: Copper windings, unless otherwise indicated.
 - 1. Multi-speed motors shall have separate winding for each speed.
- D. Rotor: Squirrel cage, unless otherwise indicated.
 - 1. Statically and dynamically balanced.
 - 2. Have secondary bars of heavy copper silver-brazed to one-piece end rings or they shall have rotor windings of one-piece cast aluminum.
 - 3. Where applicable, construct with integral fans.
- E. Bearings: Double-shielded, pre-lubricated (oil) anti-friction ball bearings suitable for radial and thrust loading.
 - 1. Provide conveniently located oil fill port.ubm

2. Unless otherwise specified, bearings shall be rated at a minimum L-10 life of 100,000 hours under axial loads.
 3. Provide motors with aluminum end brackets with steel inserts in bearing cavities.
- F. Vertical shaft construction, motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads. Grease slingers to be provided.
- G. Horizontal Shaft Construction - Coupled to fluid pumps, motors shall either have adequate thrust bearings or they shall have couplings end play and rotor float coordinated to prevent damage to rotor bearings.
- H. Temperature Rise: Matched to rating for Class B insulation.
- I. Insulation: Class F, unless otherwise indicated.
- J. Code Letter Designation:
1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
- K. Conduit/Terminal Boxes: Oversized in all cases to leave extra room after all conduits and conductors accounted for. Boxes shall be larger than called for by NEC Article 430-12.
1. Boxes shall have rubber gasket to prevent intrusion of water.
 2. Provide grounding lug in terminal box.
 3. Horizontal Motors - Locate on left hand side, when viewing motor from drive shaft ends and design such that conduit entrance can be made from above, below or either side of terminal box.
 - a. Provide with enhanced rotor and stator designs.
- L. Additional Requirements for All Polyphase Motors:
1. Hazardous area motors shall be certified to meet UL requirements for operation over motors entire speed range.
 2. Thermal overload protectors and any auxiliary components necessary to provide required starting characteristics including capacitors, resistors and automatic switching devices shall be furnished and mounted integrally unless motor starters with overload protection are provided
 3. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 4. Torque requirement for greater turndown and slower speed applications is a custom design; refer to driven equipment specification for additional requirements. Inverter duty rated motors shall be designed to operate over speed or frequency range specified.
 5. Motors for use with variable frequency controllers shall be inverter duty motors specifically designed for inverter service for speed range and load torque characteristic required by associated driven equipment. Inverter duty motors shall be specifically certified compatible with adjustable frequency controller and driven equipment, as specified in Division 26.

6. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - a. 1600 volt insulation.
 - b. Motors shall be inverter duty rated in accordance with NEMA MG 1, Parts 30 and 31.
 - c. Designed with critical vibration frequencies outside operating range of controller output.
 - d. Temperature Rise: Matched to rating for Class B insulation.
 - e. Insulation: Class F; Inverter Grade; comply with NEMA MG 1 Part 31.
 - f. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - g. Bearings: Insulated. Provide shaft grounding rings also.
 - h. Sound power levels not greater than recommended in NEMA M61-12.49. VFD duty rated motors shall not increase by more than 3 dB when operating on VFD.
7. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.
 - a. Finish: Chemical-resistant paint over corrosion-resistant primer.
8. Source Quality Control for Field-Installed Motors: Perform following tests on each motor according to NEMA MG 1:
 - a. Measure winding resistance.
 - b. Read no-load current and speed at rated voltage and frequency.
 - c. Measure locked rotor current at rated frequency.
 - d. Perform high-potential test.

PART 3 EXECUTION

3.01 FIELD-INSTALLED MOTOR INSTALLATION

- A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.
- B. Install motors on concrete bases complying with Division 03.
- C. Comply with mounting and anchoring requirements specified in Section 40 27 00.
- D. Make connections and test motor for proper rotation and speed as described herein and in Division 26.
- E. Motors shall operate without an undue noise or vibration and shall show no signs of electrical unbalance.

3.02 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

- A. All testing shall be witnessed by Engineer.
- B. Prepare for acceptance tests.
 - 1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
 - 2. Verify bearing lubrication.
 - 3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 4. Test interlocks and control and safety features for proper operation.
 - 5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.
- C. Perform following field tests and inspections and prepare test reports:
 - 1. Test report as provided in Section 01 99 00 "Motor Testing Summary Sheet" shall be completed for all motors. Submit form prior to Substantial Completion (see Section 01 77 13). Copy of all test reports shall be included in O&M Manual (see Section 01 77 13).
 - 2. All tests shall be performed at as neat operating conditions as possible.
 - 3. Perform tests all three-phase motors 1/2 HP and larger and for all single phase motors 1 HP and larger.
 - 4. Perform electrical tests and visual and mechanical inspections including optional tests and inspections stated in NETA ATS on factory- and field-installed motors. Certify compliance with test parameters.
 - 5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION

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SECTION 26 00 00
GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section specifies the basic electrical requirements for this project as well as the general requirements which apply to the work of Division 26 in addition to those stipulated in Division 01. Should any discrepancies exist between the requirements of Division 26 and those found in Division 01; the more stringent requirement shall govern except where the two requirements are contradictory in which case the Division 01 requirements shall govern.
- B. The electrical work required for this project consists of furnishing all labor, equipment and materials necessary to obtain complete and operational electrical systems as indicated on the drawings and as specified herein.
- C. The Contractor shall furnish all material and labor as required for the installation of the new electric service per the local power company's requirements. The Contractor shall coordinate with the local power company for all requirements.
- D. The Contractor shall furnish all material and labor as required for the installation of the new telecom service(s) per the local service provider(s)' requirements. The Contractor shall coordinate with the local service provider(s) for all requirements.
- E. The Contractor shall furnish and install all communications wiring and equipment and will make all final communications connections after empty conduit systems have been installed as specified herein.

1.02 CODES, STANDARDS AND PERMITS:

- A. The installation shall comply with the following:
 - 1. All applicable local and state wiring ordinances.
 - 2. The National Electrical Code (NFPA-70-2017).
 - 3. All applicable provisions of the Occupational Safety and Health Act (OSHA).
 - 4. Requirements of the power and telephone companies furnishing services to the project.
 - 5. International Building Code (2015 Edition).
 - 6. International Energy Conservation Code (2015 Edition).
 - 7. Americans with Disabilities Act (ADA).
- B. This contractor shall apply for, obtain, and pay for all permits required. At the conclusion of the installation, he/she shall secure a certificate of inspection, properly signed by the

controlling building department, which shall state that all rules have been complied with and that the work is satisfactory.

- C. The contractor is responsible for providing a complete installation in compliance with all applicable codes and local amendments or ordinances. Should any part of the plans or specifications be found in conflict with applicable codes or ordinances, the contractor shall notify the engineer prior to submitting his/her bid or shall provide required adjustments and rework at no cost to the Owner.

1.03 TRADE NAMES AND EQUALS

- A. Manufacturer's trade names or catalog numbers used in these specifications and indicated on the drawings denote type, size, quality, and design of equipment desired.
- B. Where equipment is specified as "equal", or "approved equal", it shall mean equal in the opinion of the engineer. This contractor is free to offer substitutions for consideration as equal after the contract is signed; however, he shall be prepared to furnish specified materials where substitutions are not approved.

1.04 DELIVERY, STORAGE, AND HANDLING OF MATERIAL AND EQUIPMENT

- A. The contractor shall be responsible for the purchase, delivery, and storage of all materials and equipment indicated to be supplied under this section of the specifications, and it shall be his/her responsibility to schedule the delivery of materials and equipment at such stages of the work as will permit uninterrupted construction of all phases of the work.
- B. Where owner furnished equipment is to be turned over to this contractor for installation, it shall be the responsibility of this contractor to receive such equipment and store in a safe, dry location.
- C. This contractor shall do all required rigging, hoisting, transporting, etc., of all equipment furnished under this contract, and shall further furnish any additional structural members, as may be required, for the proper support of any and all equipment furnished hereunder.

1.05 USE OF DOCUMENTS

- A. The scope of the electrical work for this project is not limited to the requirements of any one drawing, any portion of the drawings, any one specification division, or any portion of the specifications whose main theme is electrical. The scope of the electrical work for this project consists of all electrical work required to obtain complete and operating systems and equipment as indicated on or as can be reasonably inferred from all drawings and specifications.
- B. The drawings indicate diagrammatically the general arrangement of circuits and outlets, locations of switches, panelboards, electrically operated equipment & appliances and other

work. This data is as accurate as planning can determine, but accuracy is not guaranteed. Field verification of all dimensions, locations, levels, etc., to suit field conditions is directed.

- C. Should interferences prevent the installation of conduit, setting of junction boxes and cabinets, arrangement of lighting fixtures and method of suspension, etc., in the locations indicated on the drawings, the necessary deviations therefrom must be made without additional cost to the owner, where relocation is not over five (5) feet from the location shown on the drawings.
- D. Review all drawings and adjust all work to conform to all conditions shown therein. Discrepancies between different drawings, or between drawings and specifications or codes and regulations governing the installation shall be brought to the attention of the Owner's Representative prior to the date of bid opening.
- E. The locations of equipment, motors, etc., as indicated on the drawings are approximate only. Verify all dimensions with the appropriate equipment installer before rough-in. Where conduit, wiring, service equipment, lights, switches, or other electrical equipment interfere with construction; remove, relocate and rearrange such material and equipment as required to make a complete and satisfactory installation.
- F. Motor sizes indicated on the drawings are approximate only and are subject to change to suit the standard motor drives of the various equipment manufacturers. Check electrical characteristics of supplied and/or installed motors and adjust sizes of wiring and protective devices.
- G. Electrical connection types and sizes indicated on the drawings are approximately only and are subject to change based on final equipment selections. Check electrical characteristics of supplied equipment and adjust wiring and overcurrent protective devices sizes.
- H. Any offsets in conduit required or necessary to avoid interferences with structure, or the work of other trades, etc., shall be made at no additional cost to the owner.

1.06 COORDINATION

- A. The electrical contractor shall coordinate his/her work with other subcontractors and the owner to prevent any delay in the proper installation and completion of the work.
- B. The electrical contractor shall review submittal data of other trades prior to ordering material and shall adjust sizes and ratings of electrical connections and overcurrent protective devices as required based on actual equipment nameplate data.
- C. The electrical contractor shall coordinate the procurement and installation of all electrical devices, disconnects, plugs, switches, wiring, conduits, etc. with that of other trades in order to provide a complete and satisfactory installation of all assemblies, systems, and equipment.
- D. This contractor shall use every precaution to protect the work of others, and he/she will be held responsible for all damage done by his workers to the work of other trades. He/she shall

also protect his work from danger of breakage, dirt, foreign materials, etc., and shall replace all work so damaged.

- E. Coordinate phases of the work with the owner and other trades to allow the owner to continue normal business operations throughout the duration of the project. Any necessary power outages shall be scheduled for other than the owner's hours of operation or be pre-arranged with the owner.

1.07 MANUFACTURER'S RECOMMENDATIONS

- A. Unless specifically indicated otherwise, all equipment and materials shall be installed in accordance with the recommendations of the manufacturer. Adjust conductor and overcurrent protective devices sizes as required to comply with these recommendations or requirements. A copy of the manufacturer's installation documents shall be kept in the job superintendent's office and shall be available to the owner's representative at all times.

1.08 CUTTING AND PATCHING

- A. This contractor shall be responsible for all cutting and patching required for the installation of his work, and he/she shall employ workers skilled in the trades required for all cutting and patching work.
- B. This contractor shall be responsible for the proper location of all chases, recesses, and openings required for his work.
- C. This contractor shall provide all sleeves, etc., required for the introduction and placement of his work, and shall be responsible for the correct location of same.
- D. Beams or columns shall not be pierced without permission of the structural engineer, and then only as directed.

1.09 PROTECTION OF FLOORS

- A. This contractor's attention is directed to the need to protect finished floors, and he will be held responsible for damage he may do to finished floors. Where heavy equipment is to be moved across finished floors, this contractor shall make provisions to protect the floor.
- B. Where pipe cutting and threading operations are carried on by this contractor, he shall provide a suitable covering material over the floor which will assure that oil and pipe cuttings do not come in contact with the finished floor. Temporary floor covering shall be plywood or other materials as may be approved by the engineer.
- C. This contractor shall remove all temporary floor covering, as he completes his work in each area. Any damage resulting from activities of this contractor shall be repaired at his own expense.

1.10 PAINTING

- A. Painting of materials and equipment furnished under the electrical portion of the contract, if required, will be done under a separate section of the project specifications. The electrical contractor shall, however, refinish and restore to the original condition and appearance, all electrical equipment which has sustained damage to manufacturer's finish paint.
- B. All electrical equipment shall be provided with factory applied prime and finish paint, unless otherwise specified.

1.11 SHOP DRAWINGS (SUBMITTALS)

- A. Refer to Section 01 33 00 "Submittal Procedures."
- B. Refer to individual Division 26 specification sections for submittal data requirements.

1.12 RECORD DRAWINGS

- A. Refer to Section 01 78 39 "Project Record Documents."

1.13 MAINTENANCE MANUALS

- A. Refer to Section 01 78 23 "Operation and Maintenance Data."

1.14 TESTS AND ADJUSTMENTS

- A. Furnish all materials, labor, instruments, etc., and all other services required for a complete and satisfactory test and adjustment of all electrical systems and equipment. Tests and adjustments shall be made prior to acceptance by local inspection authorities.
- B. Test all circuits to determine that they are free of short circuits and that phase conductors are not grounded.
- C. Check all motor controllers to determine that properly sized overload devices are installed.
- D. Verify overcurrent protective devices are installed in accordance with the manufacturer's recommendations or as required by code based on actual nameplate data and make adjustments as required to comply.
- E. Check all electrical equipment for proper operation.

- F. Correct or replace at no additional cost to the Owner all equipment and/or wiring which tests prove to be defective or operating improperly.
- G. Thoroughly familiarize the Owner's designated representative with the proper operating procedures and maintenance requirements for all electrical systems and equipment.

1.15 TEMPORARY CONSTRUCTION POWER AND LIGHTING

- A. This contractor shall furnish and install all temporary wiring for construction power and lighting for the project as required.
- B. A temporary electrical service, if required, for construction power and lighting shall be obtained by this contractor in the name of the owner, who will pay all power and energy charges. Any cost for the temporary service connection shall be paid by this contractor.
- C. All temporary wiring for construction shall conform to Article 590 of the National Electrical Code and all applicable rules and regulations of OSHA.

1.16 FEEDER, SWITCH AND DEVICE RATINGS

- A. The sizes of feeders, motor starters, switches, protective devices, and other electrical devices indicated on the drawings are based on the average current or horsepower ratings of equipment of the same general types and sizes upon which the designs of the various systems are based. Horsepower and current ratings indicated on the drawings are for guidance only and shall not limit the size of the equipment or feeders.
- B. Check the current and horsepower ratings of all proposed or supplied equipment and adjust the sizes of all feeders, starters, switches, protective devices and other electrical devices as required to provide proper protection and satisfactory operation. This shall include increasing to the next larger size, or decreasing to the next smaller size, any individual feeder, starter, switch, protective device, or other electrical device to match actual equipment ratings. No sizes shall be decreased without approval in writing from the Engineer.

1.17 EXCAVATION AND BACKFILLING

- A. Perform all excavation and backfilling required for electrical work including necessary sheathing and bracing in accordance with the requirements of Division 31, "EARTHWORK."
- B. Dispose of all surplus backfill material in a manner approved by the Owner's designated representative.

1.18 SAFETY DEVICES

- A. Electrical equipment and wiring used during construction shall be installed and insulated in a manner to insure the safety of personnel.
- B. Provide suitable guards, signs, etc. to protect personnel from “hot” wiring in panelboards, junction boxes, etc. during the construction period.

1.19 GUARANTEE

- A. The contractor shall guarantee to the owner all work performed under this contract to be free from defects in workmanship and material for a period of one (1) year from date of final acceptance. Defects arising during this period will be promptly remedied by the contractor at his own expense upon notice by the owner. All lamps for lighting fixtures shall be excluded from this guarantee, but one (1) complete and operative set of lamps for lighting fixtures shall be in place at the time of final acceptance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Copper building wire rated 600 V or less.
 2. Connectors, splices, and terminations rated 600 V and less.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. General Cable Technologies Corporation.
 2. Service Wire Co.
 3. Southwire Company.
- C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. RoHS compliant.
 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

2.02 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 1. Material: Copper.
 2. Type: Two hole with long barrels.
 3. Termination: Crimp.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.
- E. All circuits served by variable frequency drives (VFD): Type XHHW-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.

- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. ERICO; a brand of nVent.
 - 2. Harger Lightning & Grounding.
 - 3. Thomas & Betts Corporation; A Member of the ABB Group.

2.03 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.

2.04 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Conduit Hubs: Mechanical type, terminal with threaded hub.
- D. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.

2.05 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.04 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.05 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- C. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Report measured ground resistances that exceed the following values:
1. Service-entrance rated automatic transfer switch: 10 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Steel slotted support systems.
 2. Conduit and cable support devices.
 3. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32- inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. B-line, an Eaton business.
 - b. Thomas & Betts Corporation; A Member of the ABB Group.
 - c. Unistrut; Part of Atkore International.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Stainless steel, Type 304.
 4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their

supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
5. Toggle Bolts: Stainless-steel springhead type.
6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA 101
 3. NECA 102.
- B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength

will be adequate to carry present and future static loads within specified loading limits.

Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP- 69.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Metal conduits and fittings.
 2. Nonmetallic conduits and fittings.
 3. Metal wireways and auxiliary gutters.
 4. Boxes, enclosures, and cabinets.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. Republic Conduit.
 - c. Wheatland Tube Company.
 2. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. GRC: Comply with ANSI C80.1 and UL 6.
 4. ARC: Comply with ANSI C80.5 and UL 6A.
 5. FMC: Comply with UL 1; aluminum.
 6. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings: Comply with NEMA FB 1 and UL 514B.
1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing

agency, and marked for intended location and application.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CANTEX INC.
 - b. Condux International, Inc.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.

B. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.04 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: ARC.
 - 2. Concealed Conduit, Aboveground: ARC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X, stainless steel.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 - 1. Exposed: GRC.
 - 2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 4. Boxes and Enclosures: NEMA 250, Type 1.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

3.02 INSTALLATION

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not fasten conduits onto the bottom side of a metal deck roof.
- D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- H. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches of enclosures to which attached.
- J. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
- K. Stub-ups to Above Recessed Ceilings:
 - 1. Use GRC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- N. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where an underground service raceway enters a building or structure.
 - 2. Conduit extending from interior to exterior of building.
 - 3. Where otherwise required by NFPA 70.
- O. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations.
- P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- Q. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- R. Locate boxes so that cover or plate will not span different building finishes.
- S. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- T. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Section 31 20 00 "Earth Moving."
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of

run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.04 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for conductors.
 - 2. Labels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70.
- B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue

3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
5. Color for Neutral: White.
6. Color for Equipment Grounds: Green.

C. Equipment Identification Labels:

1. Black letters on a white field.

2.03 LABELS & TAPES

A. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

B. Underground-Line Warning Tape:

1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
3. Tag: Type ID:

- a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
- b. Width: 3 inches.
- c. Overall Thickness: 5 mils.
- d. Foil Core Thickness: 0.35 mil.
- e. Weight: 28 lb/1000 sq. ft..
- f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.
- E. Self-Adhesive Labels:
 1. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- F. Underground Line Warning Tape:
 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.02 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- D. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.

END OF SECTION

SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

2.01 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

3.01 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Transformer working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

PART 2 - PRODUCTS

1.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
 2. Eaton.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; Schneider Electric USA.

2.01 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

3.01 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70[, and list and label as complying with UL 1561].
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.
- C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Aluminum.
 2. Internal Coil Connections: Brazed or pressure type.
 3. Terminal Connections: Welded.
- D. Enclosure: Ventilated.
1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 4. Environmental Protection:
 - a. Outdoor: UL 50E, Type 3R.
- E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- F. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- G. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

4.01 IDENTIFICATION

- A. Nameplates:
 - 1. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 26 05 53 "Identification for Electrical Systems."

PART 3 - EXECUTION

1.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.
- B. Verify that field measurements areas needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

2.01 INSTALLATION

- A. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- C. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.
- D. Remove shipping bolts, blocking, and wedges.

3.01 CONNECTIONS

- A. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

4.01 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Distribution panelboards.
 2. Lighting and appliance branch-circuit panelboards.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details.
 2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.

PART 2 - PRODUCTS

2.01 PANELBOARDS COMMON REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.
- D. Enclosures: Surface-mounted, dead-front cabinets.
1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 4X 316 stainless steel.
 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within

hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

- E. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity. Copper bussing shall be tin-plated for all outdoor panelboards.
- F. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- G. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- H. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.02 PERFORMANCE REQUIREMENTS

2.03 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. Siemens Industry, Inc., Energy Management Division.
 - 3. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers where individual positive-locking device requires mechanical release

for removal.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. Siemens Industry, Inc., Energy Management Division.
 - 3. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 3. MCCB Features and Accessories:

- a. Standard frame sizes, trip ratings, and number of poles.
- b. Breaker handle indicates tripped status.
- c. UL listed for reverse connection without restrictive line or load ratings.
- d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
- f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

2.06 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NECA 407.
- C. Mount panelboard cabinet plumb and rigid without distortion of box.
- D. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- E. Install filler plates in unused spaces.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.02 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."

- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This specification describes a complete adjustable speed AC drive (VFD) used to control the speed of NEMA design B inverter duty induction motors.

2.01 QUALITY ASSURANCE

- A. The VFD manufacturing facility shall be ISO 9001 and ISO 14001 certified.
- B. The VFD shall be manufactured by a company with at least ten (10) years' experience in the production of this type of equipment.
- C. All printed circuit boards shall be completely tested before being assembled into the complete VFD.

3.01 QUALIFICATIONS

- A. The VFD shall meet the following specifications:
 - 1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
 - 2. Certifications - The VFD shall conform to Underwriters Laboratories UL 508A, 508C, or UL-61800-5.
- B. Acceptable manufacturers
 - 1. Schneider/Square D
 - 2. Eaton

4.01 SUBMITTALS

- A. The Submittals shall include the following information:
 - 1. Outline dimensions and weight
 - 2. Customer connection and power wiring diagrams
 - 3. Complete technical product description, including a complete list of options provided
 - 4. Compliance to IEEE 519 – Harmonic analysis including total current distortion. In case an alternative low harmonic solution is offered, the VFD manufacturer shall provide calculations, specific to the jobsite, showing that the total harmonic current distortion (TDD) at the Point of

Common Coupling (PCC) is at or below THDi limits as recommended by IEEE 519-2022. Electrical design engineer shall provide specific electrical distribution system data necessary to perform harmonic calculations.

PART 2 - PRODUCTS

1.01 DESCRIPTION

- A. The VFDs will be of six pulse design or use the following methods for IEEE-519 compliance.
- B. Active front end VFDs shall be a 3-level Active Front End (AFE) AC drive that is designed to comply with standard IEEE 519-2022 when installed in a system that is already in compliance with the standard. A 3-level design shall be used to provide a low harmonic current load to the power system and to avoid introducing additional common mode noise to the motor. The low harmonic VFD must use 3-level active rectification to be considered an “approved equal.” AFE Units without 3-level PWM technology (if approved) will require motor dv/dt output filters and common mode noise filters.

2.01 RATINGS

- A. The VFD shall be rated to operate from 3-phase power, 350 Vac to 520 Vac.
- B. The VFD shall be rated to operate at the following environmental operating conditions. Ambient temperature: 0 to 40 °C continuous. The VFD shall have the capability to operate up to 50 °C with derating. Altitude: 0 to 3300 feet above sea level without derating, less than 95% humidity, non-condensing.
- C. The VFD shall be rated to operate from input power of 48 to 63 Hz.
- D. The normal duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes.

3.01 CONSTRUCTION

- A. The VFD manufacturer shall provide a complete package, ready-to-install solution. Third party entities that use VFD controllers from others in their package designs are not acceptable.
- B. The VFD shall offer microprocessor-based control logic that is isolated from power circuitry.
- C. The VFD shall use the same main control board for all ratings.
- D. Control interfaces shall remain consistent for all power ratings.
- E. Enclosure types shall be UL Type 12 unless otherwise specified in the drawings.

4.01 OPERATOR INTERFACE

- A. A detachable UL Type 12 / IP65 rated bi-color backlit graphical user interface terminal with keypad and capacitive wheel shall be provided for monitoring, annunciation, and configuration. The graphical display shall change to a red backlit color when an alarm occurs.
- B. A “Simply Start” menu for fast and easy commissioning shall be provided. Parameter setting shall be easily accessible and user friendly with plain text messaging and actual setting range.
- C. The user interface shall be capable of saving and downloading configurations of the VFDs, as well as transferring them to other VFDs.
- D. The user interface shall offer a mini USB port for mass storage or PC device connection.
- E. The VFD shall have self-diagnostic capabilities to display alarms, errors, and warnings as they occur and shall be able to store into memory the last 15 messages, at minimum. These shall be accessible by PC maintenance tools or by web server.
- F. The displayed messages shall be in plain text.
- G. The VFD shall display detected errors with QR codes to guide the user in the troubleshooting.
- H. The HMI shall have embedded troubleshooting information to assist with fault codes.
- I. The HMI shall be configurable to show up to 4 of the following parameters during operation:
 - a. Speed/torque in percent (%), RPM, or user-scaled units
 - b. Output frequency, voltage, current, and torque
 - c. Input voltage, power, and kilowatt hours
 - d. Heatsink temperature and DC bus voltage
 - e. Status of discrete inputs and outputs
 - f. Values of analog input and output signals
 - g. Values of PID controller reference, feedback, and error signals

5.01 PROTECTIVE FEATURES

- A. Upon power-up, the VFD shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, AC-to-DC power supply, control power, and the pre-charge circuit.
- B. The VFD shall be able to limit the motor surge limitation to twice the DC bus voltage. Suitable output filters must be provided to protect motors with the motor lengths provided in the drawings.
- C. The VFD shall provide the following IGBT protection circuits.
 - 1. IGBT overcurrent protection
 - 2. IGBT check up sequence
 - 3. IGBT check up sequence before PWM enable sequence.
 - 4. IGBT overtemperature protection
- D. The VFD shall provide VFD current protection.

- a. Short circuit protection
 - b. Ground fault protection
 - c. Overcurrent protection
- E. The VFD shall provide VFD voltage error protection.
- a. Main overvoltage protection
 - b. Main undervoltage protection
 - c. DC Bus overvoltage protection
 - d. DC Bus pre-charge protection
- F. The VFD shall provide VFD Thermal protection.
- a. VFD overtemperature protection
 - b. Fan management
 - c. Switching frequency management
- G. The VFD shall provide motor protection functions
- a. Output phase loss detection
 - b. Motor overload detection
 - c. Motor stall protection
- H. The VFD shall provide application protection functions
- a. Catch on fly function
 - b. Motor overspeed input protection
 - c. Current limitation
 - d. Power limitation
 - e. Reverse inhibition
 - f. Underload protection
 - g. Overload protection
 - h. External error management with logging
 - i. Loss of follower signal
 - j. Thermal sensor management
 - k. PID feedback

6.01 CONTROL INTERFACE:

- A. The speed command reference shall be selectable from the following sources:
- 1. I/O terminals
 - 2. Communication network
 - 3. Web server
 - 4. Remote graphic display terminal
- B. A minimum of the following standard inputs/outputs shall be provided to interface with control systems and instrumentation:
- 1. Analog inputs: 3 programmable 0(4)-20 mA or 0-10 Vdc
 - a. Two (2) analog inputs shall also be programmable for temperature sensors (PTC, PT100, PT1000, KTY84)
 - 2. Analog outputs: Two (2) programmable 0(4)-20 mA or 0-10 Vdc

3. Discrete inputs: 6 programmable isolated logic inputs as either sink or source
 4. Discrete outputs: 3 programmable relay contacts and 1 open collector output
- C. Programmable analog inputs shall be able to be assigned the following parameters at a minimum:
1. Speed reference
 2. Summing reference
 3. Subtracting reference
 4. Multiplying reference
 5. Torque reference
 6. Torque limitation
 7. PID feedback
 8. Manual PID reference
 9. PID speed reference
 10. Forced local reference
- D. Programmable analog outputs shall be able to be assigned the following parameters at a minimum:
1. Motor current
 2. Motor frequency
 3. Motor torque (signed or unsigned)
 4. Motor power
 5. Motor voltage
 6. Output frequency (signed or unsigned)
- E. Programmable discrete outputs shall be able to be assigned the following parameters at a minimum:
1. Ready
 2. Drive running
 3. Frequency reference attained
 4. Drive error
 5. Frequency threshold attained
 6. Torque sign
 7. Output contactor command
 8. Input contactor command
- F. Safety Inputs
1. The VFD shall provide two (2) inputs dedicated to the Safe Torque Off (STO) safety function, which prohibits unintended equipment operation, in accordance with IEC/EN 61508-1 SIL3.
 2. The VFD manufacturer shall provide the certified schematics and the list of devices in order to comply with IEC/EN 60204-1 stopping category 0 and 1.

3. The VFD shall integrate the safety contacts in compliance with EN-81 13.2.2.3.

7.01 COMMUNICATIONS

- A. The VFD shall provide at minimum one (1) Modbus and one (1) Ethernet Modbus TCP communication port. In addition, the following communications options shall be provided as necessary for communications. Refer to communication requirements specified elsewhere within the Contract Documents.
 1. Ethernet IP or Modbus TCP, RJ45 dual port for daisy chain
 2. Profibus DP V2, SUB-D9 connection, compliant with Drive Profile networking
 3. Profinet, RJ45 dual port for daisy chain
 4. DeviceNet, 5 terminal points
 5. CANopen daisy chain, RJ45 dual port for daisy chain
 6. CANopen SUB-D9 connection
 7. CANopen open terminals, 5 terminal points]
- B. VFD Ethernet ports shall be IPv6 compliant, allow for web server access, RSTP, and clock synchronization.
- C. The VFD shall provide an embedded web server for enhanced diagnostic, configuration, parameter access, and energy management. It shall be possible to create a user-defined custom dashboard for viewing VFD and process status through tables, charts, and graphical views. It shall be possible to export data in standard table format using the web server, for information about energy consumption as well as error and warning history.
- D. The VFD shall be compliant with the Cyber Security Management ISA Secure / Achilles.
- E. VFD communications modules shall be capable of being remotely powered by a separate external 24Vdc to allow for continued communications when the VFD power supply is off.
- F. The VFD shall provide integration connectivity via:
 1. DHCP protocol for Fast Device Replacement
 2. DTM library in compliance with standard FDT technology

8.01 CONTROL FUNCTIONS AND CONFIGURATIONS

- A. The VFD shall provide a speed set-point function capable of:
 1. Maximum output frequency function
 2. Low and high-speed scaling and limitation function
 3. Skip frequencies
 4. Speed summing references
 5. Preset speed references

6. Up-Down speed references
- B. The VFD shall provide a Stop function capable of:
 1. Deceleration ramp on power loss
 2. Freewheel stop
 3. Stop by DC injection at motor stop detection
 4. Stop by DC injection by logic input
 5. Stop on deceleration ramp adaptation
 - C. The VFD shall have an acceleration/deceleration, time-adjustable ramp function capable of:
 1. Ramp type: linear ramp, S shape ramp, with U or customized profile
 2. Ramp deceleration adaptation
 3. Ramp switching
 - D. Application programming dedicated to pumps
 1. The VFD shall provide pump control and monitoring functions
 - a. Pump cyclic start protection in order to protect the pump against in a dedicated time period
 - b. Multi-pump function to allow staging of multiple pumps with either contactors or multiple drives without the use of external controllers.
 2. The VFD shall provide pump protection functions:
 - a. Anti-jam or Deragging function
 - b. Pipe cleaning function start the pump regularly to avoid sedimentation in pump impeller
 - c. Cavitation protection
 - d. Low inlet pressure protection
 3. The VFD shall provide application control functions.
 - a. Pulse input for connection to flow meter feedback
 - b. Process control (PID) function to maintain a process at a given pressure or flow reference
 - c. Friction loss compensation function to compensate pressure losses in pipe
 - d. Pipe Fill function for smooth pipe filling and to lessen the affects of water hammer
 - e. Sleep wake-up function
 - f. Jockey pump control
 4. The VFD shall provide application protection functions.
 - a. High flow protection
 - b. Outlet pressure protection
 5. The VFD shall provide pump curve input to help optimize pump performance.
 - a. Input and storage of the pump characteristics including five (5) points of the pump curve.
 - b. A best efficiency point (BEP) function with alarms to indicate deviation from BEP.
 - E. The VFD Supplier shall have Windows-based PC software for configuring and diagnosing the VFD. It shall be possible to set and modify parameters, control the VFD, read actual values, and make trend analysis using the software.
 - F. The VFD shall provide a real time clock for time stamping detected errors.

PART 3 - EXECUTION

1.01 EXAMINATION

- A. Examine the VFD exterior and interior prior to installation. Report any damage and do not install any VFDs that are structurally, moisture, or mildew damaged.
- B. Prior to locating the VFD at the planned installation site, ensure that the location is prepared for the installation and that the storage or operating condition requirements can be maintained. Verify that the installation space requirements are satisfied. Report any conditions that are detrimental to performance of the work. Proceed with installation only after detrimental conditions have been corrected.
- C. Before, during, and after installation ensure that the VFD is protected from area construction activities and site contaminants.

2.01 INSTALLATION

- A. Install drives under this Division in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
- B. Provide power wiring. Wire and terminate connections in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.01 FIELD QUALITY CONTROL

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.
- B. Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. The Contractor shall conduct performance verification tests in the presence of a customer representative, observing and documenting complete compliance of the system to the specifications.

4.01 TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner and the Construction Management Team. Provide 4 hours of instruction from competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting for each variant of the installed systems. Schedule instruction with the Owner after submission and approval of formal training agendas.

5.01 WARRANTY

- A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

END OF SECTION

SECTION 31 23 16

EXCAVATION, TRENCHING AND GRADING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Removing and stockpiling topsoil for finish grading.
2. Excavation for footings, foundations, structures, slabs-on-grade, paving, and landscaping.
3. Excavating trenches for utilities.
4. Rough and finish grading on site.
5. Layout work.
6. Testing.
7. Protection of Work.
8. Removal or reuse of excavated material.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 03 – Concrete
3. Section 31 23 23 – Bedding, Backfilling and Compaction
4. Section 33 11 00 – Piping
5. Section 33 12 00 – Valves

1.02 REFERENCES

Reference	Title
Standard Specifications for Road and Bridge Construction	Standard Material Specifications for gravel, sand, crushed stone and gravel-cement mixtures published by Tennessee Department of Transportation.
Federal Highway Administration	Manual on Uniform Traffic Control Devices
ASTM C136	Sieve Analysis of Fine and Course Aggregates
ASTM D1556	Density of Soil in Place by Sand-Cone Method
ASTM D1557	Laboratory Compaction of Soil Using Modified Effort
ASTM D2922	Density of Soil in Place by Nuclear Methods
ASTM D3017	Water Content of Soil in Place by Nuclear Methods
OSHA	Occupational Safety and Health Administration

Reference	Title
TOSHA	Tennessee Occupational Safety and Health Administration

1.03 SPECIAL INSTRUCTIONS

- A. Contractor shall obtain all required local permits, including street cut permits, prior to commencement of work. Contractor shall contact Tennessee One Call and local utilities to locate existing utilities in accordance with Section 01 00 05.
- B. Contractor shall take all required measures for adequate control of dust during performance of Contract in accordance with Section 01 00 05.
- C. Contractor shall take all required measures for prevention of erosion during performance of Contract and until satisfactory grass cover has been established in accordance with Section 01 00 05.
- D. Contractor shall erect suitable silt and erosion control barriers to prevent siltation of drainage areas during performance of contract in accordance with Section 01 00 05.
- E. Contractor shall take all required steps to protect existing roads and drives during performance of Contract, both from physical damage and deposition of mud or rock in accordance with Section 01 00 05.
- F. Contractor shall comply with all governing authorities’ regulations in regard to dust control, erosion control, and prevention of pollution of bodies of water and streams.

1.04 GENERAL REQUIREMENTS

- A. Protection of Property and Persons:
 - 1. Protect existing building structures, curbs, walks, utilities and paving from damage by construction or equipment. Bring back to original condition any damaged in course of construction. Notify utility companies and Tennessee One-Call prior to commencement of intended work.
 - 2. Protect all bench marks and survey points.
 - 3. Protect all vegetation and other features to remain.
 - 4. Provide adequate protection to persons and property throughout progress of work.
 - 5. Provide and install construction barriers to protect persons from excavation as required.
 - 6. Current Federal OSHA and Tennessee TOSHA regulations shall be adhered to by Contractor throughout this work. Excavated cuts and slopes shall be laid back, benched and/or sheeted as required to meet OSHA and TOSHA regulations.
 - 7. Contractor shall provide a minimum of 24 hours notice to property occupant and owner before any driveway is cut or blocked. Contractor shall schedule any cutting or blocking of driveways to suit property occupant’s convenience. Except in an emergency, Contractor shall not block any driveway without first providing an alternate access to property.

- B. Utilities:
1. Disconnections: Before starting clearing of site, disconnect, or arrange for disconnection of utility service connections, such as water, gas, electricity, and telephone, in accordance with regulations of utility concerned.
 2. Protection: Preserve in operating condition all active utilities transversing project site; protect all property, including but not limited to mains, manholes, catch basins, valve boxes, poles, guys, and other appurtenances. Repair damage to any such utility due to work under this contract to satisfaction of Local Authority.
- C. Site Examination – Drawings, Specifications, and project site shall be carefully examined for thorough familiarization with all existing conditions and limitations and their relationship to and effect upon work included under this section of Specifications. No extra allowances shall be made for failure to do so.
- D. Testing – Owner shall provide laboratory to conduct testing required by this Section at his expense in accordance with Section 01 45 29. Contractor shall cooperate fully with testing laboratory performing sampling and testing required herein. Contractor shall notify testing laboratory a minimum of 24 hours in advance of when work is to be in progress.
- E. Verify that survey benchmark and intended elevations for Work are as indicated on Drawings or as provided by Engineer. Bench marks and other reference points shall be carefully maintained and, if disturbed or destroyed, shall be replaced as directed at no cost to Owner.
- F. Layout Work – Excavating and grading contractor shall have drives, walks, and parking areas staked by a competent surveyor to establish curvatures and grades.
- G. Basis of Bid:
1. Excavation shall be bid as unclassified. Excavation contractor is advised to study site carefully to determine amount and type of excavation necessary to conform to grades called for on Drawings. All costs of earth and/or rock excavation shall be included in Total Base Bid price.
 2. Excavation shall be to required depth, in all cases down to firm subgrade or bearing. If soft spots are encountered, soft material shall be removed and replaced with compacted fill, as specified herein and Section 31 23 23. Subgrade surface shall be proof rolled with a loaded dump truck to determine if any soft spots exist. Engineer shall witness proof-rolling prior to commencement and shall be final arbiter if subbase is sufficiently stable.
 - a. Proof-Rolling Requirements.
 - 1) Furnish heavy pneumatic tire roller that provides a total uniform load of not less than 25 tons when loaded and not more than 50 tons. Rollers shall meet following requirements:
 - a) Rollers shall consist of rubber tire wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange rear tires to cover gaps between adjacent tires of forward group. Furnish rollers capable of forward and backward motion.
 - b) Select and maintain operating load and tire air pressure within specified range. Furnish manufacturer's chart or tabulations showing contact areas and contact pressures for full range of tire inflation pressures and for full range of loadings for particular tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

- c) Roller shall have at least 4 pneumatic-tired wheels mounted on axles carrying no more than 2 wheels.
 - d) Roller shall be provided with wheels arranged to carry approximately equal loads on uneven surfaces.
 - e) Roller shall have width between 8 and 10 ft. that can turn 180 degrees in crown width.
 - f) Roller tires shall be capable of maintaining a maximum ground contact pressure of 150 psi.
 - g) Roller with liquid-filled tires inflated to such a level that liquid will flow from valve stem when stem is in uppermost position.
 - h) Contractor may use alternate compaction equipment that produces results equivalent to specified equipment. Contractor shall discontinue use of alternative equipment and furnish specified rollers if desired results are not achieved as assessed by Engineer.
- 2) Adjust load and tire inflation pressures within specified ranges based on manufacturer's charts or tabulations.
 - 3) Make at least 2 coverages with proof roller. Offset each trip of roller by at most one tire width. Operate rollers at a speed between no less than 2 and no more than 6 miles per hour.
 - 4) Correct unstable or nonuniform areas, if found, in accordance with Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Planning – Contractor's personnel shall familiarize themselves with requirements for preservation of topsoil, excavation, backfill, grading, borrow, wasting, and erosion control before beginning work under this section.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum. Review subsurface report and other available site information.
- B. Identify known underground, above ground, and aerial utilities by marking, staking, or flagging locations. Contact organizations identified in Section 01 00 05. Utilities include water, reclaimed water, gas, electrical, telephone, cable, fiber optic, storm sewers, sanitary sewers, laterals, and services. In event such locations indicate a possible interference, or when needed to locate points of connection to existing facilities, perform exploratory excavations to determine utilities' location and elevation. Provide Engineer with results of exploratory excavations for his review. Allow Engineer sufficient time to determine any changes required as a result of such exploratory excavations prior to start of construction.
- C. Notify utility company to remove and/or relocate utilities.

- D. When project consists of reconstructing sanitary sewers and reconnection of existing sanitary laterals, only reconnect live laterals, unless otherwise shown on Drawings. Verify whether lateral is alive or abandoned and source of lateral using such methods as necessary including dyeing, flushing with water, rodding, pipe locators, and exploratory excavations.
- E. Abandoned pipes and laterals shall be plugged in with 12 inches of concrete or grout or for large pipes with solid brick masonry.
- F. Conduct operations such that no interruptions to existing utility system shall occur. Where existing sanitary sewers or storm drain systems are being replaced or interrupted provide temporary bypass pumping or temporary piping to maintain flow around work site such that no backups occur in these sewer systems.
- G. Existing sanitary sewer laterals damaged in work or temporarily disconnected shall be restored to operation by end of each work day. Existing sanitary sewer laterals where crossing over new pipelines to be restored in accordance with details shown on drawings.
- H. Maintain existing manholes, catch basins, and other utility structures above and below grade which are to remain in their pre-work condition. Any material or debris entering same due to operation shall be promptly removed.
- I. Protect above and below grade utilities which are to remain.
- J. Protect plant life, lawns, rock outcropping and other features remaining as a portion of final landscaping.
- K. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic. Preserve control points provided by Engineer throughout life of project, and accurately replace any such point, which is damaged or moved, at Contractor's expense.
- L. Excavations shall be in complete accordance with all details of applicable codes, rules, and regulations including all local, state, and federal regulations including Occupational Safety and Health Administration (OSHA) Title 29 Code of Federal Regulations Part 1926, Subpart P - Excavations and Trenching Standards. Contractor shall designate a "Competent Person" 29 CFR 1926.32(f) who shall be responsible for inspections of excavations on a daily basis and document and maintain daily trenching and excavation logs per OSHA 29 CFR 1926.
- M. Cut out soft areas of subgrade not capable of insitu compaction. Refer to Section 31 23 23 for details.
- N. Brace walls and slabs of structures to support surcharge loads and construction loads imposed by backfilling operations.
- O. Remove all water, snow, ice and debris from surfaces to accept fill materials and from backfill material.
- P. Areas to receive compacted fill shall be graded to prevent surface runoff and ponding in accordance with this Section.
- Q. No fill or backfill material may be used without approval of Engineer. See Section 31 23 23.
- R. No geotextile fabric may be used without approval of Engineer.
- S. Backfill operations shall be started at lowest elevation in area to be backfilled, and continue, in horizontal layers, upward to limits specified. See Section 31 23 23.

- T. Backfill material shall be within 2 percent of optimum moisture content for that material. See Section 31 23 23.

3.03 REMOVAL AND STOCKPILING OF TOPSOIL

- A. Strip all topsoil to its entire depth, a minimum of 12 inches from all areas to be cut or filled. Contractor may select any method but shall comply with following:
 - 1. Scrape areas to be stripped clean of brush, woods, and grass, roots over 1/2 inch diameter, and other foreign materials.
 - 2. Do not strip topsoil in a muddy condition.
 - 3. Do not strip areas indicated not to be disturbed.
 - 4. Avoid including subsoil, debris, stones over 2 inches, and other extraneous matter in topsoil.
 - 5. Leave areas free of trash, debris, and foreign materials.
 - 6. Remove all topsoil from areas over which any construction is to be placed, such as buildings, walks, drives, roads, parking areas, etc.
 - 7. Store topsoil in an approved location for use in finish grading and protect it against loss and from admixture of debris.
- B. If borrow topsoil material is required, Contractor shall include in his Proposal cost of obtaining and placing same.

3.04 PROOF-ROLLING

- A. After topsoil stripping is done, proof roll areas to receive compacted fill with a heavily loaded rubber tired tandem axle dump truck. Operate truck at a normal walking speed so that Engineer may observe ground while walking beside truck.
- B. Engineer shall review areas for soft spots. Refer to Part 1 of this specification.

3.05 EXCAVATION – GENERAL

- A. All excavation shall be unclassified.
- B. Excavate to lines and elevations as indicated on Drawings and as necessary for proper construction of work. Contractor shall base his bid on excavation slopes recommended in geotechnical report provided in Appendix A. If sheeting and/or shoring is required, it shall be installed as recommended and designed by an Engineer employed by Contractor, cost of which shall be included in Contractor's base bid. Contractor shall employ an engineer to observe and monitor excavations and engineer shall determine stability of excavation slopes and recommend and design any sheeting, shoring, bracing, or other methods to be installed.
- C. Equipment and methods shall be suitable for work at hand. Blasting and shooting shall not be permitted without prior approval from Engineer and Owner.
- D. Side slopes shall be as vertical as possible with Contractor employing necessary sheeting, shoring, or bracing, as described in Section 31 50 00 to comply with OSHA and TOSHA regulations. Contractor shall minimize excavation of native material as much as possible except that necessary to accomplish work. Unnecessary excavation shall be backfilled at no additional cost to Owner.

- E. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases. If required to protect existing structures and improvements or to prevent cave-ins or other unstable soil conditions, Contractor shall utilize sheeting, bracing, shoring, or other acceptable methods in accordance with Section 31 50 00. Need for such protection and design of that product and cost of that protection shall be borne by Contractor.
- F. Excavate subsoil required to accommodate building foundations, slabs-on-grade, paving, site structures, and construction operations.
- G. Excavate to working elevations for piling work. Coordinate special requirements for piling.
- H. Machine-slope banks to angle of repose or less, until shored.
- I. Excavation cut not to interfere with normal 45-degree bearing splay of foundation. Undercutting of excavation faces shall not be permitted.
- J. Hand trim excavation to required undisturbed subgrade. Remove loose matter.
- K. Remove lumped subsoil, boulders, and rock under 1 cubic yard, measured by volume. Refill voids with Fill Concrete or compacted gravel/crushed stone.
- L. Stockpile excavated material in area designated on-site. Reusable fill or topsoil in excess of that required or materials unsuitable for fills and backfills shall be disposed of off-site.
- M. Rock and shale removed from excavations shall be disposed of off-site unless deemed suitable for use as backfill by Engineer, in which case Contractor shall be permitted to use material. Contractor shall at his expense pay for any testing necessary to ascertain suitability of material prior to use being approved.
- N. Excavation for footings shall be to footing dimensions unless indicated otherwise.
- O. Caved-in excavation materials and other debris shall be removed promptly from excavation.
- P. Owner reserves right to alter grades and raise or lower established levels after all or any part of excavation has been completed, and adjustment shall be made to contract price.
- Q. Should Contractor, through negligence or otherwise carry his excavation below designated subgrade or otherwise over-excavate for footings, base slabs, under slabs, or piping not authorized in advance by Engineer and Owner, Fill Concrete shall be furnished and placed as backfill in sufficient quantities to reestablish designated subgrade surface. Granular material used for backfilling shall be spread and compacted in conformance with this Section, Section 32 11 00, and Section 31 23 23 as applicable, and to percentage compaction outlined therein. Cost of this refilling operation, including any tests associated therewith, shall be borne by Contractor.
- R. Excavations shall be kept free from water at all times. Provide drainage openings through foundation walls and flexible plastic drainage piping when required. Grade top perimeter of excavation to prevent surface water from draining into excavation. Refer to Section 31 23 19.
- S. Pumps or other equipment shall be provided and operated to drain excavated areas and Contractor shall be responsible for all damages resulting from water in excavated areas or pumping operations. See Section 31 23 19.
- T. Ponding which would allow water to percolate to lower strata shall not be allowed.
- U. Frozen subsoil, ice, or free water shall be removed prior to placement of concrete.

- V. Excavation for footings and trenches may be cut to accurate sizes and side forms omitted if concrete is poured in clean cut trenches without cave-ins.
- W. Notify Engineer of unexpected subsurface conditions, or of questionable soils encountered at required subgrade elevations, and discontinue work in area until notified to resume operations.
- X. If indicated on Drawings or when unstable or unsuitable soil is encountered, excavate soil until suitable material is encountered. Backfill these areas up to bed level indicated on drawings. Backfill shall consist of 1 to 2 inch stone except that last 6 inches shall be No. 67 crushed stone as defined in Section 903 of latest Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction. Base shall be stable and free from standing water and trench walls shall be stable before normal backfilling operations commence. Follow requirements of Section 31 23 23.
- Y. Engineer and testing laboratory shall be notified when excavation for footings have reached required depth and no footings shall be placed until excavations have been inspected and approved by Engineer.
 - 1. Subgrade Inspection.
 - a. Notify Engineer when excavations have reached required subgrade.
 - b. Coordinate inspection of subgrade by geotechnical firm hired by Contractor.
 - c. If Engineer, based on information provided by geotechnical firm, determines that unsatisfactory soil or rock is present, continue excavation and replace with compacted backfill or fill material as directed.
 - d. Proof-roll subgrade below building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1) Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2) Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
 - e. Authorized additional excavation and replacement material shall be paid for according to Contract provisions for changes in Work.
 - f. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.
- Z. Excavations shall be to designed subgrade elevation unless specifically directed otherwise. Excavations in shale requiring sound subgrade shall be done by machine excavation as required to reach a sound subgrade. Fractured or disturbed rock subgrade shall not be acceptable where sound bedrock subgrade is indicated. Refer to Section 31 23 17 for acceptable rock removal methods.
- AA. Contractor shall be responsible for and shall save Owner harmless from any loss on account of any damage incurred in this work.
- BB. Rock, in areas to be finished grade, shall be removed and backfilled with good material thoroughly compacted.

- CC. Footings are to have firm bearing on material as noted on Contract Drawings and with minimum bearing capacity as notes on Drawings.
- DD. For base slabs on bearing rock, excavation for structure base slabs shall be a minimum of 6 inches below bottom of slab elevation to allow for placement of a minimum of 6 inches of pug mix base stone on top of rock bearing.
- EE. Contractor shall not cut or block any driveway unless property notice has been provided to property occupant and owner at least 24 hours in advance.
- FF. When excavated trench foundation footings without formwork are shown to be used on Contract Drawings, opened foundation excavations shall be backfilled with concrete same day they are opened. Footing widths shall be a minimum as indicated on Drawings. Footings shall be placed "neat" to excavation. Forgoing paragraph does not apply to concrete footings or walls constructed using formwork.
- GG. Rock removal methods may include rock blasting, drilling and chipping, expansive chemical and chipping or other approved methods. Rock excavation, including any required blasting, shall be done in full accordance with local ordinances, regulations, and dictates of safety by skilled operators. Rock excavation shall be evaluated by Contractor during construction for stabilizing considerations.
- HH. Excavation in sound bedrock shall be performed in such a manner as to provide safe and stable side slopes, per OSHA requirements and with a maximum height between benches of 20 ft. and at transitions from sound bedrock to weathered rock or earth. Benches are to be a minimum of 5 ft. wide. Base of rock excavations shall be at footing edge typical. Excavation for footing shall be with vertical cut.
- II. Rock embankment shall not be over-excavated. Rock embankments shall be to slopes indicated and benches at elevations indicated to establish finish grades and provide support for roadways and retaining walls. If embankments are over-excavated to where support of structures above is affected. Embankment shall be established with Fill Concrete backfill anchored to embankment per recommendations of geotechnical engineer and subject to approval of Engineer and Owner.

3.06 TRENCH EXCAVATION

- A. All excavation shall be unclassified.
- B. Contractor shall adhere to applicable requirements of general excavation described above that do not conflict with specific requirements of trench excavation.
- C. Trenches for underground piping, ductwork, drains, and similar utilities shall be excavated and maintained as shown on Drawings and specified in this Section and in such a manner as to form a neat and suitable trench in which to place bedding, pipe, and appurtenances and so as to cause least inconvenience to public.
- D. All trench excavations shall be open cut unless otherwise shown on Drawings or specified herein. No tunneling shall be done without approval of Engineer of tunnel cross section and details of construction provided by Contractor.
- E. Sides of all trenches shall be vertical to a minimum of 1 foot above top of pipe. Unless otherwise indicated on drawings, trench width shall be equal to sum of outside diameter of pipe plus 2 feet, within a tolerance of plus or minus 3 inches. This distance shall be measured at an elevation in trench which is 12 inches above top of pipe when laid to grade.
- F. Contractor shall excavate by hand wherever necessary to protect existing structures or utilities from damage or to prevent over-depth excavation in trench subgrade.

- G. Trench depths shall be sufficient to provide minimum cover of 36 inches over top of all pipes or to provide cover as otherwise specified in these Contract Documents or as shown on Contract Drawings, whichever is greater. Minimum cover specified shall be maintained at all times after installation without exception.
- H. Align trench as shown on Drawings unless a change is necessary to miss an unforeseen obstruction. Alignment changes shall be documented on record drawings in accordance with Section 01 00 05.
- I. Excavation shall be such that a flat bottom trench of allowable width is established at required subgrade elevation for subsequent installation of pipe foundation material or shape bottom of trench provides uniform bearing of pipe on undisturbed earth throughout its entire length. Bottom of trenches, whether in dirt or crushed stone bedding, must be shaped by hand, and bell holes must be dug so that full length of pipe is resting on trench bottom. Blocking shall not be used, and neither shall pipe be laid on a trench bottom that has not been leveled to provide support throughout full length of pipe. Pipe foundation material shall be as specified in Section 31 23 23.
- J. If indicated on Drawings or when unstable or unsuitable soil is encountered at trench bottom, refer to Article 3.05.
- K. Remove rock encountered in trench excavation to a depth of 6 inches below bottom of pipe barrel, backfill with an approved material, and compact to uniformly support pipe. In no case shall solid rock exist within six (6) inches of finished pipeline.
- L. When rock borings or soundings are provided, they are for information only and do not guarantee existing conditions. Make such investigations as deemed necessary to determine existing conditions.
- M. If a prefabricated, mobile shield is utilized in lieu of conventional sheeting and bracing in pipe trenches, bottom of shield shall be maintained as high as possible (preferably above spring line of pipe) so as to prevent disturbance of pipe foundation material and to avoid forces which would tend to pull pipe joints apart when shield is dragged forward. Gouged openings or troughs left by shield shall be filled with additional pipe foundation material and thoroughly compacted. Installation of sheeting and bracing and use of mobile shields shall be in complete accordance with all details of applicable safety codes, rules and regulations including all applicable local, State, Federal, and OSHA regulations.
- N. Trenches shall be opened up far enough ahead of pipe placement to reveal obstructions, but in general shall not be opened for more than 200 feet in advance of installed pipe. Excavation of trench shall be fully completed at least 5 feet in advance of pipe laying operations. No more than 40 feet of trench shall be left open overnight.
- O. Contractor shall install equipment in trench, backfill when an inspector is present, and provide rough cleanup promptly after excavation of trench. Failure of Contractor to promptly complete work in trench may result in Contractor being prohibited from excavating additional trench.
- P. Excavations beyond those designated in Contract Documents shall reestablish designated subgrade as outlined in Article 3.05. If maximum widths of pipe trenches are exceeded, installed pipes shall be fully cradled in a minimum of 6 inches of fill concrete, as specified elsewhere, and at Contractor's expense. Excavation below subgrade which is ordered by Engineer because normal subgrade has been disturbed by Contractor's operations shall be considered as unauthorized excavation.
- Q. Contractor shall gradually increase depth of trench when approaching cuts, creek banks, or other changes in grade to avoid use of fittings wherever practical and at no additional cost to Owner.

- R. Trenching required for new connections to existing utilities shall not commence until existing utilities are located and uncovered.

3.07 MAINTENANCE OF EXCAVATIONS

- A. All excavations shall be properly and legally maintained while they are open and exposed. Sufficient and suitable barricades, warning lights, flood lights, signs, etc., to protect life and property shall be installed and maintained at all times until excavation has been backfilled and graded to a safe and satisfactory condition. All signs, markers, barricades shall conform to requirements of Tennessee Department of Transportation and Federal Highway Administration Manual on Uniform Traffic Control Devices. All barricades, signs and markers shall be reflectorized.
- B. To maintain vehicular and pedestrian traffic and safety, temporary plating over trenches consisting of steel plates shall be used to temporarily bridge trench excavations. Plates shall be of size and positioned to provide adequate bearing at plate edges, shall be securely anchored, and shall be fitted in place in a manner to minimize noise when crossed by traffic. Plates shall be of sufficient thickness to safely carry heavy traffic without detrimental deflection; however, unless otherwise specified, minimum thickness of plates shall be 1-inch.
- C. Plate edges exposed to traffic shall be feathered with asphalt mix as part of trench excavation work. Work includes surveillance and adjustment of plating over trenches which shall be provided by Contractor during non-working hours, weekends, and holidays.
- D. Contractor shall maintain all excavations in a dry condition until work is complete. Contractor shall be responsible for controlling groundwater, storm water, and sewage in excavated areas. Equipment and facilities shall not be installed in water. Water shall not be allowed to submerge concrete or mortar until concrete and mortar have been set for at least 48 hours.

3.08 DISPOSAL OF EXCAVATED MATERIALS

- A. Excavated materials shall be stored safely away from edge of excavation area and shall avoid encroachment on private property.
- B. Storage of excavated materials shall be accomplished in a manner to avoid danger to workers, utilities, and vehicular and pedestrian traffic, avoid encroachment on private property, and avoid or minimize blockage of driveways, sidewalks, natural drains, etc.
- C. Material shall be stockpiled for future use only if prior approval for material reuse has been approved by Engineer otherwise material shall be considered unsuitable or surplus material and disposed of promptly. Stockpiling shall be in locations approved by Owner and Engineer prior to stockpiling activities.
- D. Excess and unsuitable excavated material shall be disposed of off-site in accordance with Section 31 11 00. No on-site material shall be used for backfilling unless testing confirms suitability of material and then only with approval of Engineer.

3.09 OBSTRUCTIONS

- A. Obstructions shown on Drawings are for information only and do not guarantee their exact locations nor that other obstructions are not present.
- B. When utilities or obstructions are not shown on Drawings but are present within work area, Contractor may request to relocate proposed work if necessary to avoid disturbing utility or obstructions.

1. If relocation is approved by Owner and Engineer, Contractor shall receive compensation for additional granular backfill, pavement replacement, and other work as may be necessary to accomplish modified work.
 2. If relocation is not approved by Owner and Engineer, Contractor and Engineer shall work together to resolve conflict with obstruction.
- C. Exercise due care in excavating adjacent to existing obstructions and do not disturb these obstructions unless absolutely necessary and then only with written approval of owner of obstruction.
- D. In event obstructions are disturbed, repair or replace as quickly as possible to condition existing prior to their disturbance and in accordance with requirements of owner of obstruction. Such repair or replacement work shall be at expense of Contractor. If owner of obstruction desires to perform repair or replacement work themselves, Contractor shall pay owner of obstruction for their repair or replacement work.
- E. If replacement or repair of disturbed obstructions is not performed after a reasonable period of time, Owner may have necessary work done and deduct cost of same from payments to Contractor.

3.10 GRADING

A. Rough Grading:

1. Rough grading shall proceed in a practical sequence as construction work progresses.
2. Grade for all building construction to elevations shown on Drawings making allowances for granular fill where required under concrete slabs.
3. Bring subgrade in project area outside building line to 4 inches below finished elevation for lawns and 18 inches for planting, and to subgrade level where paving is required.
4. Slope rough graded surfaces to drain surface water away from buildings.
5. Rough grading shall be approved before placing of topsoil is started.

B. Finish Grading:

1. All finish earth surfaces in area of site disturbed for new construction shall receive topsoil.
2. Topsoil shall not be placed when subgrade is frozen, excessively wet, extremely dry, excessively compacted, or in a condition detrimental to proposed planting.
3. Topsoil shall be removed from stockpile on site or brought in offsite if quantity of existing is not sufficient, and distributed uniformly and spread evenly. Topsoil shall be rock free. Specified thickness shall be as described in Section 32 90 00 after soil has been compacted in accordance with Contract Documents.
4. Finished surfaces shall be fine graded, neat, and uniform with no visible clumps or particles of soil exceeding 1-1/2 inches in longest dimension.
5. Grade uniformly with rounded surfaces at tops and bottoms of abrupt changes of plane.
6. Finish surfaces properly for seeding. Variation from a plane shall not exceed 1 inch in 10 feet.

7. Protect graded areas from erosion, or repair and regrade. Refill where noticeable settlement occurs. Refilling of settled areas is included in project's warranty period.
8. Remove rocks, roots, and other foreign materials and leave surface smooth and well-drained.
9. Gravel Areas - Location where gravel is to be used in lieu of grass as ground cover, gravel shall be placed on top of a geotextile fabric that shall promote drainage and prevent grass growth.

3.11 TESTING

- A. Contractor shall employ a qualified and experienced independent testing laboratory in accordance with Section 01 00 05 to perform monitoring and testing of all compacted fill, monitoring and testing of all consolidated crushed stone backfill, and to certify that fill and backfill is placed in conformance with Drawings and Specifications. Testing laboratory shall inspect all bearing and subgrade levels for compliance with bearing conditions required and shall observe all proof-rolling of subgrade levels. If laboratory employed by Contractor, laboratory shall be acceptable to Owner and Engineer.
- B. Contractor shall cooperate fully with testing laboratory performing sampling and testing required herein. Contractor shall notify testing laboratory and Engineer a minimum of 72 hours in advance of when work is to be in progress.
- C. Testing shall consist of all required laboratory tests of fill material including moisture-density relationships (Proctor), Atterburg limits and continuous inspection and field density testing of fill when it is being placed.
- D. Testing laboratory shall submit 2 copies of laboratory report to Engineer or RPR and 1 copy to Contractor.
- E. Suitability of proposed material for use as fill and backfill shall be verified by testing lab, and their report shall so state its suitability.

3.12 PERIODIC CLEANUP AND BASIC RESTORATION

- A. When work involves installation of sewers, drains, water mains, manholes, underground structures, or other disturbances of existing features in or across streets, rights-of-way, easements or private property, Contractor shall (as work progresses) promptly backfill, compact, grade and otherwise restore disturbed area to a basic condition which shall permit resumption of pedestrian or vehicular traffic and any other critical activity or function consistent with original use of land. Requirements for temporary paving of streets, walks, and driveways are specified elsewhere. Unsightly mounds of earth, large stones, boulders and debris shall be removed so that site presents a neat appearance.
- B. Contractor shall perform clean-up work on a regular basis and as frequently as required. Basic site restoration in a particular area shall be accomplished immediately following installation or completion of required facilities in that area. Furthermore, such work shall also be accomplished if partially completed facilities must remain incomplete for some time period due to unforeseen circumstances.
- C. Upon failure of Contractor to perform periodic clean-up and basic restoration of site to Engineer's satisfaction, Owner may, upon five days prior written notice to Contractor, without prejudice to any other rights to remedies of Owner, cause such work for which Contractor is responsible to be accomplished to extent deemed necessary by Engineer, and all costs resulting therefrom shall be charged to Contractor and deducted from amounts of money that may be due him.

3.13 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 01 00 05.

3.14 PROTECTION

- A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation. Refer to Section 31 50 00.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation, from freezing.
- C. Exposed subgrade surfaces shall remain undisturbed, drained, and maintained as uniform, plane areas, shaped to receive foundation components of building or structure.
- D. Protect all completed work in accordance with Section 01 00 05.
- E. Regrade and recompact fills subjected to vehicular traffic.

3.15 BACKFILLING AND COMPACTION

- A. All backfilling and compaction shall be in accordance with Section 31 23 23.

END OF SECTION

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SECTION 31 23 23

BEDDING, BACKFILL AND COMPACTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Materials authorized for use for backfilling.
2. Pipe foundations and bedding.
3. Trench backfilling.
4. Filling and backfilling around and under structures.
5. Compaction for piping, foundations and other structures.
6. Compaction test methods.
7. Removal or reuse of excavated materials.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 03 – Concrete
3. Section 31 23 16 – Excavation, Trenching and Grading
4. Section 31 50 00 – Sheeting and Bracing
5. Section 32 90 00 – Site Restoration
6. Section 33 11 00 – Piping
7. Section 33 12 00 – Valves

1.02 DEFINITIONS

A. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1-foot outside outermost edge at base of foundations or slabs.
2. 1-foot outside outermost edge at surface of roadways or shoulder.

B. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

1.03 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.

Reference	Title
Standard Specifications for Road and Bridge Construction	Standard Material Specifications for gravel, sand, crushed stone and gravel-cement mixtures published by Tennessee Department of Transportation.
ASTM C136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D698	Laboratory Compaction of Soil Using Standard Effort
ASTM D1556	Density of Soil in Place by Sand-Cone Method
ASTM D1557	Laboratory Compaction of Soil Using Modified Effort
ASTM D2922	Density of Soil in Place by Nuclear Methods
ASTM D3017	Water Content of Soil in Place by Nuclear Methods
OSHA	Occupational Safety and Health Administration
TOSHA	Tennessee Occupational Safety and Health Administration

1.04 PRECAUTIONS

- A. Contractor shall take all necessary steps and precautions, including those outlined in these Contract Documents, to notify owners of utilities and identify utilities within construction area or those that might be disturbed by work activities, protect all features of site that are to remain, and protect bench marks and survey points.
- B. Refer to Sections 01 00 05 and 31 23 16 for more specific details on precautions to be taken to protect life and property.

1.05 QUALITY ASSURANCE

- A. Contractor shall adopt compaction methods which shall produce degree of compaction specified herein, prevent subsequent settlement, and provide adequate support for surface treatment, pavement, structure and piping to be placed thereon, or therein, without damage to new or existing facilities.
- B. Natural subgrade for all footing, mats, and slabs-on-grade for structures or pipes shall consist of firm undisturbed natural soil.
- C. After excavation to subgrade is completed, subgrade shall be compacted if it consists of loose granular soil or if its surface is disturbed by teeth of excavating equipment.
1. This compaction shall be limited to that required to compact loose surface material and shall be terminated in event that it causes disturbance to underlying fine-grained soils, as revealed by weaving or deflection of subgrade under compaction equipment.
 2. If subgrade soils consist of saturated fine or silty sands, silts, or clay or varved clays, no compaction shall be applied.
- D. Testing – Contractor shall provide laboratory to conduct testing required by this Section at his expense in accordance with Section 01 45 29. Contractor shall cooperate fully with testing laboratory performing sampling and testing required herein. Contractor shall notify testing laboratory a minimum of 48 hours in advance of when work is to be in progress.

1.06 SUBMITTALS

- A. Materials required for filling, backfilling, subbase and other purposes shall be as shown on Contract Drawings, specified herein, or as ordered by Engineer. Prior to bidding, Contractor shall familiarize himself with available quantities of acceptable on-site and off-site materials.
- B. For all materials proposed, notify Engineer of source of material (whether on-site or off-site) and furnish to Engineer a certified gradation analysis clearly describing particle sizes and other testing data necessary to demonstrate full compliance with Contract Documents. Analysis shall be provided to Engineer at least 10 calendar days prior to anticipated use of proposed material. Only off-site approved materials shall be utilized unless Contractor demonstrates to satisfaction of Engineer that on-site material meets specified requirements. Contractor shall, at his own expense, engage an approved testing laboratory to perform such testing, and submit certified test results to Engineer. If similar tests of material from a particular source were performed previously, submit results of these tests to Engineer for consideration (test data must be dated within one year of anticipated use). Should any on-site material fail to compact to required levels, on-site material shall be re-excavated, disposed of properly, and replaced with approved off-site material at no additional cost to Owner.
- C. Engineer reserves right to inspect proposed source of all materials and to order such tests of materials as he deems necessary to ascertain its quality and gradation of particle size. Any additional testing required for approval of material by Engineer shall be at Contractor's expense.
- D. No materials shall be used on this project for fill, backfill, subbase, or other purpose until Contractor demonstrates to satisfaction of Engineer that proposed materials meet requirements of Contract Documents.

1.07 USE OF ONSITE MATERIALS

- A. Contractor shall be permitted to use onsite material in lieu of specified offsite material if Contractor can prove to satisfaction of Engineer and Owner that onsite material meets or exceeds specified requirements for equivalent offsite material. Contractor shall at his cost provide testing and other information as required by Engineer to determine acceptability of proposed onsite material. Engineer shall be sole arbiter of acceptability of proposed onsite material. At no time shall costs of testing or collection of other information requested by Engineer be an additional cost to Owner or be applied to any allowances or unit price items for this project. If onsite material is initially accepted based on testing provided by Contractor but material ultimately proves to be unacceptable because of its inability to be compacted or to meet other requirements of Contract Documents after placement, Contractor shall remove unsuitable onsite material and replace it with suitable offsite material at no additional cost to Owner. Owner and Engineer make no representation either explicitly or implicitly within these Contract Documents regarding suitability or unsuitability of any potentially used onsite materials. Use of any onsite materials shall be at sole risk and expense of Contractor including any assumptions made by Contractor regarding suitability of onsite material used in preparation of his bid.

PART 2 PRODUCTS

2.01 BEDDING AND BACKFILL MATERIALS

- A. Materials shall be hard and durable.
- B. Materials shall be free from organic matter, asphalt, trash, shale, debris, snow, ice and other frozen or mechanically deleterious material.
- C. Materials shall meet specified gradation requirements.

- D. Unless otherwise specified, crushed stone shall be composed of limestone pieces, chips, and fines.
- E. Materials shall meet most recent specified Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction requirements.
- F. For Structures
 - 1. Topsoil
 - a. Earth containing minimum 6 percent organic material which is capable of supporting vegetation planned for this project and in accordance with Section 32 90 00.
 - 2. Granular Fill
 - a. Crushed stone conforming to ASTM D448 Size No. 57, Type A.
- G. For Underground Piping
 - 1. Outside Roadway
 - a. Bedding
 - 1) Dry earth trench excavation –
 - a) Plastic Pressure Pipe and Gravity Sewers – TDOT Section 903 Type "A" aggregate No. 67 aggregate.
 - b) Ductile Iron Pressure Pipe –TDOT Section 903 Type "A" aggregate No. 67 aggregate.
 - 2) Wet trench excavation – TDOT Section 903 Type "A" No. 57 aggregate
 - 3) Rock trench excavation – TDOT Section 903 Type "A" aggregate No. 57 or 67 aggregate.
 - b. Backfill
 - 1) General Earth – Sound, loose earth containing optimum moisture content for compaction as indicated herein, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete and pavement less than 6 inches in maximum dimension.
 - 2) Selected shot rock shall be reasonably well graded with maximum fragment size of 6 inches.
 - 2. Inside Roadway
 - a. Bedding and Backfill – TDOT Section 903 Type "A" No. 57 aggregate.
 - 3. Unstable Soils
 - a. Bedding and Backfill – TDOT Section 903 Type "A" No. 67 aggregate.
- H. For Asphalt and Concrete Pavement – Granular Fill
 - 1. See Section 32 11 00.

- I. Fill Concrete
 - 1. TDOT Class “B”.
 - 2. Minimum 28-day compressive strength shall be 3,000 psi.
 - 3. Concrete shall not contain less than 550 pounds of cement per cubic yard.
 - 4. Refer to Section 03 31 00.
 - 5. Use when over-excavation has occurred due to error or because soft spots were encountered.
- J. Pug Mix Base Stone – Mineral aggregate base per requirements of TDOT Section 303, Grading D, for Type A base and Class A aggregate.
- K. Other Materials – All other materials not specifically described but required for a complete and proper installation, shall be as selected by Contractor subject to approval of Engineer.
- L. Unsuitable Material – Shale, weathered shale, and other unsuitable materials shall not be used for fill and/or backfill material, and shall be disposed of off-site in accordance.
- M. Geotextile Fabric:
 - 1. Piping Applications – Woven – Mirafi 500X by Tencate, or equal.
 - 2. Structural Applications – Non-Woven – Geotex 451 by Propex, Mirafi 140N by Tencate, or equal.

PART 3 EXECUTION

3.01 EXAMINATION BEFORE BACKFILLING

- A. Verify fill materials to be used are acceptable and approved by Engineer.
- B. Verify that all subsurface installations for project have been inspected and are ready for backfilling.
- C. Verify that foundation walls are properly shored and braced to withstand lateral soil pressures created when backfilled material is placed against such walls.
- D. Verify that underground tanks are anchored to their own foundation to avoid flotation after backfilling.

3.02 PREPARATION BEFORE BACKFILLING

- A. Install barriers and other devices to protect areas adjacent to construction.
- B. Protect and maintain all benchmarks and other survey points.
- C. Perform excavations and trenching in conformance with Section 31 23 16.
- D. Generally, compact subgrade to density requirements for subsequent backfill materials.
- E. Cut out soft areas of subgrade not capable of in situ compaction. Backfill these areas with 1 to 2 inch stone except that last 6 to 12 inches (refer to Drawing details for thickness) shall be No. 67 crushed stone as defined in Section 903 of latest Tennessee Department of Transportation

Standard Specifications for Road and Bridge Construction. Compact these areas to density equal to or greater than requirements for subsequent backfill material.

1. When unstable soil conditions are caused by Contractor's failure or neglect to properly handle groundwater or protect against entrance of water into excavation, Contractor shall remove and replace unstable material at no additional cost to Owner.
- F. Inspect spaces to be backfilled and remove all unsuitable materials including sheeting, bracing, forms and debris prior to commencing backfilling operations as required.
- G. Method of backfilling shall not disturb or damage adjacent walls, drainage systems, damp-proofing, waterproofing, protective coverings, utilities in trenches, underground conduits or tanks.

3.03 BACKFILLING – GENERAL

- A. Backfilling shall be started as soon as practicable and after structures or pipe installations have been completed and inspected, concrete has acquired a suitable degree of strength, and subgrade waterproofing materials have been in place for at least 48 hours. Backfilling shall be carried on expeditiously thereafter. Backfill shall be started at lowest section of area to be backfilled. Natural drainage shall not be obstructed at any time.
- B. Backfilling Prior to Approval – Contractor shall advise Engineer and Testing Laboratory, whether Owner's or Contractor's as required by Section 01 45 29, before beginning any backfill and shall allow ample time for inspection. Where any portion of work is backfilled prior to inspection and approval, Contractor may be required to uncover work for inspection at no additional cost to Owner.
- C. Backfill spaces shall be inspected prior to backfilling operations and all unsuitable materials, including sheeting, bracing forms and debris, shall be removed. No backfill shall be placed against foundation walls on structural members unless they are properly shored and braced or of sufficient strengths to withstand lateral soil pressures.
- D. If sufficient materials are not available from excavations, or excavated material is unsuitable for backfill, Contractor shall bring in off-site materials. All fill material shall be subject to approval of Engineer.
- E. Backfill material shall be inspected prior to placement and all roots, vegetation, organic matter, or other foreign debris shall be removed. Stones larger than 2 inches in any dimension shall be removed or broken. Stones shall not be allowed to form clusters with voids.
- F. Backfill material shall not be placed when moisture content is more than two percent above optimum or is otherwise too high to allow proper compaction. When material is too dry for adequate compaction, water shall be added to extent necessary.
- G. Do not start until fill material, fill areas, and equipment to be used in performing work have been approved by Engineer and all foreign materials have been removed.
- H. Before compacted fill is placed, excavated areas shall be proof rolled with a 20-ton pneumatic tire roller or loaded dump truck to determine if any soft spots exist. If soft spots are found, they shall be excavated and be replaced with compacted fill as directed by Engineer.
- I. Contractor shall fill all voids or holes in trench wall that later could lead to trench settlement.
- J. Backfill all areas to required contours, grades and elevations with unfrozen materials. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. No calcium chloride or other chemicals shall be added to prevent freezing.

- K. Backfill behind walls and around structures shall be granular fill as specified below unless otherwise noted in Contract Documents:
1. Granular fill material, Size No. 57 crushed stone per ASTM D448 to dimensions indicated on Contract Drawings or at a minimum width at base of footing or bottom of wall plus 1 foot and proceeding upwards at a slope of 2 vertical for every 1 horizontal to within 1 foot below final grade; remaining 1 foot of fill to final grade shall be earth fill or other materials as may be required given final grade conditions. Backfill beyond specified envelope of No. 57 stone shall be earth fill.
 2. Fill material shall be placed in maximum 8 inches thick loose lifts and consolidated until material is densified and stable using bulldozer, roller, vibratory tamping using a vibratory plate or sled, or equivalent equipment. Fill and backfill in other areas shall be earth fill material unless otherwise specified in Contract Documents compacted as specified herein.
- L. Before placing compacted fills, existing subgrade, after removal of topsoil, shall be benched so that slope of subgrade does not exceed five (5) feet per 100 feet unless sheeting, shoring, and bracing are utilized.
- M. Loosen top two inches of existing soil just before placing earth fills.
- N. Do not place fill in water, on muddy, frozen, or frost areas or other debris, wood, or foreign material.
- O. Place all earth fills and backfills in 8-inch maximum when compacted, horizontal layers. Perform this work when soil moisture shall permit proper compaction or when addition of water by spraying shall approach optimum conditions.
- P. Compact earth fills and backfills as required by this Section.
- Q. Crusher run used for fill or backfill is to be compacted in layers to minimum densities required by this Section. Crusher run fill is to be treated same as for earth fill.
- R. Install geotextile fabric prior to placing backfill and at completion of backfill as indicated on Contract Drawings and as required herein.
- S. Ruts or holes from construction equipment shall be graded smooth.
- T. Fills shall be shaped to provide natural drainage and shall be sealed at end of each day's work or when precipitation is likely.
- U. Surfaces of new subgrades shall be left clean.
- V. Sealed fills shall be scarified before placing next layer of fill.
- W. Backfill operations adjacent to concrete walls shall not commence until all forms and debris have been removed and footing drains, waterproofing, damp-proofing, and exterior wall construction have been examined and approved by Engineer and successful hydrostatic testing of watertight structures has been completed.
- X. Contractor shall use precaution in backfilling against walls to prevent damage to waterproofing.
- Y. Backfill or fill to be placed against concrete walls shall not be started until concrete has been cured as per Division 03. Motorized equipment shall not be used closer to structure than 4 feet. In these areas, hand operated motorized equipment shall be used. Backfill around tanks

shall not commence until tanks have been hydrostatically tested, tanks are structurally sound to receive such backfill, and Engineer has approved commencement of backfilling.

- Z. Where fill is to be placed on both sides of a grade wall, fill shall be placed in layers alternating on each side of wall. Concrete shall have been cured for at least 7 days during which average air temperature has been above 50 degrees Fahrenheit or when test cylinders show a compressive strength of seventy-five (75) percent 28-day strength.
- AA. Where fill is to be placed on one side of a wall only, fill shall not be placed until concrete has obtained full design strength. When temporary shores are required to support wall until permanent structural support has been constructed, they shall be provided by Contractor at no additional cost to Owner.
- BB. Backfilling around pipes shall be carried out simultaneously on both side of pipe in such a manner that prevents damage to pipe.
- CC. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.
- DD. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- EE. Slope grade away from building minimum 2 inches in 10 feet unless noted otherwise.
- FF. Rough grade all backfilled and filled areas to meet subsequent topsoiling or paving requirements. Make grade changes gradual. Blend slopes into level areas.
- GG. Remove surplus backfill materials from site in compliance with Section 31 11 00.
- HH. Leave fill material stockpile areas completely free of excess fill materials.
- II. Material incorporated in backfilling operation which is not in satisfactory condition shall be subject to rejection and removal at Contractor's expense.
- JJ. If Contractor fails to stockpile and protect on-site excavated material acceptable for backfill, then Contractor shall provide an equal quantity of acceptable off-site material at no expense to Owner.
- KK. Crevices and void slots in bedrock at subgrade levels shall be filled with grout or Fill Concrete. Soil seams in bedrock at subgrade level shall be over-excavated and backfilled with Fill Concrete. Payment shall be made at appropriate adjustment prices included in Contract or if not included, at a price mutually agreed upon by Owner and Contractor, and Contract Price shall be adjusted by Change Order.
- LL. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable.
 - 4. Install item.
 - 5. Backfill remaining trench, as specified herein before resuming filling or backfilling area.

3.04 PIPE BEDDING

- A. All pipes, fittings or specials which are to be installed in open trench excavations shall be properly bedded in, and uniformly supported on pipe foundations of various types specified herein and shown on Drawings. Flat-bottom trenches of required width shall be excavated to necessary depth and maintained in accordance with this section prior to installing foundation. Trenches shall be dewatered and all work performed in a dry trench.

1. Required depth of trench below pipe shall be as shown in following table:

Nominal Pipe Diameter (inches)	Depth Between Bottom of Pipe and Bottom of Normal Pipe Foundation (inches)
4	6
12	8

- B. Bedding material shall be spread in maximum of 8-inch layers until minimum required total depth of bedding has been built up above pipe. Compaction shall be in accordance with this Section. Contractor shall perform his bedding operations with care to maintain line and grade. When PVC, plastic or polyethylene pipe is used, do not compact directly over pipe until depth of backfill has reached 2 feet above top of pipe.
- C. Type I – Normal Soil Conditions - Unless shown otherwise in Drawings, all pipe shall be supported on Type I foundation. Trench shall be excavated below depth of pipe, depending on diameter of pipe. No. 57 or No. 67 aggregate, depending on location of pipe as described above, shall be furnished, placed and compacted in trench for its full width such that, after pipe has been uniformly bedded in this material, required minimum depth of aggregate remains between pipe and undisturbed trench bottom. Suitable holes shall be provided in trench bottom to permit adequate bedding of bells, couplings, or similar projections. Aggregate shall extend upward to a point 12 inches over top of pipe. Width of pipe foundation shall be outside diameter of pipe plus 2-3 feet as shown on Drawings.
- D. Type II - Moderately Unstable Soil Conditions - When specifically called for on Drawings, or when ordered by Engineer, pipe shall be supported on Type II foundation. Foundation shall be installed where a suitable supporting soil or rock stratum occurs within two feet, more or less of bottom of pipe. Trench shall be excavated to depth necessary to reach suitable supporting stratum. No. 57 or No. 67 aggregate, depending on location of pipe as described above, shall then be furnished and placed in trench for its full width. Material shall be spread in 8-inch layers, and each layer shall be compacted. Pipe foundation material to be supported on Type VII foundation, geotextile fabric foundation. Suitable holes shall be provided in trench bottom to permit adequate bedding of bells, couplings, or similar projections. Aggregate shall extend upward to a point 12 inches over top of pipe. Width of pipe foundation shall be outside diameter of pipe plus 2-3 feet as shown on Drawings.
- E. Type III - Unstable Soil Conditions - When specifically called for on Drawings, or when ordered by Engineer, or required by governing authority having jurisdiction over work pipe shall be supported on Type III foundation. Foundation shall be installed where no suitable supporting soil or rock stratum exists within two feet of bottom of pipe. Trench shall be excavated two feet deeper than bottom of pipe. Each side of trench shall be supported and maintained by a permanent system of tight, continuous sheeting (and bracing) which shall be driven below trench bottom a minimum of 12 inches and shall extend to an elevation of at least 12 inches above top of pipe. Minimum plank size to be 2-inch x 12-inch tongue and groove per Section 31 50 00. No. 57 aggregate shall then be furnished and placed in trench for its full width, and to a depth of 8 inches. Pipe foundation material to be supported on a

Type VII Foundation, Geotextile Fabric Foundation. No. 3 aggregate meeting TDOT specifications shall then be furnished and placed in trench for its full width. All material shall be spread in layers and each layer shall be compacted until their respective total depths have been built up as required. No. 3 aggregate depth shall extend a distance of 12 inches from top of No. 57 aggregate up to an elevation 6 or 12 inches below bottom of pipe, depending upon pipe diameter. No. 57 or No. 67 aggregate, depending on location of pipe as described above, shall then be furnished, placed in 8-inch layers and compacted on top of No. 3 aggregate in trench for its full width such that, after pipe has been uniformly bedded in this material, required minimum depth of aggregate remains between pipe and No. 3 aggregate. Suitable holes shall be provided in trench bottom to permit adequate bedding of bells, couplings, or similar projections. Aggregate shall extend upward to a point 12 inches over top of pipe. Width of pipe foundation shall be outside diameter of pipe plus 2 feet. All installed sheeting below an elevation established at 12 inches above top of pipe shall be left in place and undisturbed. Only cross struts and walers shall be gradually removed as construction proceeds.

- F. Type IV - Reinforced Concrete Encasement - When specifically called for on Drawings or Specifications, when under a base slab or within base slab influence area regardless of pipe size, or when ordered by Engineer or required by governing authority having jurisdiction over work, pipe shall be supported on Type IV foundation. Trench shall be excavated to a depth below bottom of pipe equal to one-quarter of inside diameter of pipe or 6 inches, whichever is greater. Excavated space shall then be completely filled with, and entire pipe encased in, concrete such that minimum concrete encasement at any point around outside barrel of pipe measures 6 inches thick. Total minimum width of concrete encasement shall equal outside diameter of pipe plus 12 inches and such minimum width shall be constant for entire length of encasement. Concrete mix, formwork, reinforcing, curing, etc., shall be in accordance with requirements of Division 03. Freshly placed concrete shall be maintained free from groundwater and no backfilling of trench shall begin until initial set has taken place, but not less than 3 hours has elapsed after encasement has been cast. Backfill a depth of 12 inches over top of concrete before beginning compaction with mechanical equipment.
- G. Type V - Concrete Cradle - When specifically called for on Drawings or when ordered by Engineer or required by governing authority having jurisdiction over work, pipe shall be supported on Type V foundation. Foundation shall be furnished and installed equal to Type IV foundation, "Concrete Encasement," except that only that portion of encasement at and below horizontal diameter of pipe shall be encased, forming a true cradle under bottom half of pipe. Maintain cradle free from groundwater for a period of 3 hours or until initial set has taken place. No. 57 or No. 67 aggregate, depending on location of pipe as described above, shall then be furnished, placed in 8-inch layers and compacted on top of concrete cradle until depth of aggregate is 12 inches over top of pipe.
- H. Type VI - Plain Concrete Encasement - When specifically called for on Drawings, or when ordered by Engineer or required by governing authority having jurisdiction over work, pipe shall be supported on Type VI foundation. Foundation shall be furnished and installed equal to Type IV foundation, "Reinforced Concrete Encasement," except that no steel reinforcing is required. Maintain encasement free of groundwater for a period of 3 hours or until initial set has taken place.
- I. In event an underground pipe is shown under a base slab and within influent area, or parallel to base slab and within influent area, pipe shall be encased in concrete for its entire length under slab and within base slab influence area in accordance with details shown on Drawings and Type IV foundation described above.
- J. Type VII - Geotextile Fabric Foundation - When specifically called for on Drawings of these Specifications, or when ordered by Engineer or required by governing authority having jurisdiction over work, pipe foundation shall be supported on a geotextile fabric foundation. Fabric to be placed on bottom of excavated foundation and extend upwards to 12 inches above pipe or top of aggregate bedding whichever is greater where it can then be placed flat with a

minimum overlap of 6 inches. Longitudinal overlaps to be a minimum of 2 feet. Fabrics to be installed and stretched tight and have no wrinkles so that fabric shall be in tension when placing pipe foundation material. Geotextile material shall be Mirafi Type 500X by Tencate; or equal.

K. Type VIII - Pressure Pipe Foundation

1. Pressure pipe foundations for rock trenches shall be Type I. All PVC or HDPE pressure pipe shall be have a Type I bedding regardless of whether trench is in earth or rock.
2. Ductile iron pressure pipe foundations in earth shall conform to Type VIII requirements and shall be used only if specifically called for on Drawings or ordered by Engineer. Otherwise, Contractor shall install ductile iron pipe in a Type I bedding as specified herein unless site conditions require otherwise.
3. Pipe and fittings shall be laid on stable foundations, free from standing water, and trimmed to shape. Approved earth backfill material as described above, shall be used for pipe foundation unless otherwise shown on Drawings. At joints, enough depth and width shall be provided to permit pipe layer to reach entirely around pipe so that joints may be made in a proper manner. Pipes shall have full bearing throughout their entire length, which shall be accomplished by shaping bottom of ditch so that suitable holes are provided to permit adequate bedding of bells, couplings, or similar projections or adequately tamping backfill under pipe in accordance with Minimum Compaction Requirements of this Section. When laid in tunnels, pipes shall be blocked in such a manner as to take weight off bells. Pipe laid in normal trench excavation shall not be laid on wood blocking. Mechanical type joints shall be tightened within AWWA recommended torque range.
4. Following sources shall be reviewed by Contractor for installation guidelines and requirements:

Pipe Material	Sources
Ductile Iron	AWWA Standard C600; Project Specification, Section 33 11 00; Project Drawings; manufacturer's recommendations.
Gray Cast Iron	AWWA Standard C600; Project Specification, Section 33 11 00; Project Drawings; manufacturer's recommendations.
PVC Pipe	ASTM Standard D2321; Project Specification, Section 33 11 00; Project Drawings; manufacturer's recommendations.
PE Pipe	AWWA Standard C901, including Appendix A; ASTM D2774; Project Specification, Section 33 11 00; Project Drawings; manufacturer's recommendations.
Prestressed Concrete Pipe	Project Specification, Section 33 11 00; Project Drawings; manufacturer's recommendations.
Copper	Project Specification, Section 33 11 00; Project Drawings; manufacturer's recommendations.

5. Unless otherwise shown on Drawings, as a minimum, all pipes shall be backfilled to springline, including hand tamping with T-bars, shovel slicing, and flatheads, and mechanically compacted and remaining backfill placed in 8-inch lifts to 18 inches above crown of pipe in accordance with Minimum Compaction Requirements of this Section. Backfill material within 12 inches of pipe shall be free of stones greater than 2 inches in any dimension. Unless otherwise shown on Drawings, minimum total finished cover over top of pipe barrel of all pressure pipes shall be 36 inches.

- L. Bedding requiring compaction shall be compacted as defined in this section.
- M. Conform to Article 3.03 as applicable in bedding installation.
- N. Always maintain proper grade and alignment during bedding and tamping process. Any pipe dislodged during this process shall be replaced by Contractor at his expense.

3.05 INITIAL BACKFILLING OF PIPING

- A. Conform to Article 3.03 as applicable.
- B. Do not begin backfilling before Engineer has inspected grade and alignment of pipe, bedding of pipe, and joints between pipes. If backfill material is placed over pipe before an inspection is made, reopen trench in order for an inspection to be made.
- C. Perform backfilling by hand, together with tamping, until fill has progressed to 18 inches above top of pipe.
 - 1. Deposit backfill material in layers approximately 8 inches thick.
 - 2. Compact by hand, or with manually operated machine tampers actuated by compressed air or other suitable means.
 - 3. Use tamps and machines of a suitable type which do not crush or otherwise damage pipe.

3.06 FINAL BACKFILLING OF PIPING

- A. Conform to Article 3.03 as applicable.
- B. After backfill has reached a point 18 inches or more above top of pipe, perform final backfilling depending upon location of work and danger from subsequent settlement.
- C. Place all earth fills and backfills in 8-inch maximum when compacted, horizontal layers
- D. Backfilling in unimproved areas.
 - 1. Dispose of and replace all soft or yielding material which is unsuitable for trench backfilling with suitable material.
 - 2. Deposit backfill to surface of ground by dragline, bulldozer, or other suitable equipment in such a manner so as not to disturb pipe.
 - 3. Compact soil as required in this Section.
 - 4. Neatly round sufficient surplus excavated material over trench to compensate for after settlement.
 - 5. Dispose of all surplus excavated material in accordance with Section 31 11 00.
 - 6. Maintain trench surface until completion of contract.
 - 7. Prior to final acceptance, remove all mounds to elevation of surrounding terrain.
- E. Backfilling beneath driveways, streets, alleys, and sidewalks where non-rigid and rigid type surfacing is to be replaced.
 - 1. Conform to Section 32 11 00 where applicable and where requirements are more stringent than those indicated in this Section.

2. Carefully deposit backfill in uniform layers, not to exceed 8 inches thick.
 3. Compact each layer thoroughly by rolling, ramming, and tamping with tools suitable for that purpose in such a manner so as to not disturb pipe.
 4. Flowable fill material shall be used only where indicated on Drawings.
- F. Backfilling of shoulders along streets and highways.
1. Conform to Section 32 11 00 where applicable and where requirements are more stringent than those indicated in this Section.
 2. Backfilling methods and materials for shoulders along streets and highways shall be in accordance with this Section or requirements of governing local, county, or state departments maintaining particular roadway or highway, whichever is more stringent.
 3. Replace with similar materials, all shoulders which may be damaged or destroyed as a result of pipe trenching.
 4. Backfilling of shoulders shall not be directly measured for payment unless traffic dislodges shoulder material rather than settling it, then any additional crushed stone placed shall be paid for as crushed stone for shoulder replacement.
 5. Where shoulders along state highways have sealed coat surfaces, replace with double bituminous seal in accordance with Section 32 12 00.
 6. Where State Highway Department or local authority requires trenches to be backfilled entirely with granular material in shoulder of roads, granular material so placed shall not be a pay item, but included in prices per linear foot of pipe.
 7. Compaction shall be as described in this Section or as required by governing local, county, or state departments maintaining particular roadway or highway, whichever is more stringent.
- G. Crushed stone for pavement maintenance and shoulder replacement.
1. Conform to Section 32 11 00 where applicable and where requirements are more stringent than those indicated in this Section.
 2. Where possible, salvage and reuse all base material that is removed during construction.
 3. Wet and thoroughly compact crushed stone and blade to tie into existing surface prior to final acceptance.
 4. Base material placed as a portion of pavement replacing items shall not be directly measured for payment unless traffic whips out base material rather than settling it, then any additional base material placed shall be paid for as crushed stone for pavement maintenance.

3.07 EXAMINATION BEFORE COMPACTION

- A. Examine spaces to be filled beforehand and remove all unsuitable materials and debris including sheeting, forms, trash, stumps, plant life, etc.
- B. Inspect backfill and fill materials beforehand and remove all roots, vegetation, organic matter, or other foreign debris. Stones larger than 2 inches in any dimension shall also be removed or broken into smaller pieces.

- C. No backfill or fill material shall be placed on frozen ground nor shall material itself be frozen or contain frozen soil fragments.
- D. Spaces to be filled shall be free from standing water so that placement and compaction of fill materials can be accomplished in “dry” conditions.

3.08 COMPACTING

- A. Method of compaction shall not disturb or damage adjacent walls, drainage systems, damp-proofing, waterproofing, protective coverings, utilities in trenches, underground conduits or tanks.
- B. Brace walls and slabs of structures to support surcharge loads and construction loads imposed by compaction operations.
- C. Proof-roll all subgrade surfaces to accept fill material in accordance with this Section, and in accordance with Sections 32 11 00 and 32 12 00 under asphalt and concrete pavement.
- D. Each layer of fill shall be compacted to specified density same day it is placed.
 - 1. Moisture content of backfill or fill material shall be adjusted, if necessary to achieve required degree of compaction.
- E. Compact each lift in accordance with Table 1 and in accordance with Section 32 11 00 for asphalt and concrete pavement. Compactions are expressed as percentages of maximum densities as determined by ASTM D698, Method D or AASHTO T-99-74, Method D.
- F. Match compaction equipment and methods to material and location being compacted in order to obtain specified compaction, with consideration of following guidelines:
 - 1. Rubber-tired rollers are preferred for most areas to prevent bridging of softer materials.
 - 2. Double smooth drum rollers may be used provided that careful inspection can prevent bridging.
 - 3. Compaction roller should be lighter in weight than proof-rolling equipment, with a minimum compaction force of 350 pounds per linear inch (PLI).
 - 4. Vibratory compaction is preferred for dry, granular materials.
 - 5. Hand compaction equipment such as impact rammers, plate or small drum vibrators, or pneumatic buttonhead compactors should be used in confined areas.
 - 6. Hydraulic compaction by pounding or jetting shall not be permitted except in unusual conditions, and then only upon written approval by Engineer and after a demonstration of effectiveness by Contractor and written acceptance by Engineer.
 - 7. Backhoe mounted hydraulic or vibratory tampers are preferred for compaction of backfill in trenches under pavements over 4 feet in depth. Upper 4 feet shall be compacted as detailed above or with hand-guided or self propelled vibratory compactors or static roller. Do not use until depth of backfill over crown of pipe is more than 4 feet.
 - 8. For plastic pipelines (PVC or PE) do not compact directly over center of pipe until backfill has reached 2 feet above top of pipe.
 - 9.

TABLE 1: COMPACTION REQUIREMENTS		
Construction Element	ASTM	Minimum Compaction
I. STRUCTURES		
a) Fill beneath foundation elements and under slabs-on-grade – hand-guided compaction	D698	98 percent
b) Fill beneath foundation elements and under slabs-on-grade - self-propelled or tractor-drawn compaction	D698	98 percent
c) Fill around structures and above footings	D698	98 percent
II. TRENCHES		
a) Fill under pipelines and pipe bedding	D698	98 percent
b) Pipe sidefills and top 2 feet of pipe backfill under pavements	D698	100 percent
c) Backfill below 2 feet under pavement	D698	95 percent
d) Backfill under lawns, gardens and cultivated fields	D698	90 percent
e) All other trenches	D698	90 percent
III. EMBANKMENTS AND FILLS		
a) Fill under streets, parking lots, and other paved areas*	D698	100 percent
b) Embankments not supporting pavement or structures	D698	95 percent
c) Rough site grading	D698	90 percent

* Top 2 feet below subgrade shall be compacted to this standard; below this may be compacted to 95 percent.

3.09 TOLERANCES

- A. Top Surface of Backfilling Under Pavement Subgrade – plus or minus 1 inch from required elevations.
- B. Top Surface of Backfilling Under Paved Areas – plus or minus 1/2 inch from required elevations.
- C. Top Surface of General Backfilling – plus or minus 1 inch from required elevations.

3.10 FIELD QUALITY CONTROL

- A. Material Testing.
 - 1. Contractor shall provide at his expense services of a qualified laboratory in accordance with Sections 01 00 05, to conduct testing to verify that backfill materials are in compliance with Contract Documents.
 - 2. Testing shall be done by a qualified, independent testing laboratory in accordance with this Section and Sections 01 45 00 and 01 45 29 and results of testing shall be provided to Engineer in accordance with Section 01 45 29.
 - 3. Tests and analysis of fill material shall be performed in accordance with ASTM D1557 and these Contract Documents.
 - 4. Contractor shall aid Engineer in obtaining representative material samples to be used in testing.

5. For each material which does not meet specifications, Contractor shall supply an equal quantity of acceptable material, at no additional compensation.
 6. Contractor shall anticipate these tests and incorporate time and effort into procedure. All re-testing costs shall be borne by Contractor.
 7. Select Material - On-Site
 - a. No on-site material shall be used without prior approval of Engineer.
- B. Compaction Testing.
1. Contractor shall provide at his expense services of a qualified laboratory in accordance with Section 01 00 05, to conduct testing to verify that compaction is in compliance with Contract Documents. Test results shall be provided to Engineer in accordance with Section 01 00 05.
 2. Testing may be conducted for every 200 cubic yards of fill or backfill, or every 75 linear feet of trench backfill placed. Engineer reserves right to increase frequency of testing.
 3. Contractor shall dig test holes and provide access to all backfill areas at no additional compensation when requested by Engineer.
 4. For each test which does not meet specifications, Contractor replace all material included in that lift or section, replace with acceptable material, and compact to specifications at no additional compensation.
 5. Contractor shall anticipate these tests and incorporate time and effort into procedures. All re-testing costs shall be borne by Contractor.
 6. Nuclear moisture density testing by “probe” methods shall be acceptable for compacted layers not exceeding 8 inches in thickness.
 - a. Nuclear “backscatter” methods shall be acceptable only for testing asphalt paving layers not in excess of 3 inches in thickness.
 - b. Only certified personnel shall conduct nuclear testing.
 - c. If nuclear method is utilized, results shall be checked by at least one in-place density test method described above.
 7. Compaction testing shall be performed in accordance with ASTM D1556, ASTM D2922, and these Contract Documents.
 8. Proof roll compacted fill surfaces under slabs-on-grade pavers, paving, and foundations.
 9. Conventional density testing of compacted shot-rock fill is not practical. A trained engineering technician working under geotechnical engineer's direction shall closely observe and document shot-rock fill placement and compaction techniques, including fill constituents and lift thickness.
- C. Unacceptable Stockpiled Material - Stockpiled material may be tested according to Material Testing Materials.
- D. Alternate Methods of Compaction - Contractor may employ alternate methods of compaction if desired degree of compaction can be successfully demonstrated to Engineer’s satisfaction.

- E. Systematic Compaction - Compaction shall be done systematically, and no consideration shall be given to incidental coverage due to construction vehicle traffic.

3.11 PROTECTION OF FINISHED WORK

- A. Protect Finished Work under provisions of Section 01 00 05.
- B. Re-grade and re-compact fills subjected to vehicular traffic.
- C. Prior to terminating work for day, final layer of compacted fill, after compaction, shall be rolled with a smooth-wheel roller if necessary to eliminate ridges of soil left by tractors or equipment used for compaction or installing material.
- D. As backfill progresses, surface shall be graded so as to drain off during incidence of rain such that no ponding of water shall occur on surface of fill.
- E. Contractor shall not place a layer of fill on snow, ice or soil that was permitted to freeze prior to compaction. These unsatisfactory materials shall be removed prior to fill placement.
- F. Settlement of backfilled areas as well as any damage caused by said settlement shall be repaired at cost to Contractor. Repair shall consist of removal of backfill, and re-backfill and re-compaction as well as any repairs to all equipment and structures. Repair work shall conform to these Contract Documents.

END OF SECTION

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SECTION 31 50 00
SHEETING AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sheeting and bracing installation, removal, and left in place.
2. Design requirements.
3. Regulatory codes and requirements.
4. Materials.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 31 23 16 – Excavation, Trenching and Grading
3. Section 31 23 23 – Bedding, Backfilling and Compaction

1.02 REGULATORY REQUIREMENTS

- A. All sheeting and bracing including use of mobile shields shall conform to Public Law 91-596 (Williams Steiger Act); Occupational Safety and Health Administration Act (OSHA) of 1970 and its amendments and regulations and to Tennessee State OSHA (TOSHA) requirements, whichever are most stringent.

1.03 REFERENCES

Reference	Title
ASTM A6/A6M	General Requirements
ASTM A328	Steel Sheet Piles
NFPA	National Forest Products Association

1.04 SUBMITTALS

- A. None.

1.05 BIDDING

- A. If Contractor determines that sheeting, shoring, bracing, or trench boxes are required to accomplish work, Contractor shall at his expense have necessary equipment designed, installed, and if necessary removed, in accordance with this Section.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Wood – Tongue and groove, No. 3 Common Douglas Fir or Hemlock or Utility grade Southern Pine; NFPA grading or equal, meeting requirements of NFPA.
- B. Steel – ASTM A36 as required by ASTM A328.
- C. Trench Boxes – Fabricated Steel or Aluminum.

PART 3 EXECUTION

3.01 PROTECTION

- A. When so designated on drawings or stated in Specifications or to comply with Local, State, or Federal (OSHA) regulations, or when sloped excavations are not feasible, not possible or allowed or if excavations endanger adjacent facilities, sheeting, shoring, bracing, or trench boxes shall be installed by Contractor.

3.02 DESIGN REQUIREMENTS

- A. Contractor shall be solely responsible for when, where, and manner to utilize sheeting, shoring, bracing, and trench boxes to protect life and property.
- B. Contractor shall design, furnish, install, monitor, and maintain sheeting, shoring, bracing, and trench boxes capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Design shall include comprehensive engineering analysis by a qualified professional engineer licensed in Tennessee, using performance requirements and design criteria indicated. Design engineer shall also monitor sheeting, shoring, bracing, and trench boxes.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 4. Monitor vibrations, settlements, and movements.
- C. Design shall include all loading conditions to which sheeting and bracing shall be subjected during construction.
- D. Design sheeting and bracing systems against failure from maximum loads that shall occur during construction, including surcharge loads and additional loading due to construction equipment.
- E. Design sheeting and bracing systems to enable safe construction of structures, utilities and appurtenances, and prevent excessive ground loss, settlement, displacement, or undermining of adjacent foundations, structures, buildings, pavement, or bottom of excavation. Contractor shall decide when there is a necessity to underpin adjacent structures or features, with approval of Owner and Engineer.
- F. Sides of all excavations shall be sufficiently sheeted, shored and braced whenever necessary to prevent slides, cave-ins, settlement or movement of banks and to maintain excavation clear of all obstructions. Wood or steel sheeting of adequate design and type shall be used in wet,

saturated or flowing ground. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand pressure exerted.

3.03 INSTALLATION

- A. Provide all materials, equipment and labor necessary to construct and maintain all required excavation support systems.
- B. Sheeting and bracing support systems shall include, but shall not be limited to, wall support such as wood sheeting, ringwales, lagging, soldier piles, steel sheeting, trench boxes and bracing members such as stringers, wales, struts, rakers, shores, tieback anchors, etc. necessary to prevent damage to work and for safety of workers, general public or adjacent property.
- C. No excavation shall be performed below a line drawn down and away at a slope of two horizontal and one vertical from nearest footing or grade beam of existing building or as shown on drawings without providing sheeting, shoring and bracing to provide lateral support for soils beneath foundations of building and to prevent damage to building.
- D. Design of bracing shall be such as to permit proper construction of walls and footings and proper installation of utilities as shown on drawings.
- E. Sheeting shall not be driven while concrete is being placed, or within 24 hours after placement.
- F. Do not brace to concrete without written approval of Engineer.
- G. Install sheeting and bracing systems in a logical sequence as excavation operations are performed.
 - 1. If a prefabricated mobile shield is used, bottom of shield shall be maintained as high as possible (preferably above spring line of pipe, maximum 2 feet) to prevent disturbance of bedding material and tension forces on pipe joints.
 - 2. Openings or troughs created by use of a shield shall be filled and compacted in accordance with Sections 31 23 16 and 31 23 23.

3.04 MAINTENANCE

- A. Contractor shall maintain on a continuous basis, until removed, all sheeting and bracing systems installed as part of Work.
 - 1. If sheet and bracing systems are to be left in place after completion of Work, Contractor shall maintain these systems on a continuous basis until they are permanently buried.
- B. Take care to avoid voids on outside of sheeting. If voids are formed, immediately fill them with suitable material and ram/compact fill to approval of Engineer.
- C. Provide a means of determining movement of excavation walls, and adjacent soil, buildings and structures and utilities.
 - 1. If movement or damage occurs, immediately cease all construction activities, install temporary measures to prevent further movement or damage and notify Engineer.
 - 2. Movement or damage due to failure of sheeting and bracing systems shall be permanently repaired as soon as possible, at no cost to Owner and at no additional cost for time.

- D. Contractor is solely responsible for effectiveness of any sheeting, shoring, bracing, and trench box installation and for safety of all persons and property in and adjacent to work area, and for all injuries and damages arising from use of sheeting, shoring, bracing, and trench boxes.

3.05 REMOVAL

- A. Remove sheeting and bracing as work progresses in a manner which shall prevent damage to finished work, adjacent structures and property whether public or private, and so that cave-ins or slides shall not occur. Sheeting shall not be removed for pipeline work until there is at least 18 inches of fill above pipe unless this shall result in damage to work or adjacent facilities, in which case Contractor shall inform Engineer of conditions and receive approval from Engineer prior to removal of sheeting. No sheeting shall be removed until work has been installed, checked, and backfilled to a level necessary to prevent damage to newly installed work and existing property.
 - 1. All voids created by removal of sheeting and bracing shall be filled and compacted in accordance to guidelines of Sections 31 23 16 and 31 23 23.
- B. Sheeting and bracing materials shall not be left in place unless otherwise shown by Drawings or ordered by Engineer in writing. Sheeting to be left in place shall be new and unused material. Where shown on drawings, specified or approved, sheeting shall be cut off as specified, or a minimum of 2 1/2 feet below proposed final grade. For pipelines, sheeting shall be cut off at depth corresponding to top of pipe unless this shall result in damage to work or adjacent facilities.
 - 1. Contractor may elect to leave sheeting and bracing in place (cut off as described above) if he elects to do so at his own expense and with Engineer's approval.
 - 2. Provide to Engineer a drawing of cut-off sheeting locations. Drawing should show site plan with dimensioned locations of sheeting, type of material remaining, and depths or elevations to top and bottom of remaining sheet.

END OF SECTION

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SECTION 32 31 00

CHAIN-LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

A. General description:

1. Furnish and install chain-link fences and gates in accordance with Contract Drawings and as specified herein.

B. Section includes:

1. Chain-link fences.
2. Gates.
 - a. Swing.

C. Related documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 03 – Concrete.
3. Division 08 – Openings.
4. Section 10 14 20 – Signage Requirements.
5. All electrical equipment, controls, and wiring shall be in full compliance with Division 26 and 40 Specifications.
6. Division 31 – Earthwork.

1.02 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.

Reference	Title
ASCE 7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASTM A36	Carbon Structural Steel
ASTM A120	Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless, for Ordinary Uses
ASTM A123	Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products
ASTM A121	Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A392	Zinc-Coated Steel Chain-Link Fence Fabric

Reference	Title
ASTM A428	Weight of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A491	Aluminum-Coated Steel Chain-link Fence Fabric
ASTM A569	Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality
ASTM A585	Aluminum Coated Steel Barbed Wire
ASTM A780	Repair of Damaged and Uncoated Areas of Hot-dip Galvanized Coating
ASTM A817	Metallic-Coated Steel Wire for Chain-link Fence Fabric and Marcellled Tension Wire
ASTM A824	Metallic-Coated Steel Marcellled Tension Wire for Use With Chain-link
ASTM B221	Aluminum and Aluminum Alloy Bars, Rods, Wire Profiles and Tubes
ASTM C94	Ready-mixed Concrete
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F552	Standard Terminology Relating to Chain-link Fencing
ASTM F567	Installation of Chain-Link Fence
ASTM F626	Fence Fittings
ASTM F900	Industrial and Commercial Swing Gates
ASTM F1043	Strength and Protective Coatings on Steel Industrial Chain-link Fence Framework
ASTM F1083	Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F1184	Industrial and Commercial Horizontal Slide Gates
IBC 2012	International Building Code (2012)
NEMA MG 1	Motors and Generators
NFPA 70	National Electric Code
WLG 2445	Chain-link Fence Manufacturers Institute, Chain-link Fence Wind Load Guide for Selection of Line Posts and Line Post Spacing
Chain-link Fence Manufacturers Institute (CLFMI)	Product Manual

1.03 PERFORMANCE AND DESIGN CRITERIA

A. Structural Performance.

1. Chain-link fence and gate framework shall withstand effects of gravity loads and following loads and stresses within limits and under conditions indicated according to ASCE 7.
2. Chain-link fence and gate framework and all components, supports, bracing, and appurtenances shall be designed to resist dead loads, live loads of operation and seismic lateral loads and other loads defined in IBC 2012, unless more conservative values are shown in Contract Documents in which case more conservative values shall be used.
3. Minimum Post Size.
 - a. Determine according to ASTM F1043 for framework up to 12 feet high, and post spacing not to exceed 10 feet.

- b. For dimensions exceeding what is described above (but not allowing for greater than 10-foot post spacing), determine minimum post size and maximum spacing of posts in accordance with CLFMI WLG 2445, based on mesh size and pattern specified and on following:
 - 1) Fence Height – as shown on Contract Drawings.
 - 2) Material Group – IA, ASTM F1043, Schedule 40 steel pipe.
- 4. Chain-link fences and gate framework shall be designed to comply with or exceed specified performance requirements and design criteria described herein. A design professional hired by Contractor, fence and gate manufacturer, and/or fence and gate supplier, shall provide a fence and gate design in compliance with Contract Documents. If, in opinion of design professional, elements described herein need to be adjusted or modified to comply with required codes, rules, and regulations, including those described in Contract Documents, such changes shall be brought to attention of Engineer by design professional, through Contractor, before completion of design.
- 5. All welding shall be in accordance with AWS standards.
- 6. Details, dimensions, and materials shown on Contract Drawings or described in the Contract Specifications are minimums and may be used without modification only if supported by design calculations. Larger dimensions shall be used if deemed necessary by manufacturer who shall have sole responsibility over structural integrity of equipment.

1.04 SUBMITTALS

- A. Submittals shall be in accordance with Contract Documents including Section 01 00 05.
- B. At a minimum, submittals shall contain, but not be limited to, following information to establish compliance with these specifications:
 - 1. Shop Drawings in accordance with Section 01 00 05.
 - a. Additional shop drawing requirements:
 - 1) Product data for fence and gate posts, rails, and fittings, chain-link fabric, reinforcements, and attachments, accessories including any privacy slats, barbed wire, razor wire, and gates and associated hardware.
 - a) Data shall include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2) Show accessories, hardware, gate operation, and operational clearances.
 - 2. Manufacturer's Certification in accordance with Section 01 00 05.
 - 3. Manufacturer qualifications showing compliance with requirements described herein.
 - 4. Installer qualifications showing compliance with requirements described herein.
 - 5. Manufacturer's installation instructions.
 - 6. Manufacturer's certification that equipment has been properly installed, aligned and tested, and meets all requirements for satisfactory performance under conditions specified in accordance with Section 01 00 05 and all related test results and associated forms.

7. Manufacturer's instruction certification that instructions to operators have been completed in accordance with Section 01 00 05.
8. Complete operation and maintenance data on equipment in accordance with Section 01 77 13.
9. Manufacturer's equipment warranty in accordance with Section 01 00 05

1.05 SOURCE QUALITY ASSURANCE

- A. Fence Manufacturer – Company specializing in manufacturing products specified in this Section with minimum ten (10) years' documented experience.
- B. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.
- D. Fence shall be installed by experienced personnel of a company regularly engaged in this type work. Work shall conform to recommendations of American Fence Association. Installer shall have a minimum of five (5) years' experience.
- E. Perform Work in accordance with CLFMI Product Manual and manufacturer's instructions.
- F. Obtain chain-link fence and gates as a complete unit including necessary fittings and accessories, from a single source provider or manufacturer.

1.06 COORDINATION

- A. Coordinate gate operators and controls with Division 26 and Division 40 requirements.

1.07 DELIVERY, HANDLING AND STORAGE

- A. Packing, Shipping, Handling, and Unloading:
 1. Equipment shall be shipped and handled in accordance with requirements of Section 01 61 00 of these specifications.
- B. Storage and Protection:
 1. Equipment shall be stored and protected in accordance with requirements of Section 01 61 00 of these specifications.

1.08 WARRANTIES AND BONDS

- A. Warranty shall be in accordance with Section 01 78 36.
- B. Warranties shall be acceptable only from equipment manufacturer. Warranties from suppliers or installers shall not be acceptable. Warranties not provided by manufacturers and for terms described in these Contract Documents shall be basis to reject equipment.
- C. Warranty period for all gate components shall be 5 years from date of substantial completion in lieu of standard 1-year warranty.

PART 2 PRODUCTS

2.01 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. Comply with CLFMI Product Manual and with requirements indicated below:
1. Fabric Height – shall be as shown on Contract Drawings.
 2. Steel Wire Fabric – Minimum wire with a diameter of 0.148 inch (9 gauge).
 3. Mesh Size – Maximum 2 inches.
 4. Fabric Coating:
 - a. Zinc-Coated Fabric – ASTM A392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating.
 - b. Coat selvage ends of fabric that is metallic coated before weaving process with fence manufacturer's standard clear protective coating.
 5. Selvage – Twisted top and knuckled bottom.

2.02 FENCE FRAMING

- A. Posts and Rails – Comply with ASTM F1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1083 based on following:
1. Fence Height – As shown on Contract Drawings.
 2. Heavy Industrial Strength – Material Group IA, round steel pipe, Schedule 40.
 - a. Fence Posts:

Fabric Height, feet	Minimum Line Post (O.D.), inches	Minimum End, Corner and Pull Post (O.D.), inches
Up to 6	1.9	2.375
Greater than 6 but less than 8	2.375	2.875
Greater than 8 but less than 10	2.875	4
Greater than 10 but less than 12	2.875	4
Greater than 12 but less than 16	4	6.625

- b. Horizontal Framework Members:
 - 1) Provide intermediate, top, and bottom rails complying with ASTM F1043.
 - a) Rail Diameter – Minimum 1.66 inches.
 3. Metallic Coating for Steel Framing:
 - a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. average zinc coating per ASTM A123. Coatings shall be applied both inside and outside surfaces.

2.03 FITTINGS

- A. All fittings shall comply with ASTM F626. Finish shall not be less than 1.2 oz. /sq. ft. zinc, unless otherwise specified herein to be greater.
- B. Post Caps – Provide for each post.
 - 1. Provide line post caps with loop to receive top rail.
- C. Rail and Brace Ends – Provide for each gate, corner, pull, and end post.
- D. Top Rail Sleeves – Pressed-steel or round-steel tubing not less than 6 inches long.
- E. Rail Clamps – Line and corner boulevard clamps for connecting intermediate and bottom rails in fence line-to-line posts.
- F. Tension and Brace Bands – Pressed steel.
- G. Tension Bars – Steel with a length not less than 2 inches shorter than full height of chain-link fabric.
 - 1. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- H. Truss Rod Assemblies – Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- I. Tie Wires, Clips, and Fasteners – According to ASTM F626.
 - 1. Standard Round Wire Ties – For attaching chain-link fabric to posts, rails, and frames, complying with following:
 - a. Hot-Dip Galvanized Steel – Minimum 0.148-inch-diameter wire with galvanized coating thickness matching coating thickness of chain-link fence fabric.
- J. Barbed Wire.
 - 1. Steel barbed wire shall comply with ASTM A121, for two-strand barbed wire, 0.099-inch-diameter line wire with 0.080-inch-diameter, four-point round barbs spaced not more than 5 inches o.c.
 - 2. Provide Type Z Class 3 zinc coating.
- K. Barbed Wire Arms.
 - 1. Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts integral with post cap; for each post unless otherwise indicated, and as follows:
 - a. Provide line posts with arms that accommodate top rail.
 - b. Provide corner arms at fence corner posts, unless extended posts are indicated.
 - c. Type I, single slanted arm for 3 barbed wire strands Type III, V-Shaped arm for 6 barbed wire strands.

2.04 GATES

A. Swing Gates.

1. General – Comply with ASTM F900 for gate posts and double swing gate types.
 - a. Fabric and Coating – to match fence.
 - b. Gate Leaf Width – as shown on Contract Drawings.
 - c. Gate Fabric Height – same as fence height as shown on Contract Drawings.
2. Pipe and Tubing:
 - a. Zinc-Coated Steel – Comply with ASTM F1043 and ASTM F1083; protective coating and finish to match fence framing.
 - b. Gate Posts – shall be round tubular steel and comply with ASTM F900.
 - 1) Fabric heights up to 6 feet.

Single Gate Width, feet	Double Gate Width, feet	Minimum Post (O.D.), inches
Up to 4	Up to 8	2.375
4 to 10	8 to 20	2.875
10 to 18	20 to 36	4

- 2) Fabric heights 6 – 12 feet.

Single Gate Width, feet	Double Gate Width, feet	Minimum Post (O.D.), inches
Up to 6	Up to 12	2.875
6 to 12	12 to 24	4
12 to 18	24 to 38	6.625
18 to 24	36 to 48	8.625

- c. Gate Frames and Bracing – Shall be round tubular steel and comply with ASTM F900.
 - 1) Rails and Braces – Minimum 1-5/8-inches outside diameter.
3. Frame Corner Construction - Welded.
4. Hardware for manually-operated gates.
 - a. Hinges – 180-degree inward 180-degree outward 360-degree inward and outward swing.

2.01 GROUT AND ANCHORING CEMENT

- A. Non-shrink, Nonmetallic Grout – Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C1107 and Division 03. Provide grout, recommended in writing by fence manufacturer, for exterior applications.

- B. Erosion-Resistant Anchoring Cement – Factory-packaged, non-shrink, non-staining, hydraulic- controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by fence manufacturer, for exterior applications. Comply with Division 03 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify layout information for chain-link fences and gates shown on Contract Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.
- B. Examine areas and conditions for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of Work.
- C. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.
- D. 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 or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 INSTALLATION

- A. Contractor shall furnish and install all fences and gates, accessories, and appurtenances according to Contract Documents, including Sections 01 61 00, and equipment manufacturer's written instructions and recommendations. Conflicts of information shall be called to attention of Engineer before proceeding with work.
- B. Equipment manufacturer shall provide Contractor with engineering and technical support related to specified equipment, and participate in commissioning, startup, testing, and training of Owner's personnel as required by Contract Documents and as necessary to allow Contractor to provide a complete and operable system.
- C. Install chain-link fencing to comply with ASTM F567, CLFMI Product Manual, and more stringent requirements indicated herein.
- D. Chain-link Fence Installation.
 - 1. Post Excavation – Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet. For rock conditions, comply with ASTM F567.
 - a. Where bedrock is encountered, termination into bedrock shall be 12 inches minimum for line posts and 18 inches minimum for gate, pull, and termination posts, or deeper as required by fence manufacturer.
 - 2. Post Setting – Set posts in concrete at indicated spacing into firm, undisturbed soil. Depth of post setting and depth of concrete shall be as determined by fence manufacturer for given site and ASTM standards.

- a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - b. Concrete Fill – Place concrete around posts to dimensions required by fence manufacturer indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter. Posts to remain unburdened and undisturbed for at least 10 days following placement of concrete.
 - 1) Exposed Concrete – Extend 2 inches above grade; shape and smooth to shed water.
 - 2) Concealed Concrete – Top 3 inches to allow covering with surface material.
 - c. Mechanically Driven Posts – Drive into soil to depth as directed by fence manufacturer for given site conditions, but no less than that described for “Post Excavation”, above. Protect post top to prevent distortion.
3. Terminal Posts – Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more or as required by fence manufacturer.
 4. Line Posts – Space line posts uniformly at no more than 10 feet o.c. or as required by fence manufacturer.
 5. Post Bracing and Intermediate Rails – Install according to ASTM F567, maintaining plumb position and alignment of fencing. 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.
 - a. Locate horizontal braces at mid-height of fabric 72 inches or higher, on fences with top rail. Install so posts are plumb when diagonal rod is under proper tension.
 6. Top Rail – Install according to ASTM F567, maintaining plumb position and alignment of fencing. 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 fence manufacturer.
 - a. Provide top rail through line post tops and splice with 6 inch long rail sleeves. Top rail and fabric shall closely parallel finish grade without excessive angle changes.
 7. Intermediate and Bottom Rails – Install and secure to posts with fittings.
 8. Chain-Link Fabric – Apply fabric to outside of enclosing framework. Leave 2 inches 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.
 9. 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 o.c.
 10. 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 per ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.
 11. Maximum Spacing – Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

12. Fasteners – Install nuts for tension bands and carriage bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
13. Barbed Wire – Install barbed wire uniformly spaced, angled toward security side of fence. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

E. Gate Installation.

1. Install gates according to fence 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 and lubricate where necessary.
2. Use gate posts to secure gate; do not swing gate from building.
3. Gates to be plumb, level, and secure for full opening without interference. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
4. Brace each gate and corner post to adjacent line post with horizontal center brace rail and 3/8-inch diameter diagonal truss rods. Install brace rail, one bay from end and gate posts. Place truss rod in tension by adjusting turnbuckle.
5. Manual Gates:
 - a. Install gates plumb, level, and secure for full opening without interference. Gate movement shall not be initiated by gravity when in an automated gate operator is disengaged/disconnected per ASTM F1184.
 - b. Attach hardware by means which shall prevent unauthorized removal.
 - c. Adjust gate and hardware for smooth operation.
 - d. All gate installations to conform to all applicable federal, state, and local codes as well as ASTM F567 and ASTM F1184.

3.04 ERECTION TOLERANCES

- A. Tolerances shall be as below, unless referenced standards herein are more stringent, in which case more stringent standard shall apply:
 1. Maximum Variation From Plumb – 1/4-inch.
 2. Maximum Offset From True Position – 1-inch.
 3. Components shall not infringe adjacent property lines.

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 MANUFACTURER'S SERVICE

- A. Provide services of equipment manufacturer or their approved representative in accordance with Sections 01 00 05 and 01 77 13. Representative for specified equipment shall be present at job-site for following services:
 - 1. Installation assistance: 1 man-day.
 - 2. Start-up and final acceptance: 1 man-day.
 - 3. Job-site training: 1 man-day.
- B. Provide equipment start-up and certification in accordance with Sections 01 00 05. Complete Equipment Start-up Report and Certification form found in Section 01 99 00.
- C. Provide all training in accordance with Sections 01 00 05. Complete Equipment Training Certification form found in Section 01 99 00.
- D. All test results, forms, and certifications shall be included in O&M manual.

END OF SECTION

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SECTION 32 90 00
SITE REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Placement of seed, sprigging, sod, and topsoil including mulch, where required.
2. Site rehabilitation of disturbed areas.
3. Restoration of uncultivated lands.
4. Site modifications and development to meet new conditions.
5. Removal and disposal of all excess materials, equipment, trash and debris used for, or resulting from, work included in this Section.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.

1.02 REFERENCES

- A. American Association of Nurserymen Standards - ANSI Standard 2-60.1, "Nursery Stock."
- B. Soil Conservation District of Department of Agriculture.

1.03 QUALITY ASSURANCE

A. Areas and Features to be Restored

1. All areas, including natural features occurring thereon, which are damaged or disturbed by Contractor's operations, shall be restored, repaired or replaced to same or superior condition which existed prior to construction or as modified herein or as shown on Drawings.
2. Artificial features shall be restored equal to a new condition or as modified herein or as shown on Drawings.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 00 05.
- B. Submit source nursery for all plantings.
- C. Topsoil - Submit sieve analysis and characteristics of topsoil as listed in PART 2 - MATERIALS.
- D. Seed mixture data.

1.05 QUALIFICATIONS

- A. All planting material to be furnished from a nursery which meets requirements of American Association of Nurserymen.

1.06 PACKING AND SHIPPING

- A. All seed furnished for this project shall be delivered in standard size unopened bags of vendor, showing weight, mixture, vendor’s name and guaranteed analysis.

1.07 STORAGE

- A. Seed shall be properly stored in dry conditions at site of work.
 - 1. Any seed damaged or spoiled during storage shall be replaced by Contractor.

1.08 ENVIRONMENTAL CONDITIONS

- A. Topsoil shall not be delivered or placed in a frozen or muddy condition.
- B. Seeding is to be done on dry or moderately dry soil.
 - 1. Seeding is to be done when wind velocity does not exceed 5 miles per hour.

1.09 GUARANTEE

- A. Any new, reestablished, replaced or disturbed plant material that fails to respond properly within one-year guarantee period shall be replaced as specified above at Contractor’s expense.
- B. Provide a uniform stand of grass by watering, moving, and maintaining seed and sod areas until Substantial completion and subsequently, until end of Contractor’s required maintenance period. Re-sod and re-seed areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by Owner.
- C. Acceptance of all site rehabilitation work shall be at sole discretion of Owner who shall make final determination regarding whether work provided is acceptable. Any additional work required to meet Owner’s requirements shall be at sole cost of Contractor.

PART 2 PRODUCTS

2.01 SEED MATERIALS

- A. Inspect and test seed for germination and purity prior to mixing. All seed shall be fresh and of latest crop year.
- B. Uniformly mix by Group.
- C. Seed Group and Use Schedule:

Seed Group	Seed Name	Quantity (% By Weight)	Allowable Periods Of Use
A (permanent; slopes 3:1 or less)	Common Bermuda (hulled seed)	40%	February 15 to August 15
	Common Bermuda (un-hulled seed)	40%	
	White Dutch Clover	20%	

Seed Group	Seed Name	Quantity (% By Weight)	Allowable Periods Of Use
B (permanent; slopes 3:1 or less)	Common Bermuda (un-hulled seed)	40%	August 16 to February 14
	Ryegrass	60%	
C (permanent; slopes greater than 3:1)	Weeping Lovegrass	10%	March 1 to July 31
	Lespedeza Sericea (scarified)	90%	
D (permanent; slopes greater than 3:1)	Lespedeza Sericea (un-scarified)	70%	August 1 to February 29
	Tall Fescue	30%	
E (temporary; slopes 3:1 or less)	Ryegrass	95%	Anytime
	Common Bermuda (un-hulled)	5%	
F (temporary; slopes greater than 3:1)	Weeping Lovegrass	10%	Anytime
	Tall Fescue	80%	

1. For residential areas using Seed Group A, omit white Dutch clover and increase both types of Bermuda to 50 percent each unless directed otherwise by Designer.
 2. For any Seed Group B applied between August 16 and February 14, in following March or April when weather is suitable, provide Seed Group A to all areas without permanent ground cover.
 3. Regardless of when used by Contractor, use of temporary Seed Group E and F shall not preclude Contractor from providing permanent Seed Groups A, B, C, and/or D at end of project.
 4. For any Seed Group C and D, in lieu of specified seed mixture, use of mixtures approved for slopes greater than 3:1 by Tennessee Department of Environment and Conservation (TDEC) shall be acceptable. Advise Engineer at time of shop drawing submittal indicating use of an approved TDEC seed mixture and documentation from TDEC indicating approval.
- D. All seed shall meet requirements of Tennessee Department of Agriculture and any more stringent Federal requirements, including those for purity and germination. Weed content of each component shall not exceed 0.1 percent.
- E. Furnish Designer a certified laboratory report showing analysis of seed to be furnished. Report shall bear signature of a senior seed technologist.
- F. Inoculate for legumes for Seed Group C and D:
1. Nitrogen fixing bacteria cultures adapted to particular seed to be treated.
 2. Furnish in containers of a size sufficient to treat specified quantity of seed to be planted.

2.02 MULCH MATERIAL

- A. Hay composed of approved stalks from grasses, sedges, or legumes; or straw composed of stalks from rye, oats, wheat, or other approved grains.
- B. Air dried and reasonably free from noxious weeds, weed seeds, and other detrimental plant growth.
- C. Suitable for spreading with mulch blower machinery.

- D. Hardwood fiber mulch, when used, shall meet following specifications.
 - 1. Moisture Content – 10.0 percent plus or minus 2.0 percent
 - 2. Organic Matter – 99.4 percent plus or minus 0.2 percent
 - 3. Ash Content – 0.6 percent plus or minus 0.2
 - 4. Water Hold Capacity – 1,050 grams minimum (per 150 grams of oven dry fiber)
- E. Mulch binders.
 - 1. Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO M-81, M-82, or M-141, for type and grade specified.
 - 2. Emulsified asphalt, Type SS-1 conforming to AASHTO M-140. In addition to Type SS-1, a special mixing material AE-3 or special priming material AE-P may be specified.

2.03 EROSION MATTING

- A. Excelsior Matting:
 - 1. Machine-produced mat of curled wood excelsior fibers, 80 percent of which are 6 inches or longer in length, evenly distributed over entire area of mat, with one side of mat covered with a maximum 1 inch by 1 inch photodegradable extruded plastic mesh; mats minimum 47-inch width and weigh 0.975 pounds per square yard plus or minus 10 percent.
 - 2. Wire staples machine made of No. 11 gauge new steel wire “U” shaped, not less than 6 inches in length with not less than a 1-inch wide throat.
- B. Straw Matting:
 - 1. Manufacturers: Propex, Inc. (formerly SI Geosolutions), Chattanooga, Tennessee 37416 USA, Phone (423) 899-0444, LandLOK S2 Erosion Control Blanket, North American Green, S150 Blanket or approved equal.
 - 2. Description: Machine-produced mat of straw fibers, evenly distributed throughout blanket, with photodegradable, extruded plastic netting covering top and bottom of each blanket.
 - 3. Netting shall be photodegradable polypropylene with mesh openings of approximately 0.4 in by 0.4 in.
 - 4. Ground Anchoring Devices:
 - a. Length: 8 to 18 inches; sufficient ground penetration to resist pullout. Use longer anchors for loose soils.
 - b. U-shaped wire staples, or metal pins.
 - c. Metal pins: Steel, minimum 0.20 inches in diameter with 1.5-inch steel washer.

2.04 JUTE MESH

- A. Open plain weave of single jute yarn and non-toxic to vegetation.

- B. Tag jute rolls for identification with 58 warp ends per yard, 41 weft ends per yard and weighing approximately 0.9 pounds per square yard with an acceptable tolerance of 5 percent.

2.05 STAPLES

- A. New and unused, machine made of No. 11 gauge steel wire formed into a "U" shape, not less than 6 inches in length with not less than a 1-inch wide throat.

2.06 SOD MATERIAL

- A. Live dense, well-rooted growth of permanent grasses, free from Johnson grass, nutgrass, and other undesirable grasses or weeds and well-suited for proposed application to particular soils.
- B. Cleanly cut in strips having a reasonably uniform thickness of not less than 2 1/2 inches, a uniform width of approximately 8 inches, and a minimum length of 12 inches.

2.07 COMMERCIAL FERTILIZERS

- A. Unless otherwise specified, inorganic 10-20-10 nitrogen, phosphoric acid, and potash for seeding and 10-10-10 or 1-1-1 for sodding.
- B. Furnish in standard containers with brand name, weight and guaranteed analysis of contents clearly marked.
- C. Comply with Federal, State, and local laws.
- D. Ammonium nitrate shall be a standard commercial product, having a minimum of 33.5 percent nitrogen.
- E. Agricultural limestone shall contain a minimum of 85% of calcium carbonate and magnesium carbonate combined, and is of particular size that 85% shall pass a No. 10 mess sieve.
- F. Notwithstanding above, fertilizer shall be as recommended by local Soil Conservation District of Department of Agriculture for type(s) of soil(s) and plant(s).

2.08 WATER

- A. Free from harmful organisms or other objectionable materials.

2.09 TOPSOIL

- A. Natural, friable, fertile, fine, sandy loam possessing characteristics of representative topsoil in vicinity which produces heavy growths of vegetation.
- B. Free from subsoil, noxious weeds, stones larger than one inch in diameter, lime, cement, ashes, slag, or other deleterious matter.
- C. Well-drained in its original position and free from toxic quantities of acid or alkaline elements. pH of topsoil shall be between 5.0 and 7.0.
- D. Topsoil shall contain no less than 6.0 percent organic matter.
- E. Topsoil shall contain less than 52 percent sand.
- F. Topsoil may be from previously excavated, stockpiled and protected materials, provided materials meet requirements for topsoil.

- G. Topsoil shall meet following gradation requirements free of stones, roots, sticks and other foreign substances:

Grain Diameter	Sieve Size	Percent Passing By Weight
6.3 mm	6.3 mm	100
4.75 mm	No. 4	60-85
0.075 mm	No. 200	20-45
0.002 mm	--	7-27

2.10 GEOSYNTHETIC MATERIALS

- A. Geosynthetic materials may be submitted for consideration by Engineer. Such material shall be installed and maintained in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Determine that surface area is ready for fine grading and/or to receive topsoil and seeding or plantings.
1. Remove trash, debris, large stones and other foreign materials from surface areas to be restored or rehabilitated.
 2. Topsoil shall be free of frozen fragments, debris, large stones, and other foreign materials.

3.02 PREPARATION

- A. Fine Grading - Areas requiring topsoil shall be fine graded to within 4 inches of finished grade to provide a minimum compacted thickness of 4 inches of topsoil at all locations.
1. All such areas, whether in cut or fill, shall be raked to a depth of 1 inch, be parallel to finished grade as shown on Drawings or required and shall be free of all stones, larger than 1 inch, roots, rubbish and other deleterious material.

3.03 INSTALLATION

- A. Areas to be Developed
1. When project site is to be modified and developed to meet new conditions, Contractor shall perform all required grading, topsoiling, fertilizing, seeding, planting, mulching and maintenance of areas, all in accordance with Drawings and as specified herein.
 2. Unless shown otherwise on Drawings, entire unpaved area within grading limits and within overall areas excavated and backfilled shall be so developed.
 3. New landscaping work and artificial features, if any, are shown on Drawings and specified elsewhere.
- B. Contractor shall reestablish all existing cultivated or landscape items, trees, shrubs, vines and ground covers as practicable.

1. Contractor shall provide additional or modify existing vegetation, as shown on Drawings.
2. Existing trees, plants, shrubs, saplings, ground cover, vines, etc., which are disturbed or damaged by Contractor's operations shall be replaced with new plant materials.

3.04 TOPSOIL

- A. Furnish and spread topsoil at depths and locations shown on drawings, but no less than 4 inches in depth and in all areas requiring rehabilitation unless otherwise shown on Drawings.
 1. Stockpiled topsoil may be used if it is acceptable to Engineer.
 2. In event this topsoil is not satisfactory, or is inadequate to cover required areas, Contractor shall furnish required amount of satisfactory topsoil from approved sources off site.
- B. Soil shall be uniformly compacted with a light hand roller to a final depth of not less than 4 inches.
 1. When finished, surface shall conform to finished lines and grades shown on Drawings or required and shall have a smooth pulverized surface at time of seeding.
 2. Any irregularities shall be corrected before fertilizer and seed are placed.
 3. Any subsequent settlement or displacement of topsoil shall be restored to an acceptable condition at Contractor's expense.

3.05 FERTILIZER

- A. Fertilizer shall be uniformly spread by a mechanical spreader at rate of 25 pounds per 1000 square feet for grade 10-20-10 or equivalent when seeding or 12 pounds per 1000 square feet for grade 10-10-10 or equivalent when sodding.
- B. If sprigging, fertilizer shall be uniformly spread by a mechanical spreader at rate of 12 pounds per 1000 square feet for grade 0-20-20 or equivalent.
- C. Not less than 100 pounds per 1000 square feet for agricultural limestone.
- D. Fertilizer shall be incorporated into upper 2 inches of topsoil immediately after spreading for seeding or upper 1/2-inch when sprigging.
- E. Fertilizer need not be incorporated in soil as specified above when mixed with seed in water and applied with power sprayer equipment, also known as hydroseeding.

3.06 SEEDING

- A. Scarify, disc, harrow, rake, or otherwise work each area to be seeded until it has been loosened and pulverized to a depth as directed by Engineer.
- B. Sow seed of specified group as soon seedbed has been prepared.
- C. Sow uniformly by means of a rotary seeder, hydraulic equipment, or other satisfactory means at rate of 1-1/2 pounds per 1,000 square feet, unless otherwise specified.
- D. Inoculate Group "C" seed and seeds of legumes, when sown alone, before sowing in accordance with recommendations of manufacturer of inoculant.
- E. Upon completion of seeding, area shall be raked lightly and rolled with a light hand roller.

- F. Do not perform seeding during windy weather, or when ground surface is frozen, wet, or otherwise non-tillable. No seeding shall be performed during December through February unless otherwise permitted.
- G. Provide seeding with mulch unless otherwise specified:
 - 1. Spread hay or straw mulch evenly over seeded area at an approximate rate of 75 pounds per 1,000 square feet immediately following seeding operations. This rate may be varied by Engineer, depending on texture and condition of mulch material and characteristics of area seeded.
 - 2. Hold hay or straw mulch in place by use of a mulch binder applied at approximate rate of 4 gallons per 1,000 square feet as required.
 - 3. Cover bridges, guardrails, signs, and appurtenances, if mulch binder is applied in such a way that it would come in contact with or discolor structures.
 - 4. When wood fiber mulch is used, uniformly apply at rate of 28 to 35 pounds per 1,000 square feet with hydraulic mulching equipment.
- H. Process of spraying grass seeds, water, fertilizer and mulch known as hydroseeding or hydro-mulching may be utilized provided that water hazards are minimized.
 - 1. Presoaking, spraying of materials and watering after spraying shall be in strict accordance with manufacturer's instructions.
 - 2. All materials, protection, maintenance, etc., shall be in conformance with this specification.
 - 3. Mulch may be a wood fiber material compatible with spray equipment.

3.07 MULCHING AND PROTECTION

- A. Contractor shall protect and maintain seeded areas to assure a full even stand of grass.
- B. Immediately after seeding and rolling, Contractor shall apply oat, wheat or rye straw, free from noxious weeds, as a mulch, to a loose depth of about 1 inch.
- C. Contractor shall perform all watering and reseeded as necessary for a minimum of 30 days and until final acceptance of Contract, to ensure establishment of a uniform stand of specified grasses.
- D. For slopes 3:1 or greater or where shown on Drawings, provide erosion matting. Comply with manufacturer's instructions for soil type, slope and, where applicable, channel flow; secure with staples.

3.08 MAINTENANCE

- A. Seeded Areas: Any portion of seeded areas failing to produce a full uniform stand of grass from any cause shall be re-seeded at full rate and re-fertilized at one-half rate and protected and maintained until such a full stand has been obtained.

3.09 RESTORATION OF UNCULTIVATED LANDS

- A. Areas of uncultivated land shall be restored as follows:
 - 1. Disturbed surfaces shall be rough-graded to original elevations (+1 inch) and general appearance which existed prior to construction (or to new elevations and grades which

are required), all debris, loose stones over 1 inch, boulders, etc., being removed in process.

2. Surface shall then be seeded with perennial rye grass, being spread at rate of 1 lb. per 800 square feet.
3. Area need not be raked or rolled after completion of seeding.

3.10 SPECIAL CONDITIONS

- A. Damaged Trees - Vegetation which has been damaged by site preparation activities and deemed non-functional by Owner or Engineer shall be replaced by Contractor with vegetation of same caliper, genus and species at no additional compensation to Contractor.

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SECTION 33 01 10

WATER WELL ABANDONMENT

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. Work included in this Section consists of conducting a well abandonment and related services on existing City of Dyersburg Well 6 at location shown on Drawings.
2. Work includes mobilization, abandonment, and site restoration. Demolition of existing wellhead mechanical, electrical, telemetry, and site improvements in accordance with Section 02 41 00.
3. Contractor shall provide all equipment capable of performing services as specified in this section, and an experienced drilling crew to perform work.
4. Contractor shall protect existing building structures, curbs, walks, utilities and paving from damage by construction or equipment. Contractor shall bring back to original condition any damaged in course of construction. Notify utility companies and Tennessee One-Call prior to commencement of intended work.
5. Contractor shall furnish and install all equipment, materials, accessories, and appurtenances according to Contract Documents, including Sections 01 00 05, and all equipment manufacturers' written instructions and recommendations. Conflicts of information shall be called to attention of Engineer before proceeding with work.
6. Any part of work which is not mentioned in Specifications or on Drawings, but which is necessary or normally required as a part of such work, or is necessary or normally required to make each abandonment satisfactorily and legally abandoned, shall be performed by Contractor as incidental work without extra cost to Owner, as if fully described in Specifications and shown on Drawings, and expense thereof shall be included in applicable unit prices or lump sum bid for work.

B. Section Includes

1. Drilling Equipment
2. Grout
3. Grout Preparation
4. Well Abandonment
5. Reporting

C. Related Documents:

1. Division 2 - Demolition
2. Division 31 - Earthwork

1.02 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.
- B. All references shall refer to latest edition of that reference including any revisions.
- C. Organizations and Legislative Documents:
 - 1. American Petroleum Institute (API)
 - 2. American Society for Testing Materials (ASTM)
 - 3. American Water Works Association (AWWA)
 - 4. Tennessee Code (Tenn. Code)
 - 5. Tennessee Department of Environment and Conservation (TDEC)
- D. Publications:

Reference	Title
API 10A	Specification for Materials and Testing for Well Cements
ASTM C150	Standard Specification for Portland Cement.
ASTM C494	Standard Specifications for Chemical Admixtures for Concrete
AWWA A100	Standard for Water Wells
AWWA C654	Disinfection of Wells
TDEC 0400-45-01	Public Water Systems
TDEC 0400-45-09	Water Well Licensing Regulations and Well Construction Standards
Tenn. Code 69-10	Tennessee Code for Well Drilling

- E. TDEC Community Public Water Systems Design Criteria and all other related TDEC rules shall apply.

1.03 ELIGIBILITY

- A. Contractor responsible for abandoning well shall be a State of Tennessee Licensed Water Well Driller or shall have a State of Tennessee Well Closure license and shall employ only competent workman for execution of this Work. All such Work shall be performed under direct supervision of a driller with a State of Tennessee Water Well Driller license or State of Tennessee Well Closure license and shall be performed by an adequate number of competent helpers satisfactory to Owner and Engineer.
- B. Drilling Superintendent shall be experienced in abandonment of wells in type of formations that existing well intersects, maintaining complete and current well logs and daily notes for well completion report.
- C. Owner may make any other investigations deemed necessary to determine ability of Contractor to perform Work, and Contractor shall furnish to Owner all such information and data for this purpose as Owner may request.

- D. Contractor shall furnish satisfactory evidence upon request that all materials to be furnished in performing specified work are new and all equipment to be used is in good working order.
- E. Contractor shall furnish equipment and perform work with equipment that is adequate for all phases of well construction. If, in opinion of Owner or Engineer, Contractor's equipment is not capable of satisfactorily performing work provided for in these specifications, Contractor shall substitute equipment satisfactory to Owner or Engineer.
- F. Contractor shall obtain, at his own expense, all permits, certificates, and licenses required of him by law for performance of his work. He shall comply with all Federal, State and Local laws, ordinances, or rules and regulations relating to accomplishment of his work.
- G. Contractor shall have all necessary insurance, including but not limited to liability insurance and accident insurance.

1.04 STANDARDS AND REGULATIONS

- A. Contractor shall maintain accurate driller logs, material setting and grouting data, and must furnish a signed copy of results to Owner and to TDEC on a form provided by TDEC or a reasonable facsimile approved by TDEC.
- B. Contractor shall abide by and implement all requirements on well construction, permits, reports, etc., as described in State of Tennessee *Community Public Water Systems Design Criteria*.
- C. As required by law, Contractor shall retain and/or post copies of permits at site.

1.05 CONSTRUCTION DETAILS

- A. Details of well scheduled for abandonment are shown below. Note depths are from land surface.

Existing Water Well No. 6	
Dyersburg Well No.	6
Casing Details	18-inch
Screen Details	12-inch
Cased Depth	575 feet
Lap Depth	510 feet
Total Depth	637 feet

1.06 SCHEDULE AND SEQUENCES

- A. Contractor shall not initiate abandonment of existing well until replacement well is placed into operating service and written authorization to proceed well abandonment and demolition is received from Owner.
- B. Engineer shall be notified of proposed abandonment start date at least five (5) working days before work begins. Owner and Engineer shall be notified of anticipated delays as soon as they become apparent.

1.07 SUBMITTALS

- A. Submittals shall be in accordance with Contract Documents including Section 01 00 05.

- B. At a minimum, submittals shall contain, but not be limited to, following information to establish compliance with these specifications:
 - 1. Shop Drawings and Certified Design Calculations:
 - a. Description of Well Abandonment Procedures.
 - 2. Quality Control Submittals:
 - a. Daily Drilling Log.
 - b. Grout Seal and Additives.
 - 3. Contract Submittals:
 - a. All permits required by local, state, and federal authorities.
 - b. Well Abandonment Report in accordance with TDEC requirements.

1.08 HYDROLOGIC CONDITIONS

- A. Contractor shall be aware that unfavorable subsurface geologic conditions may exist at well site.
- B. Any information regarding well construction details and/or sub-surface conditions provided by Owner or Engineer is intended to assist Contractor in preparing his bid. Owner and Engineer do not guarantee its accuracy, nor is necessarily indicative of conditions to be encountered in abandoning well in this contract. Contractor shall satisfy himself regarding actual well construction details, all local conditions affecting his work by personal investigations, and neither information contained in this section nor that derived from maps or plans or from Owner, shall act to relieve Contractor from any responsibility hereunder or from fulfilling any or all of terms and requirements of his contract.

1.09 FIELD MEASUREMENTS

- A. Prior to start of construction, verify by field measurements and elevations that existing conditions and structures are

1.10 DELIVERY, HANDLING AND STORAGE

- A. Delivery, handling, and storage of materials shall conform to requirements of Section 01 00 05 of these specifications.
- B. All materials shall be properly protected so that no damage or deterioration will occur during a prolonged delay from time of shipment until installation is completed and units and equipment are ready for operation.
- C. All materials must be properly protected against damage during a prolonged period at site.

1.11 BOUNDARIES OF WORK

- A. Contractor shall accept location of existing well as it is and it shall be responsible to acquaint themselves with actual site conditions prior to submitting a bid to do work.

1.12 PROTECTION OF WATER QUALITY

- A. Contractor shall take all necessary precautions during construction period to prevent contaminated water, gasoline, hydraulic oil, etc., from entering well either through opening or by seepage through ground surface. Contractor shall take precautions as necessary, or as required, to permanently prevent contaminated water or water having undesirable physical, bacteriological, or chemical characteristics from entering well.
- B. Contractor shall maintain equipment to prevent any leaks of petroleum products or hazardous substances on ground at well site. In event a spill does occur, Contractor shall immediately remove and dispose of contaminated soil in an appropriate manner, file appropriate paperwork with TDEC, and perform any soil and/or water testing as required.
- C. Contractor shall provide, install, and maintain erosion controls for life of well abandonment work, as needed and to prevent sediment and turbidity entering surface water bodies.

1.13 WELL ACCEPTANCE CRITERIA

- A. Well shall be abandoned in accordance with these specifications and all applicable Federal, State, and local regulatory requirements, and to satisfaction of Engineer. Contractor shall comply with well abandonment requirements of TDEC 0400-45-01, TDEC 0400-45-09, and Tenn. Code 69-10.

PART 2 PRODUCTS

2.01 DRILLING EQUIPMENT

- A. Contractor is responsible for selecting appropriate methods, drill rig(s), and all other equipment required to complete work.
- B. Provide all tools, bits, and all other necessary equipment for well abandonment.

2.02 GROUT

- A. Grout material used in plugging and abandonment of a water well shall consist of Portland Type I Cement and Aggregate that conforms to ASTM C150 and ASTM C476. Composition of resultant slurry shall be subject to Engineer's approval.
- B. Mixing Water
 - 1. An adequate and fresh/safe water supply for mixing mud or cementing shall be used by Contractor for construction of water supply wells (no surface water).
 - 2. Neat Cement: 94 pound sack of Portland Cement to not more than 6 gallons of water.
- C. Grout Additives:
 - 1. Additives such as bentonite to reduce shrinkage, other admixtures (ASTM C494) to reduce permeability, increase fluidity, and control set time, shall be suitable for use in potable water well construction. Not more than 4% by weight, bentonite. Use of additives must be approved by Engineer prior to their use.
- D. Bentonite tablets may be used to bridge cavernous or fractured formations to reduce loss of grout as determined by Engineer. Only bentonite tablets approved by National Sanitation Foundation (NSF) or American National Standards Institute (ANSI) certified parties as

meeting NSF product standard 60 or 61 shall be permitted. Material shall be 1/4-inch to 3/4-inch in diameter.

- E. Grout shall be mixed and placed as recommended by Manufacturer.
- F. All grout should be of fluid consistency. Desired slump is 8-inches.
- G. Grout should be mixed as close to work area as possible and transported quickly to its final position in a manner which will not permit segregation of materials.
- H. When a batch mixer is used on job site, all materials should be mixed thoroughly for at least five (5) minutes.
- I. Grout which has not been placed within 90 minutes after water is first added should be discarded.

2.03 BENTONITE

- A. High solids bentonite grout shall be a minimum of 20% solids and a weight of no less than nine and two tenths (9.2) pounds per gallon as measured by a standard mud balance.
- B. Use of bentonite, in chip or tablet form, ranging in size from one-quarter inch (1/4") to three-quarters (3/4) of an inch will be allowed as an alternate seal to slurry grouting.
- C. Bentonite shall be mixed and applied in accordance with manufacturer's recommendations. Use of low solids bentonite drilling clay (designed for use as a drilling fluid to form a filter cake on the side walls of the borehole and to increase viscosity of water) is prohibited for use as a grout or sealing material except as an additive.
- D. Only bentonite grout, bentonite tablets, or bentonite chips, approved by National Sanitation Foundation (NSF) or American National Standards Institute (ANSI) certified parties as meeting NSF product standard 60 or 61 shall be approved.

PART 3 EXECUTION

3.01 GENERAL

- A. District and/or local County Health Department shall be notified 24-hours before any grouting activities taking place at site, if required. It is responsibility of Contractor to provide proper and timely notice to appropriate agencies.
- B. Wells extending into more than one aquifer shall be filled and sealed in such a way that exchange of water from one aquifer to another is prevented.

3.02 MOBILIZATION

- A. Contractor shall provide all necessary equipment and appropriate support equipment capable of abandoning well by grouting well from bottom to top and shall set up equipment as necessary to accomplish work. Contractor shall accomplish all required work in accordance with applicable portions of these Specifications.
- B. Contractor must confine his work, personnel, equipment and activities to within limits and well site property boundary as shown on Drawings. Under no circumstances can personnel or products of this construction be allowed beyond indicated limits.

3.03 WELL ABANDONMENT

- A. Thoroughly chlorinate well to be abandoned with sufficient quantities of liquid bleach or dry hypochlorite granules to produce a free chlorine residual of twenty-five (25) parts per million (ppm).
- B. Abandonment shall be performed by pumping grout slurry to target depth using a tremie pipe. Base of tremie pipe will be placed within three (3) feet of target depth.
- C. Grout shall be placed in well bore for a minimum length of thirty (30) feet below ground surface elevation to seal well.
- D. Remaining casing shall be backfilled with either bentonite or cement grout.
- E. Placement of backfill material shall be done in such a way that there are no bridges or gaps in well bore. Top of backfill material shall remain level with land surface.
- F. Contractor shall cut down steel casing on well after wellhead demolition.

3.04 REPORTING

- A. Contractor shall furnish Engineer a daily log which shall describe activities of day and summarize quantities of materials used. Keep log up-to-date with progress of work. Keep a copy at site for inspection by Engineer. Installed quantities of items, identified on Bid Schedule, should be included in daily log.
- B. Contractor shall, within sixty (60) days of abandonment of well, shall submit a report of abandonment of well in accordance with TDEC requirements.
 - 1. Abandonment report shall be made on a form provided by TDEC or a reasonable facsimile approved by TDEC.
 - 2. Report shall include same information as required on TDEC Well Completion Report and shall include specific information on how well was closed and placement and type of backfill placed in well bore.
 - 3. Report shall include a diagram showing location and distance in feet of closed well from one specific landmark and septic system or sewer systems on property.
 - 4. Abandonment report shall be signed by licensed driller or person holding a well closure license.

3.05 CLEANUP OF CONSTRUCTION AREAS

- A. Upon completion and acceptance of well, remove from site drill rig and equipment, complete, and all debris, unused materials, and other miscellaneous items resulting from or used in operations. Replace or repair any facility which has been damaged during construction work. Restore site to its pre- drilling condition or as approved by Owner or Engineer.

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SECTION 33 11 00

PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping including fittings, specials, accessories and materials for water distribution.
2. Connection of piping to existing piping, hydrants, valves, meters, manholes, catch basins, pump stations, tanks, and treatment facilities.
3. Miscellaneous appurtenances.
4. Service connections.
5. Shop tests.
6. Installation.
7. Testing and inspection.
8. Piping Schedule.
9. Piping, fittings, appurtenances, and other equipment described herein shall, as necessary, meet lead-free requirements described in Section 01 00 05.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 03 – Concrete
3. Section 09 96 00 – Painting and Coatings
4. Section 10 14 20 – Signage Requirements
5. Division 26 – Electrical
6. Section 31 23 16 – Excavation, Trenching and Grading
7. Section 31 23 23 – Bedding, Backfilling and Compaction
8. Section 32 90 00 – Site Rehabilitation
9. Section 33 12 00 – Valves
10. Section 33 13 00 – Testing and Disinfection of Piping and Systems
11. Division 40 – Process Integration
12. Section 40 27 00 – Hangers, Anchors and Supports

13. Section 40 41 13 – Pipe Insulation and Heat Tracing

1.02 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.
- B. All references shall refer to latest edition of that reference including any revisions.
- C. Organizations:
 - 1. American National Standard Institute (ANSI)
 - 2. American Water Works Association (AWWA)
 - 3. American Society for Testing Materials (ASTM)
- D. Ductile Iron and Gray Iron Pipe

Reference	Title
Handbook of Cast Iron Pipe - Cast Iron Pipe Research Association (CIPRA)	CIPRA Standard for Flanged Pipe With Threaded Flanges
ANSI A21.4/AWWA C104	Standard for Cement–Mortar Lining for Ductile-Iron Pipe and Fittings
ANSI A21.5/AWWA C105	Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
ANSI A21.10/AWWA C110	Standard for Ductile-Iron and Gray-Iron Fittings
ANSI A21.11/AWWA C111	Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI A21.15/AWWA C115	Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
ANSI A21.50/AWWA C150	Standard for Thickness Design of Ductile-Iron Pipe
ANSI A21.51/AWWA C151	Standard for Ductile-Iron Pipe, Centrifugally Cast
ANSI A21.53/AWWA C153	Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C203	Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot Applied
AWWA C600	Standard for Installation of Ductile-Iron Mains and Their Appurtenances
ANSI/AWWA C606	Standard for Grooved and Shouldered Joints
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Standard Specification for Ductile Iron Castings

E. Steel Pipe and Fittings

Reference	Title
AWWA C200	Standard for Steel Water Pipe—6 In. (150 mm) and Larger
AWWA C203	Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot Applied
AWWA C205	Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe—4 In. (100 mm) and Larger—Shop-Applied

Reference	Title
AWWA C206	Standard for Field Welding of Steel Water Pipe
AWWA C208	Standard for Dimensions for Fabricated Steel Water Pipe Fittings
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A181	Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A183	Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A234	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

F. Stainless Steel

Reference	Title
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A774	Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

1.03 SUBMITTALS

- A. Submit under provisions of Sections 01 33 00.
- B. Product Data – Provide data describing conformance to ANSI/AWWA/ASTM codes, materials, sizes, class, dimensions, joint type, fittings, and pipe accessories.
- C. Manufacturer’s Installation Instructions - Indicate special procedures required to install products specified.
- D. Layout Drawings - Show complete piping layout, including materials, sizes, classes, locations, and dimensions.
- E. Results of shop tests, if required.
- F. Manufacturer’s Certificates:
 - 1. Certify that products meet or exceed specified requirements.
 - 2. Certify that solvent cements, primers, joining compounds and any other interior or exterior coating applied to piping system meet requirements of their intended application.
- G. For any required pipe welding, submit qualifications of proposed welders in accordance with applicable American Welding Society (AWS) standards and other standards as described herein.

1.04 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Section 01 00 05.
- B. Submit marked-up record drawings, including record location, length and depth of pipe sections, valves, cleanouts, bends, tees, service connections stationing from downstream

manhole or water main or valve box, service lateral or pipe length and depth at property line, manholes, catch basins, and rim and invert elevations where pipe enters and exits a structure, if any differ from what is shown on Contract Drawings. Record a minimum of two ties to hydrants, manholes, bends, valves, cleanouts, air relief valves, service connections, and specials

- C. Identify and locate, both horizontally and vertically, on record drawings discovery of exposed uncharted or unmapped utilities and services.
- D. Markup Contract Drawings to indicate as-built conditions.

1.05 REGULATORY REQUIREMENTS

- A. Conform to all applicable local, state, and federal codes, rules, and regulations for materials and installation of work in this Section.
- B. Conform to requirements of regulatory agencies having jurisdiction over work.
- C. Conform to any applicable permit requirements obtained by Owner.

1.06 FIELD MEASUREMENTS

- A. Prior to start of construction, verify by field measurements and elevations that existing conditions, piping, and equipment are as shown on Drawings. Notify Engineer of specific discrepancies or potential interferences.
- B. Prior to start of construction, verify by exploratory excavations that existing underground utility locations and elevations are as shown on Drawings, to confirm marked location and elevation of underground utilities by organizations identified in Section 01 76 00, or to confirm location and elevation of uncharted utilities. Notify Engineer of locations and elevations that differ from drawings and of potential interference and allow Engineer sufficient time to determine any changes required as a result of such exploratory excavation or interferences prior to start of construction.
- C. Location and elevation of existing utilities shall be confirmed by exploratory excavation prior to installation of crossing sewer service laterals or water service connections. If required, grade of lateral or water pipe to be adjusted as approved by Engineer.
- D. Where connections are to be made to existing pipes, confirm type of material and outside dimensions of pipes.
- E. Prior to installation of crossing connections from catch basin confirm location and elevation of existing utilities. If required, adjust grade of pipe connection as approved by Engineer.

1.07 TEST REQUIREMENTS

- A. Requirements for testing and disinfection of piping are described in Sections 33 13 00.

1.08 COORDINATION AND SHUTDOWNS

- A. Coordinate field work under provisions of Sections 01 00 05, including field engineering, maintenance of traffic, access to private driveways, and emergency vehicle access.
- B. Coordinate work with local utility companies (private and municipal), including organizations identified in Section 01 76 00, for location of existing utilities and protection thereof.

- C. Coordinate work with local owners where affecting operation of existing structures, pumping stations, treatment facilities, and industrial processes or when connecting to existing water mains, sewers, manholes, structures, laterals, pumping stations, treatment facilities, or industrial processes.
- D. Coordinate location of each service lateral or water connection with property Owner.
- E. Coordinate shutdowns of existing systems with local authorities. Notify affected property owners and industries at least 24 hours prior to shutdown including duration of shutdown.
- F. Coordinate requirements for providing wall and floor sleeves with required firestopping specified under Division 07.

1.09 STORAGE AND HANDLING OF MATERIALS

- A. Shall be in compliance with Section 01 00 05.
- B. Contractor shall be responsible for safely storing, in accordance with manufacturer's recommendations, materials that have been accepted until they have been incorporated into completed project. Keep interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.

PART 2 PRODUCTS

2.01 GENERAL

- A. All products included in this section shall conform to requirements of standard specifications referenced herein.
- B. Pipe material, sizes, classes, etc. shall be furnished and installed as listed herein, in Piping Schedule, or as shown on drawings except as follows:
- C. For potable water applications, all linings and sealers shall conform to all applicable local, State and Federal health codes.
- D. Underground piping systems shall be installed as shown on Drawings.
- E. Inside process piping system shall be installed as shown on Drawings. Contractor shall verify piping layout with manufacturers of appropriate process equipment.
- F. All piping in contact with potable water shall be listed NSF 61 approved.
- G. Pipe Schedule is not meant to be all inclusive of every pipe material, size, schedule, and class to be provided. Contractor shall provide properly sized pipes of proper material and schedule/class in accordance with AWWA or other standards necessary to complete work as specified even if not specifically listed in pipe schedule.

2.02 DUCTILE IRON PIPE

- A. Pipe shall be ANSI A21.51/AWWA C151 - Ductile Iron Pipe Material, thickness design conforming to ANSI A21.50/AWWA C150. Class shall be as scheduled or as indicated herein.
 - 1. For pipe 24-inch diameter and smaller, 350 psi pressure class.
 - 2. For flanged interior pipe and grooved-end pipe, wall thickness shall be minimum Class 53 except where specified pressure requires heavier pipe.

B. Exterior Pipe Coatings.

1. Exterior of ductile iron pipe shall be coated with a layer of arc-sprayed zinc with a finishing layer conforming in every respect to latest edition of ISO 8179-1. Mass of the zinc applied shall be 200 g/m² of pipe surface area. A finishing layer topcoat shall be applied to the zinc. Mean dry film thickness of finishing layer shall not be less than 3 mils with a local minimum not less than 2 mils.
2. All unexposed exterior and underground ductile iron piping and fittings shall be provided with a protective exterior coating. Coating shall be an asphaltic coating approximately 1 mil thick and conform to requirements of ANSI 21.51/AWWA C151.
3. All exposed exterior and underground piping ductile iron piping and fittings including piping inside manholes, wet wells, or pump stations and all interior ductile iron piping and fittings shall be primed prior to finished painting and have all rust, dust, and scale removed by abrasive blast cleaning in accordance with SSPC (Steel Structures Painting Council) procedures designated in specifications or on Contract Drawings. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent rusting. If rusting beyond ASTM Rust Grade 8 occurs in field, rusted portions of shop-primed ferrous metals shall be field-cleaned in accordance with SSPC blast cleaning specification appropriate for service and immediately field primed.
 - a. Shop priming of pipe and fittings shall utilize a single-component, moisture-cured primer specifically developed for ductile iron pipe and fittings for immersed and non-immersed applications and shall be certified for use in potable water systems.
 - b. Primer shall be MC-FerroClad by Wasser High-Tech Coatings, Inc., Tnemec 140-1211, or equal. Dry film thickness shall be between 3.0 and 5.0 mils.
 - c. All ferrous metal piping not primed in shop shall be abrasive blast cleaned to SSPC-SP10 near White Blast or an SSPC-SP6 Commercial Blast, depending on exposure, prior to application of any primer, pretreatment, or paint.
 - 1) Ferrous Metal Piping Coating System Schedule – See System M-4 in Section 09 96 00.
 - 2) To prevent new rusting, cleaned surfaces shall be painted immediately after cleaning.
 - d. Touchup - Any abraded areas of shop or field applied coatings shall be touched up with same type of shop or field applied coating, even to extent of applying an entire coating, if necessary. Touchup coatings and surface preparations shall be in addition to and not considered as first field coat.
 - e. Surfaces located within 2 inches of joints which are to be field welded shall be left unpainted.

C. Interior Linings of Pipes.

1. Cement Mortar Lining.
 - a. All potable water ductile iron pipe and fittings and other piping and fittings as specified in Pipe Schedule shall have cement mortar linings with seal coat which shall conform to ANSI A21.4/AWWA C104 as follows:
 - 1) Double Thickness Cement Mortar Lining - Linings shall consist of cement mortar, centrifugally applied and shall not be less than 1/8-inch for 3 inches to 12 inches inclusive, 3/16-inch for 14 inches to 24 inches inclusive, and 1/4-inch

for 30 inches to 54 inches inclusive. Inside shall be given a seal coat of asphalt material as described in ANSI A21.4/AWWA C104.

D. Joints.

1. All joints shall be as scheduled, as shown on Contract Documents, and as described herein.
 - a. All pressurized underground piping shall have restrained joints as described herein unless otherwise scheduled or unless otherwise described in these Contract Documents. Unless otherwise noted, type of restrained joint shall be at Contractor's discretion as long as type chosen is either of restrained mechanical joint type, gasketed restrained push-on joint type, or fabricated restrained push-on joint type as specified herein.
 - b. All interior piping and all exterior above-grade pipes shall have flanged joints as described herein unless otherwise scheduled or unless described otherwise in these Contract Documents.
2. Restrained Mechanical Joints.
 - a. Restrained mechanical joints shall be of mechanical joint type with wedge action type restraints, Megalug by EBAA Iron, Inc. or approved equal and shall conform to applicable sections of ANSI 21.10/AWWA C110 and ANSI 21.11/AWWA C111 or ANSI 21.53/AWWA C153, as applicable.
3. Flanged Joints.
 - a. Flanged joints shall conform to ANSI 21.15/AWWA C115.
 - b. Flanges shall be ductile iron.
 - c. Flanges shall be screw-on type flanges and face of flange shall be machined after installation of flange onto pipe.
 - d. Flanges shall be rated for a maximum working pressure of 250 psi, unless otherwise notes, and shall be drilled with a bolt pattern conforming to ANSI B16.1 Class 125.
 - e. Pipe lengths shall be fabricated to meet requirements of Drawings and design of each contractor-selected manufacturer.
 - f. Bolts for flanged pipe shall be 316 stainless steel and shall be of standard sizes as recommended by pipe manufacturer except;
 - 1) where inserts or spacers placed between flanges require use of longer bolts.
4. Grooved Joints.
 - a. Shall not be permitted to be used for this project.
5. Flanged Coupling Adapters.
 - a. Shall be used only for interior piping.
 - b. Flanged adapters supplied by manufacturer of pipe couplings, shall be provided as shown on Contract Drawings and at locations where required by equipment manufacturer for proper equipment installation.

- c. Flanged adapters supplied by manufacturer of pipe couplings shall be 125-pound ASA flanges rated for a maximum working pressure of 150 psi.
- d. Flanged adapters for pumps shall be in accordance with couplings and adapters as stated hereinafter.

E. Fittings.

1. Fittings shall be ductile iron and shall be of standard lengths and conform to ANSI A21.10/AWWA C110 or ANSI 21.53/AWWA C153.
2. Fittings shall be provided with same type of joint as pipe system except as otherwise noted herein.
3. Bolt pattern shall be drilled to conform to ANSI B16.1 Class 125.

2.03 JOINTS IN PIPING

A. Flanged Joints

1. Shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places.
2. Bolts or studs shall be uniformly tightened around joints.
3. Where stud bolts are used, bolts shall be uniformly centered in connections and equal pressure applied to each nut on stud.
4. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.
5. Gaskets shall be full face minimum 1/8-inch thick synthetic rubber conforming to Appendix A of ANSI A21.15/AWWA C115.
6. Flanges shall conform to AWWA Standard C115 (ANSI A21.15) with bolts provided in size and number called for and in accordance with American Standard with hexagonal nuts.
7. For bolt sizes and lengths, "Handbook of Cast Iron Pipe" should be consulted.

2.04 OUTSIDE COATINGS

- A. All exposed steel and cast or ductile iron piping shall receive a rust inhibitive shop primer plus cover coats in accordance with Section 09 96 00.
1. Surfaces to be painted shall be prepared in a workmanlike manner with objective of obtaining a smooth, clean and dry surface.
 2. Rust, dust, scale, oil, grease, as well as all other loose or foreign substances, including weld blisters, fins, and burrs shall be removed by cleaning, wire brushing, chipping, or sandblasting.
 3. To prevent new rusting, cleaned surfaces shall be painted immediately after cleaning.
 4. Surfaces located within 2 inches of joints which are to be field welded shall be left unpainted.

2.05 HANGERS AND SUPPORTS

- A. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or otherwise as may be required by location. Refer to Section 40 27 00.

2.06 FLEXIBLE COUPLINGS

- A. Unless otherwise shown or specified, flexible couplings shall be of a gasketed, short sleeve or split-sleeve type, with a diameter to fit pipe properly. Flexible couplings shall have a working pressure of not less than 150 PSIG.
- B. Each short sleeve coupling for joining cast iron or ductile iron pipe shall consist of one cylindrical cast iron middle ring without pipe stop, two high-grade malleable iron or steel followers, two rubber compound, wedge section gaskets, and a sufficient number of track head, electroplated steel bolts to compress gaskets properly. Cast iron couplings shall be Dresser Style 253, Smith-Blair Style 441, or equal.
- C. Each short sleeve coupling for joining steel pipe shall consist of one cylindrical steel middle ring without pipe stop, two steel follower rings, two rubber-compound, wedge section gaskets, and a sufficient number of track head, electroplated steel bolts to compress gaskets properly. Steel couplings shall be Dresser Style 38, Smith-Blair Style 411, or equal.

2.07 EXPANSION COUPLINGS

- A. Elastomer Bellows:
 - 1. Type: Reinforced molded wide arch. Expansion coupling shall have a rubber inner tube, a body constructed of multiple plies of fabric impregnated with synthetic rubber, and a protective outer cover of synthetic rubber to provide resistance to deterioration from weather and ozone. Steel wire shall be imbedded in body for additional strength.
 - 2. End Connections: Flanged, drilled 150-pound ASME B16.5 standard with split galvanized steel retaining rings unless otherwise specified. Flanges shall be full-pattern so that gaskets are not necessary.
 - 3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
 - 4. Thrust Protection: Control rods to protect bellows from overextension.
 - 5. Bellows Arch Lining: EPDM.
 - 6. Arch shall be filled for piping carrying liquids containing solids.
 - 7. Rated Temperature: 250 degrees F.
 - 8. Rated Deflection and Pressure:
 - a. Lateral Deflection: 3/4 inch, minimum.
 - b. Burst Pressure: Four times working pressure.
 - 9. Manufacturers and Products:
 - a. General Rubber Corp.; Style 1015 Maxijoint.
 - b. Mercer; Flexmore Style 450/ 510 (filled arch).

- c. Proco Products, Inc.; Series 251/ 231 (filled arch).
- d. Red Valve; Redflex J1.
- e. Or equal.

2.08 DISMANTLING JOINT

- A. Dismantling joint shall in conformance to AWWA C219 for Bolted, Sleeve-Type Couplings for Plain End Pipe. Dismantling joint shall be restrained joint and allow up to 2-inches longitudinal adjustment. Dismantling joint shall be furnished as a complete assembly consisting of spigot piece, flange adapter, tie bar and gaskets.
 - 1. Materials of construction shall be:
 - a. Spigot piece shall be ASTM A283 grade C steel.
 - b. Flange adapter in sizes up to 12-inches shall be ASTM A536 Grade 65-45-12 ductile iron.
 - c. Flange adapter in sizes above 12-inches be ASTM A283 Grade C steel.
 - d. Tie bars shall be ASTM A193 Grade B7 threaded rod utilizing rolled threads.
 - e. Gasket material shall be EPDM Grade E.
 - f. Coating shall be fusion-bonded epoxy interior, and epoxy primer exterior for field applied topcoat.
 - 2. Dismantling joint shall have a design pressure rating equal to or greater than mating flanges. Gasket seal locking studs and nuts shall be separate and independent of tie bar restraint system. Tie rod diameter shall be equal to corresponding bolt diameter of mating flange. Tie bar restraint system shall be fully end load resistant and designed with a safety factor of six.
 - 3. Dismantling joint shall be as manufactured by Dresser, Viking Johnson, Romac or approved equal.

2.09 RESTRAINED FLANGED COUPLING ADAPTER (DI PIPE)

- A. Flanged adapters shall be used for joining plain end ductile iron pipe to flanged valves, pipe, and fittings. Flanged adapters shall be suitable for working pressures to 150 PSIG and be fully restrained.
- B. Flanged adapters shall consist of an ASTM A536 ductile iron body drilled to mate with a 125-pound cast iron flange per ANSI/AWWA C115.15. B16.1, a cast iron follower ring, a rubber-compound, wedge section gasket, and a sufficient number of track head, electroplated steel bolts to compress gasket properly.
- C. Restrained flange coupling adapters shall be EBAA Iron Megaflange 2100 or equal.

2.10 PIPE ACCESSORIES

- A. Fittings - Same materials, class, coatings and linings as pipe unless specifically described otherwise under pipe description. Fittings molded or formed to suit pipe size and end design and in required tee, bends, elbow, couplings, adapters, cleanouts, reducers, and other configurations.

- B. All fittings 4 inches and larger for water distribution piping and sewage force mains shall be Ductile Iron.
- C. Where piping is to be installed above ground or within structures provide adequate supports and bracing by means of hangers, brackets or concrete supports as may be required by location. See Section 40 27 00.
- D. Hangers and supports shall be as specified in Section 40 27 00.
- E. Pipe openings in walls shall be precast or core drilled and completely sealed against water seepage with a mechanical type seal consisting of interlocking synthetic rubber links and nuts with pressure plates wider at ends, seal shall be link seal manufactured by Thunderline Corporation, Wayne MI, or equal.
- F. Pipe Connection Table - When connecting dissimilar pipe materials or when connecting new pipe to existing pipe, following connections shall be used:

Type to Type	Solvent Cement Socket Coupling	SDR PVC to Schedule 40 (GSX/SXS)	PVC Gasketed Repair Sleeve	Cast Coupling	Rubber Adapter with Shear Ring	Repair Clamp	MJ Adapter	Butt Fused	Electro-fusion	Flanged Coupling Adapter
Sch 40 to Sch 40	✓					✓				
Sch 40 to SDR PVC		✓								
Sch 80 to Sch. 80	✓					✓				
Sch 40, 80, or SDR PVC to DIP/CIP				✓		✓				✓
Sch 40, 80, or SDR PVC to clay					✓					
Sch 40, 80, or SDR PVC to asbestos cement				✓						
DIP/CIP to clay					✓					
SDR PVC to SDR PVC			✓	✓						
DIP/CIP to DIP/CIP				✓		✓				✓
CIP/DIP to Asbestos cement				✓						
PE to CIP/DIP							✓			✓
PE to Asbestos Cement							✓			
PE to PE								✓	✓	

1. Rubber Adapter With Stainless Steel Shear Rings (4 to 15 Inches) - Fernco Flexible Couplings by General Engineering Company, Box 609, Frederick, MD 21701; or equal.
2. Repair Clamp - Dresser Model 360 “All-Around” pipe repair clamps in stainless steel; or equal.
3. Cast Coupling:
 - a. Pipes up to 16 Inches – Couplings shall be ductile iron fittings, Smith-Blair Model 442 “Long Sleeve”, Dresser Model 253 “Modular Long Sleeve”, or equal with stainless steel bolts and nuts. Couplings shall receive two coats of coal tar epoxy paint on all exterior surfaces prior to installation.
 - b. Pipes larger than 16 Inches – Couplings shall be ductile iron fittings, Smith-Blair Model 411 or Dresser Model 38, or equal with stainless steel bolts and nuts. Couplings shall receive two coats of coal tar epoxy paint on all exterior surfaces prior to installation.
4. Mechanical Joint (MJ) Adapter
 - a. MJ adapters shall be provided with a stiffener.
 - b. MJ adapters shall be provided by Driscoplex, ISCO, or Smith-Blair.
5. Fused Joints - Butt fusion or electro-fused joining methods shall be used in accordance with manufacturer’s written instructions.
6. Restrained Couplings - Restrained couplings shall be provided as necessary and as indicated on Drawings for pipe sizes up to 12 inches instead of cast couplings when connecting ductile iron pipe, C900 PVC or SDR PVC pipe. Coupling shall be Series 3800 by EBAA Iron, Inc. or equal.
7. Flanged Coupling Adapters
 - a. Flanged coupling adapters for pipe sizes up to 24 inches shall meet ASTM A512.
 - b. Flanges on pipe up to 5 inches shall be ANSI 150-lb flat face. Flanges for pipes 6 inches and larger shall be AWWA C207 Class D, ANSI 150-lb.
 - c. Followers 3 inches through 12 inches shall be ductile iron ASTM A536, and for 14 inches and larger shall be heavy rolled steel AISI C1018.
 - d. Gasket shall be Grade 60 rubber.
 - e. Bolts and nuts shall be Type 304 stainless steel.
 - f. Studs shall not be used unless required for particular service. If used, studs shall be Type 304 stainless steel.
 - g. Assembly shall be finished with fusion bonded epoxy.
 - h. When connecting high density polyethylene, a 304 stainless steel stiffener shall be provided.
 - i. Flanged coupling adapters shall be Model 913 by Smith-Blair, Dresser Style 128, or equal.

8. Sleeves:
 - a. Sleeves for use in connecting ductile iron or PVC pipe shall be mechanical joint and shall be manufactured by American Cast Iron, U. S. Pipe, Griffin, McWane Pipe, or approved equal.
 - b. Sleeves shall be 250-psi pressure rating cast iron meeting latest requirements of AWWA Standard C-110 or 350 psi pressure rating ductile iron meeting latest AWWA Standard C-153.
- G. All couplings and adapters shall be of restrained type if used in any piping system called for in Pipe Schedule to be restrained. Additionally, restrained couplings and adapters shall be used whenever coupling or adapter and/or associated piping system shall be subject to any internal pressure above or below atmospheric pressure.

2.11 IDENTIFICATION

- A. Each pipe length and fitting shall be clearly marked with:
 1. Manufacturer's name and trademark.
 2. Nominal pipe size and class.
 3. Material Designation.
 4. Date of manufacture.

2.12 SHOP TESTS

- A. General
 1. All shop tests of pipe and pipe materials required by this section and/or applicable ASTM/AWWA specifications shall be performed at Contractor's expense.
 2. Refer to Piping Schedule for specific shop tests. If no tests are specified in Piping Schedule, pipe manufacturer shall submit a performance affidavit certifying his product meets or exceed these specifications and applicable ANSI/ASTM and AWWA requirements. If required by Engineer, certified test reports of prior tests shall be submitted with performance affidavit.
 3. Tests shall be conducted at pipe manufacturer's plant or when approved test facilities do not exist at point of manufacture, tests shall be conducted in certified private testing laboratories approved by Engineer.
 4. All testing machines, gauges, laboratory apparatus and other devices used for required shop tests shall be in first class condition and accurately calibrated. Shop tests shall be conducted by qualified personnel.
 5. Contractor shall submit to Engineer name or names of proposed manufacturers of pipe for this project, including shop drawings of proposed pipe and appurtenances. Each pipe manufacturer shall notify Engineer and Contractor when shop tests on lot or lots of pipe for this project are to take place, allowing sufficient time for Engineer to send a representative to witness tests.
 6. Tests shall be conducted in accordance with applicable ANSI, ASTM or AWWA specifications except as modified by these Specifications.

7. Wherever in appropriate ASTM or AWWA Specification, tests are required to be performed only “when requested by purchaser” (or words of like intent), all such optional tests shall be required and performed for all pipe furnished for this project. Certified copies of all test (and retest) results shall be submitted jointly to Engineer and Contractor unless foregoing Paragraph No. 3 applies.
8. Specific modifications and/or amendments to applicable ASTM Specifications are as follows:
 - a. Crushing Strength - Crushing strength tests shall be conducted using 3-edge bearing method except that lower bearing strips utilized in these tests may be of hardwood or hard rubber material complying with applicable ASTM Specification, unless such option is precluded under companion ASTM Specification which covers pipe itself.
9. Hydrostatic Test - When stated in Piping Schedule, hydrostatic tests shall be conducted on 0.5 percent of total length of pipe of each size produced for and shipped to this project, but in no case less than two sections (or pieces) of pipe and joint assembly of each size from lot manufactured during each 8-hour shift. test specimens of each size shall be selected at random, assembled together using required joint gaskets and couplings, suitably plugged at each end with properly anchored bulk-heads, filled with clear water, and internal hydrostatic pressure applied over a given time period as follows:

Pipe Material	Minimum Pressure	Time
Clay	5 psi	5 min.
Reinforced concrete	5 psi	15 min.
Cast iron soil pipe	5 psi	5 min.
Ductile Iron and PVC	5 psi	5 min.

- a. Polyethylene (ASTM F894) conformance tests including ASTM D618, D2122 ring stiffness constant (RSC) (D2412) and (D3212).
 - b. Specimens showing obvious leakage in pipe wall or at joint, which shall prevent compliance with required leakage tests in field, shall be tagged and rejected. If joint assembly itself is suspected as only cause for leakage, another test may be run on same specimens using another set of gaskets and couplings. If this leakage test is met, original gaskets and couplings shall be rejected, although pipe sections themselves may be shipped.
10. Upon completion of shipment of pipe furnished for this project, pipe manufacturer shall provide Engineer with a certificate, signed by an officer of corporation or firm and witnessed by a notary public, attesting that pipe and appurtenances furnished were manufactured and successfully tested in full accordance with these specifications and applicable ASTM Specifications.
11. Any section or lot of pipe, fittings or specials which does not meet requirements of these specifications and applicable ASTM, ANSI or AWWA Specifications under which product is required to be manufactured, shall be rejected.

2.13 PIPE INSULATION AND JACKETING

- A. See Section 40 41 13 for insulation and heat tracing requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Contractor shall verify all existing conditions. For interior piping, Contractor shall verify that structures are complete enough to receive pipe.
- B. Drawings and specifications may contain information relating to conditions below ground surface at site of proposed work, but such information is furnished without guarantee as to it being complete or correct. Contractor shall assume all risk and responsibilities and shall complete work in whatever manner and under whatever conditions he may encounter or create without extra cost to Owner. Location of existing underground facilities at or contiguous to site is based upon information and data furnished to Engineer by owners of such underground facilities or others, and Owner and Engineer do not assume responsibility for accuracy or completeness thereof. Contractor shall perform exploratory excavations in advance of this work to verify location, depth, size, and material of existing utilities which may interfere with work to be performed under this contract. All damage to existing utilities shall be Contractor's cost to repair or replace.
- C. Verify that trench cut, excavated base and pipe bedding are ready to receive pipe and that excavations and pipe bedding dimensions and elevations are as shown on Drawings or specified herein.
- D. All pipe or fittings which have been damaged in transit or which are obviously deformed or refinished in any way shall be rejected, marked, and removed from site of work. Any pipe or fitting which Engineer suspects is improper for job shall be temporarily rejected, marked, and set aside for subsequent investigation to determine its conformity with specifications.
- E. All pipes, fittings, and specials shall be carefully inspected in field before lowering into trench. Cracked, broken, warped, out-of-round, damaged pipe joints including damaged pipe lining or coatings or specials, as determined by Engineer, shall be culled out and not installed. Such rejected pipe shall be clearly tagged in such manner as not to deface or damage it, and pipe shall then be removed from job site by Contractor at his own expense.
- F. Any pipe showing a distinct crack with no evidence of incipient fracture beyond limits of visible crack, if approved, may have cracked portion cut off by, and expense of, Contractor before pipe is laid so that pipe used is perfectly sound and shall form an approved joint. cut shall be made in sound barrel at a point at least 12 inches from visible limits of crack.
- G. If authorized, cutting of pipe shall be done in a neat and workmanlike manner without damage to pipe lining. All pipe cutting shall be done by means of an approved type of power cutter and in accordance with manufacturer's instructions. Use of hammer and chisel, or any other method which results in rough edges, chipped or damaged pipe, is prohibited.

3.02 PREPARATION

- A. Contractor shall have on job site with each pipe laying crew, all proper tools, gauges, pipe cutters, lubricants, etc. to handle, cut, lay pipe and join pipe.
- B. Flat-bottom trenches of required width shall be excavated to necessary depth as required and maintained in accordance with Section 31 23 16.
- C. Prior to installing pipe foundation material, trenches shall have all water removed and all work performed in a dry trench. Pipe installation in frozen trench bottoms is not permitted.
- D. All pipes, fittings and specials which are to be installed in open trench excavation shall be properly bedded in a uniformly supported on pipe foundations of type specified in Section 31

23 23 and shown on Drawings. In particular, stones 2 inches and larger shall be removed from bearing surface of pipe foundation.

- E. Pipe foundation bedding material shall be spread in maximum 8-inch layers and each layer shall be compacted until required total depth of bedding has been established.
- F. Compaction methods include hand tamping with T-bars, flat heads, and shovel slicing as well as mechanical compactors. Use of a hydrohammer shall not be permitted within 4 feet of top of a pipe.
- G. Contractor shall perform his bedding operations with care to maintain straight alignment and consistent grade.
- H. Suitable holes or depressions shall be provided in pipe bedding to permit adequate bedding of bells, couplings, or similar pipe projections.

3.03 LINES AND GRADES

- A. Contractor shall furnish all labor, materials, surveying instruments, and tools to establish and maintain all lines and grades. Contractor shall have personnel on duty or on standby call, at all times, who are qualified to check line and grade of water mains as they are installed.
- B. Easements, property, staked centers of manholes and catch basins, and other control lines necessary for locating work as well as elevations used in design of work are shown on Drawings. Bench marks are shown on drawings.
- C. Contractor shall use this information to set line and use laser equipment to set line and grade. Contractor shall check grade of pipe by use of level instrument and rod at not more than 50-foot intervals.
- D. During construction, Contractor shall provide Engineer, at his request, all reasonable and necessary materials, opportunities, and assistance for setting stakes and making measurements, including furnishing of rodmen or chainmen as needed at intermittent times.
- E. Contractor shall carefully preserve bench marks, reference points and stakes established by Engineer or Owner, and in case of willful or careless destruction by his own operations he shall be charged with resulting expense to reestablish such destroyed control data and shall be responsible for any mistakes or delay that may be caused by unnecessary loss or disturbance of such control data.
- F. Contractor may use laser equipment to assist in setting pipe provided he can demonstrate satisfactory skill in its use.
- G. Use of string levels, hand levels, carpenter's levels or other relatively crude devices for transferring grade or setting pipe are not to be permitted.

3.04 TOLERANCES

- A. Pipes shall be laid to lines and grades shown on Drawings or as specified herein.
- B. Minimum depth of cover shall be maintained as shown on Drawings or as described herein.
- C. Pipes shall be straight between manholes or between points of connection to structures or pipes.
- D. Invert elevations at any location shall not vary from design elevations by more than 0.05 feet, unless a change in invert elevation has been ordered by Engineer, in which case same tolerance shall apply.

3.05 INSTALLATION

- A. All piping shall be installed by skilled workmen in accordance with best standard practice for piping installation, and in accordance with manufacturer's installation instructions where applicable.
 - 1. Proper tools and appliances for safe and convenient handling and installing of pipe and fittings shall be used.
 - 2. Great care shall be taken to prevent any pipe coating from being damaged on inside of pipe and fittings. All pieces shall be carefully examined for defects and no piece shall be installed which is known to be defective.
 - 3. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by Contractor and at his own expense.
 - 4. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in complete work.
 - 5. All piping connections to equipment or tanks shall be provided with unions or coupling flanges located so that piping may be readily dismantled from equipment or tank.
 - 6. At certain applications, Dresser or victaulic couplings may also be used, subject to Engineer's approval.
 - 7. All piping shall be installed in such a manner that it shall be free to expand and contract without injury to itself or surrounding structures or equipment.
 - 8. All piping shall be erected to accurate lines and grades and shall be supported and braced against movement temporary or permanent.
- B. Where process piping assemblies connect to equipment, valves or tanks, such piping shall be rendered compatible with approved equipment, valve or tank installed and any necessary modifications to original piping shall be shown in scaled layout on appropriate shop drawings submitted to Engineer.
- C. Piping assemblies under 4-inch size shall be essentially supported on walls and ceilings, unless otherwise shown on Drawings, being kept clear of openings and positioned above "headroom" space; where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.
- D. Installation of ductile iron pipe or plastic pipe to be in conformance with AWWA C600 or ASTM D2774, respectively, except as modified in this Section or referenced Sections or as shown on Drawings. Installation of other pipe materials shall be in conformance with their specified standards unless otherwise modified in these Contract Documents.
- E. Contractor shall furnish slings, straps and/or approved devices to provide satisfactory support of pipe when it is lifted. Transportation from storage areas to trench shall be restricted to operations which can cause no damaged to pipes, lining, castings, or coatings.
- F. Pipe shall not be dropped from trucks onto ground or into trench.
- G. Pipe laying shall proceed upgrade with bell ends pointing in direction of flow.
- H. Each pipe section shall be placed into proper position in trench on pipe bedding in such manner and by such means required to cause no injury to pipe, persons or to any property.

- I. When pipe is in proper position it shall be joined or coupled to mating end of previously laid pipe, using required joint and following manufacturer's recommended assembly procedure and as approved by Engineer. Each pipe shall be aligned with that already in place, end of previously laid pipe wiped clean, and new pipe forced home completely with horizontal axial movement and held securely in position. For reinforced concrete pipe with gasket-type joint, coat rubber gasket with recommended lubricant and snap into place in groove provided at spigot end. Before joint is shoved home, fill outer joint space with a continuous loop of polyurethane foam and unhydrated Portland cement or Butyl mastic recommended by manufacturer. When joint is shoved home, material should be squeezed firmly against shoulder of spigot to completely fill and seal outer joint space. Care shall be taken to insure that gasket is not twisted or dislodged and that pipe spigot is inserted proper distance into socket.
- J. At joints, enough depth and width shall be provided to permit pipe layer to reach entirely around pipe so that joints may be made in accordance with manufacturer's recommendations. Mechanical type joints shall be tightened within AWWA recommended torque range. Bolts shall be tightened alternately 180 degrees apart.
- K. Pipes, fittings, and specials shall be firmly bedded in pipe foundation so that pipe barrel is uniformly supported and cradled throughout its length and shall have full bearing throughout their entire length, which shall be accomplished by combination of shaping bedding and adequately compacting pipe bedding and backfill under and around pipe to spring line of pipe. Backfilling and compaction shall be in conformance with Sections 32 11 00 and 31 23 23.
- L. Pipes located under slabs shall be encased in accordance with Section 31 23 23.
- M. When installed laid in tunnels, pipes shall be blocked in such a manner as to take weight off bells. Pipe laid in normal trench excavation shall not be laid on wood blocking.
- N. Backfill material within 12 inches of pipe shall be free of stones greater than 2 inches in any dimension.
- O. Unless otherwise shown on Drawings, minimum total finished cover over top of pipe barrel of all pipes shall be 3.5 feet (42 inches).
- P. Refer to Sections 32 11 00 and 31 23 23 for other installation guidelines and requirements.
- Q. To deflect a pipe joint, first join pipe in proper manner and then deflect pipe within allowable deflection recommended by manufacturer. Contractor shall have a table showing maximum allowable deflections on site whenever pipe laying is occurring.
- R. If required, installation of polyethylene sleeves to be performed in accordance with manufacturer's instructions and ANSI A21.4/AWWA C105.
- S. Install magnetic locating tape, minimum 2 inches wide with words "Water Line Below", "Sanitary Sewer Below", or "Storm Sewer Below", or #14 copper wire if directed by Owner and Engineer, along centerline of installed pipeline for entire length at a maximum depth of 2 feet 0 inches below finished grade. If given services not listed, obtain magnetic locating tape with words applicable to given service, such as "Chemical", "Vent", etc.
- T. For each pipe entering or leaving a manhole or underground structure, two (2) pipe joints shall be located within 4 feet of outside face of wall or structure. first joint shall be a maximum of 2 feet from outside face. A wall pipe joint may be considered one of required joints.
- U. At end of each day's work or at intervals of length at option of Engineer, Engineer, with Contractor, shall check grade and inspect pipe for alignment. Defective work shall be dug up and reinstalled to satisfaction of Engineer.

- V. Completed assembly of pipe sections shall form a pipeline with uniform slope.
- W. Except where direct replacement of existing pipelines is required, no connections to existing live pipelines or laterals shall be made until leakage test and all other requirements are met and connections approved by Owner and Engineer.
- X. Pipe and fittings shall be true to both line and grade, shall show no leaks, shall show no obstruction to flow, shall have no projections of connecting pipe into line, shall be free from cracks and protruding joint materials, and shall contain no deposits of dirt, debris or other material which shall in any way reduce full cross sectional area of pipe.
- Y. Any section of pipeline which does not comply with inspection criteria defined above, shall be promptly corrected or repaired by Contractor at his own expense.
- Z. Pipe which is cracked or collapsed shall be replaced with new pipe. Pipe which is either out of line or grade shall be dug up and reinstalled to correct line and grade. Work shall be at Contractor's expense.
- AA. At points of leakage, pipe shall be dug up and replaced or repaired with approved pipe connections made in accordance with pipe connection table so as to permanently stop leak in a manner which shall receive prior approval of Engineer.
- BB. All fittings, valves, and hydrants shall be placed at required locations, spigots centered in bells, and all valve and hydrant stems plumb. Pipe shall be cut so that valves, fittings, and specials can be inserted in a neat manner to avoid any damage to pipe. Pipe cutting shall be done in a manner approved by pipe manufacturer in order to leave a smooth end at right angles to pipe axis.

3.06 CONNECTIONS TO EXISTING PIPE OR STRUCTURES

- A. Water Distribution Piping.
 - 1. Connections to existing water mains shall be by dry connection by inserting a tee with coupling or wet connection by tapping sleeve and valve, where shown on Drawings and as necessary to accomplish work and to minimize service interruptions.
 - 2. Contractor to verify outside dimension of existing water main.
 - 3. Couplings to be ductile iron fittings, Smith Blair Model 442 or 411, or equal with stainless steel bolts and nuts. Couplings shall receive two coats of coal tar epoxy paint on all exterior surfaces prior to installation.

3.07 TEMPORARY PLUGGING AND SECURING

- A. At all times when pipe laying is not actually in progress, including overnight, over weekends, or whenever dirt or debris could enter pipe during construction, open ends of pipes shall be closed temporarily with manufactured pipe plugs or temporary bulkheads or by other means such that there is no possibility of any water or foreign material entering line. If water is in trench when work is resumed, plugs shall not be removed until water has been removed and work can proceed in a dry stable trench. Newly installed pipe shall not be used to remove groundwater from trench. End of pipe shall be carefully secured to avoid displacement of misalignment while construction activities are not occurring.

3.08 CLEANING PIPELINE

- A. At conclusion of work, Contractor shall thoroughly clean all new pipes by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered during construction period.

1. Pipes shall be flushed at a minimum rate of 2.5 feet per second for a suitable duration.
 2. If, after this cleaning, any obstructions remain, they shall be corrected to satisfaction of Engineer.
- B. Where required, Contractor shall use mechanical methods to clean pipes when flushing does not remove all obstructions or material.

3.09 TESTING AND OTHER INSPECTIONS

- A. All piping shall be leak tested and flushed as required in Piping Schedule and in accordance with procedures outlined in Section 33 13 00 for respective pipe system.
- B. Any section of pipe that fails leak test shall be dug up and replaced or permanently repaired as approved by Engineer. All repairs and/or replacements shall be Contractor's cost. replaced or repaired section shall then be retested.

3.10 DISINFECTION

- A. All pipe and fittings connected to and forming part of a potable water supply system or non-potable water system shall be flushed, disinfected, and coliform tests conducted in accordance with Section 33 13 00.
- B. Disinfection shall be accomplished only after pipe has passed hydrostatic tests and shall be in accordance with AWWA Specification C651.
- C. Chlorine solution shall be flushed and disposed of in accordance with Section 33 13 00.

3.11 FLUSHING CONNECTIONS

- A. Each flushing connection shall consist of an eccentric blind flange tapped for 1-1/2-inch minimum IPS with a reducing bushing to 1-inch IPS, a 1-inch short nipple, and a 1-inch gate valve or ball valve. Each gate or ball valve on flushing connections shall be provided with a 1-inch IPS to 1-inch quick disconnect female hose coupler, and as sized otherwise on Drawings.
1. Female hose couplers shall be provided with appropriate threads or adapters and any necessary nipples to make a leak-proof seal when attached to gate valves.
 2. Hose couplers shall be Ever-Tite; OPW Kamlock; or equal.
 3. Valves for flushing connections shall be in accordance with Section 33 12 00.

3.12 COUPLINGS AND ADAPTERS

- A. All couplings and adapters shall be of restrained type if used in any piping system called for in Pipe Schedule to be restrained. Additionally, restrained couplings and adapters shall be used whenever coupling or adapter and/or associated piping system shall be subject to any internal pressure above or below atmospheric pressure.
- B. Flanged adapters shall be used to join process piping to all pump flanges and one end of each valve to allow ease of disassembly of piping from valves and pumps for maintenance and replacement.
1. Adapters shall be restrained to process piping by use of tie rods.

2. Couplings and/or adapters shall be provided by Contractor for alignment of similar types of pipe or connecting dissimilar pipe materials as required in accordance with detail shown on Drawings and as described herein.
3. Unions shall be provided adjacent to all pumps, tanks, valves and other pieces of equipment where soldered or screwed joints are utilized.
4. Provide couplings and flanged adapters as required and in accordance with this clause.
5. Where couplings and adapters are to be used they shall be installed in complete accordance with manufacturer's recommendations.

Application	Manufacturer
Flange adapters for ductile	Dresser Style 127, Smith-Blair 913, EBAA Iron Megaflange 2100, or equal
Couplings suitable for pipe material	Dresser Style 253, Smith-Blair 441, or equal
Couplings suitable for pipe material	Dresser Style 38, Smith-Blair 411, or equal

3.13 FLEXIBLE COUPLINGS

- A. Flexible couplings shall be installed on all piping and conduit wherever such piping crosses a structural expansion joint.
 1. A 1/8-inch gap shall be left between adjacent lengths of pipe with a flexible coupling joining piping.
 2. Piping shall be supported by pipe supports each side of flexible coupling as shown on Drawings and as specified in Section 40 27 00 so that coupling transmits no loads.
 3. Contractor shall provide permanent restraints for all flexible couplings installed on piping.
 4. Restraints shall keep pipe from separating when subjected to pressures up to 175 psig.
 5. Permanent restraints shall consist of tie rods and straps or welded clip angles as shown on Drawings.
 6. Permanent restraints shall also be furnished and installed on piping at adjacent pipe supports to prevent any longitudinal movement.
 7. All restraint hardware to be supplied and installed in accordance with manufacturer's recommendations.
- B. Flexible couplings to allow for thermal expansion of aeration piping shall be furnished and installed per manufacturer's instructions at locations designated in approved piping layout prepared by coupling manufacturer: "Depend-O-Lok" by Victaulic (D-O-L; FxF Type 1 Coupling). Submit piping layout to Engineer showing proposed coupling locations.

3.14 VALVES AND HYDRANTS

- A. Valves and hydrants to be installed on this project are specified in Section 33 12 00.
- B. Refer to drawings for locations of valves and hydrants to be installed on this project.

- C. Valve boxes shall be installed vertically and valve box extensions shall not impede use of T-wrench.

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SECTION 33 11 13

WATER WELL

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. Drilling and sampling of a pilot borehole near identified Production Well location.
2. Geophysical logging.
3. Construction and development of a gravel-packed Production Well as shown on Drawings and as specified herein. Production Well shall be ready to operate and shall be complete with all necessary pumps, motors, piping, valves, fittings, controls, accessories, and appurtenances, to form a complete operating system in compliance with these specifications and as shown on Drawings.
 - a. Estimated capacity of up to 2,500 GPM.
 - b. Estimated Depth of 725 feet.
4. Performing well plumbness and alignment tests on Production Well.
5. Test pumping of the Production Well. Contractor shall provide all testing as required herein and as submission to Tennessee Department of Environment and Conservation (TDEC) as required for determination of well capacity and initiation of well operation.
6. Water quality sampling of Production Well.
7. Down-hole video of Production Well.
8. Production Well will be finished off with a permanent vertical turbine pump (see Section 43 21 17 Well Pump). Contractor shall connect new pump to existing yard piping, as shown on contract drawings.
9. Disinfection of the Production Well.
10. Well analysis and report.
11. Abandonment of the new well if directed by the Owner and Engineer.
12. Miscellaneous work specified or required.

B. Related Sections include but are not necessarily limited to:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 09 96 00 – Painting and Coatings.
3. Section 10 14 20 – Signage Requirements.
4. Section 11 05 13 – Motors.

5. Section 33 11 00 – Piping.
6. Section 33 12 00 – Valves.
7. Section 43 21 06 – General Requirements for Pumping Equipment.
8. Section 43 21 17 – Vertical Turbine Pump
9. Section 46 05 00 – General Requirements for Equipment.
10. All electrical equipment, controls, and wiring shall be in full compliance with Division 26 and 40 Specifications.

1.02 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.
- B. All references shall refer to latest edition of that reference including any revisions.
- C. Organizations and Legislative Documents:
 1. American Petroleum Institute (API)
 2. American Society for Testing Materials (ASTM)
 3. American Water Works Association (AWWA)
 4. American Welding Society (AWS)
 5. NSF International (NSF)
 6. Tennessee Code (Tenn. Code)
 7. Tennessee Department of Environment and Conservation (TDEC)
- D. Publications:

Reference	Title
API 5L	Specification for Line Pipe
API 10D	Specification for Bow-string Casing Centralizers
API 10A	Specification for Materials and Testing for Well Cements
API 13A	Specification for Drilling Fluids Materials
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Stainless
ASTM A139	Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
ASTM A589	Standard Specification for Seamless and Welded Carbon Steel Water-Well Pipe
ASTM C33	Fine Aggregate
ASTM C136/C136M	Standard Test Method for Sieve Analysis of Fine to Coarse Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C494	Standard Specifications for Chemical Admixtures for Concrete

Reference	Title
ASTM D1586	Standard Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D1785	Standard Specification for Poly-Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120
ASTM F480	Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), Schedule 40 and Schedule 80
AWS	Code for Arc and Gas Welding
AWWA A100	Standard for Water Wells
AWWA B100	Standard for Granular Filter Material
AWWA C200	Standard for Steel Water Pipe, 6 Inches or Larger
AWWA C206	Standard for Field Welding of Steel Water Pipe
AWWA C654	Disinfection of Wells
NSF 61	Drinking Water System Components – Health Effects
OSHA 1910	General Industry Standards
OSHA 1926	Construction Industry Standards
TDEC 0400-45-01	Public Water Systems
TDEC 0400-45-09	Water Well Licensing Regulations and Well Construction Standards
Tenn. Code 69-10	Tennessee Code for Well Drilling

- E. TDEC Community Public Water Systems Design Criteria, Water Well Licensing Regulations and Well Construction Standards, and all other related TDEC rules shall apply.

1.03 ELIGIBILITY

- A. Bidders must have five (5) years practical experience in drilling and completing municipal or industrial water wells with a minimum depth of 900 feet and minimum diameter of 30 inches in unconsolidated aquifers. No domestic water well or oil well drilling projects are to be considered. Prospective contractors shall submit a list of at least five (5) recently completed unconsolidated aquifer municipal or industrial water well projects. List shall include name of well owner, address, telephone number, and year completed.
- B. Bidder must be a licensed water well contractor in State of Tennessee in accordance with provisions of Rules of Tennessee Department of Environment and Conservation Division of Water Supply, Chapter 0400-45-09 Water Well Licensing Regulations and Well Construction Standards, and TCA Section 69-10 Well Drilling.

1.04 STANDARDS AND REGULATIONS

- A. Contractor must submit a Notice of Intent (NOI) to TDEC Division of Water Supply on TDEC Division of Water Supply standard Well Program NOI form before drilling can begin. Contractor shall be responsible for fee. Contractor must maintain accurate driller logs, material setting and grouting data, complete results of pump test (including continuous water level measurements in production and monitoring wells), and must furnish a signed copy of results to Owner and to TDEC on a form provided by TDEC or a reasonable facsimile approved by TDEC.
- B. All work shall be performed under direct supervision of a State of Tennessee licensed Water Well Driller.

- C. All municipal water wells shall be constructed only by persons having a valid license issued by state or by persons in employ of license holders. Contractor/Driller shall abide by and implement all requirements on well construction, permits, reports, etc., as described in State of Tennessee Community Public Water Systems Design Criteria.
- D. Contractor is responsible for providing and maintaining a copy of State of Tennessee Community Public Water Systems Design Criteria, TDEC Water Well Licensing Regulations and Well Construction Standards, and a copy of project specifications on site at all times.
- E. Contractor shall obtain, at his own expense, all permits, certificates, and licenses required of him by law for performance of his work. He shall comply with all Federal, State and Local laws, ordinances, or rules and regulations relating to accomplishment of his work.
- F. Contractor shall have all necessary insurance, including but not limited to liability insurance and accident insurance.
- G. Premises, materials, tools and drilling equipment shall be maintained so as to minimize contamination of groundwater during drilling operation.
- H. All welders shall have a current certificate recognized by American Welding Society.

1.05 PERFORMANCE AND DESIGN DETAILS

- A. One (1) Production Well shall be constructed at the Dyersburg Water Treatment Plant.
- B. Production Well design details are as follows:

Well No.6 Design	
Well Design	Gravel Packed
Total Anticipated Well Depth	725 feet
Target Well Yield	2,500 GPM
Borehole Diameter	30 inch
Permanent Casing, Diameter	20 inch
Permanent Casing, Minimum Wall Thickness	0.500 inches
Permanent Casing, Material	Carbon Steel
Screen Type	Wire Wrapped, Continuous-Slot
Screen Diameter	20 inch
Screen Material	18-8 Stainless Steel, Type 304

- C. Contractor shall guarantee against following:
 - 1. Pumping of sand in excess of 5 mg/l at end of two (2) hours of pumping at design rate. Final acceptance will not be guaranteed if water produced contains more than maximum amount of sand specified.
 - 2. Collapse of casing or screens due to causes other than acts of God.
- D. Contractor shall attempt to reach a specific capacity at least of 40 gpm per foot of drawdown at a pumping rate of 2,500 gpm after 24 hours of continuous pumping. Drawdown used for calculation of specific capacity will be water level at end of 24 hours pumping test minus water level at end of 12 hour recovery test.

- E. If well does not produce guaranteed capacity or specific capacity, following procedure will be used:
 - 1. Well driller will at his expense hire a hydrologist approved by Engineer who will determine efficiency of well by a method acceptable to Engineer.
 - 2. If hydrologist and Engineer determine that well is 80 percent (80%) efficient or better, well will be accepted.
 - 3. If efficiency of well is less than 80% and hydrologist and Engineer determine that a better efficiency can be obtained, well driller will resume well development at no cost to Owner. Development will continue until 80 percent (80%) efficiency is obtained or hydrologist and Engineer determine that further development will not increase efficiency of well.
- F. Well efficiency will be calculated by estimating theoretical well specific capacity of a 100 percent (100%) efficient well using transmissivity value calculated from 24 hour pumping test results. Observed specific capacity of well (pumping capacity divided by drawdown) will be divided by theoretical 100 percent (100%) efficient specific capacity to determine efficiency of well.

1.06 SUBMITTALS

- A. Submittals shall be in accordance with Contract Documents including Section 01 00 05.
- B. At a minimum, submittals shall contain, but not be limited to, following information to establish compliance with these specifications:
 - 1. All permits, licenses, and submissions required by TDEC in accordance with Section 01 00 05.
 - 2. Resume of geophysical log analyst.
 - 3. Product Technical Data for all proposed material in accordance with Section 01 00 05, to include:
 - a. Well casing.
 - 1) Provide strength calculations and laboratory analysis of the casing's physical properties as tested by the manufacturer.
 - b. Well screen.
 - 1) Well screen slot size requirements will be selected by Contractor based on Contractor's submittals of formation grain size analysis.
 - 2) Provide strength calculation and laboratory analysis of the screen's physical properties as tested by the manufacturer.
 - c. Well filter pack gradation.
 - 1) Filter pack gradation parameters will be selected by Contractor based on Contractor's submittals of formation grain size analysis.
 - d. Well seal materials
 - 4. Manufacturer's Certification for proposed materials, where applicable, in accordance with Section 01 00 05.

5. Manufacturer's product warranty, where applicable, in accordance with Section 01 00 05.
6. Shop Drawings in accordance with Section 01 00 05.
7. Well Data to be submitted at appropriate times during construction.
 - a. Daily drillers report:
 - 1) During the drilling of the pilot borehole and Production Well, maintain a daily detailed driller's report.
 - a) Indicate any issues/problems encountered and resolution thereof.
 - 2) Furnish a complete description of all formations encountered, number of feet drilled, size of drill stem and size/type of bit used, number of hours on the job, shutdown due to breakdown, quantity of material installed, and other pertinent data as may be requested by the Owner.
 - b. Mud management records.
 - 1) Description of drilling fluids and additives
 - 2) Values of tested drilling fluid properties.
 - c. Well driller's log and associated data submittals
 - 1) During drilling of the pilot borehole and Production Well, prepare and keep a complete log setting forth the following:
 - a) The reference point for all depth measurements.
 - b) The depth at which each change of formation occurs.
 - c) The depth at which the first water was encountered.
 - d) The thickness of each stratum.
 - e) The identification of the material of which each stratum is composed, such as:
 - (1) Clay.
 - (2) Sand or silt.
 - (3) Sand and gravel: Indicate whether gravel is loose, tight, angular or smooth; color.
 - (4) Cementation: Indicate whether grains (if present) have natural cementing materials between them, e.g., silica, calcite, etc.
 - (5) Rock hardness.
 - f) Samples of formations encountered (one set total) collected from drill cuttings on 10 FT intervals and at each pronounced change in formation when drilling pilot boreholes.
 - g) Sieve analysis (ASTM C136) results in both tabular and graphical form. At a minimum the following standard US Sieve Sizes should be used: No. 4,

No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200. Provide a minimum of twenty (20) 7-point sieve analysis per pilot hole:

- h) Twenty (20) samples of water bearing sand for sieving to be selected from drill cutting samples collected between 525 and 725 FT depth.
 - i) The depth to the static water level (SWL) and changes in SWL with well depth if measurable with drilling method used.
 - j) Total depth of pilot borehole and Production Well.
 - k) Any and all other pertinent information for a complete and accurate log.
 - l) Depth or location of any lost drilling fluid, drilling materials or tools.
 - m) The depth of the Production Well surface seal.
 - n) The amount and type of cement (number of sacks) installed for the seal in Production Well.
 - o) The depth and description of the well casing, filter pack, and well sealing materials used in constructing and abandoning Production Well.
 - p) The description (to include type, length, diameter, slot sizes, material, and manufacturer) and depth interval of Production Well screens.
 - (1) Include full manufacturer's recommendations for screen to casing attachment with specific connection or welding recommendations.
 - q) Results of Production Well alignment and plumbness test.
 - r) The sealing off of water-bearing strata, if any, and the exact location thereof.
- d. Pipe tally sheets:
- 1) Prior to the installation of any material, the Contractor shall accurately measure and record the individual lengths of well casing, couplings, and blank pipe sections. The length of each piece shall be clearly marked on each item in a permanent manner approved by the Engineer.
- e. Geophysical logs:
- 1) Following completion of the pilot borehole drilling, perform or have performed the following downhole geophysical logging to include:
 - a) Spontaneous potential log (self-potential).
 - b) Resistively logging to include: short normal, long normal, lateral.
 - c) Natural gamma ray logging.
 - d) Perform geophysical log interpretation by a qualified log analyst.
 - (1) The log analyst must be able to demonstrate competence through background, training and experience when so called upon.

- (2) It is the Contractor's responsibility to assure that all log analyses and interpretations are made by a person so qualified.
 - 2) Geophysical logging data for each well.
 - a) Provide three color field copies of each log to Engineer immediately after completion.
 - b) Logs will become property of Engineer at time logging is completed.
 - 3) In addition to the field copies, submit the digital ASCII files of geophysical data on an USB drive or other method approved by Owner's Representative.
 - 4) Should the geophysical logging subcontractor supply electronic log copies using that subcontractor's proprietary log viewer, that software shall also be provided in a format installable and useable by the Engineer and Owner.
 - 5) Also require the geophysical logging subcontractor to conduct and submit post processing results of geophysical logging data, as required by the Specifications.
- f. Caliper logs:
- 1) Following completion of the Production Well borehole drilling, perform or have performed a caliper log of the borehole to total depth.
 - a) Provide three field copies of log to Engineer immediately after completion.
 - b) Logs will become property of Engineer at time logging is completed.
- g. Well development.
- 1) Provide description of methods, duration, and results of development of well.
- h. Production Well performance test results and recommendations:
- 1) Keep accurate records of the pumping tests and furnish copies of all records upon completion of the tests (manual and electronic readings).
 - a) All pumping test data shall be submitted on paper as well as in electronic format.
 - 2) Include the date of the test, the clock time and elapsed pumping time of each measurement, the depth to water below the measuring point, the pumping rate at the time of measurement, and any pertinent comments on conditions that may affect the measurements.
- i. Provide copies of the results of the well performance tests as described in these specifications.
8. Submit drawings and recommendation for upper casing depth, water-bearing sands to be screened, gage, size and manufacturer of well screen, and type and gradation of filter pack. Obtain written approval from Engineer before ordering Production Well casing, well screen and filter pack.
 9. Submit water analysis laboratory report.
 10. Submit final tabulation of well test data for well.

11. Filter Pack Analysis and Sample
 - a. Submit a laboratory report on mechanical analysis of filter pack for well.
 - b. Before delivery of filter packing material to project site, submit a two (2) pounds ample for approval of well.
12. Submit welder's certificate for each welder on project.
13. Material Certification
 - a. Submit mill certificates for approval of casing and liner before delivery of materials to project site. Mill certificate shall show casing meet specification. Destructive testing in field is not required.
 - b. Provide certification of a reliable testing laboratory that casing meet specifications.
 - c. Provide proof that certificate covers material used in field by using heat or batch numbers marked on pipe.
14. Certified Design Calculations.
15. Digital media copies of final downhole video survey prior to requesting final payment for project.
16. Submit final report on detailed well data including production pumping test on well and vibration analysis for pump and motor.
17. During construction, whenever manufacturer receives notice that components that are part of his system are to be discontinued from manufacture, manufacturer shall inform Engineer within seven (7) days of receiving that notice along with his recommendations on how to resolve this issue.

1.07 PROJECT CONDITIONS

A. Hydrological Conditions.

1. Contractor shall be aware that unfavorable subsurface geologic conditions may exist at selected well site. Loss of circulation may indicate subsurface conditions that, if severe, could cause overlying sediments to collapse, thereby causing surface stability problems at and around site. Contractor shall make all necessary investigations to establish expected subsurface conditions. Contractor, in particular, shall determine appropriate depth for surface casing to prevent well construction problems resulting from overlying sediment collapse and surface instability. Contractor shall be responsible for setting surface casing to a sufficient depth to avoid surface caving and raveling. In addition, Contractor shall use a pit casing to provide a stable platform to perform drilling. depth of pit casing shall be determined by Contractor.
2. Any information regarding sub-surface conditions provided by Owner or Engineer is intended to assist Contractor in preparing his bid. Owner and Engineer do not guarantee its accuracy, nor is it necessarily indicative of conditions to be encountered in constructing well in this contract. Contractor shall satisfy himself regarding all local conditions affecting his work by personal investigations, and neither information contained in this section nor that derived from maps or Drawings or from Owner or his agents or employees, shall act to relieve Contractor from any responsibility hereunder or from fulfilling any or all of terms and requirements of his contract.

3. Contractor is responsible for resolving issues associated with drilling through potentially unstable zones. Procedures used to resolve these issues may include dredging of formation material or cement plugging formation to resolve problem. procedures must be approved by Engineer prior to implementing. Additional work associated with this type of problem will be paid at unit prices provided in Contractor's Bid Schedule.
4. Owner reserves right to use an alternate site if unfavorable hydrogeological conditions are encountered. Additional well construction would be paid at unit prices provided in Contractor's Bid Schedule.

B. Existing Conditions

1. Contractor shall examine project site to determine necessity of a temporary construction access road. If Contractor determines one is necessary, it shall be provided by Contractor. Include costs of temporary construction access road in move-in and set-up costs to construct water well.

1.08 FIELD MEASUREMENTS

- A. Prior to start of construction, verify by field measurements and elevations that existing conditions and structures are as shown on Drawings. Notify Engineer of specific discrepancies or potential interferences.
- B. Prior to start of construction, where ordered by Engineer or shown on Drawings, verify by exploratory excavations that existing underground utility locations and elevations are as shown on Drawings, to confirm marked location and elevation of underground utilities by organizations identified in Section 01 00 05, or to confirm location and elevation of uncharted utilities. Notify Engineer of locations and elevations that differ from drawings and of potential interference and allow Engineer sufficient time to determine any changes required as a result of such exploratory excavation or interferences prior to start of construction.
- C. Verify by field measurements and exploratory excavations that existing pipe outside diameter (for tapping sleeve and valve installations) and facilities locations and elevations are as indicated and/or as shown on drawings. Notify Engineer of specific differences.

1.09 CHEMICAL QUALITY

- A. Groundwater shall be examined for chemical characteristics by tests of a representative sample in a state-certified laboratory with results reported to TDEC.
- B. Samples shall be collected at the end of well performance testing, and analyzed as soon as practical.
- C. Determination of pH and CO₂ shall be made in field.
- D. Samples for iron analysis must be acidified.

1.10 DELIVERY, HANDLING AND STORAGE

- A. Packing, Shipping, Handling, and Unloading:
 1. Equipment shall be shipped and handled in accordance with requirements of Section 01 00 05 of these specifications.
- B. Storage and Protection:
 1. Equipment shall be stored and protected in accordance with requirements of Section 01 00 05 of these specifications.

2. Contractor shall be responsible for safely storing materials needed for work that have been accepted by him until they have been incorporated into complete project.

1.11 WARRANTIES AND BONDS

- A. Warranty shall be in accordance with Section 01 00 05.

PART 2 PRODUCTS

2.01 DRILLING FLUID

- A. Make equipment for measuring fluid properties immediately available at rig site. Contractor shall select drilling fluid.
- B. Water used in construction of a water well shall be obtained from a public water supply or water well.
 1. All water used shall be treated with enough liquid bleach or hypochlorite granules to retain a free chlorine residual of at least two (2) parts per million.
 2. Contractor shall denote on the water well report submitted to TDEC from what source drilling process water was obtained.
- C. All drilling fluids and additives shall be materials specified by the manufacturer for use in water well construction, be NSF-60 approved, and approved by TDEC.
- D. Contractor shall test and keep records of mud management program.
 1. For every eight-hour shift, mud shall be checked twice with on-site lab equipment for date, time, depth, pH, mud weight, viscosity, sand content, drilling fluid additives used and at what time, and water loss.
 2. Test methods shall comply with most recent version of API Practice 13B-1.
- E. Contractor shall follow most recent version of AWWA A100 guidelines for drilling and mud properties.
- F. Contractor shall be responsible for achieving necessary performance guarantees listed in this specification and if deviation from guidelines is deemed necessary by Contractor, Contractor shall notify Engineer for its approval. If at all possible notification shall be made prior to changes to mud.

2.02 CASING

- A. Permanent Casing
 1. Permanent casing shall be 20-inch in diameter and shall have a minimum wall thickness of 0.500 inches and a weight of approximately 104 pounds per foot. Provide lengths of approximately 20 to 40 feet.
 2. Permanent casing shall be new seamless or welded, black steel pipe meeting ASTM Standards A53 or A589.
 3. Weld in accordance with AWS standards.
 4. Centralizer guides meeting the requirements of API 10D shall be attached to bottom of casing and at intervals not greater than 25 feet.

- a. Alternative welded centralizers will be approved on a case-by-case basis. Alternative centralizers shall be submitted to Engineer for review and approval.

2.03 SCREEN

- A. Provide screen with sufficient open area to transmit desired yield of 2,500 gpm at an aperture entrance velocity no greater than 0.1 feet per second assuming that 50 percent of the screen openings will be blocked by filter pack. Include with screen all required accessories which are standard products of manufacturers regularly producing such equipment.
- B. Well screen will retain minimally 90 percent of the selected filter pack.
- C. Provide well screen minimally 120 feet long, exclusive of any blank liner.
- D. A stainless steel continuous-slot wire-wrapped well screen shall be welded to bottom of permanent casing. Screen shall be manufactured of 18-8 stainless steel material, Type 304, engineered high flow.
- E. Contractor's hydrologist shall select slot size, wire wrap size and length of screen from aforementioned analysis of formation sand in which well is to be made. This analysis, proposed slot size selected and length of screen shall be submitted for approval by Engineer after pilot borehole drilling operations and prior to actual purchase of screen.
- F. Centering guides shall be used at top and bottom of screen, and at blank intervals inserted within the screened length. Guides to be used shall be stainless steel, and their positions shall be approved by Engineer.

2.04 FILTER PACK

- A. Annular space between screen and face of borehole shall be filled with select filter pack to 20 feet above top of screen. Type and size of filter pack used shall be determined by Contractor's hydrologist from analysis of water bearing formation. Filter pack shall retain most of formation material.
- B. Filter material shall consist of clean, well-rounded grains of uniform size. A minimum of 90% of grains shall be quartz. Filter pack shall exhibit a uniformity coefficient of 2.5 or less. Filter material, gradation, uniformity coefficient, etc. shall be approved by Engineer prior to placement.
- C. Provide filter pack consisting of grains with an average specific gravity of not less than 2.5.
 1. Not more than 1 percent by weight of the material shall have a specific gravity of 2.25 or less.
- D. Provide filter pack conforming physically with requirements in latest revision of "Standard for Filtering Material", (AWWA B100). Supplier shall provide Toxicity Characteristics Leaching Procedure (TCLP) test results on filter material for Engineer's approval.
- E. Stockpile filter pack in an approved manner to prevent contamination of filter pack with foreign matter.
- F. Use bagged material. Do not use bulk-purchased gravel dumped on ground.
- G. Gradation:
 1. Make final selection of filter pack gradation based on gradations of samples obtained during drilling of the zone to be screened.

2. Select gradation to retain formation sand and permit the development of a high capacity, sand-free well.

2.05 GROUT

- A. Provide fresh, clear and drinkable water. Test questionable water in accordance with ASTM C-109.
- B. Provide a copy of cementing certificate with completion manual required at end of project. Excess cement grout will be required at site prior to starting of grouting such that work can be completed in one (1) continuous operation.
 1. If Contractor believes more than one (1) continuous grouting operation is needed, Contractor shall be responsible for submitting an exception request to TDEC and approved request shall be delivered to Engineer during the submittal phase.
- C. Concrete Grout - A mixture of Portland Class A Cement (ASTM C150), sand and water in proportion of at least five (5) bags of cement per cubic yard of concrete to not more than 7 shall be used. Size of gravel should be no greater than 1/3 diameter of annular space.
- D. The use of additives to reduce permeability, increase fluidity or control time of set may be used up to 5 percent by weight.
- E. The grout material used in the backfilling or grouting of a water well shall consist of a mixture of Portland Class A cement or quick setting cement in a ratio of not over six (6.0) gallons of water per ninety-four (94) pound sack of cement, or a high solids mixing bentonite grout with a minimum of 20% solids and a weight of no less than nine and two tenths (9.2) pounds per gallon as measured by a standard mud balance.

2.06 WELL PUMP AND MOTOR

- A. Well pump and motor shall be selected in accordance with requirements of Section 43 21 17 of these specifications.

2.07 WELL PUMP FOUNDATION

- A. A concrete pedestal for the wellhead completion shall be constructed as indicated in Drawings. All exposed corners shall be chamfered, and all exposed surfaces shall be rubbed smooth and sloped away from center of well. Concrete shall be in accordance with ACI 301 and shall have a minimum strength of 4000 PSI after twenty-eight (28) days of curing.

2.08 POTABLE WATER FOR DRILLING

- A. Owner shall provide potable water for drilling purposes at no cost to Contractor. An Owner provided water meter may be provided to account for water used. A refundable deposit may be required.

2.09 WELL APPURTENANCES

- A. Well Vent:
 1. The well casing shall be vented to the atmosphere:
 - a. The vent shall terminate in a down-turned position above the top of the casing.
 - b. Opening is to be covered with 18-mesh corrosion-resistant screen.

- c. Pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing but shall not be smaller than 1.5 inch diameter.

B. Air Release Valve:

1. A 4-inch, combination, deep-well-type air and vacuum release valve with throttling device and automatic air release valve of ample capacity shall be furnished by Contractor and connected into discharge line of well pump.
2. Valve shall be of approved design and shall be capable of eliminating all column air on starting without undue velocity and shall not stick when pump is shut down.

C. Pressure Gauge:

1. Contractor shall furnish and install a 4 1/2-inch liquid-filled pressure gauge on pump discharge flange. This gauge shall be of ample size to cover operating pressure including pump shutoff head.
2. Pressure gauge will be furnished with lever handle gauge cock, mud leg, blow-off assembly, snubber device, and check valve release to facilitate removal of a gauge.

D. Pressure Indicating Transmitter:

1. Pressure indicating transmitter shall be provided by contractor in accordance with requirements of Section 40 90 00.
2. Contractor shall provide diaphragm seal and gauges in accordance with Section 43 21 06.

2.10 MISCELLANEOUS

A. Signage

1. Contractor shall provide signage in accordance with Section 01 00 05.

B. Finishes

1. Surface preparation, shop painting and field painting and other pertinent detailed painting of all equipment shall be in accordance with Section 09 96 00.

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor shall furnish and install all equipment, materials, accessories, and appurtenances according to Contract Documents, including Sections 01 00 05 and 43 21 06, and all equipment manufacturers' written instructions and recommendations. Conflicts of information shall be called to attention of Engineer before proceeding with work.

B. Contractor's Responsibilities

1. Contractor shall be responsible for performing all of work in strict accordance with these specifications.
2. Contractor shall review all aspects of equipment installation with manufacturers to ensure systems that are capable of functioning as described and that are fully compliant with manufacturer's recommendations.

3. Contractor shall notify Engineer forty-eight (48) hours in advance of performing each of following operations. Failure of Contractor to provide proper notification may result in rejection of all operations performed without notification.
 - a. Test hole drilling.
 - b. Electrical logging.
 - c. Collecting water samples.
 - d. Caliper log.
 - e. Installing screen and casing.
 - f. Placing filter pack.
 - g. Cementing.
 - h. Developing and conducting finished well test for yield and draw down.
 - i. Television survey.
 - j. Jetting out fill from bottom of well or cleaning screens (if directed by Engineer after review of television survey)
 - k. Verify bottom of well by television survey or by sounding bottom of well (if directed by Engineer).
 - l. Installing permanent pumping equipment.
 - m. Final testing of well and pumping equipment.
4. If evidence indicates that screen or casing in well is broken or that well is not constructed in accordance with specifications to satisfaction of Owner or Engineer, then Owner or their Representatives may order that proper changes be made by Contractor or, in event that proper changes cannot be made, Owner may order Contractor to abandon well, without additional cost, and to drill a new well.

C. Well Protection

1. At all times during progress of work, Contractor shall protect well in such a manner as to effectively prevent either tampering with well or entrance of foreign matter into well.
2. Well shall be capped watertight until permanent pump installation is made. A welded metal plate shall be preferred method of capping, and a properly fitted, firmly driven, solid wooden plug shall be minimum acceptable method of capping.
3. Wellheads and pump bases shall be sealed by a gasket or sealing compound and properly vented to prevent possibility of contaminating water well.

D. Disposal of Pumping Water

1. During period of well drilling, development and pump testing, Contractor will be required to route water away from well to avoid flooding of land in vicinity of both pumping well, observation wells and adjacent private property.
2. Method of water disposal shall be responsibility of Contractor.

E. Abandonment of Well

1. In event that Contractor shall fail to complete any well to depth required or should he abandon well for any other reason, he shall, if requested and directed by Owner, abandon well using approved methods outlined in State of Tennessee Community Public Water Systems Design Criteria.
2. If failure of well is due to Contractor error (i.e., hole out of vertical alignment), payment for test hole may not be made. If well is not usable due to natural problems encountered, Contractor will be paid for work completed.
3. Should completed hole fail to conform to these specifications and conditions cannot be corrected, hole will be abandoned as follows:
 - a. Thoroughly chlorinate the well prior to sealing by the addition of sufficient quantities of liquid bleach or dry hypochlorite granules to produce a free chlorine residual of 25 parts per million.
 - b. Abandon well as per State of Tennessee Community Public Water Systems Design Criteria.
 - c. Cut off casing remaining in hole at least two (2) feet below ground surface. Fill remaining two (2) feet of hole with native top soil.
4. Seal well according to most current procedures established by local, state or federal regulatory agencies.

3.02 WORK SEQUENCE

- A. General work sequence for this project shall include, but may not be limited to, following steps:
 1. Drill pilot borehole to an anticipated depth of 725 feet while collecting formation samples.
 2. Run geophysical log.
 3. Develop filter pack gradation and well screen slot-size and depth placement for Engineer review.
 4. Drill production well borehole to an anticipated depth of 725 feet.
 5. Install well casing and well screen.
 6. Install filter pack, sterilizing it as it is being placed in well.
 7. Grout casing.
 8. Conduct plumbness and alignment testing of well.
 9. Conduct well development.
 10. Conduct finished well testing.
 11. Collect water samples.
 12. Conduct a color video survey of completed well.

13. Install permanent pumping equipment.
14. Disinfect completed well.
15. Conduct field testing.
16. Complete and secure wellhead.
17. Complete final site cleanup and restoration to satisfaction of Owner and demobilize from work site.

3.03 PILOT BOREHOLE AND SAMPLES

- A. Drill pilot borehole at location of proposed well as determined by Engineer. Make hole no smaller than six (6) inches in diameter, and no larger than 10 inches in diameter, and approximately 725 feet deep.
- B. Pilot borehole drilling method:
 1. Drill borehole using the mud rotary method.
 - a. Approval for use of other drilling methods must be obtained from the Engineer 10 days prior to bid date.
 - b. Borehole shall be advanced so as to maintain the plumbness and alignment within allowable limits and provide a near gage pilot borehole to ensure the quality of the borehole geophysical logs.
 2. Drilling fluid:
 - a. Take necessary measures to protect water bearing formations from contamination and ensure that the drilling method used will not permanently plug the water bearing formations with drilling mud.
- C. Record an accurate driller's log of materials penetrated. Keep log available at well site for inspection.
- D. Collect formation samples from pilot borehole and handle in an approved manner.
 1. Samples of formations encountered (one set total) collected from drill cuttings on 10 foot (10') intervals and at each pronounced change in formation when drilling pilot borehole.
 2. Place drill cutting samples collected at specified depth intervals in approved containers and identified:
 - a. Date
 - b. Pilot borehole name
 - c. Depth interval
 - d. Sample method
 3. Obtain drill cutting and representative formation samples of water bearing formations encountered during drilling by both of the following methods so filter pack gradation and screen opening size may be determined.

- a. Twenty (20) samples of water bearing sand for sieving to be selected from drill cutting samples collected between 525 and 725 foot depth.
 - b. Collected at 10-foot intervals and at each pronounced change in formation.
 - c. Sieve analysis (ASTM C136) results in both tabular and graphical form. At a minimum the following standard US Sieve Sizes should be used: No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200. Provide a minimum of twenty (20) 7-point sieve analysis per pilot hole.
 - d. Determination of effective size and uniformity coefficient.
 - e. A written evaluation of grain size and recommendation of filter packing material and screen opening shall be provided based on results from sieve analysis.
- E. Keep a drilling-time log of all material drilled.
- F. Run geophysical logs complete with short normal, long normal, lateral, spontaneous potential, and natural gamma curves with hole size indicated. Make electric logs to total depth of pilot hole. A caliper log will be run only on the production well borehole..
- G. Down-Time Awaiting Sieve Analysis Test Results
- 1. Perform no further work after geophysical logging is complete and hole is refilled with drilling mud. Make a recommendation of screen settings to Engineer once sieve test results are known

3.04 DRILLING

- A. Drill Production Well borehole suitable for construction of a water supply well utilizing the reverse rotary method.
- B. Approval for use of other drilling methods must be obtained from the Engineer 10 days prior to the bid date. Borehole shall be straight and plumb entire depth of well.
- C. Drilling Fluid:
 - 1. Take all necessary measures to protect water bearing formations from contamination and ensure that the drilling method used will not permanently plug the water bearing formations with drilling fluid.
 - 2. The Contractor may utilize a drilling fluid comprised of either a polymer-based “mud” or a bentonite “gel”-based mud. Use of a bentonite viscosifier only, meeting the requirements of API Standard 13A, will not be permitted.
 - 3. Drilling fluid additives that have the potential to enhance biological activity shall not be used.
 - 4. All drilling fluid components and additives shall be NSF-60 approved.
 - 5. Provide and operate portable laboratory equipment for monitoring basic drilling fluid properties to include density, viscosity, pH, and filtrate rate.
- D. Dispose of drilling mud, cuttings and discharged water in prescribed manner so as not to damage public or private property.

3.05 PERMANENT CASING AND SCREEN INSTALLATION

- A. Drill Production Well borehole to a minimum of 30-inch (30") diameter to accommodate casing and screen to a maximum depth of 725 feet. Scrape borehole prior to running a caliper log.
- B. Permanent casing of well shall be installed straight and plumb and shall extend from top of well screen to top of concrete foundation.
- C. Provide casing joints which are threaded and coupled watertight joints or welded conforming to the standards of the AWS.
- D. If any clay zone is encountered in water bearing formation, clay zone shall be blanked out.
- E. If for any reason well screen cannot be placed at final design position or at a depth acceptable to Owner, Contractor shall remove and repair any damage to well screen, over drill borehole, and reinstall well screen at no additional cost to Owner. In no event shall Contractor attempt to drive or spud well screen.
- F. Set top of outer casing a minimum of 19 inches above final ground surface and at least two (2) feet above any known conditions of flooding. Center casing in hole so that a minimum of approximately 2½ inches exists between face of hole and casing. Use a casing (cementing) shoe. Space centering guides around and along pipe to insure adequate clearance for cementing operation.
- G. Well screen:
 - 1. In no instance, drive or force into position.
 - 2. The well screen assembly shall be suspended by the drilling rig and not permitted to rest on the bottom of the borehole. Assembly should be supported at top so bottom is at least one-foot (1') above bottom of hole and entire assembly is under tension during placement of filter pack.
 - 3. Join screen sections for a single interval by threaded and coupled joints, or electric arc or acetylene welding.
 - a. Ensure joint(s) are straight, sand tight, and retain 100 percent of the screen strength.
 - 4. Provide blank spacers for multiple interval screen of the same material as the screen, as determined during pilot borehole testing.
 - a. Join to screen by threaded and coupled joints, or electric arc or acetylene welding.
 - b. The resulting joints must be straight, sand tight, and retain 100 percent of the screen strength.
 - 5. To seal bottom of the deepest screen provide a plate or end cap of same material as screen
- H. Join screen to bottom of casing assembly. Place centering guides as needed on screen and casing, at intervals no greater than 25 feet.
 - 1. Centralizers shall extend out a minimum of 4 inches from casing and screen, and shall be minimally spaced at 90 degrees around the casing.
- I. Do not use end fitting and blank portions of screen in determining vertical feet of screen.

3.06 FILTER INSTALLATION

- A. After installation of screen and casing, construction of filter pack shall commence. Annular space between screen and face of bore hole shall be filled with select filter pack to 20 feet above top of screen.
- B. Placement of filter pack to bottom of well will be through a separate and temporary tremi pipe extending to near bottom of well. Filter pack shall be tremied with a hopper and water through pipe which is to be slowly removed as filter pack rises. Volume of filter material placed in well shall not be less than calculated volume of annular space available.
- C. Introduce filter pack so that volume (or weight) of filter pack in hole is readily known with 10 percent (10%) accuracy. Place in a uniform and continuous manner so that hydraulic segregation and bridging are minimized or eliminated. Do not place any filter pack which is contaminated with foreign material.
- D. Remove excess filter pack material from site after filter packing is done.
- E. Mix ½ pound of calcium hypochlorite (70 percent (70%) available chlorine) per cubic yard of filter pack and place with filter pack. Place filter pack until it is level with or from one (1) to five (5) feet below top of inner casing.
- F. Measurement of filter pack will be based on approved recommended material settings.
- G. Wash, surge, and agitate well after filter pack is placed to settle gravel pack prior to grouting to help minimize settlement during development after grouting. remove all drilling mud, silts, and clays.

3.07 GROUTING

- A. Prior to grouting, Engineer may direct flushing of annular space with drilling fluid or clean water. Grout casing in presence of Engineer or Field Project Representative.
- B. Carry out work in one (1) continuous operation, completely filling annular space between drilled hole and casing from top of filter pack to land surface using the “positive placement exterior method” as described in State of Tennessee Community Public Water Systems Design Criteria. Contractor is responsible to ensure that there is sufficient grout available during grouting procedures. Waste grout returning to surface until Engineer determines that grouting has been satisfactory.
- C. Do no further work on well until grout has firmly set, a minimum of 72 hours for neat cement and 24 hours for quick-setting cement.
- D. Prior to grouting, Engineer may direct flushing of annular space with drilling fluid or clean water. Grout casing in presence of Engineer or Field Project Representative.

3.08 PLUMBNESS AND ALIGNMENT TESTING

- A. Plumbness and vertical alignment of well to a depth of 725 feet shall meet requirements of Appendix D of AWWA A100 Standards.
- B. Contractor shall conduct a plumbness and alignment test after borehole of new well reaches final completion depth, and after well casing and well screen string has been installed and grout seal has set.
- C. Contractor shall prove alignment of well by lowering into well a straight section of pipe or dummy measuring 40 feet long with an outside diameter not more than 0.5 inches than

internal diameter of casing being tested). well will be deemed adequately straight if pipe or dummy can be lowered freely entire depth of well.

- D. If well cannot meet specified criteria for plumbness and alignment, Contractor shall correct well at Contractor's expense or abandoned due to fault of Contractor and a new well shall be constructed at no additional cost to Owner.
- E. Contractor shall submit results of plumbness and alignment testing of well to Owner for approval within three days of completing plumbness and alignment testing.

3.09 PRODUCTION WELL DEVELOPMENT

- A. To develop well, remove native silts and clays deposited on aquifer face during drilling; inorganic drilling mud; and predetermined finer fraction of filter pack. Removal is necessary to insure maximum possible specific capacity from completed well.
- B. Contractor shall furnish necessary pumps, compressors, plungers, bailers, or other needed equipment and develop well by such approved methods as necessary to give the maximum yield of water per foot of drawdown and limit sand content as indicated herein.
- C. After well screen and filter pack envelope have been installed, Contractor shall develop well. Contractor shall develop well by such methods as will effectively extract from water-bearing formation maximum practical quantity of sand, drilling mud and other fine materials in order to bring well to maximum yield per foot of drawdown and to a sand-free condition. This work must be done in a manner that does not cause undue settlement and disturbance of strata above water-bearing formation nor disturb seal affected around well casing and thereby reduce sanitary protection otherwise afforded by such seal.
- D. Specific development method required shall include a two-way directional flow through screen. This development system includes a submersible test pumping unit including a temporary power source, capable of pumping 150 percent of proposed well capacity but with satisfactory integral throttling valves furnished with development unit so that discharge may be reduced to 50 percent of proposed well capacity. This pumping unit shall be used during development in concert with a tank equipped with a pump that is independently driven. This unit shall be equipped with valving available to isolate two-way directional flow and discharge to waste. This unit shall also be equipped with an injection head that is to be welded in place to top of casing. This head shall have three (3) connections, first connection shall be coupled to drop pipe assembly attached to submersible pumping unit, second connection shall be flange and directly connect to intake side of development unit and in series to discharge valve arrangement, third connection shall directly couple with development units centrifugal pumping system to establish two-way directional flow using submersible pumping unit for discharge and centrifugal pumping unit to inject creating a backwash action in development. Contractor shall provide Engineer with reasonable yield estimates and water level measurements at specific times to determine increase in specific capacity cannot be reasonably increased by additional development.
- E. Production Well shall be considered developed when, in opinion of Engineer:
 - 1. Water is no longer turbid during development (<1 Nephelometric Turbidity Unit [NTU] within 10 minutes of startup at design pumping rate).
 - 2. Well is substantially free of sand (<0.01 mL/minute sand rate as measured by Rossum Sand Cone) at design pumping rate during initial 10 minutes of pumping (~5 ppm).
 - 3. Well is capable of producing design rate (2,500 gpm or to be determined by Engineer) without excessive drawdown.

- F. After well is developed and before development equipment is pulled from well, well shall be sterilized with a 100 mg/L Sodium Hypochlorite solution. Chlorine solution shall be introduced in screened portion of well.
- G. Contactor shall obtain Engineer's approval for location for discharging water and wastes prior to well development.

3.10 WELL TESTING

- A. A 24-hour production well test utilizing constant discharge method shall be conducted to verify to Owner and/or Engineer that new well will meet a minimum capacity of 2,500 gpm. A discharge rate of 2,500 gpm, shall be used for test, and Contractor is responsible for setting up all test pumping equipment required.
 - 1. Furnish pumping unit complete with an ample power source, controls and appurtenances capable of being operated without interruption for a period of 24 hours.
 - 2. Provide a water sample tap between the pump head and the check valve assembly.
 - 3. Contractor shall man pump equipment at all times during all well pumping tests.
 - 4. Temporary hose and/or pipe to convey pumped water overland to discharge at an Owner approved location between 200 and 800 feet away from the well, and at a location that drains from the well.
 - 5. Appropriate erosion control measures and best management practices which may include plastic or plywood sheeting to control erosion at the discharge point
- B. After well has been completely developed, constructed and cleaned out and its depth accurately recorded, Contractor shall promptly notify Engineer to that effect and shall make necessary arrangements for conducting a pumping test of finished well.
- C. Contractor shall have in place pumping unit used for well development, and pumping unit should be capable of pumping 3,750 gpm and being operated without interruption for duration of pumping test. Contractor shall also furnish, install and maintain equipment of approved size and type for measuring flow of water within 5% accuracy; such equipment to be an orifice, weir method or approved equal. To measure elevation of water level in well, an air line complete with gauge, hand pump, and check valve shall be furnished by Contractor.
- D. Contractor shall operate equipment for the duration of the pumping test. Contractor will certify that equipment is in good working order.
 - 1. Failure of pump operation for a period greater than one (1) percent of the elapsed pumping time shall require suspension of the test until the water level in the pumped well has recovered to its original level, and Contractor shall re-run test for 24 hours at no additional expense to Owner.
- E. If the pump stops operating during the pumping test as a result of equipment failure or fuel shortage, Contractor will replace equipment as needed to run the test without failure, allow groundwater levels to reach recovered levels, and re-run test for 24 hours at no additional expense to Owner. Test pump shall be used to produce a graph of pumping rate versus drawdown. Static water level shall be recorded before and after test pumping operations. Contractor shall minimally set pump at a sufficient depth below ground surface so that pumping water levels do not decline below the pump during well testing. Contractor shall make note of actually pump depth setting. After reducing drawdown data from the pumping test, time-versus-drawdown levels and recovery levels-versus-time shall be recorded and plotted in graphical form. Depth to water readings for time-versus-drawdown and recovery level-versus-time shall be taken at:

1. Zero time (pump started or stopped)
 2. Each minute for ten (10) minutes
 3. Each two (2) minutes for next ten (10) minutes
 4. Each five (5) minutes for forty (40) minutes
 5. Each fifteen (15) minutes for sixty (60) minutes
 6. Each thirty (30) minutes for one hundred eighty (180) minutes
 7. Each sixty (60) minutes for duration of test
- F. Maximum time for each test is therefore twenty-four (24)-hours; however tests will be considered complete when drawdown level becomes constant for four (4) hours and flow from well is clear.
- G. Measurement of recovery level readings shall continue until complete recovery has occurred or for 24 hours, whichever ever occurs first.
- H. After completing the final test, remove by bailing, sand pumping or other methods, any sediment, stones or other foreign material that may have accumulated in the well.
- I. Sand content testing:
1. The sand content shall be determined by averaging the results of five samples collected at the following times during the final constant-rate pumping test:
 - a. 15 minutes after start of the test.
 - b. After 1/4 of the total planned test time has elapsed.
 - c. After 1/2 of the total planned test time has elapsed.
 - d. After 3/4 of the total planned test time has elapsed.
 - e. Near the end of the pumping test.
 2. Sand production during well development and testing shall be measured by the Contractor and recorded on test records. Sand production shall be quantified as measured by a Rossum™ Sand Sampler. The maximum acceptable average sand content during the testing period shall be 5 mg/L.
- J. Following test, Contractor shall provide following testing data to TDEC central office and appropriate regional office as follows:
1. Static water level, measurements prior to starting pump,
 2. Pumping rates and duration of each period of pumping,
 3. Water-level measurements during test, and graph of drawdown vs. time,
 4. Recovery water level measurements, and graph of recovery vs. time,
 5. Depth of pump setting,
 6. Analytical results of water samples collected during the test,

7. Summary of determinations of well capacity, efficiency, aquifer characteristics,
8. Safe pumping rates, pump settings and water treatment needs.

3.11 COLLECTION OF WATER SAMPLES

- A. Water quality samples shall be collected at the end of the pumping portion of the constant discharge test.
 1. Take all samples in presence of Engineer or inspector. Contractor will pay for complete water analyses for samples. Results shall be reported to TDEC. Send samples to a state-certified laboratory where the following analyses will be conducted:
 - a. Aluminum
 - b. Carbon Dioxide
 - c. Chloride
 - d. Copper
 - e. Fluoride
 - f. Iron
 - g. Manganese
 - h. Silver
 - i. Sulfate
 - j. MBAS
 - k. Zinc
 - l. Color
 - m. Odor
 - n. pH
 - o. Total Dissolved Solids
 - p. Asbestos
 - q. Gross Alpha
 - r. Radium 226
 - s. Radium 228
 - t. Gross Beta
 - u. Tritium
 - v. Strontium-89
 - w. Strontium-90

- x. Iodine-131
- y. Cesium-134
- z. Uranium
- aa. Inorganics
 - 1) Antimony
 - 2) Aresnic
 - 3) Asbestos
 - 4) Barium
 - 5) Beryllium
 - 6) Cadmium
 - 7) Chromium
 - 8) Cyanide
 - 9) Fluoride
 - 10) Lead
 - 11) Mercury
 - 12) Nickel
 - 13) Selenium
 - 14) Silver
 - 15) Sodium
 - 16) Thallium
 - 17) Total Nitrate and Nitrite
- bb. Organics
 - 1) 2,3,7,8-TCDD
 - 2) 2,4-Dichlorophenoxyacetic Acid
 - 3) 2,4,5-Trichlorophenoxypropinic Acid
 - 4) Alachlor
 - 5) Atrazine
 - 6) Benzo(a)pyrene
 - 7) Carbofuran

- 8) Chlordane
 - 9) Dalapon
 - 10) Di(2-ethylhexyl) Adipate
 - 11) Di(2-ethylhexyl) Phthalate
 - 12) Dibromo Chloropropane (DBCP)
 - 13) Dinoseb
 - 14) Diquat
 - 15) Endothall
 - 16) Endrin (1,2,3,4,10-Hexachloro-6, 7-Epoxy 1,4,4a,5,6,7,8,8a, Octahydro- 1,4-Endo, Eudo-5, 8-Di-Methano Naphthalene)
 - 17) Ethylene dibromide (EDB) Glyphosate
 - 18) Heptachlor
 - 19) Heptachlor Epoxide
 - 20) Hexachlorobenzene
 - 21) Hexachlorocyclopentadiene
 - 22) Lindane
 - 23) Methoxychlor
 - 24) Oxamyl (Vydate)
 - 25) Pentachlorophenol
 - 26) Picloram
 - 27) Polychlorinated biphenyls (PCBs) Simazine
 - 28) Toxaphene
- cc. Volatiles (VOCs)
- 1) 1,2-Dichloroethane
 - 2) 1-Dichloroethylene
 - 3) 1,1,1-Trichloroethane
 - 4) 1, 1,1,2-Tetrachloroethane
 - 5) 1,1,2,2-Tetrachloroethane
 - 6) 1,1,2-Trichloroethane
 - 7) 1,1-Dichloropropene

- 8) 1,1-Dichloroethane
- 9) 1,2,3-Trichloropropane
- 10) 1,2,4-Trichlorobenzene
- 11) 1,2-Dichloropropane
- 12) 1,3-Dichloropropane
- 13) 1,3-Dicbloropropene
- 14) 2,2-Dichloropropane
- 15) Benzene
- 16) Bromobenzene
- 17) Bromodichloromethane
- 18) Bromoform
- 19) Bromomethane
- 20) Carbon tetrachloride
- 21) Chlorodibromomethane (Dibromochloromethane)
- 22) Chloroethane
- 23) Chloroform (Trichloromethane)
- 24) Chloromethane
- 25) Cis 1,2-Dichloroethylene
- 26) Dibromoethane
- 27) Dichloromethane
- 28) Ethyl Benzene
- 29) Monochlorobenzene (Chlorobenzene)
- 30) Ortho-Dichlorobenzene (o-Dichlorobenzene)
- 31) Para-Dichlorobenzene (p-Dichlorobenzene)
- 32) Styrene
- 33) Tetrachloroethylene Toluene
- 34) Trans 1,2-Dichloroethylene
- 35) Trichloroethylene
- 36) Vinyl Chloride

- 37) Xylenes (total)
 - a) m-Xylene
 - b) o-Xylene
 - c) p-Xylene
- 38) M-Dichlorobenzene
- 39) O-Chlorotoluene
- 40) P-Chlorotoluene

dd. Other

- 1) Alkalinity
- 2) Phenols
- 3) Corrosivity
- 4) Hardness
- 5) Sodium
- 6) Radon

- B. Determination of pH and CO₂ shall be made in field.
- C. Samples for iron analysis must be acidified.
- D. Groundwater Under the Influence Determination (GWUDI) Study must be performed and analytical results provided.

3.12 VIDEO SURVEY

- A. Contractor shall complete a video survey of full length of completed Production Well, from top of casing stickup to total depth of well. Run a dynamic vertical down-hole view video from top of well to the bottom of well at a speed not exceeding 30 feet per minute.
- B. Video survey shall be conducted after all sediment accumulating in well from well development and aquifer testing has been removed and after fresh water has been introduced from surface to clarify water standing in well as needed.
- C. If water column in well is too cloudy, Contractor shall flush well with potable water and allow sufficient time for well to become clear so that, in opinion of Owner, video survey will show sufficient detail. If quality of video does not meet approval of Owner, Contractor shall re-video well at no additional cost to Owner.
- D. Camera and cable shall be clean and disinfected with a chlorine solution at the well site, in the presence of the Engineer.
- E. Verify proper screen placement, and that a collapse or "kick" in screens, or casing has not occurred, and that there is less than five-feet (5') of debris in bottom well.
- F. Tie television elevation counter to "0" at final elevation of top of casing.

- G. If evidence of biological fouling of well exists, superchlorinate and clean well. Retelevise prior to installing pump if well required cleaning. No additional payment will be made for cleaning well.
- H. Contractor shall submit copies of well video survey to Engineer within five days of completing video surveying.
- I. Contractor shall notify Engineer at least three (3) days in advance of performing video survey of new well.
- J. Equipment:
 - 1. Color vertical down-hole and horizontal side-hole viewing capability with centralizers.
 - 2. Horizontal side-hole viewing shall be controllable to allow viewing at angles within a 360 degree rotation.
 - 3. Produce a video with an automatic on-screen depth indication to nearest 0.1 foot.
- K. Final Well Color Videos:
 - 1. Submit two USB drive copies of the well video log to the Engineer after completion of the log.

3.13 PERMANENT PUMPING EQUIPMENT INSTALLATION

- A. Permanent well pump and motor shall be installed in accordance with requirements of Section 43 21 17 of these specifications.
- B. Permanent pump shall be installed by licensed well driller and shall be tested by Contractor for an 8-hour period or as determined by Engineer to help insure satisfactory operation. Contractor shall supply permanent power in order to test pump. Contractor shall bear all associated costs regarding providing electrical power to new pump.
- C. Set well pumping equipment on foundation after foundation has cured for seven (7) days. Keep with well capped until well pumping equipment is installed. Install sole plate using manufacturer's recommended leveling and grouting procedures.
- D. At a minimum Contractor shall use either of methods shown in plans if recommendations are not available, but Contractor shall provide written acceptance of installation from manufacturer of pump for warranty purposes.
- E. Level sole plate to within 0.005" across longest faces at 90-degrees to each other.

3.14 DISINFECTION

- A. After completion of well construction, development and installation of permanent pumping equipment, well shall be disinfected by introducing a chlorine solution into well such that a concentration of at least 100 PPM of available chlorine exists in all parts of well at static conditions. Chlorine solution shall be introduced into well in such a manner that well surfaces above static level will be completely flushed with solution. Allow chlorine solution to remain for at least twenty-four (24) hours, and then pump out well to remove all traces of chlorine before taking water samples for bacteriological analysis.
- B. Disinfect well in accordance with latest revision of AWWA C654 and AWWA A100.
- C. Water Samples for Bacteriological Tests.

1. After permanent well pump has been installed and well disinfected, take a sample of water on each of three (3) successive days. Send samples to a TDEC approved laboratory for bacteriological analysis. All three (3) of successive samples submitted must be free of coliform organisms before placing well in service. If any of these analyses reveal that water from well fails to meet coliform bacteria water quality criteria as prescribed by TDEC, well shall be rechlorinated and retested until (3) successive samples are free of coliform bacteria. Additional sampling, testing, and chlorination will be completed at Contractor's expense.

3.15 FINAL REPORT AND RECORDS

- A. After well is completed, furnish complete graphic and written log of well. Final report shall show all formations encountered, their depth and thickness, size and depths of material settings, static level, pumping level, quantities, size, and type of all equipment installed.
- B. Submit drillers log, signed, and dated by well driller. Log will record materials penetrated to nearest foot.
- C. Submit recorded static water level measurements and times measurements were made.
- D. Submit a complete casing and screen location record. Record shall show individual lengths of sections casings and screen and locations of seals.
- E. Submit pumping tests data from all pumping tests conducted. Data shall show dates, water levels, discharge rates, and times of stopping and starting pump.
- F. Submit all chemical and bacteriological testing.

3.16 FINAL SITE CLEANUP AND RESTORATION

- A. All ditches and lagoons dug by Contractor shall be filled upon completion of work.
- B. Land shall be brought back to grade, restored to original conditions, grass seed sown, and strawed.
- C. All drilling equipment, vehicles, tools, discarded construction materials and debris shall be removed from job site by Contractor or his representative.

END OF SECTION

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SECTION 33 12 00

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. Work to be performed under this Section consists of furnishing, installing and testing, where required, all valves, stops, backflow preventers, hydrants, valve operators, valve boxes, shown or noted on Contract Drawings or within this specification.
2. All applicable portions of Plumbing Specifications are hereby made a part of this Section.
3. Contractor shall be responsible for safely storing materials needed for work that have been accepted by him until they have been incorporated into complete project. Keep interiors fitting valves and other accessories free from dirt and foreign matter at all times.
4. Valves, appurtenances, and other equipment described herein shall, as necessary, meet lead-free requirements described in Section 01 00 05.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 03 – Concrete.
3. Section 09 96 00 – Painting and Coatings
4. Section 10 14 20 – Signage Requirements
5. Section 31 23 16 – Excavation, Trenching and Grading
6. Section 31 23 17 – Rock Removal
7. Section 31 23 19 – Removal of Water
8. Section 31 23 23 – Bedding, Backfilling and Compaction
9. Section 32 90 00 – Site Rehabilitation
10. Section 33 11 00 – Piping
11. Section 33 13 00 – Testing and Disinfection of Piping and Systems
12. Section 40 27 00 – Hangers, Anchors and Supports

1.02 REFERENCES

- A. ANSI: American National Standards Institute.
- B. ASTM: American Society for Testing and Materials.

- C. AWWA: American Water Works Association.
- D. FM: Factory Mutual.
- E. NEMA: National Electrical Manufacturers' Association.
- F. NFPA: National Fire Protection Association.
- G. UL: Underwriters' Laboratories, Inc.
- H. NSF: National Sanitation Foundation
- I. NAPF: National Association of Pipe Fabricators
- J. All references shall refer to latest edition of that reference including any revisions.

Reference	Title
ANSI/AWWA C111	Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C500	Standard for Metal-Seated Gate Valves for Water Supply Service
ANSI/AWWA C502	Standard for Dry-Barrel Fire Hydrants
ANSI/AWWA C504	Standard for Rubber-Seated Butterfly Valves
ANSI/AWWA C506	Standard for Backflow-Prevention Devices-Reduced Pressure Principle and Double Check Valve Types
ANSI/AWWA C507	Standard for Ball Valves, 6 In. Through 60 In.
ANSI/AWWA C508	Standard for Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS
ANSI/AWWA C509	Standard for Resilient-Seated Gate Valves for Water Supply Service
ANSI/AWWA C515	Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
ANSI/AWWA C540	Standard for Power-Actuating Devices for Valves and Slide Gates
ANSI/AWWA C550	Standard for Protective Interior Coatings for Valves and Hydrants
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings

1.03 DESIGN REQUIREMENTS

- A. Design working pressure shall be 200 psig for valves 12 inches NPS in diameter and smaller.
- B. Design working pressure shall be 150 psig for valves 16 inches NPS in diameter and larger.
- C. Valves shall be designed for normal cold water use.
- D. Gate valves and resilient seated gate valves shall be designed to be leak-tight with full pressure on either face with no pressure on opposite face.
- E. Hydrants, yard hydrants, and deck hydrants shall be designed for a 300 psig test pressure and 150 psig working pressure.
- F. All valves shall be compatible with all materials that valves shall be exposed to.

- G. All valves utilized on piping systems carrying potable water shall be listed NSF 61 approval.
- H. All exterior, underground, buried, or submerged valves shall have non-rising stems. All non-rising stem valves shall be provide with valve box, extended operator, and valve position indicator.
- I. Buried valves shall have restrained mechanical joints and shall comply with ANSI/AWWA C111/A21.11.
- J. Valves located below grade in vaults or manholes shall be provided with 150-pound flanges, faced, and drilled.
- K. All valves utilized on piping systems carrying potable water shall be listed NSF 61 approval.
- L. All valves of a given type shall be supplied by a single manufacturer.

1.04 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 shall include as a minimum:
 - 1. Product Data – Indicate conformance to applicable ASTM/AWWA codes, valve material, sizes, class, dimension, type, accessories, special assemblies, and construction thereof, including manufacturer's name.
 - 2. Shop Drawings – Show types of valves, hydrants and appurtenances and indicate conformance with ANSI/AWWA codes and related details for field assembly, operations, and maintenance.
 - 3. Manufacturer's Installation Instructions – Indicate any special procedures required to install Products specified.
 - 4. Result of shop test results, if required.
 - 5. Manufacturer's Certificate - Certify that products meet or exceed specified requirements and that all valve components are fully compatible with liquid(s) they shall come in contact with.
 - 6. Certification of Chemical compatibility of pipe, gaskets, solvent welding cements, and other parts of piping system with liquid(s) that components shall be exposed to.
 - 7. Certification of UV inhibitors in plastic (CPVC, PVC, HDPE, etc.) piping located outdoors and aboveground or inside process tanks.
 - 8. Motor Actuators - For those valves with motors and actuators, submittals shall indicate dimensions and orientation of motor and actuators. Contractor shall coordinate with manufacturer to orient equipment to avoid conflicts with existing facilities.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Sections 01 77 13.
- B. Record location of valves and hydrants with a minimum of two ties to permanent objects if different from what is shown on Drawings.

1.06 REGULATORY REQUIREMENTS

- A. Conform to all applicable local, state, and federal codes, rules, and regulations for materials and installation of work in this Section including for sheeting and bracing. See Section 31 50 00.
- B. Conform to requirements of regulatory agencies having jurisdiction over work.
- C. Conform to any applicable permit requirements obtained by Owner.

1.07 FIELD MEASUREMENTS

- A. Prior to start of construction, verify by field measurements and elevations that existing conditions and structures are as shown on Drawings. Notify Engineer of specific discrepancies or potential interferences.
- B. Prior to start of construction, where ordered by Engineer or shown on Drawings, verify by exploratory excavations that existing underground utility locations and elevations are as shown on Drawings, to confirm marked location and elevation of underground utilities by organizations identified in Section 01 00 05, or to confirm location and elevation of uncharted utilities. Notify Engineer of locations and elevations that differ from drawings and of potential interference and allow Engineer sufficient time to determine any changes required as a result of such exploratory excavation or interferences prior to start of construction.
- C. Location and elevation of existing utilities shall be confirmed by exploratory excavation prior to installation of crossing sewer service laterals or water service connections. If required, grade of lateral or water pipe to be adjusted as approved by Engineer.
- D. Where connections are to be made to existing pipes, confirm type of material and outside dimensions of pipes.
- E. Verify by field measurements and exploratory excavations that existing pipe outside diameter (for tapping sleeve and valve installations) and facilities locations and elevations are as indicated and/or as shown on drawings. Notify Engineer of specific differences.

1.08 COORDINATION AND SHUTDOWNS

- A. Coordinate field work under provisions of Sections 01 00 05, including field engineering, maintenance of traffic, access to private driveways, and emergency vehicle access.
- B. Coordinate work with local utility companies (private and municipal), including organizations identified in Section 01 00 05, for location of existing utilities and protection thereof.
- C. Coordinate work with local owners where affecting operation of existing structures and treatment facilities or when connecting to existing water mains, sewers, manholes, structures, laterals, pumping stations, treatment facilities, or industrial processes.
- D. Coordinate shutdowns of existing systems with local authorities. Notify affected property owners and industries at least 24 hours prior to shutdown including duration of shutdown.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Valve size, type of valve, joint type, class, lining, coatings shall be installed as listed herein or as shown on Drawings.

- B. Valves shall be of standard manufacturer and of highest quality, both as to material and workmanship, conforming to latest edition of AWWA standards specified.
- C. All valves and hydrants shall have manufacturer's name monogrammed or initialed by manufacturer thereon and shall be identified by catalog numbers.
- D. All exterior and underground valves shall be provided with hub, spigot, mechanical joint, flange or screwed ends as described herein or shown on Drawings or to match joints in a given pipe system.
- E. Valves, 2 inches in nominal diameter and smaller shall be all brass or bronze, unless otherwise indicated.
- F. Valves over 2 inches in nominal diameter shall be iron bodied, fully brass or bronze mounted unless thermoplastic valves are specifically called for in specifications or drawings or are required for given service.
- G. All surface forming joints or bearing surfaces shall be machined to a perfect fit.
- H. All disc and seat rings shall be carefully and thoroughly secured in place with iron castings machined where rings are bare and backs of rings machined all over.
- I. After rings have been fastened securely in place, front shall be machined all over to a perfectly true and smooth bearing surface.
- J. All valves with non-rising stems shall have valve position indicators.
- K. All valves shall be provided with suitable operating devices, adapted for operation in position in which they are shown on Drawings. All screw operated valves shall open by turning to left.
- L. Valves shall open counterclockwise (left) unless otherwise specified. Each valve body or operator shall have cast thereon word OPEN and an arrow indicating direction to open.
- M. All valves to be buried, submerged, or otherwise below grade valves shall be designed for such installation. Valves designed only for interior applications shall not be accepted.
- N. All buried, submerged, or otherwise below grade valves, and interior valves where indicated, shall be provided with a 2-inch square operating nut, valve box, extended operator, and valve position indicator as specified in this Section. Handwheel operators shall be allowed only for valves located inside structures, except where interior valves are called to also utilize an operating nut in lieu of another type of operator. Extended operators shall be provided by valve manufacturer and shall conform to valve manufacturer's recommendations for given service.
- O. Valves shall be supplied with minimum design pressures indicated unless operating pressures exceed these minimum design pressures, in which case a valve designed for operating pressures to be encountered shall be supplied.
- P. Where throttling is required on small diameter piping, globe or angle valves shall be used unless otherwise indicated. In 3-inch or smaller size, they shall be standard all brass, brass discs, 200 lbs. water working pressure, Crane No. 1 or equal, or Chase Style 431 or 427, or equal, with brass discs when in copper pipe lines.
- Q. Hose bibs shall be Mueller or approved equal with vacuum breaker.
- R. All interior valves shall be provided with flange ends as described herein or shown on Drawings unless otherwise noted. Flanges shall be 125/150 pound standard conforming to ANSI B16.1.

- S. All buried, submerged, or otherwise below grade valve shall be provided with restrained mechanical joints conforming to AWWA C111 unless shown otherwise on Drawings and shall be designed for underground installation. Pressure class of joint shall be at a minimum same as piping system on which joint is being installed. Joints shall be of restrained mechanical joint type with wedge action type restraints, Megalug by EBAA Iron, Inc. or approved equal and shall conform to applicable sections of ANSI 21.10/AWWA C110 and ANSI 21.11/AWWA C111 or ANSI 21.53/AWWA C153, as applicable for metal pipe and rods for plastic pipe.
 - 1. Flanged valves shall not be allowed for buried, underground, or otherwise below grade valves unless valves are installed in a vault or otherwise accessible location and then only with approval of Engineer or unless shown on Drawings. Flanges shall be 125/150 pound standard conforming to ANSI B16.1.

2.02 GATE VALVES

- A. All gate valves shall be resilient seated gate valves as specified in Article 2.03. Gate valves specified in Article 2.02 shall be used only if indicated on drawings.
- B. Conform to Article 2.01 as applicable.
- C. Gate valves 2 inches and smaller shall be bronze gate valves with non-rising stem, double wedge disc, screwed bonnet, screwed ends, 125-pound rating, and shall be re-packable under pressure in full open position.
- D. All gate valves 2 inches and smaller shall be Stockham Figure 107; Lunkenheimer Figure 2127; or equal.
- E. All other gate valves shall conform to AWWA Standard C500 and shall be of iron body, bronze mounted, double-disc type with outside screws and yokes.
 - 1. Valves shall be constructed with bolted bonnets, provided with cast iron stuffing boxes having bolted followers.
 - 2. Stuffing boxes shall be so arranged as to be readily accessible and shall be packed ready for use with synthetic fiber, graphite impregnated stuffing.
- F. Stems shall be fabricated of brass or bronze with lath-cut, half-V pattern threads. Double-disc type gate valves shall be Kennedy Valve Manufacturing, Mueller, or equal.
- G. Valves shall be designed to withstand a hydrostatic pressure of 300 psi applied internally with gate closed and shall be guaranteed for not less than 150 psi working pressure unless otherwise shown on Drawings.
- H. All interior gate valves shall be non-rising stems, 2 inch operating nuts, O-ring seal.
 - 1. Interior gate valves shall be American Flow Control, Mueller, U.S. Pipe Co., M&H Valve Company, Kennedy, or approved equal.
- I. All underground gate valves shall be non-rising stems, 2 inch operating nuts, O-ring seal and shall open counterclockwise (left).
 - 1. Underground gate valves shall be of iron body, bronze mounted type conforming to AWWA Standard C500.
 - 2. Mechanical joint type designed for underground use at 150 psi.

3. Underground gate valves shall be American Flow Control, Mueller, US Pipe Co., M&H Valve Company, Kennedy, or approved equal.
- J. All buried gate valves 16-inch and larger shall be furnished with a bypass (Ref. Table 8, AWWA C500) to relieve seat pressure during operation.
 1. All necessary accessories for bypass valve, including valve box and operator shall be provided.
- K. Wedges shall be all bronze, size-wedge type for all valves 8 inches and smaller. Wedges shall be cast iron bronze mounted for valves 10 inches and larger. Stem collar bushings shall be all bronze.
- L. All necessary accessories shall be furnished including valve boxes, extended operators, and valve position indicators.
- M. All interior gate valves shall be equipped with handwheel operators unless otherwise specified. Handwheel or chain and wheel operators shall be replaceable with 2 inch operating nuts without replacing valve stem or removing bevel gears.

2.03 RESILIENT SEATED GATE VALVES

- A. All gate valves specified shall be resilient seated gate valves unless indicated otherwise on drawings.
- B. Resilient seated gate valve shall conform to all applicable provisions of Articles 2.01 and 2.02, with exception that bypasses are not required on resilient seated gate valves, of this Specification Section.
- C. All resilient seated gate valves shall provide at minimum a full pipe opening when fully opened.
- D. Resilient seated gate valves shall conform to AWWA Standard C509 or C515.
- E. All resilient seated gate valves shall be as manufactured by American Flow Control, Mueller, Kennedy, U.S. Pipe Co., M&H Valve Company or approved equal.

2.04 BUTTERFLY VALVES

- A. Conform to Article 2.01 as applicable.
- B. Metallic Non-Thermoplastic Butterfly Valves.
 1. Valves shall be of eccentric type; concentric type valves shall not be permitted.
 2. Valves shall meet or exceed latest revision of AWWA Standard C504 for Class 150B butterfly valves, and shall meet or exceed requirements of this specification.
 3. Where valve is installed adjacent to a fitting, flow meter, another valve, or similar items, a spool piece or adapter coupling shall be furnished as a spacer so that valve disc does not interfere with operation of adjacent meter or valve or contact cement linings on pipe or fittings.
 4. Interior valves – Provide lever actuators for valves 8 inches and smaller, self-locking traveling nut actuators with handwheel operators for valves 10-inch through 16-inch in size, and worm gear actuators with handwheel operators for valve 18 inches and larger, unless otherwise specified herein or shown on Contract Drawings. Provisions must be made for locking in any of ten positions using a standard padlock.

5. Exterior, underground, or buried valves – All underground butterfly valves shall be provided with 2 inch operating nuts, O-ring seal and shall open counterclockwise (left).
 - a. Provide handwheel and extension stem and guides when installed in a manhole.
6. All necessary accessories including valve boxes, extended operators, and valve position indicators, shall be provided for each valve
7. All butterfly valves (except for air service valves) shall have:
 - a. Epoxy coated cast iron bodies conforming to ASTM A126 Class B.
 - b. Cast iron vanes conforming to ASTM A126, Class B with solid stainless steel Type 316 seating edge, or cast iron vanes conforming to ASTM A48, Class 40 with solid stainless steel Type 316 seating edge. Disc shall provide an uninterrupted, 360-degree seating edge.
 - c. Valves shall be equipped with suitable gearing and enclosed gear case.
 - d. Full-length one-piece Type 304 stainless steel valve shafts with permanently-lubricated nylon or Teflon bearings and ductile iron or Ni-resistant disk keyed to shaft.
 - e. Non-wafer type end construction.
 - f. Resilient rubber seats of EPDM compound, or as required for other services, in valve body. Seats shall be molded in and vulcanized to valve body and so designed to prevent separation and distortion. Seat shall contain an integral shaft seal protecting valve bearings and packing from any line debris.
 - 1) Seats shall be a full-circle 360-degree seat not penetrated by valve shaft. Valve Seat shall be attached to valve disc by 18-8 Type 304 stainless steel self-locking fasteners. Valve seat shall be easily field adjustable and replaceable without any special tools or lengthy curing time.
 - g. Valves shall have permanent packing.
 - h. Valves 12-inch and smaller shall have a working pressure of 150 psi. All valves shall be tested at and shall be capable of withstanding bi-directional line hydrostatic test pressures up to 200 psi without leaking. All valve components shall conform to Underwriters Laboratories classification in accordance with ANSI/NSF Standard 61.
 - i. Shop leakage tests shall follow requirements of AWWA C504 except that test pressure shall be 200 psi for all valves 12 inches and smaller and 150 psi for all valves larger than 12 inches.
8. Butterfly valves for air piping shall have:
 - a. Cast iron bodies rated for 150 psi and provide drip-tight shutoff at differentials up to 150 psi.
 - b. Wafer type lug body rotating on a horizontal axis suitable for use with ANSI 125/150-pound flanges.
 - c. Cast iron valves conforming to ASTM A126, Class B with nichrome seating edge, or cast iron vanes conforming to ASTM A48 Class 40 with mechanically-secured rubber seat having integral 18-8 stainless steel clamp ring.

- d. Valve bearings shall be of self-lubricated bronze with shaft seals to prevent leakage and to protect bearings from internal or external corrosion.
 - e. Resilient Viton rubber seats securely fastened to prevent separation or distortion.
 - f. Full-length Type 416 stainless steel valve shafts with permanently-lubricated Teflon bearings.
 - g. Valves shall be equipped with suitable gearing and enclosed gear case.
 - h. Valves shall have permanent packing.
 - i. Actuators as specified for other butterfly valves; lever actuators for valves 8 inches and smaller shall be infinitely variable level actuators with locking device.
 - j. Valve position indicators.
 - k. Valve components suitable for operation up to at least 250 degrees F.
 - l. Valves shall be equipped with suitable gearing and enclosed gear case.
 - m. Extended operators, valve, boxes, and valve position indicators shall be provided as necessary, including on valves installed on drop legs of aeration tank piping.
9. All butterfly valves shall be manufactured as manufactured by M&H Valve Company, DeZurik or Mueller (Pratt).

2.05 CHECK VALVES

- A. Conform to Article 2.01 as applicable.
- B. All check valves, except those installed on sump pump discharge lines or on air lines or on plant outfalls or unless otherwise noted in Contract Documents, shall be of horizontal single disc swing type designed to operate with a minimum loss of pressure.
- C. Check valves shall be so designed that when there is no flow through line, disc shall hang lightly against seat and shall afford ample waterway with but a small angle of opening.
- D. All check valves shall be provided with screwed or bolted covers for access to disc.
- E. Unless shown otherwise, all check valves shall be located in horizontal piping runs and shall be provided with extended hinge pin and outside lever and weight fully installed to assist valve in closing.
- F. All check valves with outside lever and weights shall be provided with guards which protect operating personnel from swinging action of outside lever and weights.
- G. Guards shall be of a cage-type design using heavy duty wire mesh, easily removable, constructed as shown on Standard Details in Contract Drawings.
- H. Swing Check Valves:
 - 1. Swing Check Valves 2-1/2-inch and larger (lever and spring):
 - a. Rating: 175 psi up to 12-inch, 150 psi for 14-inch to 24-inch.
 - b. Type: AWWA C508, swing type with outside spring (adjustable tension) and lever, suitable for horizontal or vertical installation.

- c. Connections: Flanged, 125-pound ANSI.
- d. Materials: ASTM A126, Class B cast iron body, bronze trim. Stainless steel hinge and pins. Ductile or cast iron disc. Rubber faced disc. Cast iron outside lever and steel spring.
- e. Installation: In horizontal position.
- f. Manufacturers: GA Industries Series 230; M & H Style 259; Mueller Co.; No. A-2600 or 8001 Series; equivalent by Clow; or approved equal.

2.06 AIR AND VACUUM VALVES

- A. Conform to Article 2.01 as applicable.
- B. Air and vacuum valves shall be installed on pressure mains and elsewhere where shown on Contract Drawings.
- C. A brass shut-off valve shall be installed on all connections between air and vacuum valves and pressure mains.
- D. Each valve shall be provided with a sedimentation chamber and bronze bodied strainer to protect valve.
- E. Valves shall also have anti-siphon capabilities
- F. Air and vacuum valves shall be designed to release air from water mains when pumps are started and main is being filled and to admit air into water main when pumps are stopped and main is being drained by gravity. Valves shall be designed for use on water mains or sanitary sewage force mains depending on particular application. For sewage applications, valves shall be designed to operate with liquids carrying solids. Provide separation of liquid from sealing mechanism. Air gap separation is sustained under pressure up to 230 psi by a conical body shape, and under vibration, by a spring-loaded joint.
- G. Valves should be contained in a single, cast iron body for water application and stainless-steel bodies for sewage applications.
 - 1. All wetted components of either valve metal style shall be stainless-steel, except for molded resilient EPDM seal.
- H. Valves shall have a globe-type body with 150-flanged ends.
- I. Cross-sectional inflow area of valve shall be a minimum of 10 percent greater than equivalent pipe size of valve.
- J. Pressure rating shall be from 3 to 230 psi with test pressure rating of 360 psi.
- K. Valves must be rated 125 lb. Class.
- L. Valves must be rated for temperatures up to 250 degrees F.
- M. A drainage outlet shall be provided to allow easy removal of excess fluids.
- N. Internal components of valve shall be replaceable without removing valve from line.
- O. Valve plug shall be normally closed airtight. Venting mechanism shall allow air to escape when pressure of gas in valve body exceeds pressure in line. Additionally, air shall be allowed

to re-enter line when a vacuum pressure differential exceeds 0.25 psi. Valve shall be designed to prevent premature closing.

- P. Automatic Component - Valve shall release accumulated air from system while system is under pressure and operating.
- Q. Valves shall be APCO, Val-Matic, or approved equal and shall be Owner's standard. No alternates shall be accepted. Contractor shall verify manufacturer and model with Owner prior to shop drawing submittal.
- R. All air and vacuum release valves shall be ISO-9000 certified.

2.07 CORPORATION STOPS

- A. Corporation stops shall be of brass or bronze construction and shall be installed by wet method, connecting service line to water mains, with water main at or near operating pressure when corporation stops are installed.
- B. Corporation stops shall be installed by experienced tradesmen using proper tools especially designed for a wet-tap connection.
- C. Corporation stops shall be installed in complete accordance with pipe manufacturer's recommendations for tapping and installing corporation stops.
- D. Saddles shall be used where recommended by pipe manufacturer or as ordered by Engineer, and such saddles shall be approved for use with pipe by pipe manufacturer. Threads of service saddle shall be compatible with corporation stop specified. Saddles shall be of double strap design. Contractor shall verify diameter and pipe material ahead of time. Saddles shall be made of either brass or bronze and shall be as manufactured by Mueller Company, Ford Meter Box Company, or equal. All saddles shall be field wrapped with a polyethylene sheet.
- E. Where saddles are used, or for other reasons main cannot be tapped wet, Engineer may approve visual inspection of such connections after they have been pressurized.
- F. Buried corporation stops shall be Model H-15000 as manufactured by Mueller Company, or Model F-600 as manufactured by Ford Meter Box Company, or equal. Corporation stops located within pits or vaults shall be Model H-10045 or H-9992 with I.P. outlet as manufactured by Mueller Company, or Model F800 or F1600 with I.P. outlet as manufactured by Ford Meter Box Company, or equal.

2.08 CURB STOPS AND CURB BOXES

- A. Curb stops shall be of brass or bronze construction and two rubberized O-ring seals to provide pressure-tight seal. Curb stops shall be figure H-15204 as manufactured by Mueller-Oriseal, B22 as manufactured by Ford Meter Box Company, Hayes, Nuseal, or equal.
- B. Curb boxes shall be 2-1/2-inch shaft size two-piece screw type. They shall be adjustable from 48-inch to 72-inch. Curb boxes shall be constructed of cast iron and thoroughly coated with two coats of asphaltum varnish.
- C. Curb box top section shall include a water cover which shall be of "old style" with word "water" cast into it and shall include a brass pentagon screw.
- D. Curb box rods shall be supplied with a hole in "U" portion for insertion of a brass pin. Pins shall be supplied and shall be made of brass.
- E. Curb boxes shall be as manufactured by Ford Meter Box Company, Mueller Company, or equal.

2.09 HANDWHEEL OPERATOR

- A. Valves specified with handwheel operator shall have proper size handwheel to provide an effortless operation.
- B. Handwheels shall be made of bronze or cast iron materials, and shall be properly secured to valve stem to prevent displacement during use.
- C. Provide direction arrow on handwheel.

2.10 VALVE BOXES

- A. Valve boxes shall be provided for all buried, submerged, or otherwise below grade valves unless they are housed in valve chambers and specifically called out on drawings as not receiving a valve box. Boxes shall connect operating nut of valve and extended operator described herein to operating surface.
- B. Valve boxes shall be made of good quality cast iron and shall be of sectional adjustable type. Long section shall be 5-1/4 inches in inside diameter and fit around stuffing box of valve; or over valve operator, if a two-section box is used; or to fit a circular or oval-base section if a three-section box is used. Valve boxes shall be properly sized to accept a valve position indicator as described below. Valve boxes shall be heavy roadway type.
- C. Upper section shall be arranged to screw on over adjoining long section and shall also be full diameter. Screw-type valve boxes shall be used unless otherwise specified. Valve boxes shall be provided with cast iron lids or covers.
- D. Lids or covers shall be marked for service for which valve is used by casting words such as "WATER" for potable water system, "SEWER", "GAS", "RECLAIMED WATER", etc. An arrow shall be provided on cover to indicate direction in which valve is turned to open; this arrow shall be labeled with word "OPEN".
- E. Overall length of each valve box shall be sufficient to permit top of box to be set flush with established finished grade. In asphalt concrete pavements, top of box to be set 1/2-inch below finished grade. Asphalt concrete to be compacted 12 inches wide around upper section for a depth of 12 inches below finished grade.
- F. Valve boxes shall be set truly vertical and fully supported until sufficient backfill has been placed and compacted to ensure vertical alignment of box.
- G. Stationary rods shall be provided and cotter pinned to valve nut when valve boxes are longer than 7 feet and a T-handle stationary rod key shall be provided.
- H. Valve boxes shall be East Jordan Iron Works or equal.
- I. Contractor shall provide 18-inch x 18- inch x 12-inch deep concrete mowing pad around all valve curb boxes located in grassy areas.
- J. Valve position indicators shall be provided for all valves receiving a valve box. Valves position indicators shall be Diviner Ground Level Position Indicator manufactured by Mueller (Henry Pratt Company), or equal. Valve box indicator adapter and Diviner Indicator showing number of turns and valve position shall be provided.
- K. Where extension stems are required within valve boxes, insert stem guides shall be provided.

2.11 VALVE TAGS AND SCHEDULE

- A. Provide valve tags for all valves in accordance with Section 10 14 20.

- B. Tags shall be made from a plastic laminate of heavy plastic with an eyelet in corner and shall indicate valve number and fluid in pipe.
- C. Tags shall be fastened to each valve with a stainless steel chain. For buried valves, tags shall be fastened to concrete mowing pad, valve box, or some other conspicuous manner near valves.
- D. Tags to be made by Seton Name Plate Company, New Haven, Connecticut; W.H. Brady Company; or equal.
- E. A valve directory shall be provided by Contractor listing all valve numbers, valve function, and location. Directory shall be provided in MSExcel and searchable PDF formats.
 - 1. Buried valves shall be included in valve directory with a description of their functions and locations even though they shall not have a valve tag.

2.12 TAPPING SLEEVES AND VALVES

- A. Tapping sleeves and valves shall be provided where shown on Contract Drawings or provided as necessary to accomplish Work.
- B. Tapping sleeves shall be compatible with pipe encountered so that a watertight connection shall be made.
- C. Sleeve shall be adequate to provide reinforcement of pipe being tapped and protect this pipe against all strains resulting from either tapping pipe or connecting to pipe.
- D. Tapping valves used shall conform to Article 2.03, Resilient Seated Gate Valves.
- E. Tapping sleeves and tapping valves for this project shall be Models H-615 and H-687, respectively, as manufactured by Mueller Company or equal.
- F. Tapping contractor shall have a minimum of five years' experience in performing taps.
- G. After sleeve has been installed, but prior to making tap, sleeve shall be subjected to a hydrostatic test equal to maximum line pressure. There shall be no observed leakage from sleeve.
- H. Sleeves and valves shall have restrained mechanical joints in conformance with AWWA C111.

2.13 PIPE INSULATION AND JACKETING

- A. All bridge crossing restrained joint pipe and other pipe whose fluids could freeze due to exposure to below-freezing air temperatures shall be insulated with polyurethane insulation. Insulation shall be wrapped in a jacket made of HDPE, resin Type III, Grade P34 as defined under ASTM D-638. Insulation and jacketing shall be extended to limits shown on Drawings or as required to prevent fluid freezing. Insulation and jacketing shall be installed as recommended by manufacturer. Manufacturer shall be Insul Tek or equal.
- B. All restrained joint bends, fittings, and expansion joints and valves shall be fitted with jacket and insulation. Jacket and insulation shall be of same manufacturer as pipe insulation and shall be custom made and installed according to manufacturer's recommendations.

2.14 SPARE PARTS

- A. Following spare parts shall be furnished, where applicable, for valves of each type and size provided:

1. Stem packing – One (1) set each type and size valve
 2. Renewable stainless steel or bronze seat ring – One (1) each type and size valve
 3. O-ring stem or shaft seals – One (1) set each type and size valve
 4. Resilient seat or disc – One (1) each type and size valve
 5. Shaft bearings or bushings – One (1) set each type and size valve
 6. Hinge pin, disc, spring, – One (1) set each size check valve and disc bolts
 7. Gaskets – One (1) set each type and size valve
 8. Special tool or seat wrench – One (1) each required for valve servicing and maintenance
- B. Following spare parts shall be furnished for electric motor operators of each size and model provided:
1. O-rings and seals – One (1) set each operator
 2. Operating nut for rising stems – One (1) each operator
 3. Lubricant – One (1) year supply each operator
- C. Spare parts shall be suitably protected against corrosion and impact to withstand long-term storage. All parts shall be
- D. Each set of spare parts and special tools shall be boxed with list enclosed and clearly labeled and identified by manufacturer's name and number and valve to which they belong.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut, excavated base and valve bedding is ready to receive work and valve bedding dimensions and elevations are as indicated on drawings and as required in Sections 31 23 16 and 31 23 23.
- B. Verify that structures are complete and ready to receive work.
- C. All valves, hydrants, and appurtenances shall be carefully inspected in field before lowering into trench. Cracked, broken, warped, out-of-round, damaged joints, including damaged linings or coatings, or otherwise defective valves, hydrants and appurtenances, as determined by Engineer, shall be culled out and not installed. Such rejected material shall be clearly tagged in such manner as not to deface or damage it, and material shall then be removed from job site by Contractor at his own expense.
- D. For tapping sleeve and valve connections, Contractor, prior to making any connections, shall verify material and outside diameter (O.D.) of existing water main.
- E. Contractor shall have on job site all proper tools, gauges, pipe cutters, lubricants, etc., to properly install valves, hydrants, etc.
- F. Contractor shall verify all valve positions and locations before installation.

3.02 PREPARATION

- A. Prior to installing foundation, trenches shall have all water moved and all work performed in a dry stable trench in accordance with Sections 31 23 16 and 31 23 23.
- B. All valves, hydrants, etc. which are to be installed in open trench excavation shall be properly bedded in, and uniformly supported on pipe foundations of various types specified in Sections 31 23 16 and 31 23 23 and shown on Contract Drawings.
- C. Flat-bottom trenches of required width shall be excavated to necessary depth as required and maintained in accordance with Section 31 23 23.
- D. Bedding material shall be spread in maximum of 8-inch layers for pipe foundation and each layer shall be compacted until required total depth of bedding has been built up.
- E. Suitable holes or depressions shall be provided in bedding to permit adequate bedding of bells, couplings or similar joint projections.
- F. Compaction methods include hand tamping with T-bars, flat heads, and shovel slicing, as well as mechanical compactors.
- G. Contractor shall perform his bedding operations with care to maintain line grade and proper depth of valve and hydrants.

3.03 LINES AND GRADES

- A. Easement and property line and other control lines necessary for locating work are shown on Drawings.
- B. Conform to applicable "Lines and Grades" articles of Section 33 11 00.

3.04 TOLERANCES

- A. Valves, hydrants, and appurtenances shall be installed at elevations, locations, and lines and grades, shown on Drawings.
- B. Conform to applicable "Tolerances" articles of Section 33 11 00.

3.05 INSTALLATION

- A. Contractor shall furnish slings, straps, and/or approved devices to provide satisfactory support of valves or hydrants when lifted. Transportation from storage areas to trench shall be restricted to operations which can cause no damaged to coating or lining or castings.
- B. Valves or hydrants shall not be dropped from trucks onto ground or into trench.
- C. All valves shall be installed in accordance with specifications for pipe to which they are to be connected and as previously described for individual types of valves.
- D. Joints of valves shall be made up in accordance with Contract Drawings and/or as described under appropriate pipe joint descriptions found in other sections of these specifications.
- E. Valves shall be so located that they are accessible for operating purposes and shall bear no stresses due to loads from adjacent pipe.
- F. All valves shall be inspected before installation, and they shall be cleaned and well lubricated before being installed in line.

- G. Provide a valve box and valve position indicator for every exterior, underground, buried, or submerged valve. Valve box shall not transmit shock or stress to valve and shall be centered and plumb over operating nut of valve, with box cover flush with surface of finished pavement or such other level as may be directed by Engineer
- H. Provide a valve position indicator for all interior valves not provided with rising stems. Provide valve boxes and valve position indicators for all buried, submerged, or otherwise below grade valves. Valve box shall not transmit shock or stress to valve and shall be centered and plumb over operating nut of valve, with box cover flush with surface of finished pavement or such other level as may be directed by Engineer.
- I. Conform to applicable "Installation" articles of Section 33 11 00.
- J. All iron bodied valves shall be primed and finish painted in accordance with Section 09 96 00.

3.06 TESTS

- A. All installed valves, hydrants and appurtenances shall be subjected to pressure and leakage test as described under Section 33 13 00.

3.07 DISINFECTION OF WATER VALVES AND HYDRANTS

- A. All installed valves, hydrants and appurtenances for water service, whether potable or non-potable, shall be subjected to flushing, sterilization and coliform tests described under Section 33 13 00.

3.08 MANUFACTURER'S SERVICES

- A. A technically qualified manufacturer's representative for motorized actuators shall be present at job-site for following services, travel time excluded:
 - 1. Installation assistance, inspection, start-up, testing, adjusting and job-site training: 1 man-day.
- B. Regardless of trips specified herein, equipment supplier shall provide highly experienced personnel on-site for as long as necessary to ensure specified equipment is successfully started and is performing in compliance with Contract Documents.
- C. Trips specified in this paragraph may not be concurrent. Contractor shall assume trips are not concurrent.

3.09 CERTIFICATION

- A. Equipment Installation and Operation: Manufacturer's representative that is qualified in particular equipment requirements shall fully inspect and certify equipment installation and operation. Written certifications shall be provided that state equipment is installed properly, is operating within design parameters, and shall be warranted as required by specifications. Equipment Start-up Report and Certification form included in Section 01 00 05 of these specifications must be signed by Manufacturer's representative. Additional certification forms used by Manufacturer's Representative shall be attached to Equipment Start-up Report and Certification form.
- B. Equipment Training: Manufacturer's representative that is qualified in particular equipment requirements shall train Owner personnel in accordance to Section 01 00 05 and shall be certified on Equipment Training Certification form included in Section 01 99 00 of these specifications.

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SECTION 33 13 00

TESTING AND DISINFECTION OF PIPING AND SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pressure testing of water distribution piping and appurtenances those for reuse/reclaimed/repurified water, gravity sanitary sewers including manholes, sanitary sewage force mains and pressure sewers and pump discharge piping, storm sewers, process piping, and chemical piping.
2. Disinfection of all pipes, fittings, valves, hydrants, storage facilities, and treatment plants used in potable water.
3. Test requirements.
4. Required replacement or repair if test fails.
5. Project records.
6. Flushing and disposal of chlorinated water.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 33 11 00 – Piping
3. Section 33 12 00 – Valves

1.02 REFERENCES

- A. AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
- B. AWWA C651 – Disinfecting Water Mains
- C. AWWA C652 – Disinfection of Water Storage Facilities
- D. AWWA C653 – Disinfection of Water Treatment Plants
- E. AWWA C901, including Appendix A - ASTM D2774 for Polyethylene Pipe (PE).
- F. Local, County, State, and Federal regulatory agency requirements.

1.03 DEFINITIONS

- A. Existing pipe or pipe joints are defined as pipe existing “in place” before start of this project.
- B. New pipe or pipe joints are defined as new pipe and pipe joints constructed under this project, including new pipe replacing existing pipes.

1.04 PRESSURE AND LEAKAGE TEST REQUIREMENTS FOR WATER DISTRIBUTION PIPING, REUSE/RECLAIMED/REPURIFIED WATER PIPING, SEWAGE FORCE MAINS, PRESSURE SEWERS, AND PROCESS PIPING

- A. All piping systems shall be tested in accordance with AWWA Standard C-600 unless specified otherwise in Piping Schedules. One of following procedures shall be used, as required by Pipe Schedule:
1. Procedure A - shall consist of a 30-minute test at 100 psi followed by a 3-hour test at 50 psi.
 2. Procedure B - shall consist of a 1-hour test at 150 psi followed by a 2-hour test at 100 psi.
 3. Procedure C - shall consist of a 30-minute test at 50 psi.
 4. Procedure D - shall consist of an exfiltration test; pipe is filled with clear water to provide a head of at least 10 feet above top of pipe at highest point of pipeline under test, and then measuring loss of water from line by amount which must be added to maintain original level. In this test, test period (for taking measurements) shall not be less than three hours. To pass, there shall be no loss of water over test period.
 5. Procedure E - shall consist of a pressure test using air only. All piping shall be tested at a pressure of at least 1.5 times working pressure, unless otherwise noted in pipe schedule, for a period of not less than 2 hours.
 6. As Procedures E involves air at potentially high pressures, this test shall be allowed only when specified in Pipe Schedules shown on Drawings or only when written approval has been granted by Engineer.
- B. Contractor shall accomplish required tests on pipeline by individually testing each component section of installed main. Maximum length of section permitted to be tested at any one time shall be 1,000 feet.
- C. When no test method for piping is specified in Pipe Schedule, following procedure shall be used.
1. All newly laid pipe or any valves section thereof, shall be subjected to a hydrostatic pressure 50 percent in excess of working pressure at any point of tested, but in no case less than 150 psi in any section of pipe being tested, for a period of two hours.
- D. Test Pressure Restrictions - Test pressure shall:
1. Not be less than indicated pressure at highest point along test section for each test procedure described or 150 psi, whichever is less
 2. Not exceed pipe or thrust restraint design pressures.
 3. Duration shall be at least as long as described for each procedure; if no duration is indicated, test shall last at least 2 hours.
 4. Not vary by more than plus or minus 5 psi.
 5. Not exceed twice rated pressure of valves when pressure boundary of test section includes closed gate valves.

- E. Leakage Test
 - 1. A leakage test shall be conducted concurrently with pressure test.
 - 2. Section tested shall be drip-tight with no signs of leakage. All piping, equipment, etc., shall be dry before and after testing.
 - 3. Leakage Defined - Leakage shall be defined as quantity of water that must be supplied into newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of specified test pressure throughout duration of test after pipe has been filled with water to test pressure.
 - 4. Rate of leakage shall not exceed 10.49 gallons per day, per mile of pipe, per inch of nominal pipe diameter based on a test pressure of 150 psi for underground water distribution piping or process piping. To calculate allowable leakage in gallons per hour (gph) for other test pressures, refer to Table 6 of AWWA C600.
 - 5. No rate of leakage shall be allowed for above-ground or interior piping subjected to same testing procedures.
 - 6. Test pressure shall not exceed pipe or thrust restraint design pressures.
 - 7. Test pressure shall not exceed twice rated pressure of valves when pressure boundary of test section includes closed gate valves.
- F. When a section of pipeline has multiple uses, pipe shall be tested at highest pressure required.
- G. All costs for testing shall be borne by Contractor and all necessary equipment shall be supplied by Contractor.

1.05 DISINFECTION OF POTABLE WATER SYSTEMS AND REUSE/RECLAIMED/REPURIFIED WATER SYSTEMS

- A. All pipe, fittings, valves, hydrants, storage facilities, and treatment plants connected to and forming part of a potable water supply system or reuse/reclaimed/repurified water system shall be disinfected in full accordance with both requirements of AWWA Standard C651 and C652 and C653, Tennessee Department of Environment and Conservation, and other local, County, State, or Federal regulatory agencies having jurisdiction over work.
- B. Disinfection of pipes, fittings, valves, and hydrants shall be done by continuous feed method (per AWWA C651).
- C. Disinfection of water storage facilities shall be done by Chlorination Method 3 (per AWWA C652).
- D. Disinfection of potable and non-potable water piping, tanks, and clearwells shall be performed as described above. Disinfection of Treatment Plant filters shall be as described by Disinfection Procedure in AWWA C653. Alternative Disinfection Procedure described in AWWA C653 is not allowed without prior approval of Engineer.
- E. Contractor shall bear all costs of flushing and disinfection.
- F. Owner shall perform coliform testing on samples provided by Contractor.

1.06 SUBMITTALS

- A. Provide sealant product data, describing active ingredients, manufacturer, mixing and installation procedures, if pertinent.
- B. Contractor shall provide certification from a testing laboratory as to accuracy of calibrated gauges and/or gauges to be used for calibrating Contractors gauges.
- C. Engineer shall observe all tests. Contractor shall not conduct tests without Engineer's presence only if approved by Owner in advance in writing.
- D. Disinfection plan, which shall include location of taps, sampling points, and schedule. Plan shall describe method and rate of chlorine addition and anticipated flow through main being disinfected.
- E. For each section of gravity and pressurized water and sewer line, provide a completed "Gravity and Force Main Piping Flushing and Leakage/Pressure Testing Summary Sheet" found in Section 01 99 00.
- F. For each section of water line, provide a completed "Piping Disinfection Summary Sheet" found in Section 01 99 00.
- G. For each water-tight structure (other than manholes) that is leak tested, provide a completed "Water-Tight Structure Other than Manholes Leakage Testing Summary Sheet" found in Section 01 99 00.
- H. All test results shall be provided to Engineer within 30 days of test. All tests shall be neatly bound and indexed in a protective cover when submitted to Engineer.

1.07 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Sections 01 77 13.

1.08 REGULATORY REQUIREMENTS

- A. All testing shall be in accordance with applicable AWWA requirements.
- B. Submit proof of testing, and disinfection if performed, as required by local, county or State agencies and this Section of Specifications.
- C. Dispose of chlorinated water in accordance with requirements of state and local agencies with jurisdiction over release of potential contaminants to environment.
- D. Conform to applicable local, State and Federal (OSHA) Health and Safety Codes for storing, handling and mixing of chemical sealants.
- E. Contractor shall conform to any equipment manufacturer's installation and commissioning guidelines.
- F. Contractor to obtain necessary permits and site approval for disposal of any solids removed from sewers and disposal of excess sealants and containers.

1.09 FIELD MEASUREMENTS

- A. Measure length of test section.
- B. Measure quantity of water used to maintain test pressure during test period.

- C. Measure height of groundwater above top of pipe.
- D. Measurements required to supply data required under “Submittals” in PART 1.
- E. Measurements required to comply with requirements of any local, county, or State agencies having jurisdiction over work.

1.10 COORDINATION

- A. Provide 48-hour notice to Owner of local water department when water for flushing, testing, or disinfection is required.
- B. Owner of existing water system to operate all valves and hydrants unless Contractor has been specifically authorized to operate systems valves and hydrants by Owner in writing.
- C. Coordinate maintenance of traffic with local authorities.
- D. Advise Engineer 48 hours in advance before any testing or disinfection. All tests and disinfection shall be observed by Engineer.

PART 2 PRODUCTS

2.01 GENERAL

- A. Air Testing: Equipment to be used in making air tests shall be specially designed for this purpose as approved by Engineer. Generally products of Cherne Air Lot Equipment, United Survey, Inc., Aire Test System or equal shall be acceptable. Air Testing shall be done only when specifically called for in Contract Documents and then only with prior approval from Engineer.
- B. Disinfection agents: sodium hypochlorite solutions. Calcium hypochlorite use shall not be permitted.
- C. Miscellaneous: All other equipment not particularized herein shall be best of their particular class and suited for intended use.
- D. Materials, Equipment, and Labor
 - 1. Contractor shall furnish all materials equipment, labor, and supervision required to perform all testing and disinfection.
 - a. Contractor shall furnish a pressure gauge for measuring pressure on piping, shall provide a corporation cock in piping to attach gauge or pump connection, and shall provide plugs to seal taps after testing, and shall also furnish a suitable pump and piping necessary to make these tests.
 - 2. Materials and equipment may be new or used but shall be accurately calibrated and must be suitable for intended use.

2.02 WATER SUPPLY

- A. Owner shall supply water at no cost to Contractor for initial tests. Additional water needed due to failure of test shall be Contractor’s responsibility. Contractor is responsible for disposal of water in accordance with all Federal, State, and Local requirements by Contractor at his expense.

- B. Water supplied for flushing, testing, and disinfection shall be clean, clear and from potable sources acceptable to Engineer and Owner.

2.03 SEALANT

- A. Chemical sealant for pressure grouting shall be a flexible elastomeric compound with grouting accelerator, an acrylamide gel compound with addition of diatomaceous soil in sufficient quantities (per manufacturer's recommendations) to prevent shrinkage of sealant due to fluctuating groundwater table, an Acrylate Polymer Grout, or equal.
- B. A root-killing and inhibitive additive shall be included in sealant at rates and quantities recommended by manufacturer.
- C. Set time for sealing compounds shall be as recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Backfilling of pipe trench or around manhole to ground surface or road surface shall be in place and completed except for final paving for 30 calendar days or as approved by Engineer prior to start of testing.
- B. All pressure and leakage tests of water system shall be completed prior to start of disinfection in accordance with this Section.
- C. All work associated with access to project and traffic control, including snow and ice removal, locating and uncovering pavement from manhole cover, opening of manholes and furnishing of water shall be performed by Contractor.

3.02 PREPARATION

- A. Contractor to employ methods to prevent contaminating materials from entering water mains, piping, and manholes during storage, construction, or repair in accordance with Sections 33 11 00.
- B. Contractor shall supply all proper tools, plugs, air bags, pumps, weirs, gauges, water trucks, compressors, etc., necessary to properly conduct tests, including means to accurately measure quantity of water used to maintain test pressure during test period.
- C. All piping systems, valves, hydrants, tanks, filters, and manholes shall be thoroughly flushed of any debris, stones, silt, dirt or contaminating materials prior to any tests beginning. All surfaces of pipes and manholes shall be visible.
- D. Mechanical methods shall be used to clean piping, tanks, filters, and manholes if dirt or debris shall not be removed by flushing operations.

3.03 PRESSURE AND LEAKAGE TESTING OF WATER DISTRIBUTION PIPING, AND PROCESS PIPING

- A. Pressure and leakage tests shall be conducted on all gravity and pressure pipe prior to backfilling.
- B. Engineer shall witness all tests.
- C. All pertinent test data required in "Submittals" in PART 1 shall be provided.

- D. Contractor is responsible for temporary connections to facilitate filling of piping, release of air from piping, and pressure testing. Connection devices shall be reviewed by Engineer before starting testing. All temporary connections shall be plugged after a successful test.
- E. Pressurization - Each valved section of pipe shall be slowly filled with water. Specified test pressure, based on elevation of lowest point of line or section under test and corrected to elevation of test gauge, shall be applied by means of a pump connected to pipe.
- F. Air Removal - Before applying specified test pressure, air shall be expelled completely from pipe and valves. If permanent air vents are not located at all high points, Contractor shall install corporation cocks at such points so that air can be expelled as line is filled with water. After all air has been expelled, corporation cocks shall be closed and test pressure applied. At conclusion of pressure test, corporation cocks shall be removed and plugged, or left in place at discretion of Engineer.
- G. Examination - Any exposed pipe, fittings, valves, and joints shall be examined carefully during test. Any damaged or defective pipe, fittings, or valves that are discovered following pressure test shall be repaired or replaced with sound material and test shall be repeated until results are satisfactory to Engineer.
- H. All visible leaks, regardless of amount, shall be repaired.
- I. If section being tested fails to pass pressure or leakage test, Contractor shall determine, at his own expense, source or sources of leakage, and he shall permanently repair or replace all defective materials and/or workmanship at his expense. Extent and type of repair as well as results shall be subject to approval of Engineer. Completed pipe installation shall then be retested and required to meet pressure and leakage requirements of test.
- J. Testing and retesting shall be completed prior to final paving; and prior to disinfection, if a water main system or a reuse/reclaimed/repurified water system.
- K. Use of sealants, applied from outside or inside of pipe, is not acceptable.
- L. Disconnect all pumps, connections, and hoses from section being tested for duration of test.
- M. All tests shall be blown off at opposite end of pipe where pressure gauge is located or as directed by Engineer.
- N. Pressure gauges shall read in 1 psi increments for high pressure and 0.5 psi increments for low pressure tests.
- O. Pumps or devices for makeup water to calculate leakage shall be provided with calibration containers.
- P. All test water must be removed from interior of all stainless steel pipes by draining, blowing, mopping, etc. Water must not be allowed to stand for long periods of time within stainless steel pipe.

3.04 LEAKAGE TESTING OF WATER STORAGE FACILITIES AND OTHER WATERTIGHT STRUCTURES

- A. Watertight Structures - Tanks and portions of structures, such as basements of buildings, “dry” wells of pump stations, or any such portion of a structure intended to be watertight at all times, shall be watertight from any infiltrating groundwater or

leakage from roof decks or adjoining tanks or channels. Contractor shall repair leaks which appear during construction of project or within project guarantee period.

- B. Successful leak testing shall be completed before any surface treatment (including painting) is applied to concrete and prior to disinfection. No testing shall be conducted when following day is not a normal work day.
- C. Leak Test – Refer to Section 03 00 05.
- D. NOTE: Above testing shall not be started until all structural elements, such as tank roofs, top floor slabs, etc. are in place and have gained full strength, and all pipe with link seals are installed. No waterproofing coverings shall be applied before testing is complete.

3.05 DISINFECTION OF WATER SYSTEMS

- A. All chlorine introduced into system shall be totally dissolved.
- B. Introduction of solid hypochlorite (granules) directly into system, tank, or filters is prohibited.
- C. Injection point shall be within 10 feet of water source.
- D. For Water Mains, Fittings, Valves, and Hydrants:
 - 1. Continuous feed method shall be used for chlorine application for disinfection of water mains, fittings, valves, and hydrants in accordance with AWWA C651.
 - 2. A water main shall be filled with not less than 50 mg/L nor more than 100 mg/L of available chlorine and retained in system for not less than 24 hours. When filling water main with chlorinated water, each hydrant (in consecutive order) shall be flushed until required residual is measured.
 - 3. During this time, all valves in section treated shall be operated in order to disinfect appurtenances.
 - 4. At end of 24-hour period, disinfected water shall contain no less than 25 mg/L available chlorine throughout system.
 - 5. Disinfection shall be repeated as often as necessary at Contractor's cost until minimum residual chlorine of 25 mg/L has been maintained.
- E. For Water Storage Facilities:
 - 1. Chlorination Method 3 shall be used for chlorine application for disinfection of water storage facilities in accordance with C652.
 - 2. Each water storage facility shall have 5 percent of its volume filled with chlorine solution containing 50 mg/L of available chlorine and held for not less than 6 hours.
 - 3. After minimum of 6 hour holding time, tank shall be filled to overflow level with potable water and held for not less than 24 hours. After filling, water shall initially contain not less than 2.5 mg/L available chlorine. After 24 hours, available chlorine concentration shall not have decreased by more than 0.5 mg/L (or be less than 2.0 mg/L). A decrease of more than 0.5 mg/L (or an available chlorine concentration less than 2 mg/L) after 24 hours shall constitute a failure.

4. Disinfection shall be repeated as often as necessary at Contractor's cost until decrease in available chlorine concentration is less than 0.5 mg/L after 24 hours and available chlorine concentration is greater than 2 mg/L after 24 hours.

F. For Water Treatment Plants, other than piping and storage facilities:

1. Primary (not Alternative) Procedure shall be used for chlorine application for disinfection of Water Treatment Plant Filters in accordance with C653.
2. New filter basin containing sand, anthracite, and other media materials shall be filled with chlorine solution containing not less than 25 mg/L and retained in basin for not less than 24 hours.
 - a. At end of 24-hour period, disinfected water shall contain no less than 15 mg/L available chlorine anywhere inside basin. Tests shall be conducted at top, bottom, and intermediate points of filter.
 - b. Disinfection shall be repeated as often as necessary at Contractor's cost until minimum residual chlorine of 15 mg/L has been maintained throughout filter basin.

3.06 FLUSHING AND DISPOSAL

- A. Chlorine solution shall be thoroughly flushed out of pipes, tanks, filters, etc. prior to testing for total coliform.
- B. Contractor shall dispose of spent chlorine solutions in a manner acceptable to Owner and regulatory agencies and where its effects shall not be detrimental to animal, plant or fish life.

3.07 TOTAL COLIFORM TESTING FOR WATER DISTRIBUTION SYSTEMS

A. Water Pipes, Fittings, Valves, and Hydrants:

1. After final flushing and before water main is placed in service, a water sample or samples shall be collected from new main. At least one set of samples shall be collected from every 1,200 feet of new water main, plus one set from end of line, and at least one set from each branch. All samples shall be tested for bacteriological quality, showing absence of coliform organisms, in accordance with Tennessee Department of Environment and Conservation procedures and any other procedures from local, county, or State agencies having jurisdiction over work.

B. Water Storage Facilities and Treatment Plants:

1. After final flushing and before tank or filter is placed in service, a minimum of five (5) samples shall be taken from tank or filter not less than 30 minutes apart. All samples shall be tested for bacteriological quality, showing absence of coliform organisms, in accordance with Tennessee Department of Environment and Conservation procedures and any other procedures from local, county, or State agencies having jurisdiction over work.

C. Analyses shall be performed by state-certified laboratories. Contractor shall arrange for samples to be picked up at job site by laboratory personnel. Engineer shall witness transfer of samples from Contractor to laboratory personnel.

D. For water piping only, if initial disinfection fails to produce satisfactory bacteriological results, new main may be reflashed and shall be resampled at

Contractor's cost. If check samples also fail to produce acceptable results, Contractor shall repeat all disinfection procedures until satisfactory results are obtained.

- E. For water tanks and filters, none of samples shall show presence of coliform. If any sample indicates presence of coliform, a minimum of five (5) additional samples shall be collected and tested. A further set of at least five (5) samples shall also be collected at least 24 hours after previous set and tested. Should any of ten (10) or more repeat samples indicate presence of coliform, Contractor shall repeat disinfection procedures until acceptable results are obtained.
- F. After approval from Tennessee Department of Environment and Conservation, other local, county, or State agencies having jurisdiction over work, and Owner, water mains, tanks or filters shall be placed in service.

3.08 WATER SERVICES

- A. Water services to be installed after completion of disinfection of water mains.
- B. Services to be tested, prior to backfilling by flushing service pipe thoroughly and by observing for any leaks along pipe, or at corporation and curb stops.

Prior to connection of service line, service shall be disinfected in accordance with procedures outlined in this Section.

Pipe Diameter (inches)	*Shortest Time (min:sec)	Length for Shortest Time (ft.)	Time for Longer Length (sec.)	Time (min:sec) for Length (L) Shown					
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.855 L	5:40	5:40	5:40	5:40	5:40	5:40
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43
36	34:00	66	30.768 L	15:17	76:55	102:34	128:12	153:50	179:29

*Time allowed for 1.0 psig drop in pressure.

END OF SECTION

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SECTION 40 27 00

HANGER, ANCHORS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping and equipment hangers and supports.
2. Equipment bases and supports.
3. Inserts.
4. Vibration Isolation and Seismic Restraint.
5. Schedules.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Division 05 – Metals
3. Section 09 96 00 – Painting and Coatings
4. Section 33 12 00 – Valves
5. Section 33 11 00 – Piping

1.02 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.

Reference	Title
ASME B31.1	Code for Pressure Piping (Power Piping)
ASME B31.2	Fuel Gas Piping
ASME B31.5	Refrigeration Piping
ASME B31.9	Building Services Piping
ASTM B633	Standard Specification for Electrodeposited Coatings for Zinc on Iron and Steel
ASTM F708	Design and Installation of Rigid Pipe Hangers
MSS SP58	Pipe Hangers and Supports - Materials, Design and Manufacturer
MSS SP69	Pipe Hangers and Supports - Selection and Application
MSS SP89	Pipe Hangers and Supports - Fabrication and Installation Practices
NFPA 13	Installation of Sprinkler Systems

Reference	Title
NFPA 14	Installation of Standpipe and Hose Systems
UL 203	Pipe Hanger Equipment for Fire Protection Service
Seismic Considerations	***Refer to State and Local Building Codes***

1.03 DEFINITION

- A. Designer – Shall be a licensed engineer in State of Tennessee hired by Contractor to provide professional engineering services for design of piping systems hangers and supports, guides, anchors, bracing, heat and vibration isolation, and seismic restraints as described in this Section.

1.04 SYSTEM DESCRIPTION

A. Contractor General Requirements:

1. Contractor shall provide design for all piping supports throughout project without exception. Based on contractor-provided design, provide all pipe hangers and supports for all pipes on project.
2. Incorporate in construction pipe hangers and supports and vibration isolation and seismic restraint to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
3. Comply with maximum load ratings with consideration for allowable stresses prescribed by MSS SP-58.
4. Provide supports, guides and anchors that do not transmit unacceptable heat and vibration to building structure.
5. Selection of pipe hangers and supports shall be based upon overall design concept of piping systems and any special requirements, which may be called for in specifications. Support systems shall provide for, and control, free or intended movement of piping including its movement in relation to that of connected equipment.
6. Provide for vertical adjustments after installation of supported material and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
7. Coordinate location of hangers, supports, anchors and other devices with all contractors and subcontractors involved with project to avoid interferences and to ensure all requirements of Contract Documents are met.

B. Selection of Hangers and Supports for Pipe Movement:

1. Select hangers and supports to perform under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses being introduced into piping system and connected equipment.
2. Angularity of rod hanger resulting from horizontal movement of piping system from cold to hot positions shall not to exceed 4 degrees from vertical.
3. Where horizontal pipe movement is greater than 1/2 inch, offset pipe hanger and support so that rod hanger is vertical in hot position.
4. Where significant vertical movement of pipe occurs at hanger location, a resilient support must be used. Selection of resilient supports shall be based on permissible load variation

and effects on adjacent equipment. Support selection for typical load variations are shown in Table 2 of MSS-SP-69. Load and movement calculations shall be made for proper selection of spring hangers. Vertical movement and load transfer from riser expansion to horizontal runs shall be given consideration when applying spring hangers. Spring Cushion Hangers may be used where vertical movement does not exceed 1/4 inch, and where formal load and movement calculations are not required. Variable spring Hangers shall be used for all other resilient support requirements. Constant Support Hangers shall be used on piping systems where deviation in supporting force must be limited to 6 percent and which cannot be accommodated by a Variable Spring Hanger.

C. Vibration Isolation and Seismic Restraint.

1. Seismic zone design criteria shall be as specified on Contract Drawings.
2. All mechanical, plumbing, fire protection, and other equipment and piping described herein shall be mounted on vibration isolators to prevent transmission of vibration, and mechanically transmitted sound to building structure. Vibration isolators shall be selected in accordance with weight distribution so as to produce reasonably uniform deflections.
3. Provide vibration isolators, pipe supports, and equipment anchors, of appropriate sizes and weight loading to meet specified deflection requirements, in accordance with instructions of isolator manufacturer.
4. Provide seismic restraint for all systems and piping as described herein. Provide all miscellaneous items (angle iron, bolts, rods, etc.) required for a complete seismic restraint system. Contractor and vendors shall thoroughly coordinate seismic restraint systems.
5. Coordination of locations all installed systems (ductwork, piping, equipment, etc.) shall be responsibility of Contractor. Contractor shall locate systems such that those requiring seismic restraint are not subject to Consequential Damage from systems not required to be seismically restrained. Functional and physical interrelationship of components, their supports, and their effect on each other shall be considered, planned, and coordinated so that failure of an essential or non-essential architectural, mechanical, or electrical component shall not cause failure of an essential architectural, mechanical, or electrical component.
6. Coordinate installation with other trades including but not limited to placement of anchor bolts in concrete slabs, etc.
7. Intent of seismic portion of this specification to keep all identified systems in place during a seismic event.
8. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.

D. Vibration Isolation and Seismic Restraint Manufacturer Responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations for equipment.
2. Provide isolation systems and seismic restraints for all equipment (vibration isolated and non-isolated) and systems (piping and ductwork).
3. Provide seismic restraints for piping at wall penetrations and at vertical risers. Provide sleeves, sleeve packing, guides and seismic calculations for pipe support.

4. Provide seismic restraints for control panels and equipment starters. Provide attachment bolts, resilient mounts, and associated seismic calculations.
5. Provide installation instructions and drawings.
6. Provide calculations to determine restraint loads resulting from seismic forces presented in:
 - a. Governing codes, project seismic requirements, or 0.5G minimum seismic acceleration applied at equipment center of mass. Seismic calculations shall be certified by an engineer who is licensed State of this project and has a minimum of 5 years documented experience in design of seismic restraints for flexibly mounted equipment and piping.
7. Provide certification of seismic restraints capability to safely accept loads resulting from seismic forces determined by methods defined above. Certification must be substantiated by calculations or test reports verified by a licensed engineer.
 - a. All restraining devices shall have a preapproval number from a recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in state of job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45E to weakest mode.
 - b. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, forces described in these Contract Documents or more stringent local and state building codes acting through equipment center of gravity. Overturning moments may exceed forces at ground level.
 - c. Design restraints, isolators, anchors, bracing and attachments for as described in these Contract Documents or more stringent local and state building codes. Comply with requirements of latest edition of ASCE 7.
8. Vibration isolation specialist shall coordinate his work with that of other trades to verify that equipment speeds, in revolution per minute (rpm), are based upon actual equipment installed at project site.
9. Verify that equipment rpm and spring deflection selected are arranged so that resonance is avoided.
10. Exact mounting sizes, dimensions and quantity of isolators and static deflection required shall be determined by isolator manufacturer based upon equipment that shall be furnished and installed by Contractor.

1.05 BASIS OF DESIGN

- A. Contractor shall provide professional engineering services ("Designer") for design of piping systems supports and restraints. Contractor shall provide final design and certification for piping supports, seismic restraints, and provisions for control of dynamic forces and pipe expansion for piping on this project.

- B. Contractor shall cause design of pipe hanger and support systems to be developed in conjunction with preparation of design seismic restraints and expansion control system by Designer selected. Pipe system drawings developed by Designer shall show hanger and support locations as well as details of seismic restraints and expansion control systems. Pipe hanger and support design drawings and calculations shall be prepared and signed by Designer who is licensed State of this project and shall bear Designer's registration seal. Design provided shall meet minimum requirements as set forth in this Section. If Designer determines minimum requirements are not satisfactory for this Project, instances shall be immediately brought to attention of Engineer for resolution before completion and acceptance of design.
- C. Rods shall be of following minimum sizes unless hanger manufacturer recommends a larger size or Designer determines that size needs to be larger:

Pipe Size (inches)	Rod Diameter (inches)
1/2 to 2	3/8
2-1/2 to 3	1/2
4 to 5	5/8
6	3/4
8 to 12	7/8
14 to 16	1
18 to 24	1-1/4
24 to 36	1-1/2
42	2

- D. Anchors, guides and restraints shall be located by Designer using guidelines establish in this Section. Should need or desirability of relocating, eliminating or adding anchors, guides or restraints arise; such changes shall be brought to attention of Engineer for consideration and approval. Anchors, guides and restraints shall be designed for imposed loadings as determined by Designer. For pressure piping with joints not having a restraining design, other positive restraining means such as clamps, rods and/or thrust blocking shall be used to maintain integrity of joints. Necessity for, and location of, shock suppressors and seismic control devices shall be as determined by Designer. Location, type and number of corrective devices which may be necessary to control any unforeseen vibrations, as determined after piping is in service, are not a part of this standard. Refer to MSS SP-127 for design, selection, and application of bracing piping systems subject to seismic - wind - dynamic loading.
1. Supports for all chemical piping located within 100 feet of a chemical tank whose connection is located within lower one-third of tank shall be fully supported wherever possible utilizing fiberglass reinforced plastic (FRP) uni-strut supports. Supports shall not restrain piping from moving in any direction except downwards in order to prevent stress and strain from being placed on tank connections due to expansion and contraction of tank or piping.

E. Vibration Isolation and Seismic Restraint.

1. Vibration Isolation:

- a. Size vibration control equipment in accordance with weight distribution, pull or imposed torque as shown on equipment shop drawings. Minimum static deflections may be revised subject to prior approval.
- b. Provide revised vibration control equipment to match revised or substituted equipment.

- c. Install vibration control equipment in accordance with manufacturer's installation instructions and as specified.
 - d. Install equipment on vibration isolation curbs to provide watertight seal.
2. Seismic Restraint:
- a. Seismic restraint shall be provided for following systems:
 - b. Following specific items of equipment to be furnished under this contract shall be manufactured and assembled, and constructed so as to be capable of withstanding horizontal equivalent static force of 0.11 times operating weight of equipment, at vertical center of gravity of equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render equipment inoperative for significant periods of time following an earthquake.
 - 1) Pumps.

1.06 SUBMITTALS

- A. All submittals shall be in accordance with Sections 01 00 05. Submittals shall include following:
- 1. Shop Drawings – Indicate system layout with type, location, and detail of all equipment and pipe bases, hangers, anchors, vibration isolation and seismic restraint, and manufactured supports including those fabricated on-site. Hanger and support design submitted by Contractor shall be stamped by a registered engineer in State of Tennessee. Submission shall detail location, number, type, and size of each component of individual hangers and supports as well as show related structural assemblies and connections to equipment and structures. Deviations from design requirements of this Section shall be noted at time of submittal.
 - a. Provide layout drawings, drawn to a scale of not less than 1/8-inch to 1-foot, showing proposed layout of equipment and piping systems and location and type of each vibration isolation and seismic restraint device. Carefully examine other sections requiring coordinated shop drawings, including but not limited to Divisions 21, 22, and 23 specifications, and prepare restraint/isolation shop drawings to same scale showing location of each vibration isolation equipment base, pipe hanger, flexible connection, and isolator/seismic restraint device.
 - 2. Performance Affidavit – Provide performance affidavit in accordance with Section 01 00 05 from manufacturer supplying vibration isolation and seismic restraint equipment.
 - a. In addition to standard language of affidavit, manufacturer shall also certify that each piece of equipment and pipe has been examined for rotational speed, equipment type, mounting location, and supporting span between column centers, and that an appropriate isolator has been selected by Designer.
 - 3. Product Data - Provide manufacturers catalog data including style, materials, and load capacity and sizing schedules, characteristics, and finish.
 - 4. Design Data - Indicate load carrying capacity of trapeze, unistrut, multiple pipe, and riser support hangers.
 - 5. Manufacturer's Preparation and Installation Instructions - Indicate special procedures and assembly of components as well as any special preparation instructions or recommendations.

6. Operation and Maintenance Data – Indicate any procedures necessary for proper maintenance and upkeep of supports, hangers, anchors, etc. Include methods precautions against certain cleaning products or methods that may be detrimental to finishes or performance, if any. Submittal shall comply with Section 01 77 13.
7. Manufacturer’s Certifications – Submit in accordance with Section 01 00 05.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable code for support of process, plumbing, and hydronic piping.
- B. Supports for Sprinkler Piping - In conformance with NFPA 13.
- C. Supports for Standpipes - In conformance with NFPA 14.
- D. Supports for Electrical Conduit and Electrical Enclosures – In conformance with NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store products in accordance with Section 01 00 05.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
- D. Vibration isolation and seismic restraint equipment which show any signs of rust, cement or concrete fouling, dirt and construction debris shall be removed from project site and replaced with new.

1.09 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.10 WARRANTY

- A. Submit warranty documents in accordance with Section 01 77 13.

1.11 QUALITY ASSURANCE

- A. Utilize an installed for supports, hangers, anchors, and other devices specified herein experienced in performing work of type described in this section and who meets minimum requirements of MSS SP-89.
- B. Conduct pre-installation meeting to verify project requirements, coordinate with other trades, establish condition and completeness of substrate. Review manufacturer's installation instructions and manufacturer's warranty requirements.
- C. Responsibility for Products: Select deflection for spring isolators in accordance with recommendations in current issue of ASHRAE Handbook of Fundamentals, unless noted otherwise on drawings.

PART 2 PRODUCTS

2.01 GENERAL

- A. All model numbers provided herein are for reference purposes only so Contractor is aware of general type of equipment required to be provided. Actual model numbers and materials of construction shall be selected by Contractor and Designer in accordance with environment for which equipment shall be exposed as dictated by room and area classifications described in Section 01 00 05. All necessary adjustments to models numbers and/or manufacturers shall be made in order to provide materials compatible with specified environments.
- B. All hangers and supports shall be manufactured or fabricated from materials suitable for particular area in which they are installed.
 - 1. Contractor shall install hanger supports that are similar in material construction regardless of piping or conduit application within a given area.
 - 2. Pipe hangers and supports for process pipe, conduit, heating and ventilating piping and plumbing piping shall be constructed of similar materials, (e.g., all hangers and supports located in an interior wet location shall be manufactured from stainless steel or PVC-coated galvanized steel).
 - 3. Where applicable, fasteners, brackets and supports shall be fabricated in accordance with Division 05 and as specified herein.
 - 4. Contractor is responsible for providing supports for all piping. Costs associated with providing and installing these supports shall be included in lump sum cost.
- C. All hangers and supports shall be manufactured to comply with applicable building codes.

2.02 MATERIALS

- A. Stainless Steel - For purpose of this Section, all stainless steel shall be Type 304 except in areas classified as corrosive per Section 01 00 05 in which case Type 316 stainless steel shall be used.
- B. Polyvinyl Chloride (PVC) Coated Materials - PVC coated hangers and supports shall be installed where applicable for chemical and corrosion resistant applications as required in specified areas, or as specifically called out in other sections of these specifications. PVC coating process shall be as follows:
 - 1. Hanger or support shall be hot dipped galvanized including threads.
 - 2. Zinc surface shall be treated with chromic acid prior to coating to enhance bond between metal and plastic.
 - 3. All surfaces shall be coated with an epoxy acrylic primer of approximately 0.0005-inch thickness.
 - 4. Coating shall be applied by liquid plastisol method.
 - 5. Plastisol shall be compounded of pure materials and shall be free of any fillers or secondary plastisizers.
 - 6. A Polyvinyl Chloride (PVC) coating shall be bonded to galvanized outer surface of product. Bond between PVC coating and product surface shall be greater than tensile strength of plastic. Thickness of PVC coating shall be a minimum of 0.040 inch (40 mil).

7. Coating system shall be OCAL-40 as provided by Occidental Coating Company, Van Nuys, CA; Plasti-Bond Red as provided by Robroy Industries, Verona, PA; or equal.
- C. Steel, Steel Alloys - Steel or steel alloy hangers and supports shall conform to ANSI B31.10 and MSS Standard Practice SP-58, and ASTM A36, ASTM A48, ASTM A53, ASTM A515, and ASTM A575.
 - D. Fiberglass Reinforced Structural Shapes
 1. Structural shapes shall be made from a premium-grade polyester or vinyl ester resin with fire-retardant additives to meet Class 1 flame rating of ASTM E84 and meet self-extinguishing requirements of ASTM D635. All structural shapes shall contain a UV inhibitor.
 2. Structural FRP members, manufactured by pultrusion process, shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50 percent resin-to-glass ratio. A synthetic surface veil shall be outermost layer covering exterior surfaces. Continuous glass strand rovings shall be used internally for longitudinal strength. Continuous strand glass mats shall be used internally for transverse strength.
 - E. Hangers, anchors, and supports in contact with copper piping shall be epoxy coated.
 - F. Hangers, anchors, and supports shall receive manufacturer's standard primer in compliance with Federal Specification Spec TT-P-636 and TT-P-664 after manufacture.
 - G. Hangers, anchors, and supports shall be painted in accordance with Section 09 96 00.
 - H. All metal fabrications shall comply with applicable sections of Division 05.

2.03 MANUFACTURERS

- A. Hangers and supports shall be as manufactured by Anvil International (Anvil), N. Kingstown, RI; Basic Engineering (B.E.), Pittsburgh, PA; Carpenter & Patterson, Lakeport, NH; Unistrut Corporation; B-Line Systems; Globe Division of United States Gypsum; Robroy Industries; OCAL; National Pipe Hanger Company, Upper Marlboro, MD, or equal.

2.04 CORROSION RESISTANCE

- A. All pipe supports in wet, corrosive, hazardous or exterior locations shall have stainless steel support rods, stainless steel mounting hardware, stainless steel fasteners, and stainless steel concrete inserts. All non-stainless steel parts of hangers and supports shall be PVC coated.
- B. All other areas shall have cadmium plated appurtenances unless specified otherwise.

2.05 FASTENING DEVICES AND MOUNTING HARDWARE

- A. All pipe supports in wet, corrosive, hazardous or exterior locations shall have stainless steel support rods, stainless steel (S.S.) mounting hardware, S.S. fasteners and S.S. concrete inserts.
- B. All other areas shall have cadmium-plated appurtenances unless specified otherwise.

2.06 HANGER AND SUPPORT SCHEDULE

- A. Following schedules are provided to identify type of hangers and supports acceptable under this Contract. Contractor shall provide type of hangers and supports in these schedules, however, acceptable materials of construction shall be provided as identified in "Application Schedule" for various systems and intended location of hanger or support.

- B. For all insulated pipe, hangers shall be provided with insulation shields and insulation shall remain uninterrupted when passing through hanger. Support piping on outside of insulation.
- C. In outdoor, hazardous, wet and corrosive areas pipe supports Type A, B, C and D (as described below) shall have stainless steel support rods, stainless steel mounting hardware, stainless steel fasteners, and stainless steel concrete inserts. All non-stainless steel parts of hangers and supports shall be fully PVC-coated.
- D. Utilize Anvil Trapeze Hanger Figure #45 channel assembly when three or more lines of pipe run parallel assuming pipe sizes shall allow for use of trapeze.
- E. If U-Bolt pipe supports are required, Contractor shall use Anvil Figure No. 137, 137S, and 137C as applicable.
 - 1. Type E and I pipe supports shall be an applicable channel system, for pipe loading and Unistrut span utilized by Unistrut Corporation, B-Line Systems, Globe Division of United States Gypsum; or equal.
 - a. System shall permit rigid metal construction without welding or drilling.
 - b. All members shall be fully adjustable, demountable and reusable.
 - c. One manufacturer shall furnish system complete with all nuts, bolts, couplers, channels and all other required fittings and mechanical accessories.
 - d. Channels and accessories shall be galvanized steel with 20 mil PVC coating, all of same color.
 - e. All mounting hardware, fasteners and concrete inserts shall be stainless steel.
 - f. Pipe clamps shall be PVC-coated galvanized straps with S.S. rods, nuts, and flat washers.
 - g. Verify that load carrying capacity of Unistrut system is adequate for weight of pipes and contents and span utilized.
 - 2. Type J pipe supports shall be Anvil Figure 40 Riser Clamp with Figure 290 weldless eye nut.
 - 3. Type A pipe supports for pipes greater than 30" in diameter shall be Anvil Figure 216 Heavy Pipe Clamp with Figure 290 weldless eye nut.
- F. Electrical Conduit and Electrical Enclosures – Refer to Division 26.

2.07 INSERTS

- A. Concrete Insert: Anvil Figure #281, MSS Type 18, universal concrete inserts, adequately sized and correctly positioned to support full load operating systems.
- B. Concrete Insert, Wedge Type: Anvil Figure #281, 1/4" to 7/8".
- C. Lightweight Concrete Insert: Anvil Figure #285.
- D. Continuous Concrete Insert: Anvil Powerstrut Figure #PS-349 pre-galvanized.

2.08 ANCHORS

- A. All anchors used for concrete and masonry bolted attachments and dowels shall be adhesive anchors, except those in pre-cast roof planks.
 - 1. Grout for these anchors shall be a premeasured, two-part, self-mixing, cartridge type adhesive such as “HIT HY 150 Injection Adhesive Anchor” by Hilti or “EPCON System” by Ramset/Red Head.
 - 2. All bolted connections to concrete or masonry shall be two bolts minimum each end of member. Bolts installed into concrete and masonry shall not be closer than 6 inches on-center.
 - 3. Anchors for pre-cast roof planks shall be as shown on Contract Drawings.
- B. Expansion anchors are not allowed unless specifically requested by Contractor for a particular application and approved by Engineer.
 - 1. If approved for use, expansion anchors shall meet following criteria:
 - a. Hilti Kwik-bolt, zinc plated, metal expansion anchor.
 - b. Anchor to meet U.L., ICBO-4627 and FM listings.

2.09 CLAMPS

- A. C-Clamps: Anvil Figure #92, MSS Type 23.
 - 1. Use these for attaching hangers to steel beams. Do not weld hanger rods to structural steel members.
- B. Malleable Beam Clamps: Grinnell Figure #218, MSS Type 30: Use these for attaching hangers to bar joists.
- C. Modify figure numbers and/or materials to suit areas for which clamps shall be installed.

2.10 VIBRATION ISOLATION AND SEISMIC RESTRAINT

- A. Seismic ratings for this project, including importance factor, use group, occupancy category, mapped spectral response acceleration, spectral design coefficients, design category, site classification, and basic structural system shall be as described elsewhere in these Contract Documents. If not provided in these Contract Documents, this information shall be as defined by applicable local and state building codes.
- B. Contractor shall conform to all relevant state and local codes regarding requirements for seismic restraint in addition to those requirements described herein.
- C. Acceptable Manufacturers.
 - 1. Mason Industries, Inc.
 - 2. Kinetics Noise Control.
 - 3. Vibration Eliminator Co.
 - 4. Vibration Mountings & Controls, Inc.
 - 5. Korfund Company.

6. Amber Booth.

D. Materials and Equipment.

1. All vibration isolators and seismic restraints described in this section shall be product of a single manufacturer. Mason Industries products are basis of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with specification and have approval of Engineer.
2. Materials and equipment shall conform to respective specifications and other requirements specified below:
 - a. Squarehead bolts and heavy hexagon nuts, ANSI B18.2.1 and ANSI B18.2.2, and ASTM A 307 or ASTM A 576.
 - b. Sway Brace Material used for members shown on mechanical drawings, except for pipes, shall be structural steel conforming with ASTM A 36. Steel pipes shall conform to ASTM A 501.

E. Products.

1. Type 1: Mason Super "W", 2 layers of 3/4 inch neoprene pad with 16 gauge galvanized shim.
2. Type 3: Mason SLF, free standing spring isolator, 1/4 inch neoprene non-skid pad, leveling bolt, spring diameter no less than 0.8 of compressed height at rated load, minimal additional travel to solid equal to 50 percent or rated deflection.
3. Type 4: Mason SLR, restrained spring isolator, vertical limit stops, internal isolation pad.
 - a. Designed to resist all seismic forces.
4. Type 5: Mason SSLH, housed spring isolator, vertical limit stops, designed to provide all directional snubbing.
5. Type 6A: Mason PC30N, spring and double neoprene hanger, 1-1/4-inch neoprene element at top of housing, spring seated in neoprene cup at bottom of housing, designed to allow 30 degree arc from side to side of hangar rod, pre-compressed and locked at rated deflection with seismic up stop, with scale to show deflection.
6. Type 7: Mason SCB, SCBH, SCBV cable assembly, galvanized aircraft cable with steel cable end connections, designed to resist seismic loads with a minimum safety factor of 2.
7. Type 8: Mason SSB, solid steel channel brace with steel connector assemblies, designed to resist seismic loads with a minimum safety factor of 2.
8. Type 9: Mason Z-1225 all-directional snubber, interlocked steel members restrained by replaceable neoprene bushing.
9. Type 10: Mason BMK rectangular steel frame form for concrete inertia base, 1/2-inch reinforcing bars on 6-inch centers, both ways.
10. Type 13: Mason HS spring hanger, spring seated in neoprene cup.
11. Type 14: Mason WF steel frame base, with motor slide rail.

12. Type 15: Mason SafeFlex flexible rubber pipe connection, peroxide cured EPDM with Kevlar tire cord reinforcement, raised face rubber flanges with encased solid steel rings.
 - a. 14-inch diameter pipe and below: Mason SFDEJ twin sphere with reinforcing ring; minimum pressure rating of 250 psi at 170 degrees F. and 215 psi at 250 degrees F.
 - b. 16-inch diameter pipe and above: Mason SFEJ single sphere; minimum pressure rating of 180 psi at 170 degrees F. and 150 psi at 250 degrees F.
 - c. Control rods; Mason CR with 1/2" thick Neoprene washer bushings.

PART 3 EXECUTION

3.01 GENERAL

- A. All piping to be supported from floors, concrete slabs, ceilings or walls shall have supports and parts required for installation of piping systems which conform to requirements of Chapter 1, Section 6 of ANSI Code for Pressure Piping (B31.1), except as modified and supplemented by requirements set forth in these specifications.
- B. Support pipes on specified hangers so that equipment, pumps, and fittings do not bear weight or stresses from vibration and swaying of pipe. Support pipe risers at regular intervals in pipe shafts at least once at each floor level or a maximum of 12 feet apart. Refer to support interval spacing requirements for each pipe material later in this Section for specific spacing requirements. Do not use perforated metal, strap iron, or band iron. Do not make offsets in hangers.
- C. Do not use installed hangers, supports, or anchors for rigging or erection purposes.

3.02 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

3.03 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under project conditions.

3.04 HANGER AND SUPPORT APPLICATION SCHEDULE

- A. Materials of construction for all hangers and supports used on project shall be in accordance with Hanger and Support Application Schedule at end of this Section except as modified by Division 26 for electrical equipment.

3.05 VIBRATION ISOLATION AND SEISMIC RESTRAINT APPLICATIONS

- A. Equipment: Use restraint types listed above on following applications:
 1. Pumps, slab on grade – Type 15 (bolted directly to pad).
- B. Piping:

1. Seismically restrain all piping with type 7 or 8 restraints as listed below:
 - a. All other types of piping specified herein regardless of size.
 - b. Install transverse restraints at 40-foot intervals.
 - c. Install longitudinal restraints at 80-foot intervals.
 2. Use hold down clamps to attach multiple pipes to trapeze hangers.
- C. Anchoring.
1. Installation: Installation shall comply with manufacturer's published recommendations and shall be installed so that isolators are plumb and are operating at a manner for which they were designed.
 2. Unless otherwise specified, all equipment shall be securely bolted to isolators, steel bases or concrete inertia bases.
- D. Anchor Bolts.
1. If size and number of anchor bolts are not shown on drawings then anchor bolts shall conform to schedule for various equipment weights or manufacturer's installation recommendations, whichever is most stringent.
- E. Spreaders.
1. Spreaders shall be provided between racked or adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart or four times maximum displacement due to seismic force. Spreaders to be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe and over insulation utilizing high-density inserts and pipe protection shields where vapor-barrier-type insulation is employed.

3.06 INSTALLATION OF HANGERS

- A. Install in accordance with manufacturer's instructions.
- B. Install hanger so that rod is vertical under operating conditions.
- C. Adjust hangers to equalize load.
- D. Support from Structural Members: Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- E. Field welding of supports should be done by qualified welders using qualified welding procedures.
- F. Proper care and ventilation should be given when welding galvanized components.

3.07 INSTALLATION OF VIBRATION ISOLATION AND SEISMIC RESTRAINT

- A. All vibration isolation and seismic restraint systems must be installed in strict accordance with seismic codes, component manufacturers and building construction standards. Whenever a conflict occurs between manufacturers or construction standards, more stringent shall apply.
- B. Set anchor bolts when concrete is placed.

- C. Install isolators in accordance with recommendations of isolator manufacturer and equipment manufacturer.
- D. Isolate mechanical equipment as indicated.
- E. Remove all debris from under equipment, and thoroughly clean steel bases, inertia bases and check for free movement.

3.08 SUPPORT INTERVALS

- A. At a minimum, additional supports or anchors shall be required at:
 - 1. All bends on pump discharge line to prevent vertical or horizontal movement resulting from pressure thrusts.
 - 2. Each side of all couplings in horizontal plane to eliminate vertical force on couplings.
 - 3. All branch connections to eliminate vertical and horizontal movement.
 - 4. Both side of expansion joints to prevent horizontal movement.
 - 5. All pipe joints subject to torque along centerline of pipe. Piping shall be supported so that pumps and other equipment may be removed without providing additional pipe support.
 - 6. Where depicted on Drawings, pipe supports shall be of type indicated, otherwise Contractor shall coordinate pipe supports with Engineer.
 - 7. Points necessary to maintain pipe levels, slopes, and drainage, or to prevent sagging or swaying of pipe.
 - 8. Supports shall be within 12 inches of any flange associated with a fitting, valve, specialty, or any change in pipe direction.
 - 9. At connection point of piping to pump, both suction and discharge, such that no forces are imposed on pump connection by connection of piping.
- B. Intervals of supports, hangers, and braces shall no greater than shown in table below except as modified elsewhere in this Section and other sections of Contract Documents or when values in table are greater than that required/recommended by a pipe/equipment manufacturer, in which case lesser required/recommended spacing shall be provided in lieu of specified spacing. Any changes to spacing described below shall be brought to attention of Engineer for review prior to commencement of design.

Pipe Material	Pipe Size	Maximum Horizontal and Vertical Spacing
Plastic (non-electrical)	All Sizes	4 feet on center
Plastic (electrical)	All Sizes	3 feet on center
Flanged Ductile Iron, Steel, Wrought Iron, Black Iron	Less than 2 inches	7 feet on center
	2 inches and larger	10 feet on center
Copper	Less than 2 inches	5 feet on center
	2 to 3 inches	8 feet on center
	Greater than 3 inches	10 feet on center

Pipe Material	Pipe Size	Maximum Horizontal and Vertical Spacing
Cast Iron	All Sizes	10 feet on center

1. Flanged Ductile Iron Pipe and Steel Pipe – Additional supports and hangers shall be required for grooved end ductile iron pipe and fittings at Contractor’s expense.
2. Non-Flanged Ductile Iron Pipe – In addition to requirements above, locate hanger close to each joint behind bell.

3.09 HORIZONTAL MOVEMENT

- A. Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- B. Where horizontal pipe movement is greater than 1/2 inch, offset pipe hanger and support so that rod hanger is vertical in hot position.

3.10 EQUIPMENT BASES AND SUPPORTS

- A. Coordinate pads with Section 01 00 05.
- B. Provide templates to ensure accurate location of anchor bolts.
- C. Provide anchor bolts and accessories for mounting and anchoring equipment not supplied by equipment manufacturer. Bolts and accessories fabricated by Contractor shall conform to Division 05 requirements for structural steel.
- D. Construct supports of steel members or other material compatible with environment that supports shall be exposed to. Brace and fasten with flanges bolted to structure.
- E. Provide rigid anchors for pipes after vibration isolation components are installed.

3.11 INSERTS

- A. Provide inserts for suspending hangers from concrete slabs and sides of concrete beams.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- D. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with square steel plate and nut above slab.

3.12 FINAL ADJUSTMENTS

- A. Adjust Hangers and Supports:
 1. Ensure that rod is vertical under operating conditions.
 2. Equalize loads.
- B. Adjustable Clevis:

1. Tighten hanger load nut securely to ensure proper hanger performance.
 2. Tighten upper nut after adjustment.
- C. Clamps:
1. Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- D. Beam Clamps:
1. Tighten all set screws and lock nuts.
 2. Hammer jaw firmly against underside of beam for Figure 127 only.

3.13 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

3.14 APPLICATION SCHEDULE

CRITERIA FOR APPLICATION SCHEDULE	
Area	Acceptable Support Materials
Exterior:	
Exposed to outdoor conditions	Stainless steel

END OF SECTION

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SECTION 40 41 13

PIPE INSULATION AND HEAT TRACING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Heat tracing.
2. Hanger inserts.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 09 96 00 – Painting and Coatings
3. Division 26 – Electrical.
4. Section 33 11 00 – Piping
5. Section 33 12 00 – Valves
6. Division 40 – Process Integration.

1.02 REFERENCES

Reference	Title
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C177	Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus
ASTM C195	Mineral Fiber Thermal Insulation Cement
ASTM C335	Steady-State Heat Transfer Properties of Horizontal Pipe Insulation
ASTM C449	Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement
ASTM C518	Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Heat Flow Meter Apparatus
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	Mineral Fiber Preformed Pipe Insulation
ASTM C552	Cellular Glass Block and Pipe Thermal Insulation
ASTM C585	Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
ASTM C591	Rigid Preformed Cellular Urethane Thermal Insulation
ASTM C921	Properties of Jacketing Materials for Thermal Insulation
ASTM D1056	Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1667	Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam)

Reference	Title
ASTM D2842	Water Absorption of Rigid Cellular Plastics
ASTM E84	Surface Burning Characteristics of Building Materials
ASTM E96	Water Vapor Transmission of Materials
NFPA 255	Surface Burning Characteristics of Building Materials
ASHRAE/IESNA 90.1	Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
UL 723	Surface Burning Characteristics of Building Materials
National Commercial and Industrial Insulation Standards (Third Edition)	
International Mechanical Code (latest edition)	
International Plumbing Code (latest edition)	
International Energy Conservation Code (latest edition)	

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 00 05.
- B. Product Data - Provide product description, list of materials and thickness for each service, and locations. Submit catalog information on valve and fitting covers. Submit information on proposed hanger inserts.
- C. Manufacturer's Installation Instructions - Indicate procedures which ensure acceptable workmanship and installation standards shall be achieved.
- D. Heat Tracing:
 - 1. Submit in accordance with Section 01 00 05.
 - 2. Certified shop drawings:
 - a. Submit shop drawings and receive approval before purchase or installation of heat portion of heat trace systems.
 - b. In addition to general shop drawing requirements, include information on following specific items with submittal:
 - 1) Self-regulating heat trace cable.
 - 2) All interconnection components.
 - 3) All controls and fittings.
 - 4) Warning tape.
 - 5) Heat trace installation drawings for use by installing Contractor. Drawings shall include:
 - a) Piping drawing (in plan or isometric format; piping schematics shall not be acceptable) showing location and installation details of heat trace controller (HTC) locations, power connections (refer to Electrical Contract), tee connections, splices, end seals, thermostats (locate at power connections or as otherwise shown on Contract Drawings), maintain temperature per pipe, circuit identification number(s), line size and insulation, pipe heat loss calculations, amount and type of heating cable required, heating cable voltage, heating cable power output at maintain

temperature, associated panel and circuit identification, sensor locations, and bill of material.

6) Calculated data as follows:

- a) Heater type and output.
 - b) Heater length per circuit.
 - c) Startup current.
 - d) T-Rating.
 - e) Pipe heat loss requirements.
- c. Manufacturer's operation and maintenance manuals and information in accordance with Section 01 77 13.
- d. Manufacturer's equipment warranty in accordance with Section 01 77 13.

1.04 QUALITY ASSURANCE

- A. Materials - Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84.
- B. Heat Trace Manufacturers - All heat trace cables, connectors, controls, and fittings of like type shall be product of one manufacturer.
- C. Heat Trace Manufacturer Test Requirements - Certified test reports showing compliance with applicable UL Standards for each type of component shall be provided upon request.
- D. Codes, Approvals, and Standards – Electric heat-tracing system shall conform to specification. System shall be designed, manufactured, and tested in accordance with applicable requirements of latest edition of following codes and standards:
 - 1. FM – Factory Mutual Research Corporation.
 - 2. IEEE 515 – Institute of Electrical and Electronics Engineers.
 - 3. NEC – U.S. National Electric Code (NFPA70).
 - 4. NEMA – National Electrical Manufacturers Association.
 - 5. UL 746B – Underwriters' Laboratories, Inc.
 - 6. ANSI – American National Standards Institute.
 - 7. CSA – Canadian Standards Association.

1.05 QUALIFICATIONS

- A. Applicator - Company specializing in performing work of this section with minimum three years' experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products under provisions of Section 01 00 05.

- B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.08 WARRANTY

- A. Warranty shall be in accordance with Section 01 77 13.

PART 2 PRODUCTS

2.01 HEAT TRACED INSULATED PIPING

- A. Comply with all Division 40 requirements except as modified herein.
- B. General – all unburied exterior piping as shown on Contract Drawings shall be heat traced in accordance with specifications contained herein and as shown on Contract Drawings. Contractor shall furnish and install system complete, tested, and ready to operate, with all required controls, accessories, fittings and connectors.
- C. Line sizes and materials are as shown elsewhere in Contract Documents.
- D. Manufacturers and Models:
 - 1. Chromalox – Model SRL-XX-1CT.
 - 2. Thermon – Model BSX-XX-1.
 - 3. Raychem – Model XX BTV1-CT.
 - 4. Substitutions – Refer to Sections 01 00 05.
 - a. In case of an “or-equal”, Contractor shall demonstrate in writing, to satisfaction of Owner and Engineer at time of shop drawing submittal that manufacturer has produced specified type and size of equipment for potable water and/or sanitary wastewater service that has been in successful operation for a minimum period of ten years prior to bid date.
- E. Heat Tracing System - Purpose of heat tracing system is to provide freeze protection.
 - 1. Self-Regulating Heating Cables.
 - a. All heat-tracing systems for use at temperatures up to a continuous process (maintain) of 250 degrees F and a maximum exposure temperature of 482 degrees F shall use a self-regulating heating cable.

- b. Self-regulating heating cable shall vary its power output relative to temperature of surface of pipe or vessel. Cable shall be designed such that it can be crossed over itself without overheating and cut to length in field.
 - c. Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously.
 - d. All cables shall be capable of passing a 1.6 kV dielectric test for one minute after undergoing a 10 ft-lb. impact (IEEE 515-1997 test 4.1.8).
2. Freeze Protection Systems with No Steam Exposure.
- a. Heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) without use of thermostats of following:

Heating Cable	T-Rating	Maximum Temperature
3 W/ft	T6	185°F
5 W/ft	T5	212°F
8 W/ft	T5	212°F
10 W/ft	T4A	248°F

- b. Heating cable shall have a tinned copper braid with a resistance less than 8 mΩ/ft as determined by metallic covering conductivity test (IEEE 515-1997 test 4.1.13). Cables braided with tinned-copper or nickel-copper shall be further covered with a corrosion resistance fluoropolymer over-jacket.
- c. In order to provide rapid heat-up, and to prevent overheating of fluids and plastic pipe, heating cable shall have following minimum self-regulating indices:

Heating Cable	S. R. Index
3 W/ft	-0.020 W/°F
5 W/ft	-0.045 W/°F
8 W/ft	-0.058 W/°F
10 W/ft	-0.071 W/°F

- d. Self-regulating index is rate of change of power output in watts per degree Fahrenheit, as measured between temperatures of 50 and 100 degrees F and confirmed by type test and published data sheets.
- e. In order to facilitate longer circuit lengths and smaller breaker sizing. Heating cable shall have following maximum inrush current at 50 degrees F.

Heating Cable	Maximum Inrush (@ time = 1 sec.)	Maximum Inrush (@ time = 10 sec.)	Maximum Inrush (@ time = 300 sec.)
3 W/ft, 120 V	58 mA/ft	54 mA/ft	41 mA/ft
5 W/ft, 120 V	155 mA/ft	128 mA/ft	66 mA/ft
8 W/ft, 120 V	210 mA/ft	180 mA/ft	83 mA/ft
10 W/ft, 120 V	432 mA/ft	319 mA/ft	123 mA/ft
3 W/ft, 240 V	38 mA/ft	36 mA/ft	20 mA/ft
5 W/ft, 240 V	92 mA/ft	80 mA/ft	33 mA/ft

Heating Cable	Maximum Inrush (@ time = 1 sec.)	Maximum Inrush (@ time = 10 sec.)	Maximum Inrush (@ time = 300 sec.)
8 W/ft, 240 V	127 mA/ft	106 mA/ft	41 mA/ft
10 W/ft, 240 V	281 mA/ft	205 mA/ft	62 mA/ft

- f. In order to ensure that self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, cable shall produce less than 10 percent of rated power when energized and heated to 302 degrees F for 30 minutes. After this test, if cable is allowed to cool to 50 degrees F and is reenergized, it must not have an increasing power output leading to thermal runaway.
 - g. Self-regulating heating cable shall maintain between 75 and 110 percent of its original power output after having been cycled 500 times between 50 and 150 degrees F, allowing no more than 12 minutes of dwell time at each temperature.
 - h. Heating cable shall have following third party approvals:
 - 1) UL listed – non-classified areas.
 - 2) CSA certified – non-classified areas; Class I, Division 2 groups A, B, C, D; and Class II, Division 2 groups F, G.
 - 3) FM approved – non-classified areas; Class I, Division 2 groups B, C, D; Class II, Division 2 groups F, G; and Class III, Division 2.
 - i. Heating cables for freeze protection shall be rated for continuous exposure (maintain) capability up to 150 degrees F and continuous exposure capability up to 185 degrees F with power off.
3. Where installed on nonmetallic pipe, cable heater shall be installed using an aluminum tape applied over top and running entire length of cable.
 4. Termination for Self-Regulating Heating Cables.
 - a. All connection components used to terminate self-regulating heating cables, including power connectors, splices, tees, and end connectors, shall be approved for respective area classification and approved as a system with particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than cable manufacture.
 - 1) In order to keep connections dry, components shall be rated NEMA 4X.
 5. Connections – All power connectors, fittings, junction boxes terminations, etc., shall be of nonmetallic construction and provided by heat trace cable manufacturer.
 6. Heat trace controllers (HTC) shall be provided as detailed below. All HTC shall be of same manufacture as heat trace cable or manufacture approved to be used with heat trace cable.
 7. Controls.
 - a. Thermostats and Contactors.
 - 1) Freeze protection systems shall operate using self-regulating control, UAS thermostat in ordinary areas.

- a) Provide ambient-sensing thermostat with a fixed setpoint of 40 degrees F. Provide thermostat with adjustable setpoint between 15 degrees F and 140 degrees F.
 - b) Chromalox contactor type CONT, Square D Class 8910, or equivalent shall be used where heat tracing circuit current exceeds thermostat switch rating. Contactor enclosure type shall be minimum NEMA 4X, or greater as codes or ambient conditions may require.
- 8. Heat trace system shall maintain 40 degrees F (or temperature specified herein) in line with a minimum ambient temperature of -10 degrees F unless otherwise specified herein.
- 9. Manufacturer shall supply all equipment and design services required for a complete electrical heat tracing system.
 - a. Pipe type and size and service shall be as shown on Contract Drawings. Heat trace system manufacturer shall provide units with appropriate watts per linear foot and of sufficient quantity necessary to meet requirements specified herein.
- 10. Contractor shall make final connection of power supply to heat tracing system.
- 11. Extra heating cable shall be provided to account for additional heat loss for all valves, pipe supports, wall penetrations and similar heat sinks in accordance with manufacturer's requirements and recommendations.
- 12. Heater shall be capable of continuous operation when suspended in air at average maximum ambient temperature of 120 degrees F with design voltage applied for 30 minutes.
- 13. Heat tracing shall be suitable for installation in outdoor area.
- 14. Heaters shall operate on 120 volt, 1 phase power.
- 15. Heat tracing system shall be provided with a single setpoint thermostat control per circuit for maintaining a minimum temperature of 40 degrees F in process line. Additional controls beyond single setpoint thermostat shall be provided by manufacturer to meet control requirements specified herein.

F. Schedule of Heat Tracing.

- 1. Following identifies systems that shall require heat tracing. This list is not considered all inclusive and Contractor shall be responsible for heat-tracing all piping, whether indicated in schedule or not, subject to freezing at no additional cost to Owner. Contractor shall coordinate to provide all necessary power distribution, conduit, wire, and accessories to provide complete and operable heat trace systems for following pipe systems.
 - a. Water Lines – All proposed exterior above-grade piping.
- 2. These same pipe systems shall be insulated, but not heat traced, if less than 3 feet below grade in accordance with requirements described herein.

2.02 HANGER INSERTS

- A. For hot or cold piping systems 1-1/2 inches in diameter or larger, operating at nominal temperatures of 200 degrees F or less, inserts shall be high density such as ASTM C640 cork,

hydrous calcium silicate insulation, wood, or foam with sufficient compressive strength to support weight of piping system.

- B. At temperatures exceeding 200 degrees F, high temperature pipe insulation shall be used for high density inserts.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.
 - 1. Pipes shall be coated prior to installation of heat trace and/or insulation in accordance with Section 09 96 00.
- C. Verify that any installed heat trace system has had manufacturer recommended checks, such as meg readings, verified before beginning installation of insulation.

3.02 INSTALLATION

- A. Install all piping insulation and jacketing in accordance with International Mechanical Code.
- B. Install materials in accordance with manufacturer's instructions.
- C. On exposed piping, locate insulation and cover seams in least visible locations.
- D. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with stainless steel jacket with seams located on bottom side of horizontal piping.
- E. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with stainless steel jacket with seams located on bottom side of horizontal piping.

3.03 TOLERANCE

- A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.04 HEAT TRACED PIPING

- A. Installation - Heat tracing system shall be installed in compliance with all local codes and requirements of National Electric Code and all other codes, standards and approvals as specified herein.
 - 1. Contractor shall furnish and install all equipment according to Contract Documents, including Section 01 00 05 and manufacturer's instructions. Conflicts of information shall be called to attention of Engineer.
 - 2. Contractor shall field verify all dimensions and elevations and shall notify Engineer of any specific differences.

3. Contractor shall furnish all necessary materials and equipment for initial operation and testing.
4. Apply heat trace cable on pipe after piping has been successfully pressure tested and disinfected. Secure heating cable to piping with fiberglass tape unless alternate method approved in advance in writing by Engineer and heat tracing system manufacturer.
5. Provide and install labels indicating “CAUTION - ELECTRICAL HEAT TRACING” or similar at minimum 10 ft intervals on all heat traced pipelines. Labels shall be provided on insulation or metal jacket.
6. Heat tracing lengths shall not exceed contactor amperage ratings on temperature controller. Provide multiple runs with individual controllers as required. Circuit lengths shall not exceed manufacture’s maximum allowable circuit lengths.
7. Install and test heat tracing before applying insulation materials.
 - a. Testing - Prior to final acceptance, heat tracing system shall be tested in field as to following:
 - 1) Meggar check.
 - 2) Performance test to insure system is operating properly and in compliance with required performance.

B. Field Testing and Initial Operation:

1. Preliminary tests, field tests, start-up and initial operation shall be performed in accordance with Contract Documents, including Sections 01 61 00, 01 88 23 and this specification section.
2. All testing shall be done in presence of owner’s representative and equipment manufacturer or their approved representative.
3. Final acceptance of equipment shall be made after equipment has been demonstrated in field to meet performance requirements stated in this specification under all normal operating conditions.
4. Adjust, repair, modify, or replace any components of system, which fail to meet all specified requirements.

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SECTION 40 90 00

INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Requirements:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.

B. Description of Work:

1. Furnish to Owner a fully integrated and completely functional Control System (System) as specified herein and indicated on Contract Drawings. Primary equipment controlled and monitored by System shall include Water Well No. 6.
2. Furnish, configure and commission all SCADA and networking hardware, control panels, control devices and instrumentation as specified herein and indicated on Contract Drawings as required to facilitate system operation.
3. Furnish, install, configure and commission all software as specified herein and as required to facilitate system operation.
4. Develop all control logic, graphical operator interface screens (including local OIT and modifications to existing Wondware InTouch screens), historical and trend databases, and reports as specified herein and as required to facilitate system operation.
5. Integrator shall furnish Record Drawings in accordance with Section 01 00 05 for control panel drawings and wiring diagrams, network diagrams, and electrical interlocking diagrams for all equipment included in Scope of Work including existing systems where new equipment or instrumentation is being added.
6. Integrator shall be responsible for checkout, calibration, testing and startup of all furnished equipment and control panels.
7. Integrator shall be responsible for system level checkout, calibration, testing and startup in order to provide an integrated and fully functional System to Owner.
8. Furnish all PLC programming required to achieve an integrated and fully functional system as specified herein. All PLC programming and tag names shall be consistent and conform to Rockwell Automation's programming conventions and standards.
9. Configure real time and historical trending as specified herein.

1.02 QUALITY ASSURANCE

- ###### A. Integrator's attention is directed to fact that all specified instruments and controls must form a completely integrated system and, as such, Integrator shall become familiar with requirements necessary to provide equipment specified for System regardless of manufacture, and shall be responsible to Contractor for complete and satisfactory operation of entire control system.

1. These specifications cover intended function of equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. Contractor shall

supply all devices and appurtenances necessary to provide a complete, operable and fully functional system as indicated on Contract Drawings or specified herein.

B. Instrumentation and Control System Integrator:

1. Shall design and furnish a complete, integrated and fully functional control system, warranted to perform intended functions as indicated on Contract Drawings or as specified herein.
2. Shall provide system integration for control systems furnished by other equipment manufacturers on this project.
3. Shall be responsible for reviewing all submittals and obtaining all necessary data from individual manufacturers to determine necessary interface requirements for operation, control and/or monitoring between various process manufacturers' equipment, Owner's existing systems, and system being supplied by Integrator.

C. Contractor:

1. Shall be fully and solely responsible for work of Integrator and solely responsible to Owner for supplying a complete and fully integrated system.
2. Shall provide personal superintendence and direction of work, maintaining and supplying complete supervision over and coordination between all subcontractors employed by him and Integrator.
3. Shall furnish Integrator with all submittals for review and comment.
4. Shall be responsible for defining limits of his subcontractor's work.
5. Shall be responsible for setting of instruments (including alarms, etc. as provided under other sections).

D. Technical services:

1. Upon completion of equipment installation, provide services of a qualified field engineer for a period of not less than one (1) 8-hour day for System commissioning, calibration, start-up, and testing of equipment.
2. Minimum days specified above do not relieve Integrator from providing sufficient service to place complete System into satisfactory operation.

1.03 SUBMITTALS

A. Comply with pertinent provisions of Section 01 00 05.

B. Product data: Within 90 calendar days after Contractor has received Owner's Notice to Proceed, submit:

1. Component manufacturing data sheet indicating pertinent data and identifying each component by item number and nomenclature as indicated on drawings and in specifications.
2. Component drawings showing dimensions, mounting and external connection details.
3. Wiring schematics, each on a single drawing with full description of operation. Component identification on schematic shall be as indicated above.

4. A system schematic of hardware with component manufacturing data sheets for each item, including all ancillary and peripheral components and software.
 5. If applicable, path or coverage study with system diagrams for wireless telecommunications systems.
 6. A printed copy of following:
 - a. Equipment and Instrument List with PLC and HMI tag names.
 - b. Preliminary OIT/HMI graphics screens inclusive of local OIT and modifications to Wonderware InTouch screens, with a complete description of each screen.
 - c. A draft Functional Specification of System, incorporating items (a) and (b) above, fully detailing how entire System shall operate and be controlled by Owner. Functional Specification shall include a Process Narrative.
 - d. Functional Specification shall also include preliminary examples of all reports to be supplied.
 - e. Sample forms and reports:
 - 1) Instrument/Loop Checkout Form
 - 2) I/O Verification Report
 - 3) System Checkout Report
- C. Provide Operation and Maintenance manuals complying with provisions of Section 01 78 23.
1. Operating instructions shall incorporate a final functional description of supplied equipment or system, including panel layouts, material lists, equipment manuals, recommended spare parts lists, and wiring schematics which reflect as-built modifications.
 2. Special maintenance requirements particular to system shall be clearly defined along with special calibration and test procedures.
 3. As part of operation and maintenance manuals, provide following:
 - a. As-built Equipment and Instrument List with PLC and HMI tag names.
 - b. As-built OIT/HMI graphics screens with complete operating instructions for each screen, including pop-up windows and alarm and trend screens.
 - c. Electronic copies of all PLC programs, documented in programming software format with no password protection.
 - d. Electronic copies of all OIT/HMI application, including database in development software format with no password protection.
 - e. Device and instrument calibration, scaling and configuration information with each point identified by PLC and HMI tag name, if applicable.
 - f. Final Functional Specification and Process Narrative.
 - g. Printouts of all supplied reports including instructions for running each report and for modifying report contents.

- h. If applicable, wireless path or coverage study with as-built system diagrams, configuration information and operational data (link strength, noise, fade margins, etc.).
- D. Provide to Engineer for approval any changes, additions, corrections, etc. required to Bid Documents that are needed to accommodate system being proposed. Changes, additions, corrections, etc. shall be at Contractor's expense and shall be included in his Bid.

1.04 COORDINATION OF WORK

- A. Integrator shall be responsible for reviewing all other information contained in Contract Documents that could affect this portion of work.
- B. Plans and specifications, especially instrumentation/electrical and wiring requirements, have been formulated in an attempt to satisfy conditions for any system proposed. However, a vendor may find that some changes or additional conduit and wiring from that indicated may be required to accommodate particular equipment being proposed. Should this be case, vendor shall include in his bid price, all changes or additional requirements necessary for system. After award of contract, revised drawings must be submitted for approval indicating any changes prior to any changes being implemented.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Comply with pertinent provisions of Section 01 00 05.
- B. Schedule delivery of equipment to coordinate with project completion schedule.
 - 1. Each item of equipment to be tagged with identifying number shown on Shop Drawings.
- C. Contractor's attention is directed to fact that equipment has delicate components and extreme care shall be taken in handling to avoid internal and/or external damages.
- D. Damaged equipment shall not be accepted.
- E. Equipment not for immediate use shall be stored inside a building, with enclosures under protective coverings and shall be fully protected from moisture, extreme heat and vibration.

1.06 SPARE PARTS

- A. Contractor shall furnish one (1) of every component furnished under this section to Owner for shelf spare (excluding desktop computers/servers, printers and supplies, test equipment and handheld configurators, enclosures, internal mounting panels, internal panel lights, terminals, wires, labels, DIN rail, wire duct and cable management devices, conduit and fittings, transformers, receptacles, and non-special connectors).
- B. Contractor shall furnish a complete list of every spare part including equipment tag number and location where part is installed.

1.07 WARRANTY

- A. Comply with pertinent provisions of Section 01 77 13. There shall be a one year warranty on all work and equipment supplied under this section commencing from time of substantial completion of project as specified in Section 01 77 13. Owner shall have complete access to System during warranty period.
- B. Integrator shall provide capability for secure remote troubleshooting and warranty support of System. Minimum capability shall be via modem utilizing analog telephone lines provided

under Division 26 and indicated on Contract Drawings. Analog telephone service shall be provided by Owner.

- C. Contractor shall provide an 8-hour response time in normal working hours, five days per week for length of warranty period.
 - 1. For any service visit during this period, provide Owner and Engineer with a written report stating reason for equipment failure and recommendations to prevent recurrence.

1.08 RELATED WORK UNDER THIS CONTRACT

- A. Following items of related work are specified in other sections.
 - 1. Auxiliary contacts in motor starters for control interlocks – Division 26.
 - 2. Installation and power wiring of motor starters, disconnect switches and variable frequency drives - Division 26.
 - 3. Field control and communication wiring - Divisions 26, 27, and 40.
 - 4. Power wiring for control system - Divisions 26, 27, and 40.
 - 5. Communication and networking equipment and cabling – Divisions 26, 27, and 40.
 - 6. Section 43 21 17 – Vertical Turbine Pumps

1.09 REFERENCE STANDARDS

- A. All work must be performed in accordance with requirements of following pertinent standards and legal codes and ordinances:
 - 1. Standard Building Code and Publications referred to therein.
 - 2. Life Safety Code, NFPA No. 101.
 - 3. Occupational Safety and Health Act (OSHA).
 - 4. National Electrical Code (NEC).
 - 5. American National Standards Institute (ANSI)
 - 6. Standards and Periodicals Listings, Underwriters Laboratories.
 - 7. For work not specifically listed above, use standards and codes of National Fire Protection Association (NFPA).

1.10 INSTRUCTIONS TO OWNER

- A. Following items shall be required.
 - 1. During system commissioning and after System Acceptance, Integrator shall provide two (2) sessions, eight (8) hours each of operational instruction to Owner's operating personnel. Instruction manuals shall be submitted to Owner's representative and approved prior to start of training sessions. Manuals shall be distributed at training sessions. Training for plant operators shall consist of hands on training in a class room environment at job site during normal working hours.

2. Integrator shall provide one (1) session, four (4) hours of instruction to Owner's maintenance and engineering personnel on operation and maintenance of System. Manual prepared by Integrator shall be used for this instruction.
3. General class requirements.
 - a. Submit lesson plans to Owner's representative for training phases to include type of training to be provided and a list of reference material for review and approval by Owner.
 - b. Training Program: Accomplish training program as specified. A training day is defined as 8 hours of instruction including two 15-minute breaks and excluding lunch time, Monday through Friday. Conduct onsite training after acceptance run of system at a time mutually agreeable between Contractor and Owner. Training shall be provided to designated operating personnel identified by Owner in functional operations of system and procedures that personnel shall follow in systems operation. This phase of training shall include but not be limited to:
 - 1) Operation of equipment
 - 2) Setpoint adjustments
 - 3) Diagnostics and failure recovery procedures
 - 4) Alarms and alarm response
 - 5) Historical and trended data
 - 6) Maintenance and calibration

PART 2 PRODUCTS

2.01 GENERAL

- A. System shall consist of a combination of individual control and monitoring sub-systems, each configured to perform a specific function associated with total plant operational scheme.
- B. All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for service intended.
- C. All control panels shall be fabricated and assembled according to contract documents including adherence to wire numbering scheme, etc.
- D. All of equipment shall be manufacturer's latest and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details of design of System. Completed system shall be compatible with functions required and other equipment furnished by Contractor.
- E. All electrical components of system shall be powered by 120V AC, single phase, 60 cycle current, except as otherwise indicated on Contract Drawings or as specified herein.
- F. All contacts for control, remote motor operated, or electrically operated equipment shall be rated not less than 10 amperes at 120V AC unless otherwise specified herein.
- G. All systems and individual components, whether panel or field mounted units, shall be protected from voltage and/or current surges which may originate as a result of lightning or other external causes.

1. Protective equipment to be provided by control panel suppliers and installed in accordance with manufacturer's recommendations.
 2. Schematics of instruments submitted for approval to Engineer shall indicate how this protection shall be provided and identify items of equipment which shall be used for this purpose.
- H. Integrator shall supply Record Drawings containing all necessary information for proper maintenance and operation of System in accordance with Section 01 78 39.
1. Wire log table showing connections (wire terminations) between all furnished components to be supplied to facilitate field wiring.
 2. Interconnection information between system components and equipment found in other sections of these Specifications shall be complete with all necessary interconnection information.
 3. Notes which refer to equipment manufacturer's drawings for proper interconnection shall not be acceptable.
 4. Provide within 30 days after startup and after any field modifications.
- I. To be considered an "approved equal", Contractor shall demonstrate in writing, to satisfaction of Owner and Engineer at time of shop drawing submittal that manufacturer has produced specified type and size of equipment that has been in successful operation for a minimum period of five years prior to bid date and will seamlessly interface with the existing equipment. If equipment other than that specified is furnished the Contractor shall furnish programming, development and configuration software for alternate equipment.
- J. Temperature Control.
1. Panels shall be sized and/or provided with necessary ancillary equipment to adequately dissipate heat generated by equipment mounted on or in panel in order to maintain interior panel temperature below limits that could cause component damage or deterioration. Need for temperature control equipment shall also be based on and account for range of ambient temperatures for locations where panels are located.
 2. Furnish cooling fans with air filters if required to dissipate heat.
 3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees Fahrenheit.
 4. Any addition of ancillary equipment or other components to maintain temperatures at acceptable limits shall not affect specified NEMA rating of any control panel in any way.

2.02 POWER SUPPLIES

- A. General instrument DC power supplies shall be a 120V AC input and 24V DC output, 100W minimum, -10°C to 60°C operating temperature range without derating, short circuit protection, over-voltage protection, over-temperature protection, handle high inrush currents without shutdown, high efficient > 90% switching technology, 35mm DIN rail mounting for horizontal or vertical, screw terminals for up to #12 AWG wire, UL508 listed, full CE compliance for safety, emissions and ingress protection and require no internal or external fan cooling. Power supplies shall be Allen-Bradley XLP Series, Sola/Hevi-Duty SDN series or Phoenix Contact.

2.03 ELECTRICAL CONTROL WIRING

- A. All field wiring shall comply with National Electrical Code and Division 26 “Electrical”.
- B. All control wiring shall be furnished and installed by Division 26 and installed by Electrical Contractor.
- C. All wiring shall be in conduit as specified in Division 26.
- D. Ethernet and fiber optic cable shall be as specified in Division 27.
- E. Remote I/O Communication cable shall be Belden 9463 or approved equal.
- F. Single pair analog cable shall be tinned copper, polyethylene insulated, twisted pair with 100% aluminum-polyester shield coverage, 18 AWG stranded tinned copper drain wire and chrome PVC jacket. Cable shall be Belden 8760 or approved equal.
- G. Single triad (3-conductor) analog cable shall be tinned copper, polyethylene insulated conductors with 100% aluminum-polyester shield coverage, 18 AWG stranded tinned copper drain wire and chrome PVC jacket. Cable shall be Belden 8770 or approved equal.
- H. Multiple pair analog cable shall be tinned copper, polyethylene insulated, twisted pair with 100% aluminum-polyester shield coverage, 18 AWG or larger stranded tinned copper drain wire and chrome PVC jacket. Conductor wire size shall be 18 AWG or larger. Cable shall be Belden or approved equal.
- I. Discrete copper internal control panel shall be UL rated Type E-16 single conductor stranded silver plated copper with extruded TFE Teflon insulation. Wire shall be suitable for operation 600 volts as specified in National Electric Code, at conductor temperatures not to exceed 200°C. Wire shall be resistant to acid, alkalis, oil, flame, moisture, solvents and fungus. Wire color code shall be as follows:
 - 1. Black - 24 and 120V AC power
 - 2. White - 24 and 120V AC neutral
 - 3. Green - Ground
 - 4. Red - Control & PLC input/output wiring
 - 5. Blue - 24V DC positive
 - 6. Blue/White Strip - 24V DC negative
 - 7. Yellow - Circuit conductors which remain energized when supply disconnecting means is off.

2.04 ELECTRIC/ELECTRONIC INPUT DEVICES

- A. System shall maintain specified analog end-to-end accuracy throughout warranty period from sensor to controller readout.
- B. Sensors (transducers) shall be appropriately packaged for location.
 - 1. Architectural housing for space mounting.
 - 2. Weatherproof/sunshield housing for outdoors.

3. Thermal well housing for water applications.
 4. Protective housing for duct mounting.
- C. Sensor/transducer shall be selected to withstand ambient conditions where:
1. Moisture or condensation is a factor.
 2. Vibration exists from ductwork, equipment, etc.
 3. Reasonably expected transient conditions exist for temperatures, pressures, humidity's, etc. outside normal sensing range.
- D. Sensor/transducer shall be appropriately selected to most closely match expected sensing range.
- E. System accuracy of sensed conditions shall be as follows:
1. +/- .1 inch for filter status differential up to a 0-5 inch water column range.
 2. +/- 1% for pressure switches.
 3. +/- 0.50% for water flow.
- F. Water flow switches shall be solid state flow switches operating on thermal dispersion principle.
- G. All electronics and transmitters mounted outdoors shall be furnished with a sunscreen and shall be rated for outdoor service.

2.05 PRESSURE TRANSMITTERS

- A. Integrator shall furnish, configure and commission gauge indicating pressure transmitters as specified herein and on Contract Drawings. Contractor shall be responsible for installation as shown on Contract Drawings. All pressure measurement sensors, transmitters and related appurtenances shall be installed in strict accordance with manufacturer's shop drawings and installation instructions. Pressure transmitters shall be Rosemount Model 3051S1TG Series or equal and shall have following features.
1. 4-20 mA analog output with HART protocol; loop powered
 2. +/- 0.2% accuracy
 3. 100:1 turndown
 4. NEMA 4X enclosure
 5. 316L stainless steel wetted parts
- B. All outdoor installations shall be installed with a sunshield.
- C. Schedule

Tag	Description	Range	Classification/Remarks
WP-PIT-006	Water Well Pump No. 6 Discharge Pressure	0 - 150 psi	NEMA 4X w/Diaphragm Seal

2.06 TEMPERATURE MONITORING RELAY

- A. Integrator shall furnish, configure, and commission temperature monitoring relay as specified herein and on Contract Drawings. Contractor shall be responsible for installation as shown on Contract Drawings. All temperature monitoring relays shall be installed in strict accordance with manufacturers shop drawings and installation instructions. Temperature monitoring relay shall be Minco CT224, Motortronics TE-RTD12, or approved equal. Temperature Monitoring relay shall have the following features.
1. 120 VAC powered
 2. minimum 6 RTD inputs
 3. 3 programmable output relays
 4. 1 isolated analog output (4-20ma)
 5. NEMA 4X enclosure
 6. All outdoor installations shall be installed with a sunshield.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. If applicable, refer to Section 26 05 00, "Basic Requirements for Electrical" for requirements applying to all sections of Division 26, 27, 28, and 40 including, but not limited to, following:
1. Coordination
 2. Workmanship, Materials and Equipment
 3. Manufacturer's Recommendations
 4. Protection of Work
 5. Utility Connections
 6. Patching
 7. Painting and Identification
 8. Adjustments
 9. Contractors Test and Balance
 10. Clean-Up

3.02 ENCLOSURES

- A. For all input/output devices which require field interface devices, these devices where practical shall be mounted in a local control/field interface panel (LCP/FIP). All other field interface devices shall be mounted at point of field interface in a separate enclosure suitable for location. Integrator shall provide an enclosure which protects device(s) from dust, moisture, conceals integral wiring and moving parts.

- B. All wiring to and from LCP/FIP shall be to screw type terminals. Analog or communications wiring may use FIP as a raceway without terminating. Use of wire nuts within FIP is prohibited.
- C. All wiring within LCP/FIP's shall be run in plastic raceway to give a neat and organized appearance.

3.03 FIELD DEVICE IDENTIFICATION

- A. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with stainless steel engraved name plates.
- B. Identification shall match instrument tags in Contract Documents.
- C. Calibration settings shall be marked with paint or indelible ink.
- D. Each terminal strip termination shall be tagged with an identification that matches control drawings.
- E. Outside of each LCP/FIP shall be identified with an engraved plastic label matching identification name shown on control drawings prepared by Integrator. Lettering shall be in white against a black background.

3.04 MARKING

- A. Each control component shall be plainly and permanently marked, with number or symbol as it appears on control diagram, on an engraved stainless steel tag furnished by manufacturer.
- B. Where one control diagram serves more than one system additionally identify with system number.
- C. Junction box covers shall be marked to indicate that they are a part of control system.

3.05 IDENTIFICATION

- A. All control wires and cables shall be labeled. Wire, cable, terminal and fuse labels shall consist of complete wire number matching exactly number shown on control wiring diagrams, custom printed on a single pressure sensitive, self-adhesive tape which wraps entire circumference of wire or cable. Hand writing or combining multiple labels to make number shall not be permitted.

3.06 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Furnish one copy, electronic and printed, of Operation and Maintenance manuals.

3.07 CONTROL DIAGRAMS

- A. Control diagrams shall show all control wiring, except that a common symbol may be used for a common electrical control power supply.
- B. Diagrams shall show all interlock wiring or control wiring to control equipment whether equipment is furnished as part of Section 40 90 00 or by others. Any wiring other than power wiring (line to disconnect to starter to motor) shall be shown except following:
 - 1. Internal wiring of packaged factory pre-wired equipment.

3.08 SYSTEM TEST AND STARTUP

- A. Verify each field instrument wiring termination and submit a completed Instrument/Loop Checkout form.
- B. Utilizing control system, force all output signals to each controlled device to operate equipment across its entire operating range, verify physical state matches commanded state and verify status feedback signal matches actual state. Simulate input from each instrument across its entire operating range. Submit a completed I/O Verification report.
- C. Verify system operation and control as defined in approved System Functional Specification and submit a completed System Checkout report

END OF SECTION

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SECTION 43 21 06

BASIC REQUIREMENTS FOR PUMPING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. This section, when referenced in detailed specification section, provides minimum requirements applicable to pumping equipment furnished under this contract. More restrictive requirements, where found in individual pump specifications, shall supersede requirements of this section.
2. "Detailed pump specification", "detailed specification", "individual pump specification", "referencing section", or words of similar import in following paragraphs, shall mean specification section where requirements for specific pump performance are presented. "Pumping unit", whenever and wherever used, shall mean complete pumping assembly, including driver (whether engine, turbine, or motor) and shall include all accessories such as variable speed drives required for motor operation, gear reducers, intermediate shafting and bearings, flywheels, and all supports for all equipment furnished with pump.

B. Section Includes:

1. Submittals.
2. Balance.
3. Pump isolation and check valves.
4. Gauges on suction and discharge sides of pump.
5. Gauges for pump seal water connections.
6. Diaphragm seals.
7. Air release valves and related isolation valves.
8. Pressure switches.
9. Nameplates.
10. Fabrication requirements.

C. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 05 05 20 – Anchor Systems
3. Section 09 96 00 - Painting and Coatings
4. Section 11 05 13 – Motors

5. Section 33 12 00 – Valves
6. Section 46 05 00 – General Requirements for Equipment

1.02 DESIGN REQUIREMENTS

- A. Pump shall have necessary supports and bracing to prevent operation at a critical speed. If deemed necessary by Engineer, manufacturer shall be responsible for testing installed equipment to verify operation is not at a natural frequency. Contractor shall cause pump manufacturer to modify pump design as required if it is determined that pump is operating at a natural frequency anywhere throughout its variable speed operating range.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 00 05.
- B. Provide shop drawings for following:
 1. Gauges, including a complete schedule of all gauges and their respective ranges.
 2. Valves.
 3. Air release valves.
 4. Pressure switches.
- C. Equipment operations and maintenance data in accordance with Section 01 77 13.

PART 2 PRODUCTS

2.01 BALANCE

- A. For applicable pumps, impellers shall be dynamically balanced to ISO Standard 21940-11, Quality Grade G-6.3 or better.

2.02 PUMP ISOLATION AND CHECK VALVES

- A. Unless specifically forbidden by pump manufacturer for style of pump provided, all pumps shall be provided with an isolation valve immediately upstream and downstream of pump. Unless otherwise noted in Contract Documents, all isolation valves shall be resilient seated gate valves.
- B. Unless specifically forbidden by pump manufacturer or deemed unnecessary by Engineer in writing, discharge of all pumps shall be provided with a check valve to prevent backflow of fluid through pump.
- C. All valves shall comply with Section 33 12 00.
- D. Valves shall be provided by Contractor in accordance with pump manufacturer's requirements.

2.03 PRESSURE GAUGE FOR PUMP SUCTION AND DISCHARGE

- A. General:

1. Gauges shall be installed on suction and discharge sides of all pumps, with exception of submersible pumps, in accordance with following specifications and as shown on Contract Drawings.
2. Install pressure gauge on discharge piping for submersible pumps.
3. All wetted parts of gauges and accessories shall be compatible with specified service.
4. Contractor shall coordinate with various pump manufacturers so that all gauges and diaphragm seals are of one manufacturer. Diaphragm seals shall be provided for all gauges unless otherwise noted.
5. Gauges and diaphragm seals shall be shipped as complete unit.
6. Gauges are not required on sump pumps, polymer feed, screw, or chemical transfer pumps unless otherwise specified. Suction gauges shall not be required on peristaltic tube pumps unless otherwise specified.
7. Function: Pressure indication.
8. Type: Bourdon tube with socket; Type 316 stainless steel.
9. Suction: Compound type.

B. Performance:

1. Scale Range:
 - a. Suction: 25 feet of water above and below zero.
 - b. Discharge: 0 feet to a minimum of 5 feet of water pressure above pump shutoff head.
 - c. Or as noted otherwise.
2. Gauge shall be calibrated to read zero at atmospheric pressure.
3. Accuracy: Plus or minus 0.5 percent of full scale.

C. Features:

1. Dry with PLUS! Performance Option.
2. Dial: 4-1/2-inch diameter, unless otherwise noted.
3. Case Material: Black phenolic plastic, unless otherwise noted.
4. Element Material: Phosphor-bronze, unless otherwise noted.
5. Throttling Devices.
 - a. Pulsation Dampener required, unless otherwise noted.
 - b. Stainless steel, unless otherwise noted.
6. Pointer: Micrometer-adjustable.
7. Movement: Stainless steel, Teflon coated bearings, rotary geared.

8. Window: Glass, unless otherwise noted.
9. Socket Materials: Stainless steel, unless otherwise noted.
10. Threaded reinforced polypropylene front ring for easy zero adjustment. Gauge case shall not need to be removed to adjust.
11. Case Type: Solid front with solid wall between window and element. Rear of case, gasketed pressure relief.
12. All gauges shall have continuous duty, Teflon diaphragm seals as specified herein.

D. Process Connection:

1. Mounting:
 - a. Lower stem, unless otherwise noted.
2. Near pump suction and discharge flanges.
3. Side-mounted at pipe centerline.
4. Size: 1/2-inch, unless otherwise noted.
5. Connection Type: Threaded (NPT); where portable gauges are specified or noted on Drawings connection shall be Type 316 stainless steel quick disconnect type.
6. Tubing/piping and Fittings: Type 316 Stainless steel, unless otherwise noted.
7. Isolation valve: 1/2-inch ball valve or stopcock, Type 316 stainless steel, unless otherwise noted.
8. For chemical service, all process connection components shall be compatible.

E. Manufacturers and Products:

- a. Ashcroft; Duragauge Model 1279/1379.
- b. Approved equal.

2.04 GAUGES FOR PUMP SEAL WATER CONNECTIONS

A. General:

1. Function: Pressure indication.
2. Type: Bourdon tube.

B. Performance:

1. Scale Range:
 - a. 5 feet above pump shutoff head.
 - b. Or as noted otherwise.
2. Accuracy: Plus or minus 1.0 percent of full scale.

C. Features:

1. Dry with PLUS! Performance Option
2. Dial: 2-1/2-inch diameter, unless otherwise noted.
3. Case Material: Stainless steel, unless otherwise noted.
4. Element Material: Phosphor-bronze, unless otherwise noted.
5. Throttling Devices.
 - a. Pulsation Dampener required, unless otherwise noted.
 - b. Stainless steel, unless otherwise noted.
6. Pointer: Micrometer-adjustable.
7. Movement: Stainless steel, Teflon coated bearings, rotary geared.
8. Window: Glass, unless otherwise noted.
9. Socket Materials: Stainless steel, unless otherwise noted.
10. Threaded reinforced polypropylene front ring for easy zero adjustment.
11. Case Type: Solid front with solid wall between window and element. Rear of case, gasketed pressure relief.

D. Process Connection:

1. Mounting:
 - a. Lower stem, unless otherwise noted.
2. Size: 1/4-inch, unless otherwise noted.
3. Connection Type: Threaded (NPT).
4. Tubing/piping and Fittings: Type 316 Stainless steel, unless otherwise noted.
5. Isolation valve: 1/4-inch ball valve or stopcock, Type 316 stainless steel, unless otherwise noted.

E. Manufacturers and Products:

1. Ashcroft; Duralife Model 1009.
2. Approved equal.

2.05 DIAPHRAGM SEALS

A. General:

1. Function: Isolate sensing element from process fluid.
2. Type: Fluid-filled, corrosion resistant.

- B. Service:
 - 1. Pressure: Same as associated sensor.
 - 2. Temperature: As noted.
- C. Features:
 - 1. Materials:
 - a. Lower Housing: Type 316L stainless steel, unless otherwise noted.
 - b. Diaphragm Material: Type 316L stainless steel, unless otherwise noted.
 - 2. Diaphragm welded to upper housing.
 - 3. Filling screw in upper housing.
 - 4. Fill Fluid: Glycerin. Factory assembled and filled when possible.
 - 5. Flushing Connection: 1/4-inch NPT in lower housing.
 - 6. Diaphragm Seal Displacement: 0.1 cubic inch, maximum.
- D. Process Connections:
 - 1. Instrument: 1/2-inch female NPT, unless otherwise noted.
 - 2. Process: 1/2-inch female NPT, unless otherwise noted.
- E. Manufacturers:
 - 1. Shall be same as pressure gauge manufacturer.
 - 2. Ashcroft; Type 201.
 - 3. Approved equal.

2.06 AIR RELEASE VALVES

- A. Air release valves shall be installed on discharge side of pumps located at high point of discharge piping system.
- B. Air release valves shall be in accordance with Section 33 12 00.
- C. Isolation valves shall be provided for each air release valve supplied. Isolation valves shall be installed immediately upstream of air release valve to allow complete isolation of air release valve for maintenance purposes.
- D. Isolation valves shall be resilient seated gate valve type, or as otherwise specified elsewhere, and shall be in accordance with Section 33 12 00.

2.07 NAMEPLATES

- A. Nameplates shall be in accordance with Section 01 00 05.

2.08 FABRICATION REQUIREMENTS

A. Painting.

1. Painting, including surface preparation, shall be in full accordance with Section 09 96 00.
2. Pump manufacturer shall coordinate fully with Contractor on system and application of paints used.

B. Shop Testing.

1. Shop tests shall be performed on pumps in accordance with Section 01 00 05.
2. Include results of all factory testing in O&M Manual.
3. Conduct performance test of all pumps under simulated design conditions in factory prior to shipment.
 - a. Conditions shall include:
 - 1) Design point.
 - 2) Secondary design point (if applicable).
 - 3) Design point with motor speed reduction at specified percentage (if applicable).
 - 4) Shutoff head.
 - b. Deviation of actual data from specified performance criteria shall not exceed ± 3 percent.
 - c. Develop pump curve for each pump type using at least 10 actual data points.
 - d. Development at least 5 pump curves at different speeds for units specified to be operated with a VFD.
 - 1) Factory variable frequency drives may be used for testing.
 - e. Record motor amperage and brake horsepower and efficiency at each data point at pump curve.
4. Additional shop testing requirements shall include:
 - a. At minimum, testing shall include:
 - 1) Performance test.
 - 2) Vibration test.
 - 3) Hydrostatic test.
 - b. Provide a standard NPSH3 curve based on testing of standard pumps.
 - c. Conduct impeller balancing.
5. Results of factory testing shall be made available to engineer for review prior to shipment of units.

6. Final acceptance of any equipment shall be dependent upon satisfactory operation and performance after installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Pumping equipment shall be installed by Contractor in accordance with Section 01 00 05.
- B. Contractor shall follow written requirements provided by equipment manufacturer. Upon completion of installation work, Contractor shall submit a complete, properly signed Equipment Start-up Report and Certification as specified in Section 01 99 00 and in accordance with Section 01 00 05.
- C. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless Owner accepts an alternate installation procedure in writing, baseplates, soleplates, and mounting blocks shall be leveled and grouted with equipment removed. Pumps shall be installed in accordance with this section and ANSI/ HI 1.4 or ANSI/ HI 2.4, as appropriate for type of pumping equipment installed.
- D. If Contractor provides equipment that has suction/inlet and/or discharge/outlet dimensions that differ from those indicated in these specifications and/or Contract Drawings, Contractor shall provide any connections, piping, and other accessories necessary to allow equipment to be installed and to operate for its intended purposes.

3.02 ALIGNMENT

- A. All equipment shall be aligned to tolerances specified by respective pump manufacturer.

3.03 FIELD TESTING

- A. Field testing shall conform to requirements of Sections 01 00 05 and 01 77 13 including providing services of a qualified manufacturer's representative. All temporary measuring devices required to conduct tests shall be provided by Contractor at no additional cost to Owner.
 1. For each series of pumps of same model and size, representative shall supervise and check installation for not less than two days and supervise its initial operation, instruct operators in operation, proper maintenance and repairs for not less than one day or for a length of time defined in individual equipment sections.
- B. For all units with variable speed drives, standby generator and/or any unit with pump suction nozzle size 6 inches in diameter and greater, testing procedure shall be a plan developed jointly by Contractor and equipment manufacturer to demonstrate performance of each item of equipment at all specified operating conditions.
- C. Pumps shall be tested using type of fluid pumps were designed to operate with wherever possible. If actual fluid cannot be used, clean water may be used but final acceptance by Engineer and Owner shall be delayed until actual performance can be demonstrated with design fluid type.
- D. Pump(s), casing, motor, and base plate, shall be field tested to demonstrate operation without vibration, cavitation, overheating, or abnormal or excessive noise while pump is running throughout normal range of motor speeds. Field test shall include, but not be limited to, confirming proper installation, checking for proper alignment, confirming there are no mechanical defects in any parts, checking for correct rotation, correct operation at design point(s) including ability to deliver specified quantity and specified pressure, maximum motor

amperage draws within nameplate specifications, balanced voltages on each power leg with pump operating to within Manufacturer tolerances and demonstrated compatibility of pump/motor with controls supplied.

1. Abnormal noise or excessive vibration shall constitute failure of pump.
- E. A detailed signature vibration analysis shall be conducted on all pumps with adjustable speed drives and pumps with shaft power requirements 50 horsepower and greater and all pumps with driver ratings 100 horsepower and greater and when called in individual specification sections including a bump test and X-Y vibration profiles to prove compliance with specified vibration limits and to prove there are no field resonant conditions caused by misalignment, foundation, mounting or connecting piping and its supports, when operating over range of design.
1. A written report shall be submitted including a sketch of unit indicating where and in which direction vibration readings were taken and recorded showing peak to peak displacement in mils.
 2. Vibration levels shall be within acceptable limits for type of pump and pump speed as given in Hydraulic Institute Standards, latest edition.
- F. Where applicable, field testing shall include a wetwell drawdown test (using clean water) to verify operating point of each pump and operating points of pump running in parallel.
- G. Field tests shall be conducted by Manufacturer or his Authorized Representative. For pumping systems that include variable frequency drive(s) and/or standby generator(s), Manufacturer or his Authorized Representative of variable frequency drive and generator shall be present at time of system startup.
- H. For all pumps operating with variable frequency drives (VFDs):
1. Test for critical speeds and natural frequencies and, if necessary, prevent pumps from operating at these unwanted frequencies.
 2. Any remedy imposing a locked-out speed interval or intervals shall not be considered an acceptable remedy for identified critical speeds, unless approved by Engineer and manufacturer of any potentially affected process.

3.04 FIELD VIBRATION

- A. Vibration shall be measured in accordance with ISO 10816 for all pumps with variable speed drives and pumps with shaft power requirements 50 horsepower and greater and all pumps with driver ratings 100 horsepower and greater and whenever specified in individual section sections. An independent testing laboratory specializing in this work, retained by Contractor but acceptable to Engineer, shall perform measurements and shall submit results directly to Engineer. Root-mean-square (RMS) vibration velocity on any component when pump is operating at any specified continuous duty operating condition shall not exceed limits established for appropriate machine by ANSI/ HI 9.6.4 when pump is operating within manufacturer's listed POR. Field vibration for custom-engineered column type vertical pumps and motors shall not exceed 2.5 mils peak to peak RMS when pump is operated at any capacity condition within 85 percent and 115 percent of pump's capacity at full speed, when measured at top of pump motor. When operating at any combination of conditions outside POR for any pump regardless of type, limiting values shall be 25 percent greater than above limits. Provide a written report of test results, including a sketch of unit indicating where and in which direction vibration readings were taken and recorded showing peak to peak displacement in mils.

3.05 TRAINING

- A. Training shall conform to requirements of Sections 01 00 05 and 01 77 13. Upon completion of all training requirements, Contractor shall submit Equipment Training Certification form as specified in Section 01 99 00.

END OF SECTION

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SECTION 43 21 17
VERTICAL TURBINE PUMP

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. Install and test complete one deep set vertical turbine pump at Water Well No. 6 as shown on Drawings and as specified herein. Pump shall be ready to operate and complete with all necessary motors, piping, valves, fittings, controls, accessories, and appurtenances including spare parts, to form a complete operating pumping system in compliance with these specifications and as shown on Drawings.
2. Manufacturer shall have unitary responsibility for performance and compatibility of system components specified to be within manufacturer's scope of supply. System components within manufacturer's scope of supply not provided by equipment manufacturer shall be rejected. Unitary responsibility includes all components supplied by manufacturer within their scope of supply, even if described in more detail in another specification section or on Contract Drawings.
3. To assure proper interfacing and reliable operation of all pumping systems components, manufacturer shall assume sole responsibility for quantity and proper functioning of all components within manufacturer's scope of supply, including those not of his manufacture.

B. Section Includes:

1. Equipment.
2. Accessories.
3. Motors and drives.
4. Controls.

C. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions, and Division 01 Specifications Sections, apply to this Section.
2. Section 33 13 00– Testing and Disinfection of Piping and Systems
3. Section 05 05 20– Anchor Systems.
4. Section 10 14 20 – Signage Requirements.
5. Section 46 05 00 – General Requirements for Equipment.
6. Section 43 21 06 – General Requirements for Pumping Equipment.
7. Section 33 11 00 – Piping.
8. Section 33 12 00 – Valves.

9. Section 11 05 13 – Motors.
10. All electrical equipment, control panels, and wiring shall be in full compliance with Division 26 Specifications.

1.02 REFERENCES

- A. Publications listed below form a part of this specification. Publications are referred to in text by basic designation only. In event of conflict between requirements of this section and those of listed documents, stricter of two shall apply as determined by Engineer.
- B. All references shall refer to latest edition of that reference including any revisions.
- C. Organizations and Legislative Documents:
 1. Anti-Friction Bearing Manufacturers Association (AFBMA).
 2. American National Standards Institute (ANSI).
 3. American Standards for Testing Materials (ASTM).
 4. American Water Works Association (AWWA).
 5. Hydraulic Institute (HI).
 6. National Electrical Manufacturers Association (NEMA).
 7. National Fire Protection Association (NFPA).
 8. National Sanitation Foundation International (NSF).
 9. The Society for Protective Coatings / NACE International (SSPC/NACE).
 10. Underwriters Laboratory (UL) - Electrical Assemblies (UL 508).
- D. Publications:

Reference	Title
ANSI B16.1	Cast -Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ANSI B31.1	Power Piping
ANSI/HI 9.6.3	Rotodynamic (Centrifugal and Vertical) Pumps – Guidelines for Allowable Operating Region
ASTM A36	Standards Specification for Carbon Structural Steel
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A582	Standard Specification for Free-Machining Stainless Steel Bars.
ASTM B148	Standard Specification for Aluminum-Bronze Sand Castings.
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications
AWWA C654	Disinfection of Water Wells
AWWA E103	Horizontal and Vertical Line-Shaft Pumps

Reference	Title
NSF 61	Drinking Water System Components – Health Effects
NFPA 70	National Electrical Code (NEC)
NEMA	National Electrical Manufacturers Association
UL 508	Underwriters Laboratory (UL) - Electrical Assemblies

1.03 DEFINITIONS

- A. Terms “manufacturer” and “equipment manufacturer” listed herein are used to describe manufacturer and supplier of vertical turbine pump.
- B. Term “equipment” listed herein is used to describe vertical turbine pump and all accessories and appurtenances.

1.04 PERFORMANCE AND DESIGN CRITERIA

- A. One (1) deep set vertical turbine pump shall be provided at Water Well No. 6.
- B. Pump selection for a given application shall be predicated using primary and secondary design points outlined in performance criteria. Primary design point shall be located in proposed pump's Preferable Operating Region (POR), while secondary design point shall be located in proposed pump's Allowable Operating Region (AOR), as defined in ANSI/ HI 9.6.3. If pump manufacturer's information is silent on boundaries of AOR and POR for proposed selection, submittal shall be rejected.
- C. Vertical Turbine Pump shall meet following criteria.
 - 1. Design criteria:
 - a. Review Contract Drawings for pump support elevation, minimum and maximum water elevation, discharge elevation, and bottom of basin elevations (as applicable).

Design	Water Well Pump
Tag No.	WP:P1 6
Location	Water Well No. 6
Pump Type	Deep Set Vertical Turbine
Discharge Type	Above Floor
Discharge Flange Size (150#; minimum)	12-inch
Lubrication	Product
Fluid	Untreated Ground Water
Pump Setting	175 feet
Column Diameter (maximum)	14-inch
Number of Stages (maximum)	4
Minimum Shaft Size	1.69 inch
Shutoff Head (maximum)	330 feet
Motor Horsepower (maximum)	150 hp
Motor Speed (maximum)	1800 rpm
Electrical Supply to Motor	480 V, 3-Phase, 60 Hz.

- b. Pump shall be non-over-loading throughout their operating range. Pump assembly shall be designed to ensure speed range is not within 15 percent of first critical speed of pump shaft.
- c. Pump shall be capable of operating without cavitation at runout conditions, as well as, over full range of operating conditions.
- d. Pump shall be designed to meet specified performance requirements in piping system shown on Contract Drawings.
- e. All wetted parts of water well pump shall be NSF 61 certified.

2. Performance Criteria:

Design	Water Well No. 6
Primary Design Point	
Flow	2500 gpm
Total Dynamic Head	178 feet
Hydraulic Efficiency, Min	82%
Secondary Design Point	
Flow	1100 gpm
Total Dynamic Head	114 feet
Hydraulic Efficiency, Min	70%

1.05 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 00 05.

- B. At a minimum, submittals shall contain, but not be limited to, following information to establish compliance with these specifications:
1. Shop Drawings in accordance with Section 01 00 05.
 - a. Shop drawings shall be prepared and assembled by approved equipment manufacturers. Shop drawings prepared and assembled by manufacturer's sales representatives, distributors, dealers, fabrication shops, or other entities other than approved equipment manufacturers shall not be accepted.
 - b. Additional Shop Drawing Requirements:
 - 1) Motor test data and all other information necessary to show compliance with Section 11 05 13.
 - 2) Certified reports on all shaft sections showing compliance with specified requirements in this specification.
 - 3) Provide following static and maximum dynamic (operating) forces:
 - a) static weight
 - b) weight moment
 - c) dynamic moment
 - d) dynamic torque
 - e) dynamic shear
 - 4) Anchor bolt design for hold-down bolts shall be provided by pump manufacturer. Design shall include bolt material, diameter of bolts, and necessary bolt embedment depth.
 - a) All anchor hardware shall be Type 316 stainless steel.
 2. Performance Affidavit
 3. Shop assembly and inspection certification.
 4. Manufacturer's installation instructions.
 5. Shop test results and certified pump performance curves in accordance with Section 43 21 06. Provide shop test results to Engineer for review prior to shipment of equipment.
 - a. Performance curves for pump.
 - b. Pump manufacturer shall furnish data indicating pump motor efficiencies at 100 percent full load, 75 percent load and 50 percent load. Power factor at 115 percent rated load, 100 percent full load, 75 percent load and 50 percent load shall be indicated. Values for torque in pounds/feet at rated load are required. Full load and locked rotor current data shall be provided. No load current values are required.
 6. NSF 61 certificate for all wetted parts.
 7. Vibration, Noise, and Natural Frequency Testing.

- a. Submit qualifications of independent testing professional hired by Contractor who shall conduct tests meeting requirements specified herein.
 - b. Submit notarized certification attesting that independent testing professional has no contractual arrangements with pump manufacturer.
 - c. Provide review comments on pump manufacturer's mass elastic design.
 - d. Pump manufacturer, and not independent testing professional, shall provide report of factory/shop testing results as described herein.
 - e. Independent testing professional shall provide report of field test testing results as described herein.
 - 1) Any testing conducted by pump manufacturer in field shall also be reported.
 - f. Provide report of field acceptance testing results as described herein.
8. Manufacturer's certification that equipment has been properly installed, aligned and tested.
 9. Manufacturer's instruction certification that instructions to operators have been completed.
 10. Complete operation and maintenance data on equipment.
 11. Manufacturer's equipment warranty.
 12. During construction, whenever manufacturer receives notice that components that are part of his system are to be discontinued from manufacture, manufacturer shall inform Engineer within seven (7) days of receiving that notice along with his recommendations on how to resolve this issue.

1.06 SOURCE QUALITY ASSURANCE

- A. In order to maintain a standard of compatibility, all equipment and accessories specified in this Section shall be provided by manufacturers who have been regularly engaged in design and manufacture of equipment for at least twenty (20) years and with no less than one hundred (100) similar units installed in United States in similar applications.
- B. Equipment shall be factory operated and inspected prior to shipment to ensure proper operation of equipment.
- C. Factory Performance and Shop Tests:
 1. All factory shop tests, including required non-witness testing, shall be in accordance with Section 43 21 06.
 2. Include results of all factory testing in O&M Manual.
 3. Performance testing per ANSI/HI 14.6, with grade of 1U. Test shall determine pump capacity, head, and efficiency.
 - a. Complete pump assembly, including but not limited to bowl assembly, column, and discharge head, shall be tested by pump manufacturer according to Hydraulic Institute Standards procedures. Test shall include gallon per minute versus total head, horsepower and efficiency. A minimum of ten test points, including shut-off and design points, shall be included in test. Hydrostatic tests of bowl assemblies,

column assemblies and discharge heads, shall be in accordance with standards of Hydraulic Institute. Copies of certified test curves shall be submitted for approval prior to shipment. In addition to this testing, every pump impeller shall be dynamically balanced to ensure smooth operation and long service life.

4. Hydrostatic testing per ANSI/HI 14.6 on bowl assemblies.
 - a. Hydrostatic tests of bowl assemblies shall be in accordance with standards of Hydraulic Institute.
 - b. Bowls shall be tested at a hydrostatic pressure of 1.5 times shutoff head or two times rated head, whichever is greater.
5. Purpose of factory tests shall be to verify system performance, functionality and operability of system as specified. System shall operate satisfactorily at both primary and secondary operating points to be deemed acceptable.
6. Following documentation shall be made available for Owner and Engineer during testing:
 - a. All contract drawings and specifications, addenda, and change orders.
 - b. A copy of all test procedures.
 - c. All drawings and equipment documentation required for Supplier to provide
 - d. A hard copy printout of all customized programs.
7. Natural Frequency Testing
 - a. Pump provided for this project shall be designed to safely operate free of resonant frequencies. To ensure this, pump manufacture shall perform a structural lateral critical speed analysis for vertical variable speed driven pump. Finite Element Analysis (FEA) shall be for entire vertical pump structural unit including bowl assembly, column, discharge head, motor and a portion of discharge piping.
 - b. Pump shall have no dangerous critical or resonant lateral or torsional frequencies, or multiples of resonant frequencies within limits established herein over full range of operating speeds available with variable frequency drives.
 - 1) Torsional critical natural frequencies shall be avoided by at least 20 percent over full range of operating speeds.
 - 2) Lateral critical natural frequencies shall be avoided by at least 20 percent over full range of operating speeds.
 - a) Lateral natural frequencies (first, second, third, and half order) for pump and motor frames and all appurtenances shall be at least 125 percent of frequencies induced by rotating system.
 - 3) Analysis shall also produce an interference diagram showing relationship between operating speed, natural frequencies, and exciting frequencies. Diagram shall include calculated stresses throughout range of frequencies considered in analysis which shall be no less than full range of pump operating speeds available with this equipment. Analysis shall also show maximum deflections of shafts caused by forces acting on shaft.
 - a) Procedures shall produce Campbell diagrams depicting sources of excitation at minimum from 0.5, 1 and up to maximum allowable speed as

limited by motor power (or 2, whichever is less) and vane passing frequencies of impeller, line frequencies and motor pole frequencies.

- c. Structural dynamic modal analysis of combined pump/motor system including nearby foundation and piping out to first pipe restraint or expansion joint shall be performed using detailed 3D finite element techniques. All pump components, such as discharge head, soleplate, columns, bowl(s), and bell shall be explicitly modeled from drawings and/or solid models provided by pump OEM. Analysis shall not simply assume that foundation is infinitely rigid, rather it shall incorporate foundation design shown on installation drawings. Motor should be represented by a model that matches weight, cg, and reed frequency of motor. Analysis shall include added mass effects of submerged components and shall be evaluated at maximum and minimum water levels of wetwell. Structural dynamic analysis shall predict that no bending mode frequencies shall exist within a pump speed range from 25 percent below minimum operating speed to 20 percent above maximum operating speed.
 - d. Results of analysis shall be provided in form of a written report provided as a part of required equipment submittal package and shall demonstrate (1) natural frequencies and node shapes of pump and motor have been duly considered in design of discharge head, and (2) critical frequencies are at least 15 percent above or below specified operating range. Pump manufacturer shall certify that any calculated significant critical frequencies expected comply with above requirements.
 - e. Analysis shall demonstrate that equipment provided for this project shall not produce objectionable vibration during operation at specified range of unit performance. If harmonic analysis shows pump passes through a critical frequency between 50-100 percent of full speed, manufacturer shall modify design and/or construction of discharge heads to change natural harmonic frequency of unit(s) provided so vibration is avoided. For this reason, variable speed pump shall only utilize fabricated steel discharge heads only, so that they can be modified, gusseted, reinforced, lengthened, etc., as required. Harmonic analysis protocol and results shall be included in submittal data provided for pump, for review and approval by Engineer. All costs for FEA evaluation of pump and discharge head design, including any modifications to equipment that may be necessary to comply with requirements of these Specifications for abatement of natural frequencies, shall be borne by pump manufacturer.
8. Shop testing shall be conducted for pump prior to shipment to demonstrate that pump meet Design Requirements specified herein and in accordance with ANSI/HI 14.6.
- a. Performance curve depicting, a minimum of:
 - 1) Head vs. Capacity (gpm and feet).
 - 2) Speed of rotation (in rpm).
 - 3) Combined weight of pump and motor.
 - 4) Impeller diameter and number.
 - 5) Clearly marked operation points.
 - 6) Maximum HP motor that could be utilized.
 - 7) Shut-off head.
 - 8) Kilowatt usage at design conditions.

- 9) Efficiency (in percent) vs. flow.
- 10) Brake horsepower vs. flow.
- b. At minimum, testing shall include:
 - 1) Design point.
 - 2) Secondary design point (if applicable).
 - 3) Design point with motor speed reduction at specified percentage (60 – 40 Hz).
 - 4) Shutoff head.
 - 5) Additional points as described herein.
- c. Deviation of actual data from specified performance criteria shall not exceed ± 3 percent.
- d. Develop pump curve for pump type using at least 10 actual data points.
- e. Development of at least 5 pump curves at different speeds for units specified to be operated with a VFD.
 - 1) Factory variable frequency drives may be used for testing.
 - 2) Pump shall be tested at a minimum of 60, 50, and 40 Hz. Remaining curves may be developed using affinity laws.
- f. Record motor amperage and brake horsepower and efficiency at each data point at pump curve.
- g. Tests shall be certified by a licensed professional engineer retained by pump manufacturer.
- h. Results of factory testing shall be made available to engineer for review prior to shipment of units.
- 9. If results of factory tests fail to demonstrate compliance with requirements of Contract Documents including this Section, Contractor shall modify or replace deficient pump(s) as necessary, at no additional cost to Owner and shall resubmit certified factory test reports on modified or replacement pump.

D. Assembly:

- 1. Equipment specified herein shall be completely factory assembled as one unit as far as practical and inspected. All mating parts shall be trial fit. Manufacturer shall submit certification of shop assembly and inspection before shipment.

1.07 DELIVERY, HANDLING AND STORAGE

A. Packing, Shipping, Handling, and Unloading:

- 1. Equipment shall be shipped and handled in accordance with requirements of Section 01 00 01 of these specifications.
- 2. All components and parts shall be properly protected so that no damage or deterioration shall occur during shipment.

3. All openings such as suction and discharge flanges shall be covered with wood or metal blanks or properly sealed in plastic for shipment. To prevent damage during shipment, all drivers shall be installed at jobsite.

B. Acceptance at Site:

1. Damaged or defective components that are received shall be replaced with new components by the manufacturer.

C. Storage and Protection:

1. Equipment shall be stored and protected in accordance with requirements of Section 01 00 05 of these specifications.
2. Equipment shall be stored so as to provide protection from loss, damage, or exposure. Where pump and/or motors must be stored on jobsite for extended periods, such equipment shall be stored indoors in room with low humidity to guard against possible bearing corrosion.
3. Contractor shall assume all responsibility for proper maintenance of all equipment stored for prolonged periods.

1.08 WARRANTIES AND BONDS

1. Warranties shall be acceptable only from equipment manufacturer. Warranties from suppliers or installers shall not be acceptable. Warranties not provided by manufacturers and for terms described in these Contract Documents shall be basis to reject equipment.
2. Warranty shall not be limited by hours of running time or operation from variable frequency drives.
3. All equipment must be warranted against defective parts and design for a period of two years after final acceptance by Engineer and Owner.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Vertical turbine pump manufacturer shall be following:
1. National Pump Company, Glendale, Arizona, Model J12XHC.
 2. American Marsh LLC., Collierville, Tennessee Model 14WC.
 3. Or approved equal.
- B. Naming of a manufacturer (and model number(s)) in this specification is not an indication that manufacturer's standard equipment is acceptable in lieu of specified component features. Naming is only an indication that manufacturer may have capability of engineering and supplying a system as specified. Manufacturer shall modify his standard equipment as necessary to meet all of requirements specified herein and elsewhere in Contract Documents.
- C. Dimensions and locations shown on Drawings for equipment and accessories are based on equipment provided by National Pump Company. Any change in dimensions or location of equipment or accessories or type of accessories required to accommodate other manufacturers and/or models shall be at Contractor's expense. In addition, all costs associated with modifying design and construction of building, structural, piping, electrical, mechanical,

plumbing and instrumentation systems required to accommodate other manufacturers and/or models as well as any costs associated with schedule impacts to accommodate another manufacturer and/or model shall be responsibility of Contractor. Further, any additional testing, inspections, certifications, or other costs deemed necessary by Engineer or Owner associated with use of an alternate manufacturer shall be borne by Contractor.

- D. In case of an “or-equal”, Contractor shall demonstrate in writing, to satisfaction of Owner and Engineer at time of shop drawing submittal that manufacturer has produced specified type and size of equipment for potable water service that has been in successful operation in at least ten (10) different locations for a minimum period of five (5) years prior to bid date.

2.02 EQUIPMENT DESIGN

- A. General –Vertical turbine pump shall consist of, but not be limited to, following components which shall be supplied by manufacturer unless otherwise noted:

1. Discharge heads.
2. Pump bowls.
3. Pump impellers.
4. Column assembly.
5. Accessories.
6. Motors and drives.
7. Instrumentation and controls.

- B. Contractor shall be responsible for providing all other necessary equipment and accessories not provided by manufacturer necessary to provide a complete and operable water well pumping system including what is described in Contract Documents and required by manufacturer. These accessories and equipment shall include, but not be limited to, piping, valves, gaskets, piping and conduit supports, electrical equipment, and controls that are beyond manufacturer’s scope of supply. Contractor shall be fully responsible for reviewing entire scope of supply with manufacturer so as to be prepared to provide all other components necessary for complete and operable systems. Any costs associated with providing parts and accessories by Contractor necessary for a complete and operable system not included in manufacturer’s scope of supply shall be borne solely by Contractor at no additional cost to Owner.

- C. Discharge Heads

1. Pump heads shall be high grade fabricated steel designed to support entire column and bowl assembly. Motor mounting base plate shall be fabricated steel complying with ASTM A36 for pump support and motor mounting and attachment of anchor bolts and shall have a minimum thickness of 0.75 inch. Pump head shall be adequately fitted to base plate with a bolted machined joint to ensure a tight seal. ¾” seal flush connection and drain plug shall be provided. Provide 1/2-inch tapped connection at flange for pressure gauge. Base plate shall be attached with bottom plate grouted permanently into concrete foundation.
2. Discharge heads shall be ASTM A53, grade B fabricated steel designed for above ground discharge with sufficient strength and rigidity to support motor and carry weight of attached column and bowl assemblies. Discharge flanges shall be faced and drilled to match 150-pound ANSI connections and sized as specified in Part 1. Bottom face of discharge heads shall be circular and fully finished.

3. Discharge head shall allow for headshaft to couple above stuffing box. Stuffing box shall be provided with a compression capable of being plumbed to potable flushing system. Stuffing box shall be cast iron and rated for 150 psi discharge pressure and shall contain a minimum of five acrylic graphite packing rings and shall have a grease chamber. Packing glands shall be bronze, secured in place with stainless steel studs and adjusting nuts. Stuffing box bearing shall be C89835 bismuth bronze. A rubber slinger shall be installed on top shaft above packing gland. Top shaft shall be 416 stainless steel and shall extend through stuffing box.
4. Head Shaft shall be 400 Series Stainless Steel. Pump manufacturer shall include a method for setting and adjusting Pump Impellers.

D. Pump Bowls

1. Pump bowls, suction cases, and discharge cases shall be of close-grained cast iron complying with ASTM A48, Class 30 specifications, free of blow holes, sand holes, and other defects, and shall be accurately machined and fitted to close dimensions. Each bowl shall be provided with an aluminum bronze wear ring.
2. Annular flow velocity shall not exceed 5 feet per second.
3. Discharge bowl shall have vanes to deliver flow of water with minimum turbulence. Suction case shall be fitted with vesconite bearings and shall be provided with an ASTM A276 Type 304 stainless steel sand collar to protect suction bowl bearing from abrasives. Intermediate and suction case bowl bearings shall be of vesconite. Pump shaft shall be Type 416 series stainless steel turned and ground. It shall be supported by vesconite bearings above and below each impeller. Suction bell bearing shall be extra-long and permanently grease packed and sealed with a stainless steel sand collar. Discharge case shall also contain an extra-long support bearing.
4. A Type 304 stainless steel A276 sand collar, shall be provided to protect suction bowl bearing from abrasives. Bowl shaft shall be of sufficient diameter to transmit pump horsepower with a liberal safety factor. Bowl shaft material shall be ASTM stainless steel ASTM A582 grade 416 with hard chrome plating having a Brinell hardness of no less than 500. Bowl shaft shall have no less than 0.007- inch hard chrome per side and shall have pump shaft quality dimensional tolerances of plus 0.000 inch to minus 0.002 inch. Only shafts meeting pump shaft quality dimensional tolerances shall be acceptable.
5. Bowl shall have a flanged connection to column pipe.

E. Pump Impellers

1. Pump impellers shall be ASTM B148 C953000 aluminum bronze, enclosed, statically and dynamically balanced. Impellers shall be securely attached to bowl shaft with keys of ASTM 582M Type 316 stainless steel.

F. Column Assembly

1. Discharge column assembly shall be ASTM A 53 grade B steel pipe. Size shall be such that friction loss not exceed 5 feet per 100 foot, based on rated capacity of pump. Column pipe shall be furnished in interchangeable sections not more than 10 feet in length and shall be threaded. Ends of each section of column pipe shall be machined with 8 threads per inch with 3/16 inch taper and faced parallel and threads machined to such a degree that ends butt against bearing retainer shoulder to ensure proper alignment and to secure bearing retainers when assembled. Column adapter shall be of close grained cast iron ASTM A48 class 30, threaded to properly match discharge.

- a. Alternatively, column assembly shall be 304 stainless steel pipe. Size shall be such that friction loss not exceed 5 feet per 100 foot, based on rated capacity of pump. Column pipe shall be furnished in interchangeable sections not more than 12 feet in length and shall be threaded. Ends of each section of column pipe shall be machined with 8 threads per inch with 3/16 inch taper and faced parallel and threads machined to such a degree that ends butt against bearing retainer shoulder to ensure proper alignment and to secure bearing retainers when assembled. Column adapter shall also be stainless steel, threaded to properly match discharge.
2. Line shaft shall be of ASTM A582 416 stainless steel, ground and polished with a surface finish better than 40 RMS, interchangeable sections with Type 416 stainless steel couplings machine from solid bar stock designed with a safety factor of 1.5 times that of shaft. Butting ends shall be machined, faced and recessed square to axis of shaft. To ensure proper alignment, each section of shafting shall have a tolerance of 0.001-inch in diameter and shaft shall be straight within 0.005-inch TIR. Ends of shaft shall be accurately machine threaded. Threads shall be left hand to tighten during pump operation. Size of shaft shall be no less than determined by ANSI/AWWA E103-15 shall be such that elongation due to hydraulic thrust shall not exceed actual clearance of impellers in pump bowls. It shall be of ample size to operate pump without distortion or vibration and shall be capable of carrying maximum horsepower that may be generated by motor. Total length of shaft shall be such as to match properly length of discharge column.
 - a. Line shaft maximum allowable combined tensile and torsional stress under operating conditions shall be less than 12,000 psi at smallest net diameter in pump bowl assembly.
 3. Use of stuffing boxes with mechanical seals, or oil-lubricated seals, shall not be permitted.
 4. Column assembly shall have Type 304 stainless steel bearing retainers or carbon-steel equivalent. Each bearing retainer shall contain a water-lubricated, vesconite bearing designed for vertical turbine pump service or equivalent.
 5. After fabrication of complete discharge column and head, driver mounting flange and lower flange shall be accurately machined to insure absolute alignment of all components. No welding shall be done after machining is complete.

2.03 ACCESSORIES

- A. Contractor to provide pump isolation and check valves as required by Section 43 21 05.
- B. Pressure Gauge.
 1. Pump shall be equipped with a pressure gauge and diaphragm seal on discharge of pump. Gauge shall be equipped with a petcock and a pulsation snubber. Refer to Section 43 21 06 for additional details and requirements.
- C. Air/Vacuum Release Valve
 1. Pump shall be furnished with an air/vacuum release valve, size and location to be determined by pump manufacturer. Air/vacuum release valve shall evacuate air from pump column of pump for flow rates specified in Part 1. Air/vacuum release valve and associated isolation valve shall be furnished by pump manufacturer for installation by Contractor. Air/vacuum valve shall also have an automatic air release valve.
 2. Pump manufacturer shall provide properly sized flanged connection on pump discharge piping for installation of air/vacuum relief valve.

3. Air/Vacuum release valve shall be easily accessible by Owner. Contractor to provide necessary piping between flanged connection on pump discharge head and mounting location of air release valve.
4. All relief valves shall be provided with spring-to-close check valves and piping on air vent to prevent air from being drawn into piping.
5. Air/vacuum release valve shall be in accordance with Section 33 12 00.
6. All air/vacuum release valves from pump manufacturer and Contractor shall be furnished with following:
 - a. Cage around float (or other means determined by valve manufacturer) to protect float from damage in operation.
 - b. Air/Vacuum Valve shall be an APCO Model 1204 and Air Release Valve shall be Model 200a and both shall conform to Section 33 12 00.

D. Signage.

1. Contractor shall supply signage in accordance with Section 10 14 20.

2.04 MOTORS AND DRIVES

A. Motors.

1. Motor shall be of one manufacturer and shall be of standard design and construction meeting requirements of Section 11 05 13 and Contract Drawings.
2. Motor size(s) shall be as specified in Part 1.
3. Motor shall be provided by pump manufacturer and shall be designed for specific use with process equipment being served. Motor shall be provided with operating characteristics described in Part 1.
 - a. Motor shall be capable of supplying maximum rated horsepower and rpm at conditions and within ranges required per equipment manufacturer without overloading, overheating, or abnormal vibration as defined by Hydraulic Institute. Motor shall be capable of withstanding all forces, which may be imposed during course of normal operation. Motors shall be suitable for direct mounting to pump motor base.
4. Motor shall be of vertical hollow shaft high thrust design and shall be inverter-duty rated for use with variable frequency drive in accordance with NEMA MG1, Part 31.
5. Motor shall be provided with insulated bearings and shaft grounding rings. See Section 11 05 13 for additional requirements.
7. All pump motors shall be furnished with RTD's. Conform to requirements of Section 11 05 13. Motors shall be furnished with space heaters in accordance with Section 11 05 13.
8. Motors shall be provided with non-reverse ball bearing-type ratchet.
9. Motors shall be precision balanced motors with a peak to peak mils max displacement of 80.
10. Weight of rotating parts of pump and unbalanced hydraulic thrust of impeller shall be carried by high thrust bearings located in pump motor.

11. Motor for the pump shall meet following requirements:

Motor Parameter	Value
Motor Type	Squirrel Cage
Efficiency	Premium
Duty	Inverter, Continuous
Design	NEMA MG1
Insulation	Class F
Service Factor	1.00
Motor Enclosure	WP1
Starts per hour	2 cold or 1 hot start per hour

2.05 CONTROLS

- A. All control panels shall comply fully with Division 26, and related instrumentation and control requirements of these specifications. Interface with plant-wide SCADA system shall be coordinated with SCADA system supplier.
- B. Programmable logic controllers (PLCs), human-machine interfaces (HMIs), and related software shall comply with Division 26 requirements.
- C. General Requirements.
 1. Controls for vertical turbine pump shall provide for motor speeds through VFDs to slowly increase and decrease speeds upon energizing and de-energizing of pump.
 2. Controls for pump shall interface with Owner's SCADA system. Integrator shall provide all necessary equipment, accessories, and appurtenances to provide this interface.
 3. Any necessary modifications to existing controls equipment shall comply with Section 40 90 00, including manufacturer and model of controls accessories.
- D. Pump Controls Description.
 1. Water well pump shall be capable of being operated in Hand (Manual) and Off modes, selectable by operator via plant SCADA system.
 2. Hand: Pump status and pump speed shall be selectable-via plant SCADA system. Pump shall be capable of operating at same time. Critical speeds as determined by manufacturer during factory testing shall be locked out and not selectable.
 3. Off: Pump shall be off.
 4. All pump starts shall have the following sequence of operation
 - a. Receive Pump Start signal
 - b. Flush water solenoid valve opens
 - c. Five (5) minute delay
 - d. If flush water flow switch detects flow, pump starts. If no flow detected, no start.

5. Operators shall be capable of manually selecting Lead and or Lag pump from plant SCADA system under Manual control.
6. Following signals, separate for pump, shall be exchanged between pump and plant SCADA system:
 - a. Pump Local/Remote
 - b. Pump Run
 - c. Pump Running
 - d. Pump Speed
 - e. Pump Feedback Speed
 - f. Pump VFD Fault
 - g. Pump Fail
 - h. Hours of Run Time
 - i. Bearing Temperature

2.06 SPARE PARTS AND SPECIAL TOOLS

- A. No spare parts shall be required for pump.
- B. No special tools shall be required for disassembly, maintenance or repair of pump.

2.07 FABRICATION

- A. All equipment shall conform to general fabrication requirements as specified by manufacturer.
- B. Shop Assembly and Site Assembly.
 1. Isolate dissimilar metals with dielectric using appropriate fasteners.

2.08 FINISHES

- A. Surface preparation, shop painting and field painting and other pertinent detailed painting of all equipment shall be in accordance with manufacturer's requirements. All coatings shall be approved for use with potable water.
- B. Assemblies indicated below shall be shop coated by manufacturer:
 1. Bowl unit outside surfaces.
 2. Bowl unit inside surfaces.
 - a. Bowl water passages shall be coated with an abrasion resistant baked enamel, phenolic or epoxy.
 3. Column inside surfaces.
 - a. Rotoblast ID of column. Coating shall be air applied (orbiter) sprayed. Coating shall be equal to Tnemec FC20 140/141 Pota-pox epoxy. Approximate dry mil thickness

shall be 4-6 mils. Epoxy coating shall be FDA, NSF61-G/372, and AWWA approved for potable water.

4. Column outside surfaces.
 - a. Shot blast manufactures coatings O.D. of column. Coating shall be air applied. Coating shall be equal to Tnemec FC20 140/141 Pota-pox epoxy. Approximate dry mil thickness shall be 4-6 mils. Epoxy coating shall be FDA, NSF61-G/372, and AWWA approved for potable water.
5. Discharge head inside surfaces.
6. Discharge head exterior surfaces.
7. Steel sub base.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Contractor shall install all equipment, accessories, and appurtenances according to Contract Documents, including Section 43 21 06, and equipment manufacturer's written instructions and recommendations. Conflicts of information shall be called to attention of Engineer before proceeding with work.
- B. Equipment manufacturer shall provide Contractor with engineering and technical support related to specified equipment, and participate in commissioning, startup, testing, and training of Owner's personnel as required by Contract Documents and as necessary to allow Contractor to provide complete and operable pump systems.
- C. Contractor shall field verify all dimensions and elevations and shall notify Engineer of any specific differences.

3.02 FIELD QUALITY ASSURANCE AND INITIAL OPERATION

- A. Field Acceptance Testing:
 1. Preliminary tests, field tests, start-up and initial operation shall be performed in accordance with Contract Documents, including Section 43 21 06 and this specification section.
- B. Final acceptance of equipment shall be made after equipment has been demonstrated in field to meet performance requirements stated in this specification under all normal operating conditions and verification that motors are not overloaded in normal operating conditions.
 1. Pump casing, motor, and base plate shall be checked for abnormal noise and vibration while pump is running throughout normal range of motor speeds. Abnormal noise or excessive vibration shall constitute failure of pump.
 - a. If excessive vibration is noted as determined by Engineer, pump manufacturer shall conduct a detailed signature vibration analysis on pump, including a bump test and X-Y vibration profiles, to prove compliance with specified vibration limits and to prove there are no field resonant conditions caused by misalignment, foundation, mounting or connecting piping and its supports, when operating over range of design.

- 1) A written report shall be submitted including a sketch of unit indicating where and in which direction vibration readings were taken and recorded showing peak to peak displacement in mils.
- 2) Vibration levels shall be within acceptable limits for type of pump and pump speed as given in Hydraulic Institute Standards, latest edition.
- 3) All expenses for conducting vibration analyses and correcting any defects or failures shall be borne solely by Contractor at no additional cost to Owner. Owner and Engineer shall review and approve of any modifications proposed by Contractor prior to work commencing.

3.03 VIBRATION, NOISE, AND NATURAL FREQUENCY TESTING

- A. Field testing by independent testing professional for vibration, noise, and natural frequencies shall not negate need for pump manufacturer to conduct all factory tests and field testing and reviews customary for equipment and for additional testing and reviews by pump manufacturer as described in this specification section.
- B. Independent Testing Professional.
 1. Contractor shall retain services of an independent testing professional meeting requirements specified herein to perform vibration, noise, and natural frequency testing in field on installed equipment as part of field acceptance testing described in Part 3. In the submittal process, if an independent testing professional is used for FEA in lieu of manufacturer, that same testing professional shall also be used for field vibration, noise, and natural frequency testing. FEA analysis is only required for submittal process and additional field FEA is not required.
 2. Independent testing professional shall be a licensed professional engineer in State of Tennessee and shall have at least 10 years of experience in vibration, noise, and natural frequency testing. Independent testing professional shall be completely independent of pump manufacturer. Independent testing professional shall be certified to ISO 18436 Level 3 standards.
 - a. Independent testing professional shall provide a notarized certification attesting to having no contractual arrangements with pump manufacturer.
 3. Contractor shall provide qualifications of independent testing professional for review and approval by Engineer and Owner.
 4. Independent testing professional shall identify any testing requirements described herein that professional has concerns with and advise Engineer of any recommended modifications to those requirements prior to any testing occurring.
 5. Independent testing professional shall be hired by Contractor.
- C. Field Testing Standards
 1. Independent testing professional and pump manufacturer shall review field installation of pump prior to commencement of field tests.
 - a. Pump manufacturer shall certify in writing that pump is ready for continuous operation prior to any vibration testing commencing, and then only after all installation activities are complete.
 2. All documentation produced and submitted by independent testing professional shall bear registration seal and signature.

3. Following testing shall be conducted by an independent testing professional as part of required field acceptance testing on installed equipment.
 - a. Each complete pumping assembly, including rotating elements such as shaft, impeller, and couplings, frames, supports, and all related structural elements, including motor and all attached appurtenances, and mounting as well as a structurally representative section of cover shall be subjected to a vibration, noise, and natural frequency analysis to identify and eliminate potentially harmful resonant conditions.
 - 1) Spectral analysis shall be conducted to identify all discrete sources of vibration. Vibration testing shall be performed to measure unfiltered root mean square (RMS) readings for vibration velocity. Total overall unfiltered peak vibration velocity shall not exceed 0.17 inch per second over operating range, in accordance with HI 9.6.4. Velocity measurements shall be taken on one point of each bearing housing. Analysis shall include evaluation of control pulse frequencies induced by variable frequency drive. Analysis report shall include a statement produced by variable frequency drive manufacturer detailing all control pulse frequencies generated by equipment between 1/4 and 18 times motor running speed.
 - a) Analysis shall include evaluation of all frequencies indicative of mechanical defects, adverse hydraulic phenomena, and electrical defects. Any defects or sources of adverse hydraulic phenomena shall be eliminated prior to acceptance for substantial completion.
 - b. Final reports of field testing shall include three-dimensional graphics illustrating distortions and displacements for all-natural frequencies identified by analysis.
 - c. Reports produced shall comply with ANSI/HI 9.6.4 as applicable.
 - d. Reports and documents shall be, at minimum, those described in “Submittals” portion of this Section.
 - e. Reports shall include recommendations of modifications to pumps, covers, or both that may be necessary if vibration, noise, or natural frequency issues are determined to exist as part a result of testing.
 - 1) Pump manufacturers shall be responsible for designing any changes to their equipment to prevent detrimental resonance. Cost of changes, whether to pump shall be borne solely by pump manufacturer.
4. Instruments used in factory and field testing shall have been calibrated within one year of date of test to recognized test standards traceable to National Institute of Standards and Technology or other Engineer-approved source.

3.04 MANUFACTURER’S SERVICE

- A. Provide services of equipment manufacturer or their approved representative in accordance with Section 43 21 06. Representative for specified equipment shall be present at job-site for following services:
 1. Installation assistance: 1 man-day(s).
 2. Start-up and final acceptance: 1 man-day(s).
 3. Job-site training: 1 man-day(s).

- B. Provide equipment start-up and certification in accordance with manufacturer's requirements and Section 46 05 00.
- C. Provide all training in accordance with manufacturer's requirements and Section 46 05 00.
- D. All test results, forms, and certifications shall be included in O&M manual.

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SECTION 46 05 00

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. This section specifies general requirements, in addition to those of Section 01 00 05, which are applicable to all process mechanical equipment including those specified in, though not limited to, Divisions 43, 44, and 46. Contractor is responsible for ensuring that all process mechanical equipment meets requirements of this section in addition to specific requirements of each individual equipment specification section.
2. Equipment lists: Equipment lists, presented in these specifications and as specified on drawings, are included for convenience of Resident Project Representative and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. Contractor shall prepare his own material and equipment takeoff lists as necessary to meet requirements of contract documents and specifications.

B. Related Documents:

1. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions (if included), and Division 01 Specifications Sections, apply to this Section.
2. Section 05 05 20 – Anchor Systems
3. Division 26 – Electrical
4. Division 40 – Process Integration
5. Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment.
6. Division 46 – Water and Wastewater Equipment.

1.02 COORDINATION

- A. Contractor shall assume full responsibility for coordination of installation of all equipment, materials and products furnished under these Contract Documents. Contractor shall be completely responsible for verification that all structures, piping and equipment components furnished by Contractors and/or by Contactor's Subcontractors and Suppliers are fully compatible.
- B. Arrangement of equipment shown on Drawings is based upon information available to Owner at time of design and is not intended to show exact dimensions conforming to a specific manufacturer unless otherwise noted. Drawings are, in part, diagrammatic, and some features of illustrated equipment installation may require revision to meet actual submitted equipment installation requirements. Contractor shall, in determining cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate equipment actually provided. No additional payment shall be made for such revisions and alterations.

1.03 UNIT RESPONSIBILITY

- A. Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by unit responsibility manufacturer, where specified. Unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished by manufacturer under specification for equipment assembly, whether specified directly in equipment specification or specified elsewhere but referenced in equipment assembly specification, is compatible and operates reliably and properly to achieve specified performance requirements. Unless otherwise specified, unit responsibility manufacturer shall be manufacturer of driven component equipment in equipment assembly. Unit responsibility manufacturer is designated in individual equipment specifications found elsewhere in this project manual. Agents' representatives or other entities that are not a direct division of driven equipment manufacturing corporation shall not be accepted as a substitute for driven equipment manufacturer in meeting this requirement. Requirement for unit responsibility shall in no way relieve Contractor of his responsibility to Owner for performance of all systems as provided in General Conditions.
- B. Where variable frequency drives are used, Contractor shall require driven equipment manufacturer to coordinate with variable frequency drive supplier. Provide all necessary motor data to variable frequency drive supplier to ensure that variable frequency drive is sized for full nameplate motor horsepower, full load current, torque and starting characteristics of driven load at installed altitude and ambient temperature.

1.04 PATENT ROYALTIES

- A. All royalties and fees for patents covering materials, articles, apparatus, devices, or equipment shall be included in prices bid by Contractor.

1.05 BALANCE

- A. Unless specified otherwise, for all machines 25 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to following criteria:

$$e = 16 \times \frac{W}{N}$$

Where:

e = imbalance, ounce-inches, maximum.

W = Weight of balanced assembly, pounds mass

N = Maximum operational speed, rpm

- B. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

1.06 FIELD TESTING

- A. Perform in accordance with Section 01 00 05, as specified herein and as specified in individual equipment specification sections. After installation and checkout, all equipment shall be field tested. During field tests, equipment shall be subjected to various full load and partial load conditions and emergency operating and shutdown conditions. Ability of equipment to operate in prescribed manner without overheating, jamming, excessive noise or vibration, or evidence of excessive wear shall be demonstrated to satisfaction of Engineer.

- B. A record shall be made of each field test showing operating temperatures and pressures, motor current and voltage, speed, flow rate, and other pertinent data. Information recorded for fans, blowers, compressors, and pumps shall include static pressures entering and leaving equipment, fluid temperature entering and leaving equipment, ambient temperature, barometric pressure and relative humidity, rpm, and discharge flow rate. Refer to individual equipment specification sections for additional testing requirements. Five (5) copies of all recorded test data and information shall be submitted to Engineer for approval.
- C. All equipment handling or operating in potable water, wastewater, sludge, or corrosive or toxic materials shall be field tested using clean water at normal operating temperatures. Water used shall be potable water unless other sources are approved in writing by Engineer.
- D. Should results of tests indicate that equipment has failed to perform in accordance with requirements of applicable detailed equipment specification, in opinion of Engineer, Contractor shall make at his own expense such modifications or adjustments as required for satisfactory operation, including replacement of any or all components, if necessary. Following modifications or adjustments, Contractor shall repeat field tests as specified herein. This procedure shall be repeated until results of field tests indicate that equipment has satisfied requirements of applicable specification section.

1.07 INSTALLATION CERTIFICATION

- A. An experienced, competent, and authorized service representative of manufacturer of each item of equipment or other person acceptable to Engineer shall visit site of work and inspect, check, adjust if necessary, and approve equipment installation. In each case, equipment manufacturer's representative or other person authorized by Engineer to perform installation check shall be present when equipment is placed in operation and shall revisit jobsite as often as necessary until all trouble is corrected and equipment installation and operation are satisfactory in opinion of Engineer.
- B. Each equipment manufacturer's representative or other person authorized by Engineer to perform installation check shall furnish to Owner, through Engineer, a written report as specified in Section 01 99 00 certifying that equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and (4) has been operated under full load conditions and that it operated satisfactorily. Work described under these Contract Documents shall not be accepted as complete until satisfactory installation certifications have been submitted in accordance with requirements of this section.
- C. Contractor shall properly coordinate visits by manufacturer's representatives, particularly where operation of an item of equipment is dependent on operation of additional equipment. Prior to calling manufacturer's representative, Contractor shall ensure that all necessary related equipment, structures, piping, and electrical work is complete. Contractor shall pay for any revisits to site by manufacturer's representative made necessary due to Contractor's failure to properly coordinate visits.
- D. Contractor shall inform Engineer of any impending visits of manufacturer's representatives at least 72 hours before visits so that Engineer can make arrangements to have his representative at site to witness installation check and certification of manufacturer's representative.
- E. Contractor shall secure services of manufacturer's representative at site of work for as long as is necessary to check installation and place equipment in satisfactory operation. At a minimum, representative shall be on site for durations specified in individual equipment sections.
- F. Electrical connections to equipment shall be made only upon approval of manufacturer's representative.

- G. All costs for this work shall be included in contract price(s) and no separate payment shall be made.

1.08 EQUIPMENT LABELING

- A. Refer to Section 01 00 05.

1.09 LEAD-FREE REQUIREMENTS

- A. Equipment, accessories, appurtenances, and other components described in individual specification sections of these Contract Documents, on Contract Drawings, and elsewhere in these Contract Documents shall, as necessary, meet lead-free requirements described in Section 01 00 05.

PART 2 PRODUCTS

2.01 LUBRICATION AND LUBRICATION FITTINGS

- A. Refer to Section 01 00 05.

2.02 ANCHOR BOLTS

- A. Contractor shall provide suitable anchor bolts for each item of equipment in accordance with equipment manufacturers' requirements and recommendations unless otherwise noted in individual equipment specifications. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting anchor bolts when structural concrete is placed. Two nuts and two washers shall be provided for each bolt. Anchor bolts to be embedded in concrete shall be provided with sufficient threads to permit a nut and washer to be installed on concrete side of concrete form or supporting template, but in no case shall bolts be threaded less than 2 inches. Anchor bolts used in anchoring rotating or vibrating equipment shall be provided with suitable lock washers.
- B. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit a minimum of one inch of grout beneath baseplate and to provide adequate anchorage into structural concrete. Individual, embedded anchor bolts for heavy equipment shall be centered in a PVC sleeve having an inside diameter approximately two times bolt diameter and an embedded length approximately 8 times bolt diameter. Fill sleeve with silicone rubber or wax and protect threads above sleeve from damage and concrete splatter.
- C. Unless otherwise indicated, anchor bolts, nuts and washers for anchoring equipment to foundations and connecting bolts for equipment assemblies supported by other assemblies shall conform to requirements of Section 05 05 20. Unless otherwise specified, Contractor shall provide Type 316 stainless steel anchor bolts and washers, and Type 416 stainless steel or other corrosion resistant, non-galling alloy nuts. In ferrous chloride and ferric chloride containment areas, unless otherwise specified, provide Hastelloy C or Alloy 276 anchor bolts, nuts, washers and connecting bolts.
- D. Where equipment bases (i.e., pumps) are installed with grout holes, subsequent to field testing, those bases shall be totally filled with grout.

2.03 GROUTING

- A. Non-shrink, cementitious, non-metallic aggregate grout shall be used for column base plates, structural bearing plates, equipment bases limited to equipment less than 25 horsepower or 750 pounds and all locations where general term "non-shrink grout" is indicated on drawings.

- B. Epoxy grout for equipment bases greater than 25 horsepower or 750 pounds shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98 percent effective bearing area. When cured at a temperature of 73 degrees F, neat epoxy binder shall have a 1-day compressive strength of not less than 5,000 psi and a 28-day compressive strength of not less than 12,000 psi when tested in accordance with ASTM C579.

2.04 GUARDS

- A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements.
 - 1. Indoor Applications:
 - a. Guards shall be fabricated of minimum 14-gauge steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of guard. Guards shall be galvanized after fabrication.
 - b. Connect to equipment frame with galvanized bolts and wing nuts.
 - 2. Exterior Applications:
 - a. Guards shall be fabricated of minimum 15-gauge stainless steel or aluminum.
 - b. Construct to prevent entrance of snow, rain, and moisture.
 - c. Connect to equipment frame with stainless steel bolts and wing nuts.
 - d. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.05 PRESSURE AND TEMPERATURE GAUGES

- A. Contractor shall furnish a compound pressure/vacuum gauge on suction and a pressure gauge on discharge of each compressor and blower, unless otherwise specified. Gauges shall be 4.5 inches in diameter with phenolic plastic cases, unless otherwise noted, and clear shatter-proof lenses. Gauges shall have a white background and black pointers and characters. Maximum scale reading shall be approximately twice maximum operating pressure of fluid being measured. Filling medium shall glycerin. Accuracy shall be plus or minus 1 percent. Operating mechanism shall be of Bourdon type with positive protection against any solids contamination of operating mechanism provided.
 - 1. Gauges on suction and discharge of pumps shall be in accordance with Section 43 21 06.
- B. Pressure gauges shall be provided with NPT connections and shall be isolated from piping by ball valves, gauge cocks or as shown on Drawings.
- C. Pressure gauges on rotary or reciprocating equipment shall be provided with pressure snubbers.
- D. Pressure gauges installed on process lines containing sludge or other liquids with suspended solids shall be equipped with diaphragm seals. Gauges and diaphragm seals shall be by same manufacturer and shall be shipped as complete units, factory filled with glycerin fluid.
- E. Pressure gauges for steam service shall have stainless steel case and shall be equipped with pigtail siphon.
- F. Unless otherwise specified, Contractor shall furnish a bi-metallic temperature gauge on discharge of each air compressor or blower. Temperature gauges shall be approximately 5

inches in diameter with stainless steel case and white background and black pointers and characters. All temperature gauges shall have a range of 0-250 degrees F unless otherwise required for process conditions. Accuracy shall be plus or minus 1 percent. Temperature gauges shall be furnished with stainless steel thermowells and NPT connections.

2.06 LIFTING EYES

- A. Provide on all equipment 50 pounds or greater.
- B. Provide on other equipment as specified in detailed equipment specifications.

2.07 SPARE PARTS, SPECIAL TOOLS AND ACCESSORIES

- A. Furnish as required by individual Specifications and as specified herein. See Section 01 00 05 for additional requirements.
- B. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Special tools and accessories shall include those tools and accessories not normally available in an industrial hardware or mill supply house. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
- C. Schedule:
 - 1. Ensure that shipment and delivery occur concurrently with shipment of associated equipment.
 - 2. All spare parts and special tools shall be delivered shortly after equipment is installed.
- D. Packaging and Shipment:
 - 1. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
 - 2. Prominently displayed on each package, following:
 - a. Project number.
 - b. Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
 - c. Applicable equipment description.
 - d. Quantity of parts in package.
 - e. Equipment manufacturer.
 - 3. Deliver materials to Site. All spare parts and special tools shall be delivered to Owner to allow them to be filed and stored in a dry place.
 - 4. Notify Resident Project Representative upon arrival for transfer of materials.
 - 5. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.
- E. Spare parts shall be turned over to Owner and Spare Parts Transfer Form found in Section 01 99 00 completed and delivered to Engineer.

- F. Store in accordance with provision of Section 01 00 05. Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

2.08 CONTROLS AND CONTROL PANELS

- A. All controls shall be in accordance with Section 40 90 00 except as otherwise modified in individual specification sections.
- B. Any control panel containing an HMI or PLC shall be provided with a 120-volt single phase duplex receptacle in accordance with Division 26 requirements. Equipment manufacturer, if he is supplier of panel, or Contractor shall provide panel with necessary transformers to supply necessary power to receptacle.
- C. All control panels shall be provided with surge arrestors in accordance with Section 40 90 00.
- D. All control panels shall be provided with means to be either wall mounted or free-standing. Contractor shall, if necessary, provide necessary Type 316 stainless steel unistrut and all other necessary components including anchors necessary to construct a stand in order to mount control panel if a wall is not in location where panel is shown to be installed and panel is not designed to be a free-standing unit. Concrete housekeeping pads shall be provided for all free-standing control panels in accordance with structural drawings and specifications.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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