CONTRACT DOCUMENTS

AND

SPECIFICATIONS

FOR

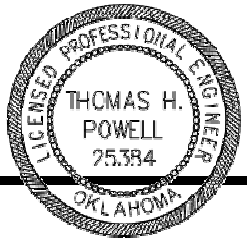
PROJECT NO. TMUA ES 2015-17, C2
SOUTHSIDE WWTP PEAK FLOW OPTIMIZATION: THIRD RIVER CROSSING AND DIVERSION FACILITIES

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

PREPARED BY:
Greeley & Hansen, LLC
312 South Boston Ave, Suite 300
Tulsa, OK. 74103
Ana Stagg, P.E.
(800) 837 9779 ph



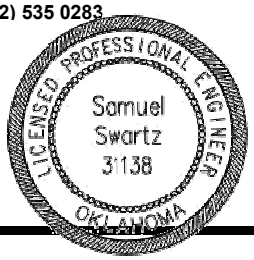
Greeley & Hansen, LLC
312 South Boston Ave, Suite 300
Tulsa, OK. 74103
Thomas H Powell, P.E.
(800) 837 9779 ph



WALLACE ENGINEERING
200 East Mathew Brady Street
Tulsa, OK 74103
Mondher Labbane, S.E.
918 584 5858 ph



McMillen Jacobs Associates
200 South Wacker Drive, Suite 3100
Chicago, IL 60606
Sam Swartz, P.E.
(312) 535 0283



City of Tulsa
Engineering Services Department

Account Number: 6031-5451101-040522152001, 6031-5451101-040522152004, 6037-5451101-0405221122002

Engineering Services Division
2317 South Jackson Avenue
Tulsa, Oklahoma 74107
(918) 596-9565

VOLUME II - TECHNICAL SPECIFICATIONS

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SECTION 00 0 10

TULSA MUNICIPAL UTILITIES AUTHORITY

SSWWTP PEAK FLOW OPTIMIZATION:

THIRD RIVER CROSSING AND DIVERSION FACILITIES

VOLUME II – TECHNICAL SPECIFICATIONS

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END OF SECTION

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description of Work

B. Constraints

C. Work By Others

D. CONTRACTOR's Use of Site

E. Work Sequence

F. Owner Occupancy

1.2 DESCRIPTION OF WORK

A. General: The Work to be done under this Contract consists of the construction of improvements as shown and specified in Contract Documents entitled Southside Wastewater Treatment Plant Peak Flow Optimization: Third River Crossing and Diversion Facilities, TMUA Project Number: ES2015-17, C2. The Southside Wastewater Treatment Plant is located at 5300 South Elwood Avenue in Tulsa, Oklahoma. Construction elements include the following:

1. Modifications of Junction Box 782

2. New 42-inch river crossing (Sanitary Sewer) connecting the new East and West Bank Junction Structures

3. New East Bank Junction Structure with associated modifications to the existing twin, 36-inch river crossings

4. New West Junction Structure with associated modifications to the existing twin, 36-inch river crossings

5. New 42” sanitary sewer connecting New West Bank Junction Structure to the Influent Lift Station

6. Removal and replacement of 24-inch sanitary sewer with 36-inch between the Influent Lift Station and upstream manhole including modifications within the manhole and modifications at the Influent Lift Station

7. New 36-inch Diversion pipe from the existing 36-inch Cherry Creek Force Main to Cherry Creek Flow Equalization Basin.

8. New Valve Vault along the new 36-inch Force Main with associated sump pump discharge piping.

9. New Headwall connection at Flow Equalization Basin 1.

B. The Work includes:

1. Furnishing of all labor, material, superintendence, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, services and other means of construction necessary or proper for performing and completing the Work.

2. Sole responsibility for adequacy of CONTRACTOR'S plant and equipment.

3. Maintaining the Work area and site in a clean and acceptable manner.

4. Maintaining existing facilities in service at all times except where specifically provided for otherwise herein.

5. Protection of finished and unfinished Work.

6. Repair and restoration of Work damaged during construction.

7. Furnishing as necessary proper equipment and machinery, of a sufficient capacity, to facilitate the Work and to handle all emergencies normally encountered in Work of this character.

8. Furnishing, installing, and protecting all necessary guides, track rails, bearing plates, anchor and attachment bolts, and all other appurtenances needed for the installation of the devices included in the equipment specified. Make anchor bolts of appropriate size, strength and material for the purpose intended. Furnish substantial templates and shop drawings for installation.

C. Implied and Normally Required Work: It is the intent of these Specifications to provide the OWNER with complete operable systems, subsystems and other items of Work. Any part or item of Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable is deemed to be included in the Work and the Contract Amount. All miscellaneous appurtenances and other items of Work incidental to meeting the intent of these

Specifications are included in the Work and the Contract Amount even though these appurtenances may not be specifically called for in these Specifications.

D. Quality of Work: Regard the apparent silence of the Contract Documents as to any detail, or the apparent omission from them of a detailed description concerning any Work to be done and materials to be furnished as meaning that only the best general practice is to prevail and that only materials and workmanship of the best quality are to be used. Interpretation of these specifications will be made upon this basis.

1.3 CONSTRAINTS

A. The Contract Documents are intended to allow the CONTRACTOR flexibility in construction of the Work, however the following constraints apply to both Option A and B Methods of Construction:

1. Prepare and submit a comprehensive schedule of proposed sequence of construction of the various parts of the improvements for approval in accordance with Section 01 32 16. Arrange the schedule to complete work in phases and permit operation by the OWNER of completed phases and parts thereof.

2. The work under this Contract must also be accomplished while the JB-782 overflow conduit, and flows to the City of Tulsa's Southside Wastewater Treatment Plant from JB-781 and JB-989 is maintained. Any work, which affects the existing facilities, must be carried out so that the operation of the existing facilities will not be jeopardized or materially reduced in efficiency as a result of the work.

3. Access to the River Parks Authority East Trail jogging path and biking lane must be provided at all times during construction. Contractor shall construct and maintain temporary gravel jogging paths on the north and south sides of the construction. In advance of scheduled special events involving the East Trail Bike path and bike lane, Contractor shall construct and maintain additional temporary fencing to provide park users the full use of the existing jogging path in both directions through the construction area without needing to use the temporary gravel jogging paths. Construction shall not be allowed to occur during any scheduled special events, however, CONTRACTOR shall remain responsible for maintenance of flows to the Southside Wastewater Treatment Plant.

4. Flaggers are required for all construction activities that require crossing East 54th Street, Riverside Drive, or the East Trail jogging path and biking lane. The CONTRACOR must provide flaggers that have been trained on all Oklahoma Department of Transportation regulations and standards for Construction Signing and Traffic Control, Section 880.

5. Design the sequence of construction to maintain uninterrupted conveyance of wastewater at all times during construction. Wastewater flows to the Southside Wastewater Treatment Plant must be maintained at all times, except when flow is temporarily stored in the collection system to install temporary bulkheads and new fillet in JB-782. Maximum water surface elevation inside JB-781 and JB-989 shall not be allowed to exceed elevation 611.75 (NAVD 88) at any time during construction. The CONTRACTOR must monitor the level in both JB-781 and JB-989 throughout the duration of the PROJECT and record daily values which shall be submitted to the Construction Manager on a monthly basis. Failure to keep water surface elevations below the stated values may result in a Sanitary Sewer Overflow (SSO) in the collection system. An SSO may result in a monetary "Fine" being levied by the Oklahoma Department of Environmental Quality (ODEQ), and hence, the CONTRACTOR would be responsible for paying any and all such fines. If an overflow were to occur at JB-781, JB782, or JB-989 the CONTRACOR must estimate the volume of wastewater released into the Environment by recording the "Time" the SSO started and stopped. All SSOs which may be caused upstream of the stated locations will be estimated by the OWNER.

6. By-passing of untreated wastewater to the Arkansas River as a result of construction operations is not permitted under any circumstances.

7. Generators provided and operated at all times during the construction period by the CONTRACTOR shall be the "Whisper Quiet" type and rated to have a maximum noise level of 55 dBA during their operation.

8. Sewers are susceptible to surcharge conditions during rain events. CONTRACTOR shall be responsible for monitoring weather and be solely responsible for any impacts to unfinished work if wet weather flows surcharge JB-782 during construction. Be prepared at all times during construction to safeguard workmen and protect the work from damage due to flooding. CONTRACTOR shall furnish all services, labor, materials, power, fuel and equipment necessary to remove all water, regardless of its source, that may enter the Work.

9. Provide and make as a part of Work any temporary structures, connections, piping, electrical and other services necessary to maintain service during the construction period. Remove all temporary facilities after successful completion of the Work.

10. Work on this Contract must be coordinated with the operation of the plant. Notify the OWNER, with written notice, of the CONTRACTOR's planned procedures for each specific alteration or shutdown of existing facilities 14 calendar days before the alteration or shutdown begins. Do not commence with the alteration or shutdown until specific permission has been granted by the OWNER in each case. The OWNER will coordinate the

CONTRACTOR's planned procedure with the operation of the treatment facility. The making of connections to existing facilities or other operations that interfere with the operation of the existing equipment must be completed as quickly as possible and with as little delay as possible. Prior to commencing with the work all required components, tools, and equipment are to be on-site. Work multiple or extended shifts to complete the work within the specified amount of time. The costs for any additional labor, equipment, and material to complete the required modifications within the specified amount of time are to be included in the CONTRACTR's Bid and no separate payment will be made therefore.

11. Any operational functions of the existing plant that are required to be done to facilitate the work of the CONTRACTOR will be performed by OWNER only as identified in approved planning.

12. If it is necessary for the proper operation or maintenance of the plant, the CONTRACTOR must reschedule work to not conflict with necessary operation or maintenance of the plant.

13. The OWNER will be the sole judge of when the CONTRACTOR's operations are causing interference with wastewater and sludge treatment processes, and the OWNER's orders and instructions must be carried out without delay.

14. The CONTRACTOR will maintain a temporary access road to the existing facilities from Riverside Drive and the ability to access existing structures for operation and maintenance. CONTRACTOR will be responsible for procuring a Right of Way Permit from the City of Tulsa's Right of Way Department.

15. The CONTRACTOR shall be responsible for procuring a Watershed Development Permit from the City of Tulsa's Development Services Department.

16. All spills of fuel or other pollutants in excess of five gallons shall be reported to the DEQ, within twenty-four (24) hours, to the pollution prevention hotline at 1-800-522-0206.

17. Contractor shall provide continues access to the Work Area to DEQ for inspection purposes.

18. CONTRACTOR shall perform work in such a manner to prevent damage to portions of the existing sewers and structures which are to remain in place. Repair or replace, without cost to the City, any portions of sewers and structures which are outside of the limits of removal, as shown on the Contract Documents, and which are damaged by the CONTRACTOR.

19. Work will be performed within an existing floodplain. In accordance with Tulsa District, and Army Corps of Engineers requirements, under no circumstances will any of the following be permitted or allowed to be discharged or dumped into waters of the State of Oklahoma including the Arkansas River:

    A. Discharges of untreated or filtered sanitary sewage or water
    B. Debris created during construction
    C. Excess excavated soil not used as backfill
    D. Excess materials not used during construction
    E. All fueling and servicing of vehicles and equipment shall be done above the Ordinary High Water Mark (OHWM).
    F. Any material and fuels used in the project shall be stored and/or stockpiled above the Ordinary High Water Mark (OHWM) and shall be removed from a likely flood zone prior to any predicted flood.

    This restriction applies to all construction activities conducted throughout the duration of the project.

B. In addition to the previously described general constraints, the following specific constraints apply:

    1. For installing the new River Crossing by means of Open-Cut Construction (Option A):

        a. All work within the River and outside of the Excavation Support Systems must be conducted during the months of September through February unless approved by the OWNER.

        b. All grade lines within the floodplain shall be restored back to original grade accept adjacent to the new East Bank Junction Structure where new grade lines are shown in the Contract Documents. No material outside of the floodplain can be used to re-establish grade for the new River Crossing.

        c. Only existing river bottom material within the Limits of Construction can be used for installing the new River Crossing.

        d. To mitigate material loss outside of the Limits of Construction, CONTRACTOR shall completely cover any earthen berms with geotextile fabric.

        e. No more than 300 lineal feet of trench can be excavated at any given time during construction of the new River Crossing.

f. Construction equipment cannot be stored in the River overnight. CONTRACTOR must demobilize from within the River after each work day.

g. All construction shall be done in a manner that will minimize any increase in turbidity and prevent downstream deposition of bank material during or after construction.

h. The following Coordination Plan shall be carried out by the CONTRACTOR when working within the Arkansas River. Failure to comply with the subject Coordination Plan will result in Liquidated Damages as defined by Division I:

(1) Lines of Communication

(a) The CONTRACTOR will contact the Construction Manager assigned to the PROJECT directly.

(b) The Construction Manager will contact the US Army Corps of Engineers (USACE) and the Southwestern Power Administration (SWPA) directly based on communication with the CONTRACTOR.

(c) The USACE and SWPA will contact the Construction Manager assigned to the PROJECT directly.

(d) The Keystone Dam and Flood Control Status can be monitored daily on the Keystone Lake website provided below:
www.swt-wc.usace.army.mil/KEYS.lakepage.html

(2) River Work Protocols

(a) Flood Control – If the US Army Corps of Engineers requires to release greater than 6,000 CFS for an extended period of time at the Keystone Dam to manage flooding within the region the "Flood Control" protocol will be initiated following the Lines of Communication established in this Coordination Plan. Upon notification to the CONTRACTOR by the Construction Manager that the "Flood Control" protocol has been initiated by USACE, the CONTRACTOR shall have 24 hours to perform the following:

1) Secure any non-encased 42-inch pipe by plugging the open end with an inflatable plug, fill in the entire 300 LF of exposed trench with excavated River material and then proceed to fill the installed pipe with River water to prevent floating.

2) Uninstalled pipe must be removed outside of the River.

3) All geotextile fabric must be removed and all earthen berms leveled to prevent washout of material downstream.
4) Once the River Exceeds Elevation 603.5 (NAVD 88), all work equipment and personnel until further notice shall remain demobilized from within the River.
5) The CONTRACTOR must remain idle until the "Flood Control" protocol is lifted. If the Construction Manager is notified by the USACE that the Arkansas River elevation will be dropping below an elevation 603.50, then the "Flood Control" protocol will end and the CONTRACTOR will get notification from the Construction Manager to mobilize back into the River.
6) Upon Notification the CONTRACTOR has 24 hours to mobilize back onsite and resume construction.

The CONTRACTOR will be paid to initiate this Protocol under Contract Item 14 – Mobilization and Demobilization Into River.

(b) Power Generation – The Southwestern Power Administration has given notice to the OWNER that one of two Turbines (rated for a peak discharge of 6,000 CFS per turbine) will be under maintenance until February of 2022 and until then the Keystone Dam's Hydro Electric Power Generation Peak Capacity is limited to 6,000 CFS, which correlates to a River Elevation at JB-782 of approximately EL 603.50 (NAVD 88). If this condition changes during Construction, the OWNER will initiate a PROJECT Coordination Meeting to discuss the changes to this Coordination Plan based on the Lines of Communication established for the PROJECT.

(3) River Level Monitoring
(a) The CONTRACTOR is responsible for monitoring the Arkansas River during Construction and shall submit a means for monitoring the River Levels at the PROJECT location. Once approved by the Construction Manager, the Contractor will provide Daily Records of River elevations on a monthly basis using the NAVD88 Benchmark for the PROJECT location while working within the Arkansas River.

2. For installing the Diversion Facilities:

   a. Coordinate construction of new Headwall at Flow Equalization Basin 1 with the OWNER.

   b. Coordinate connection of new 36-inch Diversion Line with the OWNER. The 36-inch Cherry Creek Force Main system can be out of service for no more than 8 hours for making connection.

1.4 WORK BY OTHERS

A. Work on other projects, which may take place concurrently with this CONTRACT and which is excluded from this CONTRACT, is as follows:

1. Tulsa SSWWTP Peak Flow Optimization: Plant Improvements and FEB Basin Drain Valve Replacement (TMUA Project ES2015-17, C1)
2. Tulsa SSWWTP Odor Control Improvements (TMUA Project ES2015-05 & ES 2015-12)

1.5 CONTRACTOR'S USE OF SITE

A. Limit use of site and premises for work and storage to allow for the following:

1. Coordination of the Work under this CONTRACT with the work of the other contractors where Work under this CONTRACT encroaches on the Work of other contractors.

2. OWNER occupancy and access to operate existing facilities.

3. Coordination of site use with ENGINEER.

4. Responsibility for protection and safekeeping of products under this CONTRACT.

5. Providing additional off-site storage at no additional cost to OWNER as needed.

1.6 SECURITY

A. The project site where equipment installation work is to be performed under this Contract is a secured site. The CONTRACTOR shall be responsible for security as described below at the site where he is performing work under this Contract.

B. Site Access: The CONTRACTOR shall respect all existing security measures at the project site, and shall implement the following measures to apply to all work performed under this Contract.

1. For each employee the CONTRACTOR employs for work at the project site, CONTRACTOR shall provide the following information to the ENGINEER: Name, address, Social Security Number, telephone number, length of employment with CONTRACTOR. CONTRACTOR shall also complete background checks and ID quest forms for all his employees employed for this project, to gain access to the project site.

2. CONTRACTOR shall maintain a log book listing as a minimum the names of all persons admitted to the secured site by the CONTRACTOR, the purpose of the site visit, the dates and times of arrival at the site, entry to the secured site, and departure from the site.

3. CONTRACTOR and OWNER acknowledge that CONTRACTOR shall not solely be responsible for all secured access to the site, that City personnel will have access and will be performing their regular duties pertaining to the operation and maintenance of the site facilities, and that security at the site shall require the cooperation of all persons authorized to access the site for the performance of their work. To the extent that CONTRACTOR is responsible for and has control of secured access, CONTRACTOR shall restrict site access to only persons essential to the performance or inspection for the work being performed under the Contract.

4. CONTRACTOR shall provide ENGINEER twenty-four (24) hours advance notification of any delivery of equipment or materials to the site, and shall make arrangements with ENGINEER to provide for inspection of such delivery.

C. Any observation by the CONTRACTOR of activity at or associated with the project site that CONTRACTOR observes and considers to be unusual or suspicious in nature, or that CONTRACTOR believes poses a threat to the integrity or welfare of the project site or associated facilities, shall be duly noted at the time of the observation in the log book identified in item B.2 above. Any such observation shall be immediately reported to the ENGINEER.

D. No statement pertaining to security in these Specifications shall constitute a contract between CONTRACTOR and OWNER for the performance of security services.

1.7 SAFETY

A. CONTRACTOR shall be responsible for performing all work under this contract in a safe manner and in compliance with all applicable local, state, and federal safety and health regulations.

B. CONTRACTOR shall submit a site-specific safety plan and emergency response plan prior to start of work. CONTRACTOR’s attention is directed to safety regulations applicable to the work under this contract.

C. Fire Prevention and Protection: The CONTRACTOR shall take all necessary measures to prevent fire, and shall provide satisfactory fire fighting means at the location of work.

1.8 WORK SEQUENCE

A. Construct Work in stages to accommodate OWNER's use of premises during construction period and in accordance with the limitations on the sequence of construction specified. Coordinate construction schedules and operations with ENGINEER.

B. Coordinate Work of all subcontractors.

1.9 OWNER OCCUPANCY

A. OWNER will occupy premises during entire period of construction in order to maintain normal operations. Cooperate with OWNER's representative in all construction operations to minimize conflict, and to facilitate OWNER usage.

B. Conduct operations so as to inconvenience the general public in the least.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

A. Starting Work: Start Work within 10 days following the date stipulated in the written order from the Authority to proceed with the work and execute with such progress as may be required to prevent delay to other contractors or to the general completion of the project. Execute Work at such items and in or on such parts of the project, and with such forces, material and equipment, as to complete the Work in the time established by the Contract. At all times, schedule and direct the Work so that it provides an orderly progression to completion within the specified time for completion.

END OF SECTION

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SECTION 01 26 00

CHANGE ORDER, WORK CHANGE DIRECTIVE AND FIELD ORDER PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Definitions

B. Change Orders

C. Work Change Directives

D. Field Orders

1.2 DEFINITIONS

A. Change Order: Refer to the Change Order definition in Article 1 of the General Conditions.

B. Work Change Directive: Refer to the Work Change Directive definition in Article 1 of the General Conditions.

C. Overhead: Overhead is defined as the cost of administration, field office and home office costs, general superintendence, office engineering and estimating costs, other required insurance, materials used in temporary structures (not including form work), additional premiums on the performance bond of the CONTRACTOR, the use of small tools, scheduling costs, and all other costs incidental to the performance of the change or the cost of doing business.

D. Field Orders: Refer to the Field Order definition in Article 1 of the General Conditions.

1.3 CHANGE ORDERS

A. Initiation of Proposals:

1. From time to time, the OWNER or the ENGINEER may issue a request for a Change Order proposal. The request will contain a description of the intended change with supplementary or revised Drawings and Specifications as applicable, and the projected time for accomplishing the change.

2. The CONTRACTOR may propose a change in the Work by submittal of a Change Order request to the ENGINEER describing the proposed change with a statement of the reason for the change and the effect on the Contract times and price, along with supporting documentation.

B. Execution of a request for a Change Order Proposal:

1. When a proposal is requested for changed work, submit proposal within 14 days following receipt of the request from OWNER or ENGINEER. State the increase or decrease, if any, in Contract Completion times and Contract Price.

2. Explain proposal in sufficient detail to permit review by OWNER.

3. For omitted work, the decrease in the Contract Price will be determined by the ENGINEER and will include appropriate amounts for profit and overhead.

4. The OWNER and ENGINEER will review the proposal and may request additional information and documentation. Provide these items upon request.

5. If the OWNER decides to proceed with the change, the OWNER will issue a Change Order for signature first by the CONTRACTOR and then by the OWNER.

6. The CONTRACTOR will promptly complete the approved change in the Work on receipt of the executed Change Order.

a. Failure to sign the Change Order does not relieve the CONTRACTOR from performing the Work if the Change Order is signed by the OWNER.

C. Execution of a change order request:

1. The OWNER and ENGINEER will review the request and may request additional information and documentation. Provide these items upon request.

2. For omitted work, the decrease in the Contract Price will be determined by the ENGINEER and will include appropriate amounts for profit and overhead.

3. If the OWNER decides to proceed with the change, the OWNER will issue a Change Order for signature first by the CONTRACTOR and then by the OWNER.

4. The CONTRACTOR will promptly complete the approved change in the Work on receipt of the executed Change Order.

a. Failure to sign the Change Order does not relieve the CONTRACTOR from performing the Work if the Change Order is signed by the OWNER.

D. Compute the cost of both additive and deductive changes in the Work in accordance with Article 12 of the General Conditions and as follows:

1. Include the costs of labor crew foreman and general foreman performing or directly supervising the changed Work on the site. Include travel and subsistence, but only to the extent incurred.

2. To the labor cost add all net premium for Workman's Compensation, taxes pursuant to the Federal Social Security Act, and payments required under State and Federal unemployment laws.

3. Add necessary extra materials, delivered at the site.

4. Include rent for plant and equipment at unit rental costs for similar rentals from an independent firm (i.e. a firm which is not owned in whole or in part by the CONTRACTOR). If equipment is owned by CONTRACTOR or rented from a firm in which the CONTRACTOR has an interest, calculate the rent in accordance with the applicable provisions and terms of the current "Cost Reference Guide for Construction Equipment" published by Dataquest.

1.4 WORK CHANGE DIRECTIVES

A. Initiation by OWNER: OWNER may issue a Work Change Director with a Notice to Proceed without a prior request for a Change Order Proposal or the CONTRACTOR's signature.

B. Payment Determination: The OWNER will designate the method of determining the amount of compensation or credit, if any, based on one of the methods contained in Article 12 of the General Conditions.

C. Timing: Proceed with the change in the Work immediately upon receipt of the Work Change Directive.

D. Addition to Contract: The Work Change Directive Orders will be incorporated into the Contract Documents via a Change Order at a later date.

1.5 FIELD ORDERS

A. The ENGINEER may issue a written order at any time during the course of construction.

B. Field Orders serve as documentation of minor changes in the work not involving a change in the Contract Price or Times.

C. Proceed with the change described in the Field Order immediately upon receipt of the field order.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 29 00

PAYMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Schedule of Values

B. Application for Payment

1.2 SCHEDULE OF VALUES

A. Approval of Schedule: Submit for approval a Schedule of Values, in duplicate, for all of the Work. Submit schedule of Values within 15 calendar days after work has commenced. Prepare the schedule of values as a detailed breakdown of lump sum and unit prices bid for each item of the Contract. The total of all items, so broken down, shall equal the total amount of the Contract. Submit such other information relating to bid prices as requested by the ENGINEER, and revise the Schedule of Values to a form acceptable to the ENGINEER. Following acceptance of the Schedule of Values, it may be used for checking CONTRACTOR'S applications for partial payments, but shall not be binding on the OWNER or ENGINEER for any purpose whatsoever. Be advised that no partial payment will be processed unless the Schedule of Values is submitted in accordance with the above requirements.

B. Format: Utilize a format similar to the Table of Contents of the Project Specifications. Identify each line item with number and title of the major specification section. Identify site mobilization, bonds and insurance. Include within each line item, a direct proportional amount of CONTRACTOR'S overhead and profit.

C. Revisions: With each Application for Payment revise schedule to list approved Change Orders.

1.3 APPLICATION FOR PAYMENT

A. Required Copies: Submit three copies of each application. Present required information in typewritten form or on electronic media printout. Present actual invoices for materials for direct payment by OWNER. Include a current summary of payment to date.

B. Execute certification by signature of authorized officer.

C. Use data from approved Schedule of Values.

D. Stored Materials: When payment for materials stored is permitted, submit a separate schedule for Materials Stored showing line item, description, previous value received, value incorporated into the Work and present value.

E. Change Orders: List each authorized Change Order as an extension on continuation sheet, listing Change Order number and dollar amount as for an original item of work.

F. Final Payment: Prepare Application for Final Payment as required in General Condition GC-29(2).

G. Submit an updated construction schedule with each Application for Payment. Revise schedule to show Work completed to date and remaining Work. Schedule remaining Work to achieve completion of all contract Work by the contract completion date.

H. Submit application for payment to ENGINEER on, or before, the first day of each month.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 29 50

CONTRACT ITEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract Items

1.2 OPTION A - CONTRACT ITEM 1 – PROJECT MOBILIZATION AND DEMOBILIZATION

A. Description: Under the Contract Item for Project Mobilization and Demobilization, furnish all labor, materials, equipment and services, and do all Work necessary to mobilize and subsequently demobilize the construction preparatory operations. The Work includes bonds, insurance, movement in and out of personnel and equipment, project signs, and establishment of the Contractor's and Engineer's offices. A maximum of 5 percent of the total bid for Contract Item 1 is allowed for Mobilization and Demobilization in the bid proposal.

B. Payment: Project Mobilization and Demobilization will be paid by EACH in the following manner:

1. Sixty percent (60%) of the price bid for mobilization and demobilization may be included in the pay estimate which reflects five percent (5%) completion of the Work.

2. An additional fifteen percent (15%) of the price bid for mobilization and demobilization may be included in the pay estimate which reflects fifty percent (50%) completion of the Work.

3. The final twenty five percent (25%) of the price bid for mobilization and demobilization may be included in the final pay estimate.

1.3 OPTION A - CONTRACT ITEM 2 - TEMPORARY CONSTRUCTION FENCE

A. Description: The Work under this Contract Item includes furnishing all labor, materials, equipment and services for the installation, and maintenance of temporary construction fence together with all associated and appurtenant Work as shown, specified and directed in the Contract Documents. Work also includes the removal of temporary construction and fence at the end of construction.

B. Measurement for Payment: The quantities of Temporary Construction Fence in lineal feet, to be measured for payment under Option A Contract Item 2 will be the actual lineal feet of Temporary Construction Fence. Unauthorized additional Temporary Construction Fence will not be measured or paid for.

C. Payment: Payment for Temporary Construction Fence will be made at the Contract unit price per lineal foot for Option A Contract Item 2.

1.4 OPTION A - CONTRACT ITEM 3 - TEMPORARY CONSTRUCTION ENTRANCE/EXIT

A. Description: The Work under this Contract Item includes furnishing all labor, materials, equipment and services for the installation, and maintenance of temporary construction Entrance/Exit Gates together with all associated, maintenance of traffic and traffic control personal (Flaggers) required for moving construction equipment in and out of each Entrance/Exit Gate shown and directed in the Contract Documents. Work also includes the removal of temporary construction gates at the end of construction.

B. Measurement for Payment: Measurement for payment for Temporary Construction Entrance/Exit will be made at the Contract unit price.

C. Payment: Payment for Temporary Construction Entrance/Exit Work will be paid by EACH for Option A Contract Item 3.

1.5 OPTION A - CONTRACT ITEM 4 - TEMPORARY SILT FENCE

A. Description: The Work under this Contract Item includes furnishing all labor, materials, equipment and services for the installation, and maintenance of temporary silt fence together with all associated and appurtenant Work as shown, specified and directed in the Contract Documents. Work also includes the removal of temporary silt fence at the end of construction.

B. Measurement for Payment: The quantities of Temporary Silt Fence in lineal feet, to be measured for payment under Option A Contract Item 4 will be the actual lineal feet of Temporary Silt Fence. Unauthorized additional Temporary Silt Fence will not be measured or paid for.

C. Payment: Payment for Temporary Silt Fence will be made at the Contract unit price per lineal foot for Option A Contract Item 4.

1.6 OPTION A - CONTRACT ITEM 5 – EAST BANK JUNCTION STRUCTURE

A. Description: Under the Contract Item for East Bank Junction Structure Work, furnish all labor, materials, equipment and services, and do all Work for the demolition, construction, and placing in trouble-free operation the East Bank

Junction Structure and all appurtenances. The Work includes providing all excavation support systems, protection of existing facilities and monitoring equipment, excavation of both earth and rock, dewatering facilities as required, concrete structure Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of East Bank Junction Structure will be made at the Contract unit price.

C. Payment: Payment for East Bank Junction Structure Work will be paid by EACH for Option A Contract Item 2.

1.7 OPTION A - CONTRACT ITEM 6 – WEST BANK JUNCTION STRUCTURE

A. Description: Under the Contract Item for West Bank Junction Structure Work, furnish all labor, materials, equipment and services, and do all Work for the demolition construction, maintenance, testing and placing in trouble-free operation the West Bank Junction Structure and all appurtenances. The Work includes excavation support system, protection of existing facilities and monitoring equipment, excavation of both earth and rock, dewatering facilities, as required, concrete structure Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of West Bank Junction Structure will be made at the Contract unit price.

C. Payment: Payment for West Bank Junction Structure Work will be paid by EACH for Option A Contract Item 6.

1.8 OPTION A - CONTRACT ITEM 7 – EAST BANK SITE IMPROVEMENTS

A. Description: Under the Contract Item for East Bank Site Improvements Work, furnish all labor, materials, equipment and services, and do all Work for Site improvements at the New East Bank Junction Structure. The Work includes new railing, new stairs and access gate, gravel, regrading, and restoring all disturbed areas back to existing, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Payment: Payment for East Bank Site Improvements Work will be paid by EACH for Option A Contract Item 7.

1.9 OPTION A - CONTRACT ITEM 8 – WEST BANK SITE IMPROVEMENTS

A. Description: Under the Contract Item for West Bank Site Improvements Work, furnish all labor, materials, equipment and services, and do all Work for Site

Improvements at the New West Bank Junction Structure. The Work includes restoring all disturbed areas back to existing, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of West Bank Site Improvements will be made at the Contract unit price.

C. Payment: Payment for West Bank Site Improvements Work will be paid by EACH for Option A Contract Item 8.

1.10 OPTION A - CONTRACT ITEM 9 – EAST BANK JUNCTION STRUCTURE – PRECAST CONCRETE SLAB

A. Description: Under the Contract Item for East Bank Junction Structure – Precast Concrete Slab Work, furnish all labor, materials, equipment and services, and do all Work for providing precast concrete slabs, access hatches, manhole frame and lids, and stop log covers for the new West Bank Junction Structure as shown and specified on the Contract Documents.

B. Payment: Payment for East Bank Junction Structure – Precast Concrete Slab Work will be paid by EACH for Option A Contract Item 9.

1.11 OPTION A - CONTRACT ITEM 10 – WEST BANK JUNCTION STRUCTURE – PRECAST CONCRETE SLAB

A. Description: Under the Contract Item for West Bank Junction Structure – Precast Concrete Slab Work, furnish all labor, materials, equipment and services, and do all Work for providing precast concrete slabs, access hatches, and stop log covers for the new West Bank Junction Structure as shown and specified on the Contract Documents.

B. Payment: Payment for West Bank Junction Structure – Precast Concrete Slab Work will be paid by EACH for Option A Contract Item 10.

1.12 OPTION A - CONTRACT ITEM 11 – STOP LOG – 32-INCH

A. Description: Under the Contract Item for Stop Log – 32-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 32-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 32-Inch Work will be paid by EACH for Option A Contract Item 11.

1.13 OPTION A - CONTRACT ITEM 12 – STOP LOG – 36-INCH

A. Description: Under the Contract Item for Stop Log – 36-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 36-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 36-Inch Work will be paid by EACH for Option A Contract Item 12.

1.14 OPTION A - CONTRACT ITEM 13 – STOP LOG – 46-INCH

A. Description: Under the Contract Item for Stop Log – 46-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 36-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 46-Inch Work will be paid by EACH for Option A Contract Item 13.

1.15 OPTION A - CONTRACT ITEM 14 – STOP LOG – 72-INCH

A. Description: Under the Contract Item for Stop Log – 72-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 72-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 72-Inch Work will be paid by EACH for Option A Contract Item 14.

1.16 OPTION A - CONTRACT ITEM 15 – BAR RACK

A. Description: Under the Contract Item Bar Rack Work, furnish all labor, materials, equipment and services, and do all Work for providing one Bar Rack with a width of 72-inches for the East Bank Junction Structure as shown and specified on the Contract Documents.

B. Payment: Payment for Bar Rack will be paid by EACH for Option A Contract Item 15.

1.17 OPTION A - CONTRACT ITEM 16 – BURIED 42-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (RIVER)

A. Description: Under the Contract Item for Buried 42-Inch CCFRPM Pipe (RIVER), furnish all labor, materials, equipment, and services to provide Buried 42-Inch CCFRPM Pipe as shown and specified. The Work includes protection of existing facilities, excavation of both earth and rock, installation of concrete encased pipe, placement of backfill, testing and placing the pipe in service. Cost associated to, mobilization and demobilization into the Arkansas River, construction of earthen berms, and dewatering the trench, if required, will be paid for under Option A Contract Items 23 and 24.

B. Measurement for Payment: The quantities of Buried 42-Inch CCFRPM Pipe (RIVER), in lineal feet, to be measured for payment under Option A Contract Item 16 will be the actual lineal feet of concrete encased pipe. Unauthorized additional concrete encased pipe will not be measured or paid for.

C. Payment: Payment for Buried 42-Inch CCFRPM Pipe (RIVER) will be made at the Contract unit price per lineal foot for Option A Contract Item 16.

1.18 OPTION A - CONTRACT ITEM 17 – BURIED 42-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (EAST AND WEST RIVER BANKS)

A. Description: Under the Contract Item for Buried 42-Inch CCFRPM Pipe (EAST AND WEST RIVER BANKS), furnish all labor, materials, equipment, and services to provide Buried 42-Inch CCFRPM Pipe as shown and specified. The Work includes erosion control measures, excavation support system, protection of existing facilities, excavation of both earth and rock, dewatering the trench, if required, installation of concrete encased pipe, placement of backfill, testing and placing the pipe in service.

B. Measurement for Payment: The quantities of Buried 42-Inch CCFRPM Pipe (EAST AND WEST RIVER BANKS), in lineal feet, to be measured for payment under Option A Contract Item 17 will be the actual lineal feet of concrete encased pipe. Unauthorized additional concrete encased pipe will not be measured or paid for.

C. Payment: Payment for Buried 42-Inch CCFRPM Pipe (EAST AND WEST RIVER BANKS) will be made at the Contract unit price per lineal foot for Option A Contract Item 17.

1.19 OPTION A - CONTRACT ITEM 18 – BURIED 42-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (PLANT)

A. Description: Under the Contract Item for Buried 42-Inch CCFRPM Pipe (PLANT), furnish all labor, materials, equipment, and services to provide Buried 42-Inch CCFRPM Pipe as shown and specified. The Work includes erosion control measures, excavation support system, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, placement of pipe bedding, placement of backfill, testing and placing the pipe in service.

B. Measurement for Payment: The quantities of Buried 42-Inch CCFRPM Pipe (PLANT), in lineal feet, to be measured for payment under Option A Contract Item 18 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 42-Inch CCFRPM Pipe (PLANT) will be made at the Contract unit price per lineal foot for Option A Contract Item 18.

1.20 OPTION A - CONTRACT ITEM 19 – BURIED 36-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (PLANT)

A. Description: Under the Contract Item for Buried 36-Inch CCFRPM (PLANT), furnish all labor, materials, equipment, and services to provide Buried 36-Inch CCFRPM Pipe as shown and specified. The Work includes erosion control measures, excavation support system, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, placement of pipe bedding, placement of backfill, modifications at the Influent Lift Station and upstream Manhole, temporary bypass pumping, testing and placing the pipe in service.

B. Measurement for Payment: The quantities of Buried 36-Inch CCFRPM Pipe (PLANT), in lineal feet, to be measured for payment under Option A Contract Item 19 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 36-Inch CCFRPM Pipe (PLANT) will be made at the Contract unit price per lineal foot for Option A Contract Item 19.

1.21 OPTION A - CONTRACT ITEM 20 – KING PILES

A. Description: Under the Contract Item for King Piles, furnish all labor, materials, equipment and services, and do all Work for installing King Piles for constructing the excavation support systems. The Work includes installing all King Piles required for constructing excavation support systems as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: The quantities of King Piles, in vertical feet, to be measured for payment under Option A Contract Item 20 will be the actual vertical feet of King Piles installed. Unauthorized additional King Piles will not be measured or paid for.

C. Payment: Payment for King Piles will be made at the Contract unit price per vertical foot for Option A Contract Item 20.

1.22 OPTION A - CONTRACT ITEM 21 – SHEET PILES

A. Description: Under the Contract Item for Sheet Piles, furnish all labor, materials, equipment and services, and do all Work for installing Sheet Piles for constructing the excavation support systems. The Work includes installing all Sheet Piles required for constructing excavation support systems as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: The quantities of Sheet Piles, in square feet, to be measured for payment under Option A Contract Item 21 will be the actual square feet of Sheet Piles installed. Unauthorized additional Sheet Piles will not be measured or paid for.

C. Payment: Payment for Sheet Piles will be made at the Contract unit price per vertical foot for Option A Contract Item 21.

1.23 OPTION A - CONTRACT ITEM 22 – CONSTRUCTION EQUIPMENT FOR WORK INSIDE RIVER

A. Description: Under the Contract Item for Construction Equipment for Work Inside River, furnish all necessary construction equipment to remain onsite for completing the work within the Arkansas River for Option A Contract Item 16.

B. Measurement for Payment: Measurement for payment of Construction Equipment for Work Inside River will be made at the Contract unit price.

A. Payment: Payment for Construction Equipment for Work Inside River will be made at the Contract unit price per month for Option A Contract Item 22.

1.24 OPTION A - CONTRACT ITEM 23 – DEWATERING FACILITIES FOR WORK INSIDE RIVER

A. Description: Under the Contract Item for Dewatering Facilities for Work Inside River, furnish all necessary dewatering equipment to remain onsite for completing the work within the Arkansas River for Option A Contract Item 16.

B. Measurement for Payment: Measurement for payment of Dewatering Facilities for Work Inside River will be made at the Contract unit price.

C. Payment: Payment for Dewatering Facilities for Work Inside River will be made at the Contract unit price per month for Option A Contract Item 23.

1.25 OPTION A - CONTRACT ITEM 24 – MOBILIZATION AND DEMOBILIZTION INTO RIVER

A. Description: Under the Contract Item for Mobilization and Demobilization into River, furnish all labor, materials, equipment, and services to construct and spread earthen berms for completing the work within the Arkansas River for Option A Contract Item 16.

B. Measurement for Payment: Measurement for payment of Mobilization and Demobilization into River will be made at the Contract unit price.

A. Payment: Payment for Mobilization and Demobilization into River Work will be paid by EACH for Option A Contract Item 24.

1.26 OPTION A - CONTRACT ITEM 25 – OWNER ALLOWANCE

A. Description: Under the Contract Item for OWNER Allowance provide all labor, material, equipment, and services to provide miscellaneous mechanical, electrical, plumbing, or other work that is not identified in the Construction Documents/Plans and which is authorized by the OWNER.

B. Payment: Payment of costs for labor, materials, equipment, services, and overhead and profit will be made in accordance with General Condition GC-26 Extra Work. Unauthorized additional OWNER work will not be measured or paid for.

1.27 OPTION A - ADDITIVE ALTERNATE CONTRACT ITEM 1 – DIVERSION VALVE VAULT

A. Description: Under the Contract Item for Diversion Valve Vault, furnish all labor, materials, equipment and services, and do all Work for the demolition, construction, and placing in trouble-free operation the Diversion Valve Vault and all appurtenances. The Work includes providing exploratory excavation such as potholing to locate buried pipelines, structure excavation, subgrade preparation, structure bedding, concrete, reinforcing steel, piping, valves, equipment, backfilling and compaction, electrical work, surface restoration and all other work required to complete the Diversion Valve Vaults as shown and specified in the Contract Documents up to and including a point five (5) feet outside the foundation of the structure.

B. Measurement for Payment: Measurement for payment of Diversion Valve Vault will be made at the Contract unit price.

C. Payment: Payment for Diversion Valve Vault Work will be paid by EACH for Option A Additive Alternate Contract Item 1.

1.28 OPTION A - ADDITIVE ALTERNATE CONTRACT ITEM 2 – DIVERSION HEADWALL CONNECTION

A. Description: Under the Contract Item for Diversion Headwall Connection, furnish all labor, materials, equipment and services, and do all Work for the demolition, construction, and placing in trouble-free operation the Diversion Headwall Connection. The Work includes demolition of existing Flow Equalization Basin 1, concrete, reinforcing steel, surface restoration and all other work required to complete the Diversion Headwall Connection as shown and specified in the Contract Documents up to and including a point five (5) feet outside the Flow Equalization Basin limits.

B. Measurement for Payment: Measurement for payment of Diversion Headwall Connection will be made at the Contract unit price.

C. Payment: Payment for Diversion Headwall Connection Work will be paid by EACH for Option A Additive Alternate Contract Item 2.

1.29 OPTION A - ADDITIVE ALTERNATE CONTRACT ITEM 3 – BURIED 36-INCH DIP

A. Description: Under the Contract Item for Buried 36-Inch DIP, furnish all labor, materials, equipment, and services to provide Buried 36-Inch Ductile Iron Pipe as shown and specified. The Work includes erosion control measures, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, PCCP to DI T-Fitting, restrained joints, placement of pipe bedding, placement of backfill, testing and placing the pipe in service. Road and Curb replacement will be paid for under Option A Additive Alternate Contract Items 7 and 9.

B. Measurement for Payment: The quantities of Buried 36-Inch DIP, in lineal feet, to be measured for payment under Option A Additive Alternate Contract Item 3 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 36-Inch DIP will be made at the Contract unit price per lineal foot for Option A Additive Alternate Contract Item 3.

1.30 OPTION A - ADDITIVE ALTERNATE CONTRACT ITEM 4 – BURIED 2-INCH PVC

A. Description: Under the Contract Item for Buried 2-Inch PVC, furnish all labor, materials, equipment, and services to provide Buried 36-Inch Polyvinyl Chloride Pipe as shown and specified. The Work includes erosion control measures, excavation of trench, dewatering the trench, if required, installation of pipe and

fittings, placement of pipe bedding, placement of backfill, testing and placing the pipe in service. Road and Curb replacement will be paid for under Option A Additive Alternate Contract Items 5 and 6.

B. Measurement for Payment: The quantities of Buried 2-Inch PVC, in lineal feet, to be measured for payment under Option A Additive Alternate Contract Item 4 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 2-Inch PVC will be made at the Contract unit price per lineal foot for Option A Additive Alternate Contract Item 4.

1.31 OPTION A - ADDITIVE ALTERNATE CONTRACT ITEM 5 – ROAD REPLACEMENTD

A. Description: Under the Contract Item for Road Replacement, furnish all labor, material, equipment, and services necessary to demolish existing paving and install new pavement as required for Option A Additive Alternate Contract Item 2. The Work includes protection of the structures and adjacent property, demolition of pavement, disposal of demolished pavement, appurtenant demolition Work, subgrade compaction, compacted aggregate base, pavement and appurtenant road Work. Excavation under demolished pavement will be paid for under Option A Additive Alternate Contract Item 3.

B. Measurement for Payment: The pay quantity of square foot will be computed using the standard pay width for the type of pavement replaced and the length of the pavement cut along the centerline of the pipe. Unauthorized additional New Road will not be measured or paid for.

C. Payment: Payment for this item shall be made at the unit price bid per square foot for Option A Additive Alternate Contract Item 5. No payment will be made for the replacement of pavement damaged by the Contractor's equipment movement. No payment will be made for joint sealer, tack coats, or edge sealing.

1.32 OPTION A - ADDITIVE ALTERNATE CONTRACT ITEM 6 – CURB REPLACEMENT

A. Description: Under the Contract Item for Curb Replacement, furnish all labor, material, equipment, and services necessary to demolish existing and construct New Concrete Curb as required for Option A Additive Alternate Contract Item 6. Replacement shall be made to the standards and specifications of the typical existing. The Work includes concrete curb, gutter and appurtenant Work.

B. Measurement for Payment: The quantities of Curb Replacement, in lineal feet, to be measured for payment under Option A Additive Alternate Contract Item 6 will be the actual lineal feet of concrete curb replaced. Unauthorized additional New Concrete Curb will not be measured or paid for.

C. Payment: Payment for Curb Replacement will be made at the Contract unit price per lineal foot for Option A Additive Alternate Contract Item 6.

1.33 OPTION B - CONTRACT ITEM 1 – PROJECT MOBILIZATION AND DEMOBILIZATION

A. Description: Under the Contract Item for Project Mobilization and Demobilization, furnish all labor, materials, equipment and services, and do all Work necessary to mobilize and subsequently demobilize the construction preparatory operations. The Work includes bonds, insurance, movement in and out of personnel and equipment, project signs, and establishment of the Contractor's and Engineer's offices. A maximum of 5 percent of the total bid for Contract Item 1 is allowed for Mobilization and Demobilization in the bid proposal.

B. Payment: Project Mobilization and Demobilization will be paid by EACH in the following manner:

1. Sixty percent (60%) of the price bid for mobilization and demobilization may be included in the pay estimate which reflects five percent (5%) completion of the Work.

2. An additional fifteen percent (15%) of the price bid for mobilization and demobilization may be included in the pay estimate which reflects fifty percent (50%) completion of the Work.

3. The final twenty five percent (25%) of the price bid for mobilization and demobilization may be included in the final pay estimate.

1.34 OPTION B - CONTRACT ITEM 2 - TEMPORARY CONSTRUCTION FENCE

A. Description: The Work under this Contract Item includes furnishing all labor, materials, equipment and services for the installation, and maintenance of temporary construction fence together with all associated and appurtenant Work as shown, specified and directed in the Contract Documents. Work also includes the removal of temporary construction and fence at the end of construction.

B. Measurement for Payment: The quantities of Temporary Construction Fence in lineal feet, to be measured for payment under Option B Contract Item 2 will be the actual lineal feet of Temporary Construction Fence. Unauthorized additional Temporary Construction Fence will not be measured or paid for.

C. Payment: Payment for Temporary Construction Fence will be made at the Contract unit price per lineal foot for Option B Contract Item 2.

1.35 OPTION B - CONTRACT ITEM 3 - TEMPORARY CONSTRUCTION ENTRANCE/EXIT

A. Description: The Work under this Contract Item includes furnishing all labor, materials, equipment and services for the installation, and maintenance of temporary construction Entrance/Exit Gates together with all associated, maintenance of traffic and traffic control personal (Flaggers) required for moving construction equipment in and out of each Entrance/Exit Gate shown and directed in the Contract Documents. Work also includes the removal of temporary construction gates at the end of construction.

B. Measurement for Payment: Measurement for payment for Temporary Construction Entrance/Exit will be made at the Contract unit price.

C. Payment: Payment for Temporary Construction Entrance/Exit Work will be paid by EACH for Option B Contract Item 3.

1.36 OPTION B - CONTRACT ITEM 4 - TEMPORARY SILT FENCE

A. Description: The Work under this Contract Item includes furnishing all labor, materials, equipment and services for the installation, and maintenance of temporary silt fence together with all associated and appurtenant Work as shown, specified and directed in the Contract Documents. Work also includes the removal of temporary silt fence at the end of construction.

B. Measurement for Payment: The quantities of Temporary Silt Fence in lineal feet, to be measured for payment under Option B Contract Item 4 will be the actual lineal feet of Temporary Silt Fence. Unauthorized additional Temporary Silt Fence will not be measured or paid for.

C. Payment: Payment for Temporary Silt Fence will be made at the Contract unit price per lineal foot for Option B Contract Item 4.

1.37 OPTION B - CONTRACT ITEM 5 – EAST BANK JUNCTION STRUCTURE

A. Description: Under the Contract Item for East Bank Junction Structure Work furnish all labor, materials, equipment and services, and do all Work for the demolition, construction, and placing in trouble-free operation the East Bank Junction Structure and all appurtenances. The Work includes providing all excavation support systems, protection of existing facilities and monitoring equipment, excavation of both earth and rock, dewatering facilities as required, concrete structure Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of East Bank Junction Structure will be made at the Contract unit price.

C. Payment: Payment for East Bank Junction Structure Work will be paid by EACH for Option B Contract Item 5.

1.38 OPTION B - CONTRACT ITEM 6 – WEST BANK JUNCTION STRUCTURE

A. Description: Under the Contract Item for West Bank Junction Structure Work furnish all labor, materials, equipment and services, and do all Work for the demolition construction, maintenance, testing and placing in trouble-free operation the West Bank Junction Structure. The Work includes excavation support system, protection of existing facilities and monitoring equipment, excavation of both earth and rock, dewatering facilities as required, concrete structure Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of West Bank Junction Structure will be made at the Contract unit price.

C. Payment: Payment for West Bank Junction Structure Work will be paid by EACH for Option B Contract Item 6.

1.39 OPTION B - CONTRACT ITEM 7 – EAST BANK SITE IMPROVEMENTS

A. Description: Under the Contract Item for East Bank Site Improvements Work furnish all labor, materials, equipment and services, and do all Work for Site improvements at the New East Bank Junction Structure. The Work includes new railing, new stairs and access gate, gravel, regrading, and restoring all disturbed areas back to existing, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of East Bank Site Improvements will be made at the Contract unit price.

C. Payment: Payment for East Bank Site Improvements Work will paid by EACH for Option B Contract Item 7.

1.40 OPTION B - CONTRACT ITEM 8 – WEST BANK SITE IMPROVEMENTS

A. Description: Under the Contract Item for West Bank Site Improvements Work furnish all labor, materials, equipment and services, and do all Work for Site improvements at the New West Bank Junction Structure. The Work includes restoring all disturbed area back to existing, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of West Bank Site Improvements will be made at the Contract unit price.

C. Payment: Payment for West Bank Site Improvements Work will paid by EACH for Option B Contract Item 8.

1.41 OPTION B - CONTRACT ITEM 9 – EAST BANK JUNCTION STRUCTURE – PRECAST CONCRETE SLAB

A. Description: Under the Contract Item for East Bank Junction Structure – Precast Concrete Slab Work, furnish all labor, materials, equipment and services, and do all Work for providing precast concrete slabs, access hatches, manhole frame and lids, and stop log covers for the new West Bank Junction Structure as shown and specified on the Contract Documents.

B. Payment: Payment for East Bank Junction Structure – Precast Concrete Slab Work will be paid by EACH for Option B Contract Item 9.

1.42 OPTION B - CONTRACT ITEM 10 – WEST BANK JUNCTION STRUCTURE – PRECAST CONCRETE SLAB

A. Description: Under the Contract Item for West Bank Junction Structure – Precast Concrete Slab Work, furnish all labor, materials, equipment and services, and do all Work for providing precast concrete slabs, access hatches, and stop log covers for the new West Bank Junction Structure as shown and specified on the Contract Documents.

B. Payment: Payment for West Bank Junction Structure – Precast Concrete Slab Work will be paid by EACH for Option B Contract Item 10.

1.43 OPTION B - CONTRACT ITEM 11 – STOP LOG – 32-INCH

A. Description: Under the Contract Item for Stop Log – 32-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 32-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 32-Inch Work will be paid by EACH for Option B Contract Item 11.

1.44 OPTION B - CONTRACT ITEM 12 – STOP LOG – 36-INCH

A. Description: Under the Contract Item for Stop Log – 36-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 36-inches for both the East and

West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 36-Inch Work will be paid by EACH for Option B Contract Item 12.

1.45 OPTION B - CONTRACT ITEM 13 – STOP LOG – 46-INCH

A. Description: Under the Contract Item for Stop Log – 46-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 36-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 46-Inch Work will be paid by EACH for Option B Contract Item 13.

1.46 OPTION B - CONTRACT ITEM 14 – STOP LOG – 72-INCH

A. Description: Under the Contract Item for Stop Log – 72-Inch Work, furnish all labor, materials, equipment and services, and do all Work for providing stop logs and associated lifting mechanism with a width of 72-inches for both the East and West Bank Junction Structures as shown and specified on the Contract Documents.

B. Payment: Payment for Stop Logs – 72-Inch Work will be paid by EACH for Option B Contract Item 14.

1.47 OPTION B - CONTRACT ITEM 15 – BAR RACK

A. Description: Under the Contract Item Bar Rack Work, furnish all labor, materials, equipment and services, and do all Work for providing one Bar Rack with a width of 72-inches for the East Bank Junction Structure as shown and specified on the Contract Documents.

B. Payment: Payment for Bar Rack will be paid by EACH for Option B Contract Item 15.

1.48 OPTION B - CONTRACT ITEM 16 – RECEIVING SHAFT

A. Description: Under the Contract Item Receiving Shaft furnish all labor, materials, equipment and services, and do all Work for constructing the Receiving Shaft for installing the New 42-Inch CCFRPM pipe (RIVER) as specified and shown. The Work includes protection of existing facilities, excavation of rock, dewatering the receiving shaft, if required, as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of Receiving Shaft will be made at the Contract unit price.

C. Payment: Payment for Receiving Shaft will be paid by EACH for Option B Contract Item 16.

1.49 OPTION B - CONTRACT ITEM 17 – JACKING SHAFT

A. Description: Under the Contract Item Jacking Shaft furnish all labor, materials, equipment and services, and do all Work for constructing the Jacking Shaft for installing the New 42-Inch CCFRPM pipe (RIVER) as specified and shown. The Work includes protection of existing facilities, excavation of rock, dewatering the jacking shaft, if required, as shown and specified, except for Work specifically included under the other Contract Items.

B. Measurement for Payment: Measurement for payment of Jacking Shaft will be made at the Contract unit price.

C. Payment: Payment for Receiving Shaft will be paid by EACH for Option B Contract Item 17.

1.50 OPTION B - CONTRACT ITEM 18 – MOBILIZE AND SETUP MTBM EQUIPMENT

A. Description: Under the Contract Item Mobilize and Setup MTBM Equipment furnish all labor, materials, equipment and services, and do all Work for mobilizing and setting up the MTBM onsite for installing the New 42-Inch CCFRPM pipe (RIVER) as specified and shown.

B. Measurement for Payment: Measurement for payment of Mobilize and Setup MTBM Equipment will be made at the Contract unit price.

C. Payment: Payment for Mobilize and Setup MTBM Equipment will be paid by EACH for Option B Contract Item 18.

1.51 OPTION B - CONTRACT ITEM 19 – REMOVE MTBM EQUIPMENT

A. Description: Under the Contract Item Remove MTBM Equipment furnish all labor, materials, equipment and services, and do all Work for removing the MTBM Equipment offsite as specified and shown.

B. Measurement for Payment: Measurement for payment of Remove MTBM Equipment will be made at the Contract unit price.

C. Payment: Payment for Remove MTBM Equipment will be paid by EACH for Option B Contract Item 19.

1.52 OPTION B - CONTRACT ITEM 20 – BURIED 42-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (RIVER)

A. Description: Under the Contract Item for Buried 42-Inch CCFRPM Pipe (RIVER), furnish all labor, materials, equipment, and services to provide Buried 42-Inch CCFRPM Pipe as shown and specified. The Work includes protection of existing facilities, and installing the pipe by means of microtunneling. Cost associated to, mobilizing, setting up and removing the MTBM equipment, constructing the Receiving Pit and Jacking Pit will be paid for under Option B Contract Items 17,18, and 19.

B. Measurement for Payment: The quantities of Buried 42-Inch CCFRPM Pipe (RIVER), in lineal feet, to be measured for payment under Option B Contract Item 20 will be the actual lineal feet of concrete encased pipe. Unauthorized additional concrete encased pipe will not be measured or paid for.

C. Payment: Payment for Buried 42-Inch CCFRPM Pipe (RIVER) will be made at the Contract unit price per lineal foot for Option B Contract Item 20.

1.53 OPTION B - CONTRACT ITEM 21 – BURIED 42-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (PLANT)

A. Description: Under the Contract Item for Buried 42-Inch CCFRPM Pipe (PLANT), furnish all labor, materials, equipment, and services to provide Buried 42-Inch CCFRPM Pipe as shown and specified. The Work includes erosion control measures, excavation support system, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, placement of pipe bedding, placement of backfill, testing and placing the pipe in service.

B. Measurement for Payment: The quantities of Buried 42-Inch CCFRPM Pipe (PLANT), in lineal feet, to be measured for payment under Option B Contract Item 21 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 42-Inch CCFRPM Pipe (PLANT) will be made at the Contract unit price per lineal foot for Option B Contract Item 21.

1.54 OPTION B - CONTRACT ITEM 22 – BURIED 36-INCH CENTRIGUALLY CAST, FIBERFLASS-REINFORCED POLYMER MORTAR (CFRPM) PIPE (PLANT)

A. Description: Under the Contract Item for Buried 36-Inch CCFRPM Pipe (PLANT), furnish all labor, materials, equipment, and services to provide Buried 36-Inch CCFRPM Pipe as shown and specified. The Work includes erosion control

measures, excavation support system, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, placement of pipe bedding, placement of backfill, modifications at the Influent Lift Station and upstream Manhole, temporary bypass pumping, testing and placing the pipe in service.

B. Measurement for Payment: The quantities of Buried 36-Inch CFRPM Pipe (PLANT), in lineal feet, to be measured for payment under Option B Contract Item 22 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 36-Inch CCFRPM Pipe (PLANT) will be made at the Contract unit price per lineal foot for Option B Contract Item 22.

1.55 OPTION B - CONTRACT ITEM 23 – OWNER ALLOWANCE

A. Description: Under the Contract Item for OWNER Allowance provide all labor, material, equipment, and services to provide miscellaneous mechanical, electrical, plumbing, or other work that is not identified in the Construction Documents/Plans and which is authorized by the OWNER.

B. Payment: Payment of costs for labor, materials, equipment, services, and overhead and profit will be made in accordance with General Condition GC-26 Extra Work. Unauthorized additional OWNER work will not be measured or paid for.

1.56 OPTION B - ADDITIVE ALTERNATE CONTRACT ITEM 1 – DIVERSION VALVE VAULT

A. Description: Under the Contract Item for Diversion Valve Vault, furnish all labor, materials, equipment and services, and do all Work for the demolition, construction, and placing in trouble-free operation the Diversion Valve Vault and all appurtenances. The Work includes providing exploratory excavation such as potholing to locate buried pipelines, structure excavation, subgrade preparation, structure bedding, concrete, reinforcing steel, piping, valves, equipment, backfilling and compaction, electrical work, surface restoration and all other work required to complete the Diversion Valve Vaults as shown and specified in the Contract Documents up to and including a point five (5) feet outside the foundation of the structure.

B. Measurement for Payment: Measurement for payment of Diversion Valve Vault will be made at the Contract unit price.

C. Payment: Payment for Diversion Valve Vault Work will be paid by EACH for Option B Additive Alternate Contract Item 1.

1.57 OPTION B - ADDITIVE ALTERNATE CONTRACT ITEM 2 – DIVERSION HEADWALL CONNECTION

A. Description: Under the Contract Item for Diversion Headwall Connection, furnish all labor, materials, equipment and services, and do all Work for the demolition, construction, and placing in trouble-free operation the Diversion Headwall Connection. The Work includes demolition of existing Flow Equalization Basin 1, concrete, reinforcing steel, surface restoration and all other work required to complete the Diversion Headwall Connection as shown and specified in the Contract Documents up to and including a point five (5) feet outside the Flow Equalization Basin limits.

B. Measurement for Payment: Measurement for payment of Diversion Headwall Connection will be made at the Contract unit price.

C. Payment: Payment for Diversion Headwall Connection Work will be paid by EACH for Option B Additive Alternate Contract Item 2.

1.58 OPTION B - ADDITIVE ALTERNATE CONTRACT ITEM 3 – BURIED 36-INCH DIP

A. Description: Under the Contract Item for Buried 36-Inch DIP, furnish all labor, materials, equipment, and services to provide Buried 36-Inch Ductile Iron Pipe as shown and specified. The Work includes erosion control measures, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, restrained joints, placement of pipe bedding, placement of backfill, testing and placing the pipe in service. Road and Curb replacement will be paid for under Option B Additive Alternate Contract Items 7 and 9.

B. Measurement for Payment: The quantities of Buried 36-Inch DIP, in lineal feet, to be measured for payment under Option B Additive Alternate Contract Item 3 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 36-Inch DIP will be made at the Contract unit price per lineal foot for Option B Additive Alternate Contract Item 3.

1.59 OPTION B - ADDITIVE ALTERNATE CONTRACT ITEM 4 – BURIED 2-INCH PVC

A. Description: Under the Contract Item for Buried 2-Inch PVC, furnish all labor, materials, equipment, and services to provide Buried 36-Inch Polyvinyl Chloride Pipe as shown and specified. The Work includes erosion control measures, excavation of trench, dewatering the trench, if required, installation of pipe and fittings, placement of pipe bedding, placement of backfill, testing and placing the pipe in service. Road and Curb replacement will be paid for under Option B Additive Alternate Contract Items 5 and 6.

B. Measurement for Payment: The quantities of Buried 2-Inch PVC, in lineal feet, to be measured for payment under Option B Additive Alternate Contract Item 4 will be the actual lineal feet of pipe. Unauthorized additional pipe will not be measured or paid for.

C. Payment: Payment for Buried 2-Inch PVC will be made at the Contract unit price per lineal foot for Option B Additive Alternate Contract Item 4.

1.60 OPTION B - ADDITIVE ALTERNATE CONTRACT ITEM 5 – ROAD REPLACEMENTD

A. Description: Under the Contract Item for Road Replacement, furnish all labor, material, equipment, and services necessary to demolish existing paving and install new pavement as required for Option B Additive Alternate Contract Item 2. The Work includes protection of the structures and adjacent property, demolition of pavement, disposal of demolished pavement, appurtenant demolition Work, subgrade compaction, compacted aggregate base, pavement and appurtenant road Work. Excavation under demolished pavement will be paid for under Option B Additive Alternate Contract Item 3.

B. Measurement for Payment: The pay quantity of square foot will be computed using the standard pay width for the type of pavement replaced and the length of the pavement cut along the centerline of the pipe. Unauthorized additional New Road will not be measured or paid for.

C. Payment: Payment for this item shall be made at the unit price bid per square foot for Option B Additive Alternate Contract Item 5. No payment will be made for the replacement of pavement damaged by the Contractor's equipment movement. No payment will be made for joint sealer, tack coats, or edge sealing.

1.61 OPTION B - ADDITIVE ALTERNATE CONTRACT ITEM 6 – CURB REPLACEMENT

A. Description: Under the Contract Item for Curb Replacement, furnish all labor, material, equipment, and services necessary to demolish existing and construct New Concrete Curb as required for Option B Additive Alternate Contract Item 6. Replacement shall be made to the standards and specifications of the typical existing. The Work includes concrete curb, gutter and appurtenant Work.

B. Measurement for Payment: The quantities of Curb Replacement, in lineal feet, to be measured for payment under Option B Additive Alternate Contract Item 6 will be the actual lineal feet of concrete curb replaced. Unauthorized additional New Concrete Curb will not be measured or paid for.

C. Payment: Payment for Curb Replacement will be made at the Contract unit price per lineal foot for Option B Additive Alternate Contract Item 6.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 31 00

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination

B. Preconstruction Conference

C. Progress Meetings

1.2 COORDINATION

A. General: Coordinate scheduling, submittals, and Contract work to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Accessory Placement: Place conduits, saddles, boxes, cabinets, sleeves, inserts, foundation bolts, anchors and other like work in floors, roofs or walls of buildings and structures in conformity with the construction program.

1.3 PRECONSTRUCTION CONFERENCE

A. General: Prior to commencement of the Work, in accordance with the General Conditions, the OWNER will conduct a preconstruction conference to be held at a predetermined time and place.

B. Delineation of Responsibilities: The purpose of the conference is to designate responsible personnel, to establish a working relationship among the parties and to identify the responsibilities of the OWNER, ENGINEER and the CONTRACTOR. Matters requiring coordination will be discussed and procedures for handling such matters, established. The agenda will include:

1. Submittal procedures
2. Partial Payment procedures
3. Maintenance of Records
4. Schedules, sequences and maintenance of facility operations
5. Safety and First Aid responsibilities
6. Change Orders
7. Use of site
8. Housekeeping
9. Equipment delivery

C. Attendees: The preconstruction conference is to be attended by the representatives of the CONTRACTOR, the OWNER and the ENGINEER who will be associated with the project. Representatives of regulatory agencies, subcontractors, and principal suppliers may also attend when appropriate.

D. Chair and Minutes: The preconstruction conference will be chaired by the OWNER who will also arrange for the keeping and distribution of minutes to all attendees.

1.4 PROGRESS MEETINGS

A. Meeting Frequency and Format: Schedule progress meetings on at least a monthly basis or more frequently as warranted by the complexity of the Project, to review the Work, discuss changes in schedules, maintain coordination and resolve potential problems. Invite OWNER, ENGINEER and all subcontractors. Suppliers may be invited as appropriate. Meeting notes will be prepared by ENGINEER who will distribute the notes to attendees within 10 calendar days after each meeting. Meeting notes will summarize meeting highlights.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 32 16

PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Form of Schedules

B. Content of Schedules: Submit for approval, a preliminary progress schedule in duplicate, in accordance with the General Conditions.

C. Schedule Revisions

D. Submittal Requirements

1.2 FORM OF SCHEDULES

A. Prepare schedules in form of a horizontal bar chart.

1. Provide separate horizontal bar for each trade or operation.

2. Utilize a horizontal time scale and identify first work day of each week.

3. Utilize scale and spacings to allow space for notations and future revisions.

B. Utilize a listing format which chronologically indicates the order of start of each item of work.

C. Identify each listing by major specification section numbers.

1.3 CONTENT OF SCHEDULES

A. Completion Dates: Show the beginning and ending contract dates stated in documents. Schedules showing completion prior to the contract completion date will be accepted but in no event will they be considered basis for a claim for delay against the OWNER by the CONTRACTOR for the period between the early completion date and the completion date provided in the Contract Documents.

B. Show complete sequence of construction by activity. Coordinate CONTRACTORS project schedule with the final accepted schedule of values.

C. Show dates for beginning and completion of each major element of construction and installation dates for major items of equipment. Elements shall include, but not be limited to, the following:

1. Shop drawing receipt from supplier/manufacturer submitted to ENGINEER, review and return to supplier/manufacturer

2. Material and equipment order, manufacturer, delivery, installation, and checkouts

3. Performance tests and supervisory services activity

4. Demolition

5. Excavation, sheeting, shoring, dewatering

6. Construction of various facilities

7. Piping and equipment installation

8. Warranty Log

9. Electrical work activity

10. Heating, ventilating, and air conditioning work activity

11. Plumbing work activity

12. Miscellaneous concrete placement

13. Subcontractor's items of work

14. Backfilling, grading, seeding, sodding, landscaping, fence construction, and paving

15. Final cleanup

16. Allowance for inclement weather

17. Coordination with concurrent Work on site

D. Show projected percentage of completion for each item as of first day of each month.

1.4 SCHEDULE REVISIONS

A. As a minimum, revise construction schedule every 30 calendar days to reflect changes in progress of Work for duration of Contract.

B. Indicate progress of each activity at date of submittal.

C. Show changes occurring since previous submittal of schedule.

1. Major change in scope
2. Activities modified since previous submittal
3. Revised projections of progress and completion
4. Other identifiable changes

D. Provide a written report as needed to define:

1. Problem areas, anticipated delays, and impact on schedule
2. Corrective action recommended and its effect
3. Effect of changes on schedules of other Contractors

1.5 SUBMITTAL REQUIREMENTS

A. Schedule: Submit final progress schedule in accordance with "General Conditions".

B. For preliminary and final submittal of construction progress schedule and subsequent revisions thereof, furnish three copies to ENGINEER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 33 00

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description

B. Definitions

C. Submittal Procedures

D. ENGINEER'S Actions on Submittals

E. Repetitive Reviews

F. Example Format for CONTRACTOR's Approval and Certification Stamp

G. CONTRACTOR's Submittal Transmittal Form

1.2 DESCRIPTION

A. This Section specifies procedural requirements for submittals made by the CONTRACTOR to the ENGINEER. Specific submittals required for individual elements of the Work are specified in the associated, individual Specification Sections. Except as otherwise indicated in other Specification Sections, comply with the requirements specified herein for each type of submittal.

1.3 DEFINITIONS

A. Shop Drawings: The term "Shop Drawings", as used in the General Conditions includes all "Action Submittals" and "Information Submittals" as defined below.

B. Action Submittals: The following submittals require approval by the ENGINEER as described in Subsection 3.2 of this Section:

1. Manufacturer's Documents: Technical data, detailed drawings and other similar information specially prepared for this Project by product manufacturers and suppliers, including fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports, instructions, design mix formulas, measurements, and similar information not in standard printed form.

2. Product Data: Stock or standard printed information on materials and equipment that has not been specially prepared for this Project, including specifications, installation instructions, catalog cuts, wiring diagrams, and color charts.

3. Working Drawings: Technical data, drawings and other similar information specially prepared for this Project by the CONTRACTOR or Subcontractors, including fabrication and installation drawings, diagrams, and other similar information.

4. 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.

5. Mock-Ups: Special types of samples that are too large or otherwise inconvenient for handling in the manner specified for transmittal of sample submittals.

6. "Or Equal" or Substitution Requests: Wherever a proprietary item is identified by the product, manufacturer or supplier name and/or model number, an “Or Equal” (“equal to” or “equivalent”) item may be submitted unless the description of the item contains a prohibition against an ”Or Equal”.

    a. An item may be determined “Or Equal” only at the sole discretion of the ENGINEER, based upon the following criteria:

        (1) The item is equal in quality, durability, appearance, strength, and design characteristics.

        (2) The item will perform to meet the design concept.

        (3) No changes to other work will be required to accommodate the item.

        (4) No addition to the Contract Price or Contract Times will be required as a result of the use of the item.

        (5) OWNER will not incur any additional cost as a result of the use of the item.

    a. If the ENGINEER, at its sole discretion, determines that a proposed item is not an “Or Equal”, the proposed item may be considered as a “Substitute” item.

C. Information Submittals: The following submittals require acknowledgement by the ENGINEER as described in Subsection 3.2 of this Section:

1. CONTRACTOR's Licensed Professional Submittals: Certificates and other documents required by the Contract Documents to be prepared and submitted by the CONTRACTOR's Licensed Professionals.

2. Inspection and Test Reports

3. Mill reports

4. Guarantees

5. Warranties - Prior to the warranty start date of each piece of equipment, provide the OWNER with a Warranty Log (see sample form) including actual dates of the manufacturer's start up services, Operations and Maintenance manual approval, request for approval and approval receipt. On a monthly basis, furnish to the OWNER an updated Warranty Log. Distribute copies at Progress Meetings.

6. Certifications, including letter from manufacture certifying the installer as qualified to install the manufacturer's products.

7. Experience records

8. Maintenance agreements

9. Operation and maintenance manuals

10. Survey data and reports: property surveys, building or structure condition surveys, field measurements, quantitative records of actual Work, damage surveys, photographs, and similar data required by Specification sections.

11. Physical work records

12. Quality testing and certifying reports

13. Industry standards

14. Record drawings

D. Other Submittals: For submittals concerning the following refer to the indicated Contract Document Section:

1. Listing of manufacturers – Section 01 60 00

2. Suppliers, and subcontractors -Article 6.06 of the General and Supplementary Conditions

3. Construction progress schedule – Section 01 32 16 or 01 32 17

4. Warranty Log – Section 01 33 00

5. Schedule of shop drawing submissions - Article 2.05 of the General and Supplementary Conditions.

6. Bonds – Article 12 of the General and Supplementary Conditions

7. Schedule of values – Section 01 29 00

8. Payment applications– Section 01 29 00

9. Insurance certificates - Article 12 of the General and Supplementary Conditions

E. Clarifications and Interpretations: Refer to the General Conditions

1. The CONTRACTOR is responsible to review the Contract Documents, determine the type and extent of the Work and make all necessary field measurements before starting the Work. If any conflict, error, ambiguity, or discrepancy is discovered the CONTRACTOR is to submit a written request for interpretation or clarification from ENGINEER. The ENGINEER will issue a written clarification or interpretation of the requirements of the Contract Documents as ENGINEER may determine necessary, consistent with the intent of and reasonably inferable from the Contract Documents. Such written clarifications and interpretations will be binding on the CONTRACTOR.

2. If the CONTRACTOR submits a written request for information that does not, in the sole discretion of the ENGINEER, require clarification or interpretation of the Contract Documents, ENGINEER will notify CONTRACTOR that such information is contained (or could otherwise be reasonably determined) in the Contract Documents. The CONTRACTOR shall reimburse OWNER for ENGINEER's charges for evaluating and responding to such a request for information.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 SUBMITTAL PROCEDURES

A. Scheduling:

1. Submit, for approval by the ENGINEER, a preliminary schedule of submittals, in duplicate, within 15 calendar days after the starting date of the contract. ENGINEER will review no submittals until an acceptable schedule of submittals has been submitted. If the CONTRACTOR intends to request a substitute(s) for the materials or equipment specified, schedule substitution request(s), along with any related, subsequent submittals, in the schedule of submittals and submit as scheduled.

2. Schedule, prepare and transmit each submittal to ENGINEER sufficiently in advance of scheduled performance of related Work and other applicable activities.

B. Coordination:

1. Coordinate the preparation and processing of submittals with the performance of the Work. Coordinate each submittal with other submittals and related activities, such as substitution requests, testing, purchasing, fabrication, delivery, and similar activities that require sequential performance. Coordinate submissions for different items of interrelated work so that one submittal will not be delayed by ENGINEER's need to review a related submittal.

2. ENGINEER may return any submittal requiring coordination with other submittals without review and marked “Revise and Resubmit”. This type of returned submittal will be counted as a submittal subject to the provisions of 3.3 –REPETITIVE REVIEWS of this Section.

3. The ENGINEER will not hold a submittal awaiting additional information from the CONTRACTOR.

C. Submittal Preparation:

1. All Submittals: Review each submittal to determine, as applicable, that:

a. The submittal is required by the Contract Documents. The ENGINEER will only review submittals required by the Contract Documents.

b. The materials and equipment depicted in the submittal are intended for incorporation into the Work.

c. The submittal is complete and in sufficient detail to allow ready determination of compliance with the Contract Documents.

d. The items depicted in the submittal will fit in the space available.

e. The information in the submittal has been coordinated with the requirements of the Contract Documents; work to be performed by all trades involved; field measurements and other requirements of the Work.

f. The submittal does not contain standard printed information unless full identification of the project-specific portions and any project-specific supplementary information is shown thereon in ink or typewritten form.

g. The submittal does not encompass more than one Section of the Specifications.

h. The submittal presents, where applicable, such data as dimensions, weights, and performance characteristics on drawings for mechanical and electrical equipment. Show conformance with the performance characteristics and other criteria included in the Contract Documents.

i. Variations from the Contract Documents have been specifically noted on the Submittal Transmittal Form and highlighted on all relative documents within the submittal that are affected by the variation.

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

(2) ENGINEER's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each such variation at the time of each submittal as required by paragraph (1) above and ENGINEER has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample approval; nor will any approval by ENGINEER relieve CONTRACTOR from

responsibility for complying with the requirements of the Contract.

j. The submittal is in compliance with the Contract Documents and a completed approval and certification stamp has been placed on each submittal document. Use a rubber stamp containing the information shown in the sample stamp at the end of this section. ENGINEER will rely upon CONTRACTOR's certification of compliance that the CONTRACTOR has reviewed and approved the submittal and has confirmed that the submittal conforms to all the requirements of the Contract Documents except for variations specifically noted on the Submittal Transmittal Form and all attached documents. Submittals will be returned to CONTRACTOR without action if certification is not provided and the submittal will be counted as a submittal subject to the provisions of 3.3 –REPETITIVE REVIEWS of this Section.

2. Manufacturer's Documents and Working Drawing submittals:

a. Accurately and distinctly present the following:

(1) Graphical information at accurate scale

(2) Name, address and telephone number of manufacturer or supplier

(3) Materials and equipment that are to be included in the Work

(4) Compliance with standards

(5) All dimensions, clearly identifying those dimensions based on field measurement

(6) Arrangements and sectional views

(7) Necessary details, including complete information on making connections between Work in this project, work in other related projects and existing facilities

(8) Electrical wiring connections between all equipment provided including all internal wiring between internal components of equipment

(9) Kinds of materials and finishes

(10) Parts list and descriptions thereof

(11) Spare parts, lubricants or special tools required by the Contract Documents

b. Include the following on each drawing or page:

(1) Preparation date and revision dates

(2) Project name

(3) Specification Section number and page number

(4) Identification of equipment or materials

(5) Name of CONTRACTOR (and Subcontractor if applicable)

(6) Name of Supplier and/or Manufacturer

(7) Field dimensions, clearly identified

(8) Standards or industry specification references

(9) Identification of variations from the Contract Document requirements

(10) Physical location and location relative to other facilities that the Work-related equipment or materials are to be installed adjacent to or connected with

(11) Provide 8-inch wide by 3-inch high blank space for CONTRACTOR's and ENGINEER's stamps

c. Transmit all submittals electronically in pdf format, unless specifically requested for prints. Submittals will be returned with review comments electronically.

3. Product Data:

a. Assemble all data into a single submittal for each element of work or system. Where product data has been printed to include information on several similar products, some of which are not required for use on the subject Project, clearly mark copies to show such information is not applicable.

b. Where data must be specially prepared for required materials or equipment because standard printed data are not suitable for use, submit the data as a Manufacturer's Document and not as Product Data.

c. Submit product data with appropriate Manufacturer's Document or Working Drawing, when applicable.

d. Submit an electronic copy.

4. Samples:

a. Whenever possible, provide samples physically identical with the materials proposed for incorporation into the Work. Where variations in color, pattern or texture and the like are inherent in materials represented by samples, submit multiple samples (not less than 3) showing the approximate range of variations.

b. Submit samples for visual review of generic kind, color, pattern, texture, and for a final check of coordination of these characteristics with other related elements of the Work and existing facilities.

c. Include information with each sample to provide a generic description of the item, and its name, manufacturer, limitations, and compliance with standards.

d. Submit 3 sets of samples, where specifications indicate selection of color, pattern, texture or similar characteristics from manufacturer's range of standard choices is necessary.

5. Mock-Ups:

a. Mock-ups and similar samples are recognized as special types of samples. Comply with samples submittal requirements to the greatest extent possible. Process Submittal Transmittal Forms to provide a record of activity.

6. Requests for "Or Equal" or Substitution

a. ENGINEER will, at its sole discretion, determine if the item is "Or Equal" or an acceptable Substitution. Prepare submittals as described above. CONTRACTOR shall reimburse OWNER for ENGINEER's Charges for evaluating a proposed "Or Equal" submittal that receives a negative determination. CONTRACTOR shall reimburse OWNER for ENGINEER's charges for evaluating a proposed Substitution, whether or not a positive determination is made or the CONTRACTOR withdraws the request for Substitution, and for changes resulting from an approved Substitution.

b. For Substitution Requests submit sufficient written information including the following:

(1) Certify that the proposed Substitution is functionally equivalent to the specified item and its performance characteristics, when it is incorporated into the Work, will be equivalent to the specified item.

(2) State the extent, if any, to which the use of the proposed Substitution will affect the performance of the construction work and/or the characteristics of the completed work.

(3) Describe all differences between the proposed Substitution and the specified item.

(4) Describe the sources of supplies, replacement parts, repair services and technical support.

(5) Provide an itemized estimate of all costs or credits directly or indirectly attributable to the use of such Substitution, including redesign engineering, construction and energy costs.

(6) Furnish additional information as requested by the ENGINEER.

(7) CONTRACTOR may be required to furnish a guarantee or other surety for any Substitution at no addition to the Contract Time or Price.

c. Substitute means, methods, techniques, sequences, or procedures of construction may be used in place of those required by the Contract Documents if approved by ENGINEER, at ENGINEER's sole discretion. Follow the procedure described in b. above, submitting appropriate information.

d. Provide sufficient time for ENGINEER to evaluate each "Or Equal" and Substitution Request. Do not order, install or utilize any "Or-Equal" or Substitution until ENGINEER's determination is complete. ENGINEER's approval will be in the form of an approved submittal for an "Or Equal" item or in the form of a Change Order for a Substitution. CONTRACTOR will be advised in writing of any negative determination.

e. Provide all information and documents in support of any proposed "Or-Equal" or Substitution at no addition to the Contract Times or Price.

7. CONTRACTOR's Licensed Professional Submittals

a. Submit electronic copies of certificates and other documents required by the Contract Documents to be prepared and submitted by the CONTRACTOR's Licensed Professionals.

8. Inspection and Test Reports:

a. Identify each inspection and test report as either specially prepared for the Project or a standard publication of workmanship control testing at point of production. Submit electronic copy in accordance with the requirements for Manufacturer's Documents or Product Data, respectively as described in this Section.

9. Mill Test Reports, Experience Records, Physical Work Records, Guarantees, Warranties, and Maintenance Agreements:

a. Refer to the Contract Documents sections for specific requirements.

10. Survey Data:

a. Refer to the various Contract Documents for specific requirements. Furnish electronic copies. Provide electronic copies of final property survey (if any).

11. Certifications, Quality Testing and Certifying Reports:

a. Refer to Specification sections for specific requirements on submittal of certifications. Submit electronic copies. Certifications are submitted for review of conformance with specified requirements and information. Submittal is final when reviewed and returned by ENGINEER with no further action required.

12. Closeout Submittals:

a. Refer to Specification sections and Section 01 78 00 for specific requirements on submittal of closeout information, materials, tools, and similar items such as:

(1) Warranties and Bonds

(2) Record Drawings

(3) Special Tools

13. Operation and Maintenance Manuals:

a. Submit Operation and Maintenance Manuals in accordance with Section 01 78 23

D. Submittal Transmittal Form: Use the Submittal Transmittal Form found at the end of this Section to forward each specific submittal package to the ENGINEER. Provide all the information indicated on the Form and answer each question. Submittals with incomplete information on the Submittal Transmittal Form will be returned to the CONTRACTOR marked "Revise and Resubmit" and will be counted as a submittal subject to the provisions of 3.3 –REPETITIVE REVIEWS of this Section.

E. Submittal Numbering:

1. Number all submittals as follows:

(A) - (B)

Where:
(A) = Specification Section Number
(B) = Consecutive submittal number for the Specification Section Number listed in (A), with an alphabetic suffix indicating the sequential version of the submittal.

Examples: 01 13 00-001A indicates the initial version of submittal number 001 for Specification Section 01 13 00.
01 13 00-001B indicates the second version of submittal number 001 for Specification Section 01 13 00.
01 13 00-002A indicates the initial version of submittal number 002 for Specification Section 01 13 00.

2. When a document(s) is resubmitted for any reason, use a new Submittal Transmittal Form with the same submittal number and a new, sequential alphabetic suffix.

F. Resubmittal Preparation:

1. Comply with the requirements described in the Submittal Preparation subsection above. In addition:

a. Identify on the Submittal Transmittal Form that submittal is a resubmission.

b. Make and clearly identify any corrections or changes required by ENGINEER's notations on the previous, returned submittal.

c. Respond to ENGINEER's notations:

(1) On the Submittal Transmittal Form or on a separate page(s) attached to the Submittal Transmittal Form, answer or acknowledge, in writing, all notations or questions indicated by ENGINEER on the ENGINEER's response to the previous submittal.

(2) Identify each response by the corresponding question or notation number established by ENGINEER.

(3) If CONTRACTOR does not respond to each notation or question, the ENGINEER will return the resubmission without action. Additional resubmittals will be required until the CONTRACTOR provides a written response to all of the ENGINEER's notations or questions.

d. Indicate CONTRACTOR initiated revisions or variations:

(1) On the Submittal Transmittal Form identify variations or revisions from the previously reviewed submittal, other than those called for by ENGINEER.

(2) ENGINEER's responsibility for variations or revisions is established in paragraphs 6.17.D.3 and 6.17.E.3 of the General Conditions.

G. Distribution

1. Manufacturer’s Documents, Working Drawings, Product Data and Samples and Mock-ups:

a. After a submittal is stamped “Approved” (See Subsection 3.2), place the date of approval on two additional copies of the submittal and transmit to the OWNER and FIELD ENGINEER, together with one copy of a Submittal Transmittal Form indicating the submittal is a “Distribution of Approved Submittal”. For Mockups, distribute a Submittal Transmittal Form only.

After a submittal is stamped “Approved as Noted” (See Subsection 3.2), make the changes noted by ENGINEER and place the date of approval on two additional copies of the submittal and transmit to the OWNER and FIELD ENGINEER together with one copy of a Submittal Transmittal Form indicating the submittal is a “Distribution of Approved as Noted Submittal”.

b. If changes other than those marked by the ENGINEER are made, follow the requirements of Paragraph 3.1, F to obtain ENGINEER approval.

c. Unless required elsewhere, provide distribution of ”Approved” and “Approved as Noted” submittals to subcontractors, suppliers, governing authorities, and others as necessary for proper performance of the Work.

d. Maintain one set of ”Approved” and revised “Approved as Noted” submittals at the Project site, available for use by the ENGINEER and others.

e. Maintain returned final set of samples at the Project site, in suitable condition and available for quality control comparisons throughout the course of performing the Work. Incorporate only undamaged samples into the Work, when permitted by the Contract Documents.

H. CONTRACTOR’s Licensed Professional Submittals

a. After a submittal is acknowledged by the ENGINEER (See Subsection 3.2,2), place the date of acknowledgement on two additional copies of the submittal and transmit to the OWNER and FIELD ENGINEER together with one copy of a Submittal Transmittal Form indicating the submittal is a “Distribution of Acknowledged Submittal”.

b. Maintain one set of submittals at the Project site, available for use by the ENGINEER and others.

3.2 ENGINEER’S ACTIONS ON SUBMITTALS

A. General:

1. Review and approval by the ENGINEER of Action Submittals will be subject to the provisions of General Conditions. 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 requirements of the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole. ENGINEER’s review or approval of any submittal does not authorize a change to the Contract Time or Price.

2. ENGINEER’s review and approval of Action Submittals 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) nor to safety precautions or programs incident thereto. The review and approval of a separate item will not indicate approval of the assembly in which the item is a part.

3. ENGINEER will stamp each Action Submittal except Requests for Interpretation or Clarification with an appropriate action stamp and transmit electronically to the CONTRACTOR.

B. ENGINEER's Action

1. Stamps:

a. Approved:

(1) Where submittals are stamped "Approved", Work covered by submittal may proceed PROVIDED THE WORK COMPLIES WITH THE CONTRACT DOCUMENTS. Acceptance of Work will depend upon that compliance.

b. Approved As Noted:

(1) When submittals are stamped "Approved as Noted", Work covered by submittal may proceed PROVIDED IT COMPLIES WITH ENGINEER'S NOTATIONS AND CORRECTIONS ON SUBMITTAL AND WITH THE CONTRACT DOCUMENTS. Acceptance of Work will depend on that compliance.

c. Revise and Resubmit:

(1) When submittals are stamped "Revise and Resubmit" do not proceed with Work covered by submittal. Do not permit Work covered by submittal to be used at Project site or elsewhere where Work is in progress.

(2) Revise submittal in accordance with ENGINEER's notations and corrections and resubmit in accordance with Subsection 3.1F of this Section.

2. Acknowledgements of Information Submittals

a. When Information Submittals conform to the format requirements in the Contract Documents ENGINEER will acknowledge such submittals electronically via a response transmittal.

b. If an Information Submittal does not conform to the format requirements of the Contract Documents, ENGINEER return the electronic submittal with comments or questions. Do not proceed

with Work covered by the submittal and do not permit Work covered by the submittal to be used at Project site or elsewhere where Work is in progress. Resubmit the Information Submittal until the ENGINEER acknowledges that the submittal conforms to the format required.

3.3 REPETITIVE REVIEWS

A. Cost of Repetitive Reviews: Submittals will be reviewed no more than twice at the OWNER's expense. All subsequent reviews will be performed at times convenient to the ENGINEER and at the CONTRACTOR's expense based on the ENGINEER's then prevailing rates including all direct and indirect costs and fees. Reimburse the OWNER for all such costs and fees invoiced to the OWNER by the ENGINEER for third and subsequent submittals. ENGINEER will keep a submittal log and present it during monthly progress meetings. Log will note approvals, first rejection, second rejection and review time associated with reimbursable expenses.

B. Time Extension: Any need for more than one resubmission, or any other delay in ENGINEER's review of submittals, will not entitle CONTRACTOR to an extension of the Contract Time.

3.4 EXAMPLE FORMAT FOR CONTRACTOR'S APPROVAL AND CERTIFICATION STAMP

A. An example format for the CONTRACTOR's approval and certification stamp is as follows:

CONTRACTOR'S NAME

_____ Approved and Certified to comply with the Contract Documents.

_____ Approved and Certified to comply with the Contract Documents, except for variations specifically noted on the Submittal Transmittal Form and the associated documents.

PRINTED NAME: _____

TITLE: _____

SIGNATURE: _____

DATE: _____

3.5 CONTRACTOR'S SUBMITTAL TRANSMITTAL FORM

A. The format for the CONTRACTOR's Submittal Transmittal Form is as follows:

CONTRACTOR'S NAME

SUBMITTAL TRANSMITTAL FORM

Project Name

TO:_____ DATE:_____

SITE:_____

ATTN:_____ SPEC. REF. NO._____

DRAWING REF. NO._____

FROM:_____ SUBMITTAL NO. _____

1. The following documents are forwarded for your review:

No. of Repros/Copies	Document Originator	Description	Document No.	Date
/				
/				
/				
/				
/				
/				

2. Will item submitted for review fit in space provided in the Contract Documents? _____ Yes _____ No _____ Not Applicable

3. Has work indicated in this submittal been coordinated with all trades? _____ Yes _____ No _____ Not Applicable

4. Has the Contractor approved submittal and affixed completed approval and certification stamp? _____ Yes _____ No

5. Contractor's description and justification for variations from the Contract Documents. (Use additional pages, if necessary)

_____

_____

_____

_____

6. Remarks:_____

_____

_____

_____

Printed Name: _____

Signature:_____

END OF SECTION

City of Tulsa/TMUA/RMUA Equipment Warranty Information														
Project:														
Project No:														
Contractor:														
Contractor Ph:														
Engineer:	Greeley and Hansen													
Engineer Ph:	(312) 558-9000													
** Warranty start date is based on date of written acceptance from owner or if the following items have been completed (1) Start-up by Manufacture (2) Training (3) Approved O&M Manual														
Equipment/Matl/ Structure	Spec Section	Service	Type	Equipment Number	Supplier	Supplier Ph #	Approval Request	Approval Received	Anticipated Start Date	Start-up Date	Warranty Start **	Warranty Duration (Yrs)	Warranty End	O & M Approved
Location														

(NO TEXT FOR THIS PAGE)

SECTION 01 42 00

REFERENCES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Reference Abbreviations

B. Abbreviations

C. Reference Standards

D. Definitions

1.2 RELATED SECTIONS

A. Information provided in this section is used where applicable in individual Specification Sections, Divisions 1 through 49.

1.3 REFERENCE ABBREVIATIONS

A. Reference to a technical society, trade association or standards setting organization, may be made in the Specifications by abbreviations in accordance with the following list:

AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ACI	American Concrete Institute
ADC	Air Diffusion Council
AFBMA	Anti-friction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	Association of Home Appliance Manufacturers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
APA	American Plywood Association
ARI	American Refrigeration Institute
ASCE	American Society of Civil Engineers

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders' Hardware Manufacturers Association
BIA	Brick Institute of American
CABO	Council of American Building Officials
CAGI	Compressed Air and Gas Institute
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRD	U.S. Corps of Engineers Specifications
CRSI	Concrete Reinforcing Steel Institute
CTI	Cooling Tower Institute
DHI	Door and Hardware Institute
DOH	Department of Health
DOT	Department of Transportation
FCC	Federal Communications Commission
Fed. Spec.	Federal Specifications
FGMA	Flat Glass Marketing Association
FM	Factory Mutual
HMI	Hoist Manufacturing Institute
HPMA	See HPVA
HPVA	Hardwood Plywood Veneer Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IFI	Industrial Fasteners Institute
ISO	International Standards Organization
MIL	Military Specifications
MSS	Manufacturer's Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NACM	National Association of Chain Manufacturers
NBS	National Bureau of Standards, See NIST
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NFPA	National Fluid Power Association
NIST	National Institute of Standards and Technology
NLMA	National Lumber Manufacturers Association
NSF	National Sanitation Foundation

OSHA	Occupational Safety and Health Act
PCI	Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPI	Society of the Plastics Industry
SSPC	Steel Structures Painting Council
STI	Steel Tank Institute
TCA	Tile Council of American
TIMA	Thermal Insulation Manufacturers' Association
UL	Underwriters' Laboratories, Inc.
USBR	U. S. Bureau of Reclamation
USBS	U. S. Bureau of Standards, See NIST

1.4 ABBREVIATIONS

A. Abbreviations which may be used in individual Specification Sections Divisions 1 through 49 are as follows:

alternating current ..... ac
American wire gauge ..... AWG
ampere(s) ..... amp
ampere-hour(s) ..... AH
annual ..... ann
Ampere Interrupting Capacity ..... AIC
atmosphere(s) ..... atm
average ..... avg

biochemical oxygen demand ..... BOD
Board Foot ..... FBM
brake horsepower ..... bhp
Brinell Hardness ..... BH
British thermal unit(s) ..... Btu

calorie (s) ..... cal
carbonaceous biochemical oxygen demand ..... CBOD
Celsius (centigrade) C
Center to Center ..... C to C
centimeter(s) ..... cm
chemical oxygen demand ..... COD
coefficient, valve flow ..... C_v
condensate return ..... CR
cubic ..... cu
cubic centimeter(s) cc
cubic feet per day ..... cfd
cubic feet per hour ..... cfh
cubic feet per minute ..... cfm
cubic feet per minute, standard conditions ..... scfm
cubic feet per second ..... cfs
cubic foot (feet) ..... cu ft
cubic inch(es) ..... cu in
cubic yard(s) ..... cu yd

decibels ..... dB
decibels (A scale) ..... dBa
degree(s) ..... deg
dewpoint temperature ..... dpt
diameter ..... dia
direct current ..... dc
dissolved oxygen ..... DO
dissolved solids ..... DS
dry-bulb temperature ..... dbt

efficiency ..... eff
elevation ..... el
entering water temperature ..... ewt
entering air temperature ..... eat
equivalent direct radiation ..... edr

face area ..... fa
face to face ..... f to f
Fahrenheit ..... F
feet per day ..... fpd
feet per hour ..... fph
feet per minute ..... fpm
feet per second ..... fps
foot (feet) ..... ft
foot-candle ..... fc
foot-pound ..... ft-lb
foot-pounds per minute ..... ft-lb/min
foot-pounds per second ..... ft-lb/sec
formazin turbidity unit(s) ..... FTU
frequency ..... freq
fuel oil ..... FO
fuel oil supply ..... FOS
fuel oil return ..... FOR

gallon(s) ..... gal
gallons per day ..... gpd
gallons per day per cubic foot ..... gpd/cu ft
gallons per day per square foot ..... gpd/sq ft
gallons per hour ..... gph
gallons per minute ..... gpm
gallons per second ..... gps
gas chromatography and mass spectrometry ..... GC-MS
gauge ..... ga
grain(s) ..... gr
gram(s) ..... g
grams per cubic centimeter ..... gm/cc

Heat Transfer Coefficient ..... U
height ..... hgt
Hertz ..... Hz
horsepower ..... hp
horsepower-hour ..... hp-hr
hour(s) ..... hr

humidity, relative ..... rh
hydrogen ion concentration ..... pH

inch(es) ..... in
inches per second ..... ips
inside diameter ..... ID

Jackson turbidity unit(s) ..... JTU

kelvin ..... K
kiloamperes ..... kA
kilogram(s) ..... kg
kilometer(s) ..... km
kilovar (kilovolt-amperes reactive) ..... kvar
kilovolt(s) ..... kV
kilovolt-ampere(s) ..... kVA
kilowatt(s) ..... kW
kilowatt-hour(s) ..... kWh

linear foot (feet) ..... lin ft
liter(s) L

megavolt-ampere(s) ..... MVA
meter(s) ..... m
micrograms per liter ..... ug/L
miles per hour ..... mph
milliampere(s) ..... mA
milligram(s) ..... mg
milligrams per liter ..... mg/L
milliliter(s) ..... mL
millimeter(s) ..... mm
million gallons ..... MG
million gallons per day ..... mgd
millisecond(s) ..... ms
millivolt(s) ..... mV
minute(s) ..... min
mixed liquor suspended solids ..... MLSS

nephelometric turbidity unit ..... NTU
net positive suction head ..... NPSH
noise criteria ..... nc
noise reduction coefficient ..... NRC
number ..... no

ounce(s) ..... oz
outside air ..... oa
outside diameter ..... OD

parts per billion ..... ppb
parts per million ..... ppm
percent ..... pct
phase (electrical) .... ph
pound(s) ..... lb
pounds per cubic foot ..... pcf
pounds per cubic foot per hour ..... pcf/hr
pounds per day ..... lbs/day
pounds per day per cubic foot ..... lbs/day/cu ft
pounds per day per square foot ..... lbs/day/sq ft
pounds per square foot ..... psf
pounds per square foot per hour ..... psf/hr
pounds per square inch ..... psi
pounds per square inch absolute ..... psia
pounds per square inch gauge ..... psig
power factor ..... PF
pressure drop or difference ..... dp
pressure, dynamic (velocity) ..... vp
pressure, vapor ..... vap pr

quart(s) ..... qt

Rankine ..... R
relative humidity ..... rh
resistance ..... res
return air ..... ra
revolution(s) ..... rev
revolutions per minute ..... rpm
revolutions per second ..... rps
root mean squared ..... rms

safety factor ..... sf
second(s) ..... sec
shading coefficient ..... SC
sludge density index ..... SDI

Sound Transmission Coefficient ..... STC
specific gravity ..... sp gr
specific volume..... Sp Vol
sp ht at constant pressure ..... Cp
square ..... sq
square centimeter(s) ..... sq cm
square foot (feet)..... sq ft
square inch (es)..... sq in
square meter(s) ..... sq m
square yard(s)..... sq yd
standard ..... std
static pressure..... st pr
supply air .... sa
suspended solids ..... SS

temperature ..... temp
temperature difference..... TD
temperature entering..... TE
temperature leaving..... TL
thousand Btu per hour ..... Mbh
thousand circular mils ..... kcmil
thousand cubic feet ..... Mcf
threshold limit value..... TLV
tons of refrigeration.....tons
torque ..... TRQ
total dissolved solids ..... TDS
total dynamic head ..... TDH
total kjeldahl nitrogen..... TKN
total oxygen demand ..... TOD
total pressure ..... TP
total solids..... TS
total suspended solids..... TSS
total volatile solids ..... TVS

vacuum ..... vac
viscosity..... visc
volatile organic chemical ..... VOC
volatile solids .....VS
volatile suspended solids ..... VSS
volt(s) V
volts-ampere(s)..... VA
volume..... vol

watt(s) ..... W
watthour(s)..... Wh
watt-hour demand .....WHD
watt-hour demand meter .....WHDM
week(s)..... wk
weight..... wt
wet-bulb..... WB
wet bulb temperature ..... WBT

yard(s) ..... yd
year(s) .....yr

B. Use ASME Y1.1-1989, “Abbreviations for use on Drawings and in Text” for abbreviations for units of measure not included herein in Paragraph 1.4.

1.5 REFERENCE STANDARDS

A. Latest Edition: Construe references to furnishing materials or testing, which conform to the standards of a particular technical society, organization, or body, to mean the latest standard, code, or specification of that body, adopted and published as of the date of bidding this Contract. Standards referred to herein are made a part of these Specifications to the extent which is indicated or intended.

B. Precedence: The duties and responsibilities of the OWNER, CONTRACTOR or ENGINEER, or any of their consultants, agents or employees are set forth in the Contract Documents, and are not changed or altered by any provision of any referenced standard specifications, manuals or code, whether such standard manual or code is or is not specifically incorporated by reference in the Contract Documents. Any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority, to undertake responsibility contrary to the powers of the ENGINEER as set forth in the Contract Documents cannot be assigned to the ENGINEER or any of the ENGINEER's consultants, agents or employees.

1.6 DEFINITIONS

A. In these Contract Documents the words furnish, install and provide are defined as follows:

1. Furnish (materials): to supply and deliver to the project ready for installation and in operable condition.

2. Install (services or labor): to place in final position, complete, anchored, connected in operable condition.

3. Provide: to furnish and install complete. Includes the supply of specified services. When neither furnish, install or provide is stated, provide is implied.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 45 00

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Inspection Services

B. Inspection of Materials

C. Quality Control

D. Costs of Inspection

E. Acceptance Tests

F. Failure to Comply with Contract

1.2 RELATED SECTIONS

Related Work Specified in Other Sections Includes, But is Not Limited to, the Following

A. Section 01 33 00 - Submittals: Specific Submittal Requirements

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Certificate Submittals: Furnish the ENGINEER authoritative evidence in the form of Certificates of Manufacture that the materials and equipment to be used in the Work have been manufactured and tested in conformity with the Contract Documents. Include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

1.4 INSPECTION SERVICES

A. OWNER's Access: At all times during the progress of the Work and until the date of final completion, afford the OWNER and ENGINEER every reasonable, safe, and proper facility for inspecting the Work at the site. The observation and inspection of any work will not relieve the CONTRACTOR of any obligations to

perform proper and satisfactory work as specified. Replace work rejected due to faulty design, inferior, or defective materials, poor workmanship, improper installation, excessive wear, or nonconformity with the requirements of the Contract Documents, with satisfactory work at no additional cost to the OWNER. Replace as directed, finished or unfinished work found not to be in strict accordance with the Contract, even though such work may have been previously approved and payment made therefor.

B. Rejection: The OWNER and the OWNER's Authorized Representatives have the right to reject materials and workmanship which are defective or require correction. Promptly remove rejected work and materials from the site.

C. Inferior Work Discoveries: Failure or neglect on the part of the OWNER or the OWNER's Authorized Representatives to condemn or reject bad or inferior work or materials does not imply an acceptance of such work or materials. Neither is it to be construed as barring the OWNER or the OWNER's Authorized Representatives at any subsequent time from recovering damages or a sum of money needed to build anew all portions of the Work in which inferior work or improper materials were used.

D. Removal for Examination: Should it be considered necessary or advisable by the OWNER or the OWNER's Authorized Representatives, at any time before final acceptance of the Work, to make examinations of portions of the Work already completed, by removing or tearing out such portions, promptly furnish all necessary facilities, labor, and material, to make such an examination. If such Work is found to be defective in any respect, defray all expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the Contract, the cost of examination and restoration of the Work will be considered a change in the Work to be paid for in accordance with applicable provisions of the Contract.

E. Operation Responsibility: Assume full responsibility for the proper operation of equipment during tests and instruction periods. Make no claim for damage which may occur to equipment prior to the time when the OWNER accepts the Work.

F. Rejection Prior to Warranty Expiration: If at anytime prior to the expiration of any applicable warranties or guarantees, equipment is rejected by the OWNER, repay to the OWNER all sums of money received for the rejected equipment on progress certificates or otherwise on account of the Contract lump sum prices, and upon the receipt of the sum of money, OWNER will execute and deliver a bill of sale of all its rights, title, and interest in and to the rejected equipment. Do not remove the equipment from the premises of the OWNER until the OWNER obtains from other sources, equipment to take the place of that rejected. The OWNER hereby agrees to obtain other equipment within a reasonable time and the CONTRACTOR agrees that the OWNER may use the equipment furnished by the CONTRACTOR without rental or other charge until the other new equipment is obtained.

1.5 INSPECTION OF MATERIALS

A. Premanufacture Notification: Give notice in writing to the ENGINEER sufficiently in advance of the commencement of manufacture or preparation of materials especially manufactured or prepared for use in or as part of the permanent construction. When required, notice to include a request for inspection, the date of commencement, and the expected date of completion of the manufacture or preparation of materials. Upon receipt of such notice, ENGINEER will arrange to have a representative present at such times during the manufacture or testing as may be necessary to inspect the materials, or will notify CONTRACTOR that the inspection will be made at a point other than the point of manufacture or testing, or that the inspection will be waived. Comply with these provisions before shipping any materials. Such inspection will not constitute a release from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

B. Testing Standards: Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized, applicable test codes except as may otherwise be stated herein.

1.6 QUALITY CONTROL

A. Testing

1. Field and Laboratory

a. Provide personnel to assist the ENGINEER in performing the following periodic observation and associated services.

(1) Soils: Observe and test excavations, placement and compaction of soils. Determine suitability of excavated material. Observe subgrade soils and foundations.

(2) Concrete: Observe forms and reinforcement; observe concrete placement; witness air entrainment tests, facilitate concrete cylinder preparation and assist with other tests performed by ENGINEER.

(3) Masonry: Sample and test mortar and grout; inspect brick and block samples and sample panels; inspect placement of reinforcement and grouting.

(4) Structural Steel: Verify that all welders are certified; visually inspect all structural steel welds; mechanically test high-tensile bolted connections.

b. When specified in Divisions 2 through 46 of the Contract Documents, provide an independent laboratory testing facility to perform required testing. Qualify the laboratory as having performed previous satisfactory work. Prior to use, submit to the ENGINEER for approval.

c. Cooperate with the ENGINEER and laboratory testing representatives. Provide at least 24 hours notice prior to when specified testing is required. Provide labor and materials, and necessary facilities at the site as required by the ENGINEER and the testing laboratory.

d. Provide an independent testing agency, a member of the National Electrical Testing Association, to perform inspections and tests specified in Division 26 of these Specifications.

2. Equipment: Coordinate and demonstrate test procedures as specified in the Contract Documents or as otherwise required during the formal tests.

3. Pipeline and Other Testing: Conform to test procedures and requirements specified in the appropriate Specification Section.

4. Testing Costs: Include the costs of all testing other than soils, concrete, and masonry testing of material placed under this Contract in the Contract Item 1 (Structures and Equipment Work). Include the costs of strength chloride ion and shrinkage tests specified in Division 3.

B. Reports

1. Certified Test Reports: Where transcripts or certified test reports are required by the Contract Documents, meet the following requirements:

a. Before delivery of materials or equipment submit and obtain approval of the ENGINEER for all required transcripts, certified test reports, certified copies of the reports of all tests required in referenced specifications or specified in the Contract Documents. Perform all testing in an approved independent laboratory or the manufacturer's laboratory. Submit for approval reports of shop equipment tests within thirty days of testing. Transcripts or test reports are to be accompanied by a notarized certificate in the form of a letter from the manufacturer or supplier certifying that tested material or equipment meets the specified requirements and the same type, quality, manufacture and make as specified. The certificate shall be signed by an officer of the manufacturer or the manufacturer's plant manager.

2. Certificate of Compliance: At the option of the ENGINEER, or where not otherwise specified, submit for approval a notarized Certificate of

Compliance. The Certificates may be in the form of a letter stating the following:

a. Manufacturer has performed all required tests

b. Materials to be supplied meet all test requirements

c. Tests were performed not more than one year prior to submittal of the certificate

d. Materials and equipment subjected to the tests are of the same quality, manufacture and make as those specified

e. Identification of the materials

1.7 COSTS OF INSPECTION

A. OWNER's Obligation: Initial inspection and testing of concrete, mortar, grout, backfill and structural steel furnished under this Contract will be performed by the OWNER or his authorized Representatives or inspection bureaus without cost to the CONTRACTOR. If subsequent testing is necessary due to failure of the initial tests or because of rejection for noncompliance, reimburse the OWNER for expenditures incurred in making such tests.

B. CONTRACTOR's Obligation: Include in the Contract Price, the cost of all shop and field tests of equipment and other tests required by the Contract Documents except those tests described above under "OWNER's Obligation". The OWNER may perform tests on any material or equipment furnished under this Contract at any time during the Contract. If tests performed by the OWNER result in failure or rejection for noncompliance, reimburse the OWNER for expenditures incurred in making such tests. Tests performed by the OWNER shall prevail in determining compliance with Contract requirements.

C. Reimbursements to OWNER:

1. Materials and equipment submitted by the CONTRACTOR as the equivalent to those specifically named in the Contract may be tested by the OWNER for compliance. Reimburse the OWNER for expenditures incurred in making such tests on materials and equipment which are rejected for noncompliance.

2. When a witness or shop test is performed at the manufacturer's facilities or an operational test is performed at the site of work, the ENGINEER'S services associated with the first test of each material or equipment item will be furnished by the OWNER. Reimburse the OWNER for the costs for the ENGINEER'S services associated with retests or failed original tests or test extensions due to failure to complete the original tests as scheduled. Any

costs so incurred will be billed by the OWNER and deducted from the CONTRACTOR'S subsequent partial payment.

1.8 ACCEPTANCE TESTS

A. Preliminary Field Tests: As soon as conditions permit, furnish all labor and materials and services to perform preliminary field tests of all equipment provided under this Contract. If the preliminary field tests disclose that any equipment furnished and installed under this Contract does not meet the requirements of the Contract Documents, make all changes, adjustments and replacements required prior to the acceptance tests.

B. Final Field Tests: Upon completion of the Work and prior to final payment, subject all equipment, piping and appliances installed under this Contract to specified acceptance tests to demonstrate compliance with the Contract Documents.

1. Furnish all labor, fuel, energy, water and other materials, equipment, instruments and services necessary for all acceptance tests.

2. Conduct field tests in the presence of the ENGINEER. Perform the field tests to demonstrate that under all conditions of operation each equipment item:

a. Has not been damaged by transportation or installation
b. Has been properly installed
c. Has been properly lubricated
d. Has no electrical or mechanical defects
e. Is in proper alignment
f. Has been properly connected
g. Is free of overheating of any parts
h. Is free of all objectionable vibration
i. Is free of overloading of any parts
j. Operates as intended

3. Operate work or portions of work for a minimum of 100 hours or 14 days continuous service, whichever comes first. For those items of equipment which would normally operate on wastewater or sludge, plant effluent may be used if available when authorized by ENGINEER. If water can not properly exercise equipment, conduct 100-hour test after plant startup. Conduct test on those systems which require load produced by weather (heating or cooling) exercise only when weather will produce proper load.

C. Failure of Tests: If the acceptance tests reveal defects in material or equipment, or if the material or equipment in any way fails to comply with the requirements of the Contract Documents, then promptly correct such deficiencies. Failure or refusal to correct the deficiencies, or if the improved materials or equipment, when

tested again, fail to meet the guarantees or specified requirements, the OWNER, notwithstanding its partial payment for work and materials or equipment, may reject said materials or equipment and may order the CONTRACTOR to remove the defective work from the site at no addition to the Contract Price, and replace it with material or equipment which meets the Contract Documents.

1.9 FAILURE TO COMPLY WITH CONTRACT

A. Unacceptable Materials: If it is ascertained by testing or inspection that the material or equipment does not comply with the Contract, do not deliver said material or equipment, or if delivered remove it promptly from the site or from the Work and replace it with acceptable material without additional cost to the OWNER. If the Contractor fails to remove unacceptable materials and equipment from the site, or make satisfactory progress in doing so, within forty-eight (48) hours after the service of a written notice from the ENGINEER ordering such removal, the unacceptable material or equipment may be removed by the OWNER and the cost of such removal to be taken out of money that may be due or become due the CONTRACTOR on account of or by virtue of this Contract. Fulfill all obligations under the terms and conditions of the Contract even though the OWNER or the OWNER's Authorized Representatives fail to ascertain noncompliance or notify the CONTRACTOR of noncompliance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 45 50

LEAKAGE TESTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Testing for any signs of leakage in all pipelines and structures required to be watertight.

1. Test all pipelines with water under the specified pressures.

2. Test all structures with water under the specified pressures.

B. Operation of Existing Facilities: Conduct all tests in a manner to minimize as much as possible any interference with the day-to-day operations of existing facilities or other contractors working on the site.

1.2 PERFORMANCE REQUIREMENTS

A. Written Notification of Testing: Provide written notice when the work is ready for testing, and make the tests as soon thereafter as possible.

1. Personnel for reading meters, gauges, or other measuring devices, will be furnished by the OWNER.

2. Furnish all other labor, equipment, air, water and materials, including meters, gauges, smoke producers, blower, pumps, compressors, fuel, water, bulkheads and accessory equipment.

1.3 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

1.4 SUBMITTALS

A. General: Provide all submittals, as specified in Division 1.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PRESSURE TESTS OF EXPOSED PLANT PIPING

A. Testing: Pressure test exposed pipelines for leakage by maintaining the fluid in the pipe at the specified pressure for a period of 60 minutes. Examine all accessible joints during the test. Stop all visible leakage.

B. Test Pressures: Test the various pipelines at the test pressures specified in Section 40 05 10.

3.2 PRESSURE TESTS OF BURIED OR CONCEALED PLANT PIPELINES AND WATER MAINS

A. Testing: Completely backfill all harnessed sections of buried piping before such sections are tested.

1. Pressure test buried or concealed pipelines for leakage by maintaining the fluid in the pipe at the specified pressure for a minimum period of 4 hours.

2. Pressure test the piping for leakage as a whole or in sections, valved or bulkheaded at the ends. Apply the specified pressure to the piping through a tap in the pipe by means of a hand pump or other approved method. Do not use air for testing.

B. Test Pressures: Test the piping at the test pressures specified in Sections 33 05 50 and 40 05 10.

C. Allowable Leakage: Stop all visible leakage. Do not allow leakage for any piping, as determined by the above test, to exceed the allowable leakage for cast-iron water mains as given by the following formula in Section 5.2 of AWWA C600:

$$L = \frac{S \times D \times (P)^{1/2}}{148{,}000}$$

in which L is the allowable leakage in gallons per hour, S is the length of water main tested in feet, D is the nominal diameter of the pipe in inches and P is the average test pressure in psi gauge.

3.3 LOW PRESSURE AIR TEST FOR NEW RIVER CROSSING (OPTION A)

A. Testing Protocol: Perform low pressure air test on the new 42-inch River Crossing as defined below:
   1. Perform a low pressure air test every 100 lineal feet of pipe installed, prior to pouring the concrete encasement.
   2. Allow the Resident Project Representative to inspect the invert elevation, exterior joints and reinforcement of the 100 foot segment of pipe prior to each low pressure air test.
   3. All inverts must be demonstrated in the field to the Resident Project Representative that the end of each 100 foot segment matches what is shown on the Contract Drawings. The low pressure air test cannot move forward unless approved by the Resident Project Representative in the field.
   4. Provide an inflatable plug capable of pressurizing the new pipeline segment to the specified test pressure and has a means to monitor the pressure within the pipeline.
   5. Plug the entire pipe segment back to either the East or West Bank Junction Structure for each individual test.
   6. The Resident Project Representative shall witness each low pressure air test and document passing prior to the contractor proceeding with pouring the concrete encasement.
   7. Continue to perform low pressure air tests every 100 lineal feet until the entire length of River Crossing has passed.

B. Test Pressure: All Tests shall meet the specified Test Pressure on the Buried Piping Schedule in Specification Section 33 05 50.

C. Passing Test: A passing test is when the initial Test Pressure holds for a minimum of 2 hours.

3.4 LOW PRESSURE AIR TEST FOR NEW RIVER CROSSING (OPTION B)

A. Testing Protocol: Perform low pressure air test on the new 42-inch River Crossing as defined below:
   1. Perform one low pressure air test on approximately 1800 lineal feet of pipe connecting from the New East and West Bank Junction Structures.
   2. Provide an inflatable plug capable of pressurizing the new pipeline segment to the specified test pressure and has a means to monitor the pressure within the pipeline.
   3. Plug each end of the pipeline and test the entire system at once.
   4. The Resident Project Representative shall witness the low pressure air test.

B. Test Pressure: All Tests shall meet the specified pressure on the Buried Piping Schedule in Specification Section 33 05 50.

C. Passing Test: A passing test is when the initial Test Pressure holds for a minimum of 2 hours.

3.5 LOW PRESSURE AIR TEST FOR NEW INTERCONNECTION PIPING

A. Testing Protocol: Perform low pressure air test on the new 36-inch and 42-inch Interconnection piping as defined below:
   1. Perform one low pressure air test on approximately 130 lineal feet of pipe connecting the new West Bank Junction Structure, existing sanitary Sewer Manhole, and the Influent Lift Station Wet Well.
   2. Provide an inflatable plug capable of pressurizing the new pipeline segments to the specified test pressure and has a means to monitor the pressure within the pipeline.
   3. Plug each end of the pipeline and test the entire system at once.
   4. The Resident Project Representative shall witness the low pressure air test.

B. Test Pressure: All Tests shall meet the specified pressure on the Buried Piping Schedule in Specification Section 33 05 50.

C. Passing Test: A passing test is when the initial Test Pressure holds for a minimum of 2 hours.

3.6 VALVE TESTING

A. Testing: Operate valves in the section under test through several complete cycles of closing and opening. In addition, have the test pressure for each valve, when in the closed position, applied to one side of the valve only. Test each end of the valve in this manner.

B. Test Pressure: Test each valve at the same test pressure as that specified for the pipe in which the valve is installed.

C. Leakage: Stop all external and internal leakage through the valves.

D. Movement: Stop all valve movement or structural distress.

3.7 REPAIR OF PIPING LEAKS

A. Procedures: Repair leaks as follows:

   1. Replace broken pipe or joint assemblies found to leak.

   2. When leakage occurs in excess of the specified amount, locate and repair defective valves, pipe, cleanouts or joints.

   3. If the excess leakage is determined to be caused by defective materials furnished, improper workmanship, or damage to the materials, make the necessary repairs or replacements at no addition to the Contract Price.

4. If defective portions cannot be located, remove and reconstruct as much of the original work as necessary to obtain piping that meets the leakage requirements specified herein and retest, all at no addition to the Contract Price.

3.8 LEAKAGE TESTS FOR NEW AND EXISTING WATERHOLDING CONCRETE STRUCTURES

A. Perform leakage tests on new concrete wet wells, tanks, junction chambers and similar water holding structures before placing in service, by filling the structure with water to the typical operating level. Test shall conform to the requirements of ACI 350.1R-93/AWWA 400-93. Testing shall not be performed before fourteen (14) days after all portions of structure elements have been completed, and not before all the structure elements have attained the specified compressive strength. The CONTRACTOR shall be responsible for proper disposal of all water used for leakage testing. The method of disposal shall be subject to approval by the OWNER.

1. Fill the structure to be tested with water to the specified level. Allow a 3-day interval between the time the structure is filled with water and the start of the leakage testing to minimize the effect of the concrete absorption on the test results.

2. Inspect the walls and all joints for leakage. If structural distress is observed, report immediately to the OWNER. Visible flowing leaks or damp spots that show on the exterior surface of the structure shall not be permitted.

3. After the 3-day interval in Step 1 above, begin the test and observe the water level in the structure for a 72 hour period.

   a. Make an inspection for locations of leakage through the exterior surface of the structure, especially in areas around fittings; and construction, expansion and other joints. Monitor underdrains for any increase in flow.

   b. Continue the test for the number of days it would take to produce a ½-inch drop in water level at the maximum allowed water loss described below. Take water level readings at 24 hour intervals at the same time of day to minimize the effects of temperature.

   c. Leakage will be considered acceptable if:

      (1) There are no visible leakages or visible damp areas and

      (2) The amount of water loss in each 24 hour period is not more than 0.1 percent of the volume to which the structure was filled,

after correcting for the evaporation loss or precipitation gain in accordance with ACI 350.1R-93, Chapter 3.

d. If visible leaks appear, submit, for approval, the repair procedure and materials for all elements of structure. Make the repairs at no additional cost to the OWNER. Leakage test the structure again after repairs. Continue repair and re-test cycle until the structure passes the leakage test.

e. Damp areas are not permitted at any location on the tank wall. Damp areas are defined as spots where moisture can be picked up on a dry hand. All such areas shall be repaired as necessary at no additional cost to the OWNER.

END OF SECTION

SECTION 01 50 00

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Temporary Utilities

C. Temporary Construction

D. Barricades and Enclosures

E. Fences

F. Security

G. Temporary Controls

H. Traffic Regulation

I. Field Offices and Sheds

J. Engineer's Field Office

1.2 GENERAL REQUIREMENTS

A. Plant and Facilities: Furnish, install, maintain and remove all false work, scaffolding, ladders, hoistways, braces, pumping plants, shields, trestles, roadways, sheeting, centering forms, barricades, drains, flumes, and the like, any of which may be needed in the construction of any part of the Work and which are not herein described or specified in detail. Accept responsibility for the safety and efficiency of such works and for any damage that may result from their failure or from their improper construction, maintenance or operation.

B. First Aid: Maintain a readily accessible, completely equipped first aid kit at each location where work is in progress.

C. Safety Responsibility: Accept sole responsibility for safety and security at the site. Indemnify and hold harmless the OWNER and the OWNER's Authorized Representatives, including Greeley and Hansen LLC, Wallace Engineering and

McMillen Jacobs Associates, for any safety violation, or noncompliance with governing bodies and their regulations, and for accidents, deaths, injuries, or damage at the site during occupancy or partial occupancy of the site by CONTRACTOR's forces while performing any part of the Work.

D. Hazard Communication: Furnish two copies of the CONTRACTOR's Hazard Communication Program required under OSHA regulations before beginning on site activities. Furnish two copies of amendments to Hazard Communications Program as they are prepared.

1.3 TEMPORARY UTILITIES

A. Water: Provide all necessary and required water without additional cost, unless otherwise specified. If necessary, provide and lay water lines to the place of use; secure all necessary permits; pay for all taps to water mains and hydrants and for all water used at the established rates.

B. Light and Power: Provide without additional cost to the OWNER temporary lighting and power facilities required for the proper construction and inspection of the Work. If, in the ENGINEER's opinion, these facilities are inadequate, do NOT proceed with any portion of the Work affected thereby. Maintain temporary lighting and power until the Work is accepted.

C. Heat: Provide temporary heat, whenever required, for work being performed during cold weather to prevent freezing of concrete, water pipes, and other damage to the Work or existing facilities.

D. Sanitary Facilities: Provide sufficient sanitary facilities for construction personnel. Prohibit and prevent nuisances on the site of the Work or on adjoining property. Discharge any employee who violates this rule. Abide by all environmental regulations or laws applicable to the Work.

E. Connections to Existing Utilities:

1. Unless otherwise specified or indicated, make all necessary connections to existing facilities including structures, drain lines, and utilities such as water, sewer, gas, telephone, and electricity. In each case, obtain permission from the OWNER or the owning utility prior to undertaking connections. Protect facilities against deleterious substances and damage.

2. Thoroughly plan in advance all connections to existing facilities. Have on hand at the time of undertaking the connections, all material, labor and required equipment. Proceed continuously to complete connections in minimum time. Arrange for the operation of valves or other appurtenances on existing utilities, under the direct supervision of the owning utility.

1.4 TEMPORARY CONSTRUCTION

A. Bridges: Design and place suitable temporary bridges where necessary for the maintenance of vehicular and pedestrian traffic. Assume responsibility for the sufficiency and safety of all such temporary work or bridges and for any damage which may result from their failure or their improper construction, maintenance, or operation. Indemnify and save harmless the OWNER and the OWNER's representatives, including Greeley and Hansen LLC, Wallace Engineering and McMillen Jacobs Associates, from all claims, suits or actions, and damages or costs of every description arising by reason of failure to comply with the above provisions.

1.5 BARRICADES AND ENCLOSURES

A. Protection of Workmen and Public: Effect and maintain at all times during the prosecution of the Work, barriers and lights necessary for the protection of Workmen and the Public. Provide suitable barricades, lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the Work causes obstructions to normal traffic, excavation sites, or constitutes in any way a hazard to the public.

B. Barricades and Lights:

1. Protect all streets, roads, highways, excavations and other public thoroughfares which are closed to traffic; use effective barricades which display acceptable warning signs. Locate barricades at the nearest public highway or street on each side of the blocked section.

2. Statutory Requirements: Install and maintain all barricades, signs, lights, and other protective devices within highway rights-of-way in strict conformity with applicable statutory requirements by the authority having jurisdiction.

1.6 FENCES

A. Existing Fences: Obtain written permission from the OWNER prior to relocating or dismantling fences which interfere with construction operations. Reach agreements with the fence owner as to the period the fence may be left relocated or dismantled. Install adequate gates where fencing must be maintained. Keep gates closed and locked at all times when not in use.

B. Restoration: Restore all fences to their original or better condition and to their original location on completion of the Work.

1.7 SECURITY

A. Preservation of Property:

1. Preserve from damage, all property along the line of the Work, in the vicinity of or in any way affected by the Work, the removal or destruction of which is not called for by the Drawings. Preserve from damage, public utilities, trees, lawn areas, building monuments, fences, pipe and underground structures, and public streets. Note: Normal wear and tear of streets resulting from legitimate use by the CONTRACTOR are not considered as damage. Whenever damages occur to such property, immediately restore to its original condition. Costs for such repairs are incidental to the Contract.

2. In case of failure on the part of the CONTRACTOR to restore property or make good on damage or injury, the OWNER may, upon 24 hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any moneys due or which may become due the CONTRACTOR under this Contract. If removal, repair or replacement of public or private property is made necessary by alteration of grade or alignment authorized by the OWNER and not contemplated by the Contract Documents, the CONTRACTOR will be compensated, in accordance with the General Conditions, provided that such property has not been damaged through fault of the CONTRACTOR or the CONTRACTOR's employees.

B. Public Utility Installations and Structures:

1. Public utility installations and structures include all poles, tracks, pipes, wires, conduits, vaults, manholes, and other appurtenances and facilities, whether owned or controlled by public bodies or privately owned individuals, firms or corporations, used to serve the public with transportation, gas, electricity, telephone, storm and sanitary sewers, water, or other public or private utility services. Facilities appurtenant to public or private property which may be affected by the Work are deemed included hereunder.

2. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. Existing public utility installations and structures are indicated on the Drawings only to the extent such information was made available to, or found by, the ENGINEER in preparing the Drawings. These data are not guaranteed for completeness or accuracy, and the CONTRACTOR is responsible for making necessary investigations to become fully informed as to the character, condition, and extent of all public utility installations and

structures that may be encountered and that may affect the construction operations.

3. Contact utility locating service sufficiently in advance of the start of construction to avoid damage to the utilities and delays to the completion date.

4. Remove, replace, relocate, repair, rebuild, and secure any public utility installations and structures damaged as a direct or indirect result of the Work under this Contract. Costs for such work are incidental to the Contract. Be responsible and liable for any consequential damages done to or suffered by any public utility installations or structures. Assume and accept responsibility for any injury, damage, or loss which may result from or be consequent to interference with, or interruption or discontinuance of, any public utility service.

5. Repair or replace any water, electric, sewer, gas, or other service connection damaged during the Work with no addition to the Contract price.

6. At all times in performance of the Work, employ proven methods and exercise reasonable care and skill to avoid unnecessary delay, injury, damage, or destruction to public utility installations and structures. Avoid unnecessary interference with, or interruption of, public utility services. Cooperate fully with the owners thereof to that end.

7. Give written notice to the owners of all public utility installations and structures affected by proposed construction operations, sufficiently in advance of breaking ground in any area or on any unit of the Work, to obtain their permission before disrupting the lines and to allow them to take measures necessary to protect their interests. Advise the Chiefs of Police, Fire and Rescue Services of any excavation in public streets or the temporary shut-off of any water main. Provide at least 24 hours notice to all affected property owners whenever service connections are taken out of service.

C. Miscellaneous Structures: Assume and accept responsibility for all injuries or damage to culverts, building foundations and walls, retaining walls, or other structures of any kind met with during the prosecution of the Work. Assume and accept liability for damages to public or private property resulting therefrom. Adequately protect against freezing all pipes carrying liquid.

D. Protection of Trees and Lawn Areas:

1. Protect with boxes, trees and shrubs, except those ordered to be removed. Do not place excavated material so as to cause injury to such trees or shrubs. Replace trees or shrubs destroyed by accident or negligence of the

CONTRACTOR or CONTRACTOR's employees with new stock of similar size and age, at the proper season, at no additional cost to the OWNER.

2. Leave all existing lawn areas in as good condition as before the start of the Work. Restore all existing lawn areas damaged, removed or destroyed during the Work and that are to remain lawn areas by seeding or sodding.

1.8 TEMPORARY CONTROLS

A. During Construction:

1. Keep the site of the Work and adjacent premises free from construction materials, debris, and rubbish. Remove this material from any portion of the site if such material, debris, or rubbish constitutes a nuisance or is objectionable.

2. Remove from the site all surplus materials and temporary structures when they are no longer needed.

3. Neatly stack construction materials such as concrete forms and scaffolding when not in use. Promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

4. Properly store volatile wastes in covered metal containers and remove from the site daily.

5. Do not bury or burn on the site or dispose of into storm drains, sanitary sewers, streams, or waterways, any waste material. Remove all wastes from the site and dispose of in a manner complying with applicable ordinances and laws.

B. Smoke Prevention:

1. Strictly observe all air pollution control regulations.

2. Open fires will be allowed only if permitted under current ordinances.

C. Noises:

1. Maintain acceptable noise levels in the vicinity of the Work. Limit noise production to acceptable levels by using special mufflers, barriers, enclosures, equipment positioning, and other approved methods.

2. Supply written notification to the OWNER sufficiently in advance of the start of any work which violates this provision. Proceed only when all applicable authorizations and variances have been obtained in writing.

D. Hours of Operation:

1. Operation of construction equipment between the hours of 7:00 p.m. and 6:00 a.m. the following day is prohibited. For operation of this equipment during this period obtain written consent from the OWNER.

2. Do not carry out nonemergency work, including equipment moves, on Sundays without prior written authorization by the OWNER.

E. Dust Control:

1. Take measures to prevent unnecessary dust. Keep earth surfaces exposed to dusting moist with water or a chemical dust suppressant. Cover materials in piles or while in transit to prevent blowing or spreading dust.

2. Adequately protect buildings or operating facilities which may be affected adversely by dust. Protect machinery, motors, instrument panels, or similar equipment by suitable dust screens. Include proper ventilation with dust screens.

F. Temporary Drainage Provisions:

1. Provide for the drainage of stormwater and any water applied or discharged on the site in performance of the Work. Provide adequate drainage facilities to prevent damage to the Work, the site, and adjacent property.

2. Supplement existing drainage channels and conduits as necessary to carry all increased runoff from construction operations. Construct dikes as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect the OWNER's facilities and the Work, and to direct water to drainage channels or conduits. Provide ponding as necessary to prevent downstream flooding.

3. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

G. Pollution: Prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. Do not permit sanitary wastes to enter any drain or watercourse other than sanitary sewers. Do not permit sediment, debris, or other substances to enter sanitary sewers. Take reasonable measures to prevent such materials from entering any drain or watercourse.

1.9 TRAFFIC REGULATION

A. Parking: Provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Contract, to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.

B. Access: Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian. Provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when the CONTRACTOR has obtained permission from the owner or tenant of private property, or from the authority having jurisdiction over the public property involved, to obstruct traffic at the designated point.

1.10 FIELD OFFICES AND SHEDS

A. CONTRACTOR's Office: Erect, furnish, and maintain a field office with a telephone. Have an authorized agent present at this office at all times while the Work is in progress. Keep readily accessible copies of the Contract Documents, required record documents, and the latest approved shop drawings at this field office.

B. Material Sheds and Temporary Structures: Provide material sheds and other temporary structures of sturdy construction and neat appearance.

C. Location: Coordinate location of field offices, material sheds and temporary structures with ENGINEER and OWNER.

1.11 ENGINEER’S FIELD OFFICE

A. General: Provide and maintain an ENGINEER’S field office trailer, together with all foundations, steps, landings, handrails, furniture, office equipment, computer equipment, utilities and all other appurtenances required for a complete and functional installation. Provide the ENGINEER’S trailer at the project site for the duration of the construction project. Coordinate the location of the ENGINEER’S trailer with the OWNER and ENGINEER. Make the completed field office trailer available for occupancy by the ENGINEER no later than the first day that the CONTRACTOR is on site to begin other construction activities.

B. Type and Size: Provide a new mobile, tandem-axle field office trailer of not less than 36-feet exterior body length and 14-feet exterior body width.

C. Arrangement: Arrange trailer's floor plan to provide one office sized at 14'-0" x 10'-0" office space, one washroom, one 4'-0" x 5'-0" storage room and the remainder of the open area in the center of the trailer. Provide a night light over each outside door. Provide privacy locks on the interior door for the washroom and passage locks for all other doors. Provide each window with an operable sash, screen and venetian blinds. Provide an electric furnace with 2-ton air conditioner complete with heating/cooling thermostat. Provide ductwork and regulator type grills in each room. Provide 100 ampere, 120/240 volt electrical service. Provide complete internal connections for single exterior water supply and single exterior sanitary sewer. Provide an electric in line water heater for sink. Provide one bottled water cooler service with hot and cold taps and refrigerated storage compartment of approximately one cubic foot capacity. Provide ten gallons or more of bottled water per week for the duration of the project. Provide one small new 3CF refrigerator with freezer. Provide washroom with lavatory, water closet, cabinet with mirror, toilet tissue holder, paper towel dispenser, wastebasket and an electrical outlet at the lavatory. Provide one fully-equipped standard first-aid cabinet and one UL-rated 2A:120B:C 20-pound nominal capacity fire extinguisher. Provide one fully-equipped standard first-aid cabinet. Provide a stock of paper towels and toilet paper throughout the construction period. Provide trailer cleaning to include sweeping and mopping at least once a month minimum.

Have the field office suitably blocked or otherwise installed in accordance with local ordinances. Enclose the air space beneath the trailer with exterior grade plywood panel siding. Provide hinged access doors at utility connection area.

D. Furnishings: Provide the following new or in like new condition:

- One 30-inch by 60-inch flattop desk with drawers
- Two swivel office chairs
- Eight straight-back office chairs
- Two conference tables
- Two four-drawer, legal-size, steel filing cabinets with locks and keys. Complete with frame and filled with hanging folders.
- Full sized plan rack with 6ea aluminum plan holders
- One Fire Extinguisher, Multipurpose Dry Chemical Type
- One new Industrial Scientific Ventis Mx4 (VTS-K1231100101) air monitor as supplemental PPE for the ENGINEERs sole use suitable for use during onsite conditions (with minimum monitoring of LEL, O2, H2S and CO). Provide maintenance and calibrations as needed and required for the duration of the project.
- Three wastebaskets
- Complete computer system Dell™ Inspiron 15R (i15RMT-12439sLV) Laptop Computer With 15.6" Touch-Screen Display & 3rd Gen Intel® Core™ i7 Processor, Silver, 4 USB ports. Computer shall be Dell to match City service after project.

- One HP Officejet 7610 Wide-Format e-All-In-One Inkjet Printer, Copier, Scanner, Fax, Photo or equal with cords and spare toner cartridge. Provide paper, ink and maintenance service for the duration of the project. Provide print paper for the duration of the project. Include spare color ink onsite.
- Two power surge protectors for all electronic equipment
- One Sony – Cyber-shot DSC-W710 16.1 Megapixel Digital Camera silver/black/red. Provide one spare 4GB memory card.

E. Utility Connections: Connect the water to an existing line and the sanitary sewer to either an existing sewer or other approved facilities. Provide water piping and a meter that is suitable for use by others after completion of the project.

Arrange for the local power company to provide separate, complete and metered electrical service to the field office. Provide a suitable meter installation as approved. Connect the electrical service to the trailer to provide a complete operating installation. Pay each monthly power cost for the ENGINEER'S field office.

Arrange with the local internet service provider to provide either DSL or cable modem high speed service to the field office that is suitable for use by others after completion of the project. If DSL service is provided include a third telephone line. Pay each monthly internet connection charge.

F. Final Ownership: At the completion of construction, the trailer and furnishings with the exception of the computer, printer, air monitor and camera listed under Subpart 1.11 D shall remain the property of the CONTRACTOR. Deliver the computer, printer, air monitor and camera to the City at the end of the project.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 60 00

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description

B. Substitutions

C. Manufacturer's Written Instructions

D. Transportation and Handling

E. Storage, Protection and Maintenance

F. Manufacturer's Field Quality Control Services

G. Special Tools and Lubricating Equipment

H. Lubrication

1.2 DESCRIPTION

A. Proposed Manufacturers List: Within 15 calendar days of the date of the Notice to Proceed, submit to the ENGINEER a list of the names of proposed manufacturers, materialmen, suppliers and subcontractors, obtain approval of this list by OWNER prior to submission of any shop drawings. Upon request submit evidence to ENGINEER that each proposed manufacturer has manufactured a similar product to the one specified and that it has previously been used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

B. Furnish and install Material and Equipment which meets the following:

1. Conforms to applicable specifications and standards.

2. Complies with size, make, type, and quality specified or as specifically approved, in writing, by ENGINEER.

3. Will fit into the space provided with sufficient room for operation and maintenance access and for properly connecting piping, ducts and services, as applicable. Make the clear spaces that will be available for operation and maintenance access and connections equal to or greater than those shown

and meeting all the manufacturers' requirements. Make all provisions for installing equipment furnished at no increase in Contract Price.

4. Manufactured and fabricated in accordance with the following:

    a. Design, fabricate, and assemble in accordance with best engineering and shop practices.

    b. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.

    c. Provide two or more items of same kind identical, by same manufacturer.

    d. Provide materials and equipment suitable for service conditions.

    e. Adhere to equipment capabilities, sizes, and dimensions shown or specified unless variations are specifically approved, in writing, in accordance with the Contract Documents.

    f. Adapt equipment to best economy in power consumption and maintenance. Proportion parts and components for stresses that may occur during continuous or intermittent operation, and for any additional stresses that may occur during fabrication or installation.

    g. Working parts are readily accessible for inspection and repair, easily duplicated and replaced.

5. Use material or equipment only for the purpose for which it is designed or specified.

6. Whenever materials and equipment are specified in both descriptive terms and by the manufacturer’s or supplier’s product name, model number, catalog number, and the like and there appears to be a conflict between the descriptions and the manufacturer’s or supplier’s number or name for the product, the descriptions shall govern.

7. Provide equipment that is safeguarded in accordance with applicable federal, state and local codes.

8. Provide materials and equipment whose protruding members, joints, corners, gear covers, and the like are finished in appearance. Grind smooth all exposed welds and miter the corners of structural shapes.

1.3 SUBSTITUTIONS

A. Substitutions:

1. CONTRACTOR'S requests for changes in equipment and materials from those required by the Contract Documents are considered requests for substitutions and are subject to CONTRACTOR'S representations and review provisions of the Contract Documents when one of following conditions are satisfied:

a. Where request is directly related to an "or equal" clause or other language of same effect in Specifications.

b. Where required equipment or material cannot be provided within Contract Time, but not as result of CONTRACTOR'S failure to pursue Work promptly or to coordinate various activities properly.

c. Where required equipment or material cannot be provided in manner compatible with other materials of Work, or cannot be properly coordinated therewith.

2. CONTRACTOR'S Options:

a. Where more than one choice is available as options for CONTRACTOR'S selection of equipment or material, select option compatible with other equipment and materials already selected (which may have been from among options for other equipment and materials).

b. Where compliance with specified standard, code or regulation is required, select from among products which comply with requirements of those standards, codes, and regulations.

c. "Or Equal": For equipment or materials specified by naming one or more equipment manufacturer and "or equal", submit request for substitution for any equipment or manufacturer not specifically named.

B. Conditions Which are Not Substitution:

1. Requirements for substitutions do not apply to CONTRACTOR options on materials and equipment provided for in the Specifications.

2. Revisions to Contract Documents, where requested by OWNER or ENGINEER, are "changes" not "substitutions".

3. CONTRACTOR'S determination of and compliance with governing regulations and orders issued by governing authorities do not constitute substitutions and do not constitute basis for a Change Order, except as provided for in Contract Documents.

1.4 MANUFACTURER'S WRITTEN INSTRUCTIONS

A. Instruction Distribution: When the Contract Documents require that installation, storage, maintenance and handling of equipment and materials comply with manufacturer's written instructions, obtain and distribute printed copies of such instructions to parties involved in installation, including six copies to ENGINEER.

1. Maintain one set of complete instructions at jobsite during storage and installation, and until completion of work.

B. Manufacturer's Requirements: Store, maintain, handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's written instructions and in conformity with Specifications.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult ENGINEER for further instructions.

2. Do not proceed with work without written instructions.

C. Performance Procedures: Perform work in accordance with manufacturer's written instructions. Do not omit preparatory steps or installation procedures, unless specifically modified or exempted by Contract Documents.

1.5 TRANSPORTATION AND HANDLING

A. Coordination with Schedule: Arrange deliveries of materials and equipment in accordance with Construction Progress Schedules. Coordinate to avoid conflict with work and conditions at site.

1. Deliver materials and equipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Protect bright machined surfaces, such as shafts and valve faces, with a heavy coat of grease prior to shipment.

3. Immediately upon delivery, inspect shipments to determine compliance with requirements of Contract Documents and approved submittals and that material and equipment are protected and undamaged.

B. Handling: Provide equipment and personnel to handle material and equipment by methods recommended by manufacturer to prevent soiling or damage to materials and equipment or packaging.

1.6 STORAGE, PROTECTION, AND MAINTENANCE

A. On-site storage areas and buildings:

1. Conform storage buildings to requirements of Section 01 50 00.

2. Coordinate location of storage areas with ENGINEER and OWNER.

3. Arrange on site storage areas for proper protection and segregation of stored materials and equipment with proper drainage. Provide for safe travel around storage areas and safe access to stored materials and equipment.

4. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

5. Store materials such as pipe, reinforcing and structural steel, and equipment on pallets, blocks or racks, off ground.

6. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment which are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

B. Interior Storage:

1. Store materials and equipment in accordance with manufacturer's instructions, with seals and labels intact and legible.

2. Store materials and equipment, subject to damage by elements, in weathertight enclosures.

3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

C. Accessible Storage: Arrange storage in a manner to provide easy access for inspection and inventory. Make periodic inspections of stored materials or equipment to assure that materials or equipment are maintained under specified conditions and free from damage or deterioration.

1. Perform maintenance on stored materials of equipment in accordance with manufacturer's instructions, in presence of OWNER or ENGINEER.

2. Submit a report of completed maintenance to ENGINEER with each Application for Payment.

3. Failure to perform maintenance, to notify ENGINEER of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

D. OWNER'S Responsibility: OWNER assumes no responsibility for materials or equipment stored in buildings or on-site. CONTRACTOR assumes full responsibility for damage due to storage of materials or equipment.

E. CONTRACTOR'S Responsibility: CONTRACTOR assumes full responsibility for protection of completed construction. Repair and restore damage to completed Work equal to its original condition.

F. Special Equipment: Use only rubber tired wheelbarrows, buggies, trucks, or dollies to wheel loads over finished floors, regardless if the floor has been protected or not. This applies to finished floors and to exposed concrete floors as well as those covered with composition tile or other applied surfacing.

G. Surface Damage: Where structural concrete is also the finished surface, take care to avoid marking or damaging surface.

1.7 MANUFACTURER'S FIELD QUALITY CONTROL SERVICES

A. General:

1. Provide manufacturer's field services in accordance with this subsection for those tasks specified in other sections.

2. Provide training as specified in Section 01 79 00.

3. Include and pay all costs for suppliers' and manufacturers' services, including, but not limited to, those specified.

B. Installation Instruction: Provide instruction by competent and experienced technical representatives of equipment manufacturers or system suppliers as necessary to resolve assembly or installation procedures which are attributable to, or associated with, the equipment furnished.

C. Installation Inspection, Adjustments and Startup Participation:

1. Provide competent and experienced technical representatives of equipment manufacturers or system suppliers to inspect the completed installation as follows.

a. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

b. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

c. Verify that wiring and support components for equipment are complete.

d. Verify that equipment or system is installed in accordance with the manufacturer's recommendations, approved shop drawings and the Contract Documents.

e. Verify that nothing in the installation voids any warranty.

2. Provide manufacturer's representatives to perform initial equipment and system adjustment and calibration conforming to the manufacturer's recommendations and instructions, approved shop drawings and the Contract Documents.

3. Obtain ENGINEER'S approval before start-up of equipment. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.

4. Furnish ENGINEER with three copies of the following. When training is specified, furnish the copies at least 24 hours prior to training.

   a. "Certificate of Installation, Inspection and Start-up Services" by manufacturers' representatives for each piece of equipment and each system specified, certifying:

      (1) That equipment is installed in accordance with the manufacturers' recommendations, approved shop drawings and the Contract Documents.

      (2) That nothing in the installation voids any warranty.

      (3) That equipment has been operated in the presence of the manufacturer's representative.

      (4) That equipment, as installed, is ready to be operated by others.

   b. Detailed report by manufacturers' representatives, for review by ENGINEER of the installation, inspection and start-up services performed, including:

      (1) Description of calibration and adjustments if made; if not in Operation and Maintenance Manuals, attach copy.

(2) Description of any parts replaced and why replaced.

(3) Type, brand name, and quantity of lubrication used, if any.

(4) General condition of equipment.

(5) Description of problems encountered, and corrective action taken.

(6) Any special instructions left with CONTRACTOR or ENGINEER.

D. Field Test Participation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to participate in field testing of the equipment specified in Section 01 45 00.

E. Trouble-Free Operation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to place the equipment in trouble-free operation after completion of start-up and field tests.

1.8 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. General: Furnish, per manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)

B. Time of Delivery: Deliver special tools and lubricating equipment to OWNER when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Quality: Provide tools and lubricating equipment of a quality meeting equipment manufacturer's requirements.

1.9 LUBRICATION

A. General: Where lubrication is required for proper operation of equipment, incorporate in the equipment the necessary and proper provisions in accordance with manufacturer's requirements. Where possible, make lubrication automated and positive.

B. Oil Reservoirs: Where oil is used, supply reservoir of sufficient capacity to lubricate unit for a 24-hour period.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

CERTIFICATE OF INSTALLATION, INSPECTION AND START-UP SERVICES

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify that the named equipment has been inspected, adjusted and operated by the Manufacturers' Representative and further certify:

1. That the equipment is installed in accordance with the manufacturer's recommendations, approved shop drawings and the Contract Documents.
2. That nothing in the installation voids any warranty.
3. That equipment has been operated in the presence of the manufacturer's representative.
4. That equipment, as installed, is ready to be operated by others.

MANUFACTURERS' REPRESENTATIVE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

Attach the detailed report called for by Specification Section 01 60 00.

Complete and submit three copies of this form with the detailed report to ENGINEER as specified.

SECTION 01 71 23

LINES AND GRADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General

B. Surveys

C. Datum Plane

D. Protection of Survey Data

1.2 GENERAL

A. Construct all work in accordance with the lines and grades shown on the Drawings. Assume full responsibility for keeping all alignment and grade.

1.3 SURVEYS

A. Control Points: Base horizontal and vertical control points will be established or designated by the ENGINEER and used as datum for the Work. Perform all additional survey, layout, and measurement work.

1. Keep ENGINEER informed, sufficiently in advance, of the times and places at which work is to be performed so that base horizontal and vertical control points may be established and any checking deemed necessary by ENGINEER may be done, with minimum inconvenience to the ENGINEER and at no delay to CONTRACTOR. It is the intention not to impede the Work for the establishment of control points and the checking of lines and grades set by the CONTRACTOR. However, when necessary, suspend working operations for such reasonable time as the ENGINEER may require for this purpose. Costs associated with such suspension are deemed to be included in the Contract Price, and no time extension or additional costs will be allowed.

2. Provide an experienced survey crew including an instrument operator, competent assistants, and any instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement of work performed by the CONTRACTOR.

1.4 DATUM PLANE

A. All elevations indicated or specified refer to the Mean Sea Level Datum Plane, 1988 General Adjustment, of the United States Coast and Geodetic Survey and are expressed in feet and decimal parts thereof, or in feet and inches.

1.5 PROTECTION OF SURVEY DATA

A. General: Safeguard all points, stakes, grade marks, known property corners, monuments, and bench marks made or established for the Work. Reestablish them if disturbed, and bear the entire expense of checking reestablished marks and rectifying work improperly installed.

B. Records: Keep neat and legible notes of measurements and calculations made in connection with the layout of the Work. Furnish copies of such data to the ENGINEER for use in checking the CONTRACTOR's layout. Data considered of value to the OWNER will be transmitted to the OWNER by the ENGINEER with other records on completion of the Work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Scheduling of Shutdown

1.2 RELATED SECTIONS

Related Work Specified in Other Sections Includes, but is Not Limited to, the Following

A. Section 01 11 00 - Summary of Work

1.3 GENERAL REQUIREMENTS

A. Coordination: Perform all cutting, fitting or patching of the Work that may be required to make the several parts thereof join in accordance with the Contract Documents. Perform restoration with competent workmen skilled in the trade.

B. Improperly Timed Work: Perform all cutting and patching required to install improperly timed work, to remove samples of installed materials for testing, and to provide for alteration of existing facilities or for the installation of new Work in the existing construction.

C. Limitations: Except when the cutting or removal of existing construction is specified or indicated, do not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without the ENGINEER's concurrence.

1.4 SCHEDULING OF SHUTDOWN

A. Connections to Existing Facilities: If any connections, replacement, or other work requiring the shutdown of an existing facility is necessary, schedule such work at times when the impact on the OWNER's normal operation is minimal. Overtime, night and weekend work without additional compensation from the OWNER, may be required to make these connections, especially if the connections are made at times other than those specified.

B. Request for Shutdowns: Submit a written request for each shutdown to the OWNER and the ENGINEER sufficiently in advance of any required shutdown.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Safeguards: Provide all shoring, bracing, supports, and protective devices necessary to safeguard all work and existing facilities during cutting and patching operations.

B. Location of Embedment's: Employ impulse radar (non x-ray type) nondestructive testing prior to core drilling or cutting of existing walls, floors and ceilings to identify location of embedded pipes or conduits.

C. Material Removal: Cut and remove all materials to the extent shown or as required to complete the Work. Remove materials in a careful manner with no damage to adjacent facilities. Remove materials which are not salvageable from the site.

3.2 RESTORATION

A. Final Appearance and Finish: Restore all work and existing facilities affected by cutting operations, with new materials, or with salvaged materials acceptable to the ENGINEER, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, patch and refinish entire surfaces.

END OF SECTION

SECTION 01 74 00

CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cleaning During Construction

B. Final Cleaning

C. Final Inspection

1.2 CLEANING DURING CONSTRUCTION

A. During construction of work, at all times, keep the site work and adjacent premises as free from material, debris, and rubbish as is practicable and remove it from any portion of the site, if in the opinion of the ENGINEER, such material, debris, or rubbish constitutes a nuisance or is objectionable.

B. Remove from the site all surplus materials and temporary structures when no further need therefore exists.

C. Immediately upon installation of any portion of the work, restore all fills, topsoil, and utilities to their location and condition prior to construction.

1.3 FINAL CLEANING

A. Requirements: At the completion of work and immediately prior to final inspection, clean the entire project as follows:

1. Thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. Leave the structures and site in a complete and finished condition to the satisfaction of the ENGINEER.

2. Direct all subcontractors to similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.

3. Remove all temporary structures and all debris, including dirt, sand, gravel, rubbish and waste material.

4. Should the CONTRACTOR not remove rubbish or debris or not clean the buildings and site as specified above, the OWNER reserves the right to have the cleaning done at the expense of the CONTRACTOR.

B. Employ experienced workers, or professional cleaners, for final cleaning.

C. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

E. 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.

F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.

G. Remove snow and ice from access to buildings.

H. Replace air-handling filters if units were operated during construction.

I. Clean ducts, blowers, and coils, if air-handling units were operated without filters during construction.

J. Vacuum clean all interior spaces, including inside cabinets.

K. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.

L. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

M. Clean interior of all panel cabinets, pull boxes, and other equipment enclosures.

N. Wash and wipe clean all lighting fixtures, lamps, and other electrical equipment which may have become soiled during installation.

O. Perform touch-up painting.

P. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

Q. Remove erection plant, tools, temporary structures and other materials.

R. Remove and dispose of all water, dirt, rubbish or any other foreign substances.

1.4 FINAL INSPECTION

A. After cleaning is complete the final inspection may be scheduled. The inspection will be done with the OWNER and ENGINEER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 78 00

CONTRACT CLOSE OUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Warranties and Bonds

B. Record Drawings

C. Special Tools

1.2 WARRANTIES AND BONDS

Prior to final payment deliver to the OWNER the original and one copy of all bonds, warranties, guarantees and similar documents, including those customarily provided by manufacturers and suppliers which cover a period greater than the one year correction period. Show OWNER as beneficiary of these documents.

1.3 RECORD DRAWINGS

At the site keep and maintain one record copy of all Contract Documents, reference documents and all technical documents submitted in good order. On Mylar tracing media, and using drafting symbols and standards consistent with the original documents, annotate Contract Drawings to show all changes made during the construction period. Annotated drawings are to be made available to ENGINEER for reference at all times.

At completion of the CONTRACT and before final payment is made, deliver to the ENGINEER one set of clearly readable, reproducible Contract Drawings reflecting all changes made during construction. Mark each drawing "Record Drawing" in ink.

1.4 SPECIAL TOOLS

Special tools are considered to be those tools which, because of their limited use, are not normally available but which are necessary for maintenance of particular equipment.

For each type of equipment provided under this CONTRACT, furnish a complete set of all special tools including grease guns and other lubricating devices, which may be needed for the adjustment, operation, maintenance, and disassembly of

such equipment. Furnish only tools of high grade, smooth forged alloy tool steel. Manufacture grease guns of the lever type.

Furnish and erect one or more neat and substantial steel wall cases or cabinets with flat key locks and clips or hooks to hold each special tool in a convenient arrangement.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: Furnish to the ENGINEER 3 hard copies and 6 electronic copies on compact disk (CD) of an Operation and Maintenance Manual for all equipment and associated control systems furnished and installed.

1.2 QUALITY ASSURANCE

A. Reference Codes and Specifications: No current government or commercial specifications or documents apply.

1.3 SUBMITTALS

A. Prior to the Work Reaching 50 Percent Completion, submit to the ENGINEER for approval two hard copies of the preliminary manual with all specified material for each piece of equipment provided as detailed in the subsequent specification sections. Submit the approval copies with the partial payment request for the specified completion. Furnish to the OWNER 3 copies of the CONTRACTOR's final project Operation and Maintenance manual after completion of equipment training. Provide space in the manual for additional material. Submit any missing material for the manual prior to requesting certification of substantial completion.

B. Prior to requesting a certificate of beneficial occupancy, the associated equipments' preliminary Operation and Maintenance manuals must be submitted and approved.

C. Provide 6 copies of the final CONTRACTOR's Operation and Maintenance manual electronically on CD complete after the submission of any missing material prior to requesting certification of substantial completion. CONTRACTOR shall ensure that all material required for a complete CONTRACTOR's Operation and Maintenance manual is included on the electronic copy. The electronic version of the final manual shall be submitted in the latest PDF file format and follow the same contents, organization and formatting as the final hardcopies of the manual. Provide final CONTRACTOR's Operation and Maintenance Manual after completion of equipment training.

1.4 FORMAT AND CONTENTS

A. Prepare and arrange each copy of the manual as follows:

1. One copy of an equipment data summary (see sample form) for each item of equipment which shall include the following as a minimum:

    a. Name and contact information of manufacturer.

    b. Name and contact information of local manufacturer representative.

    c. Equipment serial numbers.

    d. Equipment warranty information, including warranty start and end dates.

    e. Equipment layout drawings complete with as-built information and dimensions.

    f. Manufacturer's certificates of proper installation.

    g. Certified equipment test results (i.e. pump curves, load tests, etc…).

2. One copy of an equipment preventive maintenance data summary (see sample form) for each item of equipment.

3. One copy of equipment Antero nameplate and summary data (see sample form) for each item of equipment.

4. One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.

5. List of electrical relay settings and control and alarm contact settings.

6. Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems.

7. One valve schedule giving valve number, location, fluid, and fluid destination for each valve installed. Group all valves in same piping systems together in the schedule. Obtain a sample of the valve numbering system from the ENGINEER.

8. All information provided in the manual shall be modified so that it ONLY includes information pertaining to the approved equipment and shall accurately depict the equipment provided. All "optional" and non-pertinent

materials and information shall be excluded from the manual or noted as such.

9. Furnish all O&M Manual material on 8-1/2 by 11 commercially printed or typed forms or an acceptable alternative format.

B. Organize each manual into sections paralleling the equipment specifications. Identify each section using heavy section dividers with reinforced holes and numbered plastic index tabs. Use 3-ring, slant ring, hard-back binders Type No. AVE-VS11 as manufactured by Avery Company, or equal. Binder size shall be 3-inch maximum. Punch all loose data for binding. Arrange composition and printing so that punching does not obliterate any data. Print on the cover and binding edge of each manual the project title, and manual title, as furnished and approved by the ENGINEER.

C. Leave all operating and maintenance material that comes bound by the equipment manufacturer in its original bound state. Cross-reference the appropriate sections of the CONTRACTOR's O&M manual to the manufacturers' bound manuals.

D. Label binders Volume 1, 2, and so on, where more than one binder is required. Include the table of contents for the entire set, identified by volume number, in each binder.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

TMUA Southside Wastewater Treatment Plant
Digester Gas Improvements
TMUA Project Number: ES 2010-04 Contract 2

Equipment Name: Specification Reference:

Antero Number:

Vendor:

Manufacturer: Local Representative:

Name: Name:

Address: Address:

Telephone: Telephone:

Number Supplied: Location/Service:

Model No: Serial No:

Type:

Size/Speed/Capacity/Range (as applicable):

Power Requirement (Phase/Volts/Hertz):

Purchase Price:

Date placed in service:

Parts Associated/Details:

Maintenance Schedule:

If applicable Motor info:

Size/Speed/Capacity/Range (as applicable):

Power Requirement (Phase/Volts/Hertz):

TMUA Southside Wastewater Treatment Plant
Digester Gas Improvements
TMUA Project Number: ES 2010-04 Contract 2

Preventive Maintenance Summary

Equipment Name: Location:

Manufacturer:

Name:

Address:

Telephone:

Model No: Serial No:

Maintenance Task	Lubricant/Part	D	W	M	Q	SA	A	O&M Manual Reference

NOTES:

*D-Daily W-Weekly M-Monthly Q-Quarterly SA-Semi-Annual A-Annual

ANTERO NAMEPLATE AND SUMMARY DATA

Antero Number: _____

Description: _____

Submittal Date: _____

Project #: _____

Spec. #: _____

Vendor: _____

Manufacturer: _____

Model #: _____

Serial #: _____

Purchase Price: $_____

Date Placed in Service: _____

Training Date: _____

Warranty Start Date: _____

Parts Associated/Details: _____

_____

_____

_____

Maintenance Schedule (Summarized from O&M Manual)

- ✓ Initial: _____
- ✓ Weekly: _____
- ✓ Monthly: _____
- ✓ Semi-Annual: _____
- ✓ Annual: _____

Applicable Motor Information: N.A. (Circle if not applicable)

Vendor: _____

Manufacturer: _____

Model #: _____

Serial #: _____

Frame: _____ Insul. Class: __ _____

Volts/Hz/Amps: _____

HP / RPM / SF: _____

(NO TEXT FOR THIS PAGE)

SECTION 01 79 00

TRAINING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Training

1.2 TRAINING

A. Training: Provide the services of knowledgeable, technically competent, factory trained specialists to instruct Plant personnel in the operation and maintenance of the equipment and system components listed in Paragraph B. The OWNER will furnish training classroom space.

1. Coordinate services with the OWNER, with a minimum of 30 days prior notice.

2. Provide a combination of classroom and "hands-on" instruction designed to completely familiarize operating and maintenance personnel with the systems theory, standard operating procedures, safety features and emergency procedures, and general maintenance of all components. The classroom setting will be followed up with a site visit to the equipment's location and continue training with additional "hands-on" instruction as appropriate and coordinated with the authority.

3. Conduct all training at the Plant on Wednesdays, as directed by Authority.

4. Provide final Operation and Maintenance Manual only after completion of training.

B. Provide two training sessions for the specified equipment below on different days as coordinated with the Authority:

Specification	Equipment Name	Minimum Hours
40 05 20	Valves (Diversion Valve)	4

C. Length of Training: The minimum lengths of training for one session are listed in Paragraph B. above.

D. Credentials: Submit for approval, credentials of equipment manufacturer representatives who are to be course instructors at least 30 days prior to a proposed training session.

E. Scheduling: Submit training outline and other information described in paragraphs G through K for approval at least 30 days prior to the proposed date for the training sessions. Verify scheduling with the OWNER at least 30 days prior to the training sessions.

F. Number of Copies: For each training class, provide instructional material including detailed drawings for at least ten attendees plus five extra copies, plus duplicate copies of all audio-visual aids utilized during each training course.

G. Training Outline Submission: Provide a proposed training outline including the topics presented in Paragraph K. Identify specific components and procedures in the proposed training outline.

H. Training Topic Detail: Detail specific training topics. Describe "hands-on" demonstrations planned for the training. Reference training aids to be utilized in the training (i.e. video tapes, slides, transparencies) and attach where applicable.

I. Training Handouts: Attach training handouts to the proposed training outline.

J. Training Segment Duration: Indicate the duration of each training segment.

K. Training Outline:

1. Equipment Operation

    a. Describe equipment's operating (process) function.

    b. Describe equipment's fundamental operating principles and dynamics.

    c. Identify equipment's mechanical, electrical and electronic components and features.

    d. Identify all support equipment associated with the operation of the subject equipment.

2. Detailed Component Description

    a. Identify and describe in detail each component's function.

    b. Where applicable, group related components into subsystems.

    c. Identify, and describe in detail, equipment safety features and control interlocks.

3. Equipment Preventive Maintenance

   a. Describe preventive maintenance inspection procedures required to perform and inspect the equipment in operation, and spot potential trouble symptoms (anticipate breakdowns).

   b. Outline recommended routine lubrication and adjustments (preventive maintenance).

4. Equipment Troubleshooting

   a. Define recommended systematic troubleshooting procedures.

   b. Provide component specific troubleshooting checklists.

   c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

5. Equipment Corrective Maintenance

   a. Describe recommended equipment preparation requirements.

   b. Identify and describe the use of special tools required for maintenance of the equipment.

   c. Describe component removal/installation and disassembly/ assembly procedures.

   d. Perform at least two "hands-on" demonstrations of common corrective maintenance repairs.

   e. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

   f. Define recommended torquing, mounting, calibration, and alignment procedures and settings, as appropriate.

   g. Describe recommended procedures to check/test equipment following corrective repair.

L. Certificate: Provide "Certificate of Instructional Services" signed by CONTRACTOR and manufacturer's representative, verifying that training has been accomplished to satisfaction of all parties. Use form provided in this section, and furnish ENGINEER with three copies.

M. Substantial Completion: Training provided by manufacturers' representative and OWNER does not constitute substantial completion.

N. Equipment Use: Use of equipment for training will not void manufacturers' or contract warranties.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

CERTIFICATE OF INSTRUCTIONAL SERVICES

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify the equipment Manufacturers' Representative has instructed OWNER's personnel in startup operation and maintenance of this equipment as required in the Contract Documents.

MANUFACTURER'S REPRESENTATIVE

Signature _____

Name: (print) _____

Title: _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

COMMENTS:

Complete and submit three copies of this form to ENGINEER upon completion of training as required by Specification Section 01 79 00.

(NO TEXT FOR THIS PAGE)

SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: All work necessary for the removal and disposal of buildings, structures, foundations, piping, equipment and roadways, or any part thereof including masonry, steel, reinforced concrete, plain concrete, electrical facilities, and any other material or equipment shown or specified to be removed.

B. Basic Procedures and Schedule: Carry out demolition so that adjacent structures, which are to remain, are not endangered. Schedule the work so as not to interfere with the day to day operation of the existing facilities. Do not block doorways or passageways in existing facilities.

C. Additional Requirements: Provide dust control and make provisions for safety.

1.2 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

B. Site Inspection: Visit the site and inspect all existing structures. Observe and record any defects which may exist in buildings or structures adjacent to but not directly affected by the demolition work. Provide the OWNER with a copy of this inspection record and obtain the OWNER's approval prior to commencing the demolition.

1.3 QUALITY ASSURANCE

A. Limits: Exercise care to break concrete well for removal in reasonably small masses. Where only parts of a structure are to be removed, cut the concrete along limiting lines with a suitable saw so that damage to the remaining structure is held to a minimum.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION OF EXISTING DRAWINGS

A. Drawings of existing structures and equipment will be available for inspection at the office of the OWNER.

3.2 PROTECTION

A. General Safety: Provide warning signs, protective barriers, and warning lights as necessary adjacent to the work as approved or required. Maintain these items during the demolition period.

B. Existing Services: Undertake no demolition work until all mechanical and electrical services affected by the work have been properly disconnected. Cap, reroute or reconnect interconnecting piping or electrical services that are to remain in service either permanently or temporarily in a manner that will not interfere with the operation of the remaining facilities.

C. Hazards: Perform testing and air purging where the presence of hazardous chemicals, gases, flammable materials or other dangerous substances is apparent or suspected, and eliminate the hazard before demolition is started.

3.3 DEMOLITION REQUIREMENTS

A. Explosives: The use of explosives will not be permitted.

B. Protection: Carefully protect all mechanical and electrical equipment against dust and debris.

C. Removal: Remove all debris from the structures during demolition and do not allow debris to accumulate in piles.

D. Access: Provide safe access to and egress from all working areas at all times with adequate protection from falling material.

E. Protection: Provide adequate scaffolding, shoring, bracing railings, toe boards and protective covering during demolition to protect personnel and equipment against injury or damage. Cover floor openings not used for material drops with material substantial enough to support any loads placed on it. Properly secure the covers to prevent accidental movement.

F. Lighting: Provide adequate lighting at all times during demolition.

G. Closed Areas: Close areas below demolition work to anyone while removal is in progress.

H. Material Drops: Do not drop any material to any point lying outside the exterior walls of the structure unless the area is effectively protected.

3.4 DISPOSAL OF MATERIALS

A. Final Removal: Remove all debris, rubbish, scrap pieces, equipment, and materials resulting from the demolition unless otherwise indicated. Take title to all demolished materials and remove such items from the site.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 10 00

CONCRETE FORMWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Provide concrete formwork for structural concrete as specified to form concrete to profiles shown.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 20 00 - Concrete Reinforcement
2. Section 03 15 00 - Concrete Accessories
3. Section 03 31 00 - Cast-In-Place Concrete

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ACI 318 - Building Code Requirements for Reinforced Concrete
2. ACI SP-4 - Formwork for Concrete
3. ACI 303R - Guide to Cast-in-Place Architectural Concrete
4. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials
5. ACI 301- Specifications for Structural Concrete for Buildings
6. ACI 347- Recommended Practice for Concrete Formwork

1.3 SUBMITTALS

A. Construction Joints: Submit diagrams of construction joints.

B. Product Data:

1. Form oil
2. Form release agent
3. Form sealer

1.4 QUALITY ASSURANCE

A. Formwork Compliance: Use formwork complying with ACI SP-4 and ACI 303R.

B. Design and construct forms to withstand stresses due to weight of fresh concrete, vibration during consolidation and loads of equipment and workmen. Comply with ACI 318.

C. Limit deflections of forms to provide smooth, straight surfaces without unsightly bulges and deformations.

1.5 DELIVERY, STORAGE AND PROTECTION

A. Store materials off of the ground and protected from weather.

1. Prevent warpage, twisting and excessive moisture gain of wood materials.
2. Discard damaged or deformed materials.

B. Protect smooth faces of form liner materials from abrasion, denting or scarring during handling.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Release Agent
   Magic Kote VOC by Symons Corporation
2. Form coating
   A.C. Horn Corporation, Brooklyn, NY
3. Form liners
   Dura-Tex by Symons Corporation, Des Plaines, IL
4. Form ties
   a. Water Retaining Structures and Below Grade Structures: Symons, S-Panel Ties, or equal, with water seal and one (1) inch break back cones on both tie ends, shall be used on all wall forms.
   b. Other Structures: Symons, S-Panel Ties, or equal, with one (1) inch break back cones on both tie ends, unless otherwise called out or shown in the DRAWINGS or approved by ENGINEER, shall be used on all wall forms.
5. Rustications
   Symons Corporation, Des Plaines, IL

2.2 MATERIALS

A. Forms for unexposed concrete surfaces: plywood, lumber, metal or another acceptable material. Provide lumber dressed on at least two edges and one for tight fit.

B. Forms for concrete surfaces exposed to view: plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth exposed surfaces. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown on drawings. For plywood, use one of the following:

1. Overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
2. Concrete form plywood, complying with U.S. Product Standard PS-1 "B-B Plywood, Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

C. Forms for sidewalks and paving: nominal 2-inch thick wood or steel secured in place by stakes or pins.

D. Structural Concrete: Provide structural concrete form materials as follows:

1. Obtain approval for form material before construction of the forms.

2. Use a barrier type form release agent.

3. Use form ties, hangers, and clamps of such type that, after removal of the forms, no metal will be closer than 1.5 inch from concrete surface. Wire ties will not be permitted.

4. Provide ties with swaged washers or other suitable devices to prevent seepage of moisture along the ties. Leave the ties in place.

5. Twisted Wire Ties: Twisted wire ties with loops to hold forms in position are not permitted.

6. Use lugs, cones, washers, or other devices which do not leave holes or depressions greater than 7/8-inch in diameter.

PART 3 EXECUTION

3.1 DESIGN

A. Design Responsibility: Be responsible for the design, engineering and construction of the architectural concrete formwork and the structural concrete formwork. Conform the work to the recommendations of ACI SP-4 and ACI 303R.

B. Setting Time and Slag Use: The presence of fly ash or ground granulated blast furnace slag in the concrete mix for architectural concrete and structural concrete will delay the setting time. Take this into consideration in the design and removal of the forms.

C. Responsibility during Placement: Assume and take sole responsibility for adequate design of all form elements for support of the wet concrete mixtures specified and delivered.

D. Consistency: Design forms to produce concrete members identical in shape, lines and dimensions to members shown.

3.2 CONSTRUCTION DETAILS FOR FORMWORK

A. Structural Concrete Details: Follow the following details for all structural concrete:

1. Provide forms which are substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subjected. Make forms sufficiently tight to prevent leakage of concrete.

2. Determine the size and spacing of studs and wales by the nature of the work and the height to which concrete is placed. Make forms adequate to produce true, smooth surfaces with not more than 1/8-inch variation in either direction from a geometrical plane. Provide horizontal joints which are level, and vertical joints which are plumb.

3. Supply forms for repeated use in sufficient number to ensure the required rate of progress.

4. Thoroughly clean all forms before reuse and inspect forms immediately before concrete is placed. Remove deformed, broken, or defective forms from the work.

5. Provide temporary openings in forms at convenient locations to facilitate cleaning and inspection.

6. Coat the entire inside surfaces of forms with a suitable form release agent just prior to placing concrete. Form release agent is not permitted on the reinforcing steel.

7. Assume and take responsibility for the adequacy of all forms and remedying any defects resulting from their use.

B. Construction Joints:

1. Locate construction joints only where required as shown on submittals.
   a. Construction joints shall be plumb and level. In order to avoid irregular lines at horizontal construction joints in exposed concrete faces, tack a continuous strip of dressed lumber, one inch thick, to inside of wall or grade beam form, with its lower edge at line of construction joint. About one hour after placing concrete in lower part of wall or grade beam, remove strip, level off irregularities which appear in joint line with wood float and remove any laitance present.
   b. Provide shear keys and waterstops as required in construction joints.

3.3 FORM REMOVAL

A. Structural Concrete Form Removal: Do not remove forms for structural concrete until the concrete has hardened sufficiently to support its own load safely, plus any superimposed load that might be placed thereon. Leave the forms in place for the minimum length of time indicated below or until the concrete has reached the minimum strength indicated as determined by testing, whichever time is reached first.

1. The times indicated represent cumulative days or hours, not necessarily consecutive, during which the air surrounding the concrete is above 50 degrees F. These times may be decreased if reshores are installed.

		Minimum Time	Minimum Strength (psi)
a.	Columns	24 hrs.	1800
b.			
c.	Side forms for girders and beams	24 hrs.	1800
d.	Walls	24 hrs.	1800

		Minimum Time	Minimum Strength (psi)
e.	Bottom forms of slabs		
	Under 10 feet clear span	4 days	2300
	10 to 20 feet clear span	7 days	2700
	Over 20 feet clear span	10 days	2900
f.	Bottom forms of beams and girders		
	Under 10 feet clear span	7 days	2700
	10 to 20 feet clear span	14 days	3000
	Over 20 feet clear span	21 days	3500

2. Increase form removal times as required if concrete temperature following placement is permitted to drop below 50 degrees F or if fly ash or ground granulated blast furnace slag is used in the concrete mix.

3. Withdraw the removable portion of form ties from the concrete immediately after the forms are removed. Clean and fill holes left by such ties with grout as specified in Cast-In-Place Concrete, Subsection Structural Concrete Surfaces.

4. Plug tie holes flush with the surface using portland cement mortar. Prewet tie holes with clean water and apply a neat cement slurry bond coat. Densely tamp mortar of a dry-tamp consistency into the tie holes exercising care so as not to smear mortar onto the finished concrete surface. Include sufficient white cement in the mortar mix to cause the plugged holes to blend in with the adjacent surfaces. Make sample patches with different mixes to assure that this requirement is met.

3.4 RESHORING

A. Reshoring Method: Develop a system for reshoring and early removal of forms, in the event early stripping of forms becomes necessary. Include details and schedules in this system for each element which is to be reshored.

B. Construction Load Support: Do not support construction loads upon any unshored portion of the structure exceeding the structural design loads.

3.5 TOLERANCES

A. Tolerance Limits: Design, construct and maintain concrete form and place the concrete to provide completed concrete work within the tolerance limits set forth in ACI SP-4.

3.6 SURVEY OF FORMWORK

A. Field Survey: Employ an engineer or surveyor to check by instrument survey the lines and levels of the completed formwork before concrete is placed and make whatever corrections or adjustment to the formwork are necessary to correct deviations from the specified tolerances.

B. Placement Surveying Requirements: Check formwork during the placement of the concrete to verify that the forms, braces, tie rods, clamps anchor bolts, conduits, piping, and the like, have not been knocked out of the established line, level or cross section by concrete placement or equipment.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 15 00

CONCRETE ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing concrete accessories shown and specified herein such as waterstops, dovetail anchor slots, cast-in-place reglets, inserts, joint filler, preformed joint seal, joint sealant and neoprene pads.

B. Products Installed: Waterstops, dovetail anchor slots, cast-in-place reglets, inserts, joint filler, preformed joint seal, joint sealant and neoprene pads.

C. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 20 00 - Concrete Reinforcement
3. Section 03 31 00 - Cast-in-Place Concrete

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AASHTO - Standard Specifications for Highway Bridges

2. ASTM A 240 - Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

3. ASTM A 536 - Standard Specifications for Ductile-Iron Castings

4. ASTM D 412 - Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension

5. ASTM D 3545 - Test Methods for Alcohol Content and Purity of Acetate esters by Gas Chromatography

6. ASTM D 3575 - Test Methods for Flexible Cellular Materials Made From Olefin Polymers

7. CRD-C513 - Specifications for Rubber Waterstops

8. CRD-C572 - Specifications for Polyvinyl Chloride Waterstop

9. Fed. Spec. TT-S-00227 - Sealing Compound, Elastomeric Type, Multicomponent (for Calking, Sealing, and Glazing in Buildings and Other Structures)

10. Fed. Spec. TT-S-00230 - Sealing Compound, Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures)

1.3 SUBMITTALS

A. General: Provide all Work related submittals, including the following, as specified in Division 1.

B. Product Data and Information:

1. Manufacturer's Data and Specifications: Submit printed manufacturer's data and specifications for each item used on this project.

2. Samples: Provide one sample of each item used.

3. Joint Sealant and Preformed Joint Seal: Indicate special procedures, surface preparation and perimeter conditions requiring special attention. All products in contact with potable water, shall be "NSF Standard 61" certified. Submit certified material records indicating approval for use with potable water.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 and as follows:

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Joint Filler

a. Sonoflex F Foam by Sonneborn Building Products

b. PVC Joint Filler No. 327 by A.C. Horn

2. Sealant Backup Material

a. Sealtight Backer Rod
b. Sonofoam Backer Rod

3. Preformed Joint Seal

a. Evazote 380, ESF by Epoxy Industries

4. Wedge Inserts

a. Type F-7 by Dayton Superior, Miamisburg, OH

5. Dovetail Anchor

a. A.A. Wire Products Co.
b. Dur-O-Wal Inc.

6. Flashing Reglets

a. Standard reglets by Beehive Anchoring System

2.2 MATERIALS

A. Extruded Waterstops: Provide waterstops made of extruded polyvinyl chloride unless otherwise shown or specified.

1. Do not use any reclaimed plastic material in their manufacture.

2. Provide plastic waterstops meeting the requirements of CRD-C572, except as modified herein. Provide a Shore A/10 durometer hardness between 73 and 79, the tensile strength not less than 1850 psi, and specific gravity not more than 1.38.

3. Unless otherwise shown, use waterstops for construction joints which are flat, at least 6 inches wide, and not less than 3/8-inch thick at the thinnest section. Provide these waterstops with ribbed longitudinal strips.

4. Unless otherwise shown, provide waterstops for expansion joints at least 9 inches wide and not less than 1/4-inch thick at the narrowest point and not less than 3/8-inch thick immediately adjacent to the center of the waterstop. Provide the waterstop with ribbed longitudinal strips with a 3/4-inch inside diameter hollow bulb center. Limit joint movement to 1/4-inch under a tensile force of not more than 500 pounds per lineal inch.

B. Stainless Steel Waterstops: Provide stainless steel waterstops where shown or specified.

1. Fabricate stainless steel waterstops from ASTM A 240 Type 316, 20 gauge stainless steel, conforming to the dimensions and profiles shown.

2. Prefabricate and miter corners and intersections for all stainless steel waterstops. Make only butt joints in the field.

C. Rubber Waterstops: Provide rubber water stops where shown or specified.

1. Provide rubber water stops of either the molded or extruded type, fabricated from a high grade tread type compound, either SBR or natural rubber, conforming to CRD-C513.

2. Provide water stops for construction joints at least 6 inches wide and 3/8-inch thick and with solid end bulbs 3/4-inch in diameter.

3. Provide water stops for expansion joints 9 inches wide and 3/8-inch thick and with solid end bulbs 1-inch in diameter and a hollow center bulb 1-1/2 inches in diameter with a 3/4-inch diameter center cavity.

D. Expansion Joint Filler: Use joint filler for all expansion joints.

1. Provide a closed cell polyethylene or PVC joint filler of the thickness shown.

E. Joint Sealant Requirements: Finish expansion joints with a joint sealant where shown or specified.

1. Joint sealant materials may be either a single component urethane compound meeting the requirements of Fed. Spec. TT-S-00230C, or a 2-component urethane compound meeting the requirements of Fed. Spec. TT-S-00227E, except as modified in this specification.

2. Provide the urethane sealant of 100 percent polymer, non-extended, containing no solvent, lime, or coal tar. Color as selected by the ENGINEER, but not black. Conform sealant properties to the following:

	Property	Value	Test Method
a.	Maximum final cure	3 days	--
b.	Minimum tensile strength	140 to 200 psi	ASTM D 412
c.	Minimum elongation	400%	ASTM D 412

d.	Modulus at 100% elongation	40-60 psi	ASTM D 412
e.	Shore A hardness	25-40	ASTM D 2240
f.	Solid content	98-100%	--
g.	Peel strength	20-40 lb/in.	Fed. Spec. TT-S-00230C Fed. Spec. TT-S-00227E
h.	Minimum recovery	80-90%	Fed. Spec. TT-S-00230C Fed. Spec. TT-S-00227E
i.	Initial tack-free cure	24-48 hrs.	Fed. Spec. TT-S-00230C Fed. Spec. TT-S-00227E

3. Provide primer as recommended by the manufacturer of the sealant, subject to approval.

4. Provide fillers and backup materials in contact with sealant which are nonimpregnated and free from asphalt, creosote, oil or extractable plasticizers. Use a backup material of a closed cell polyethylene foam rod with a diameter 1/4-inch larger than the joint width.

F. Preformed Joint Seal: Provide a preformed joint seal where shown or specified.

1. Provide joint material which is resilient, non-extrudable, impermeable, closed-cell, cross-linked, ethylene vinyl acetate, low density, polyethylene copolymer, nitrogen blown material which is ultraviolet light, weather and wear resistant, and which is concrete beige in color.

2. Conform material properties with the following:

	Property	Value	Test Method
a.	Density, pcf	2.8 to 3.4	ASTM D 3575 Suffix: W, Method A
b.	Water Absorption total immersion 3 months	0.02% by volume	ASTM D 3575 Suffix: L
c.	Tensile Strength	125 psi	ASTM D 3575 Suffix: T
d.	Elongation before breaking	255%	ASTM D 3575 Suffix: T
e.	Working Temperature	-94 to 160 F	--

G. Neoprene Pads: Use neoprene pads as shown or required where slabs or beams must be prevented from bonding to footings, walls, columns or other rigid parts of the structure.

1. Use neoprene pads of a structural grade meeting the requirements of Section 25, Division 2 of the AASHTO Standard Specifications for Highway Bridges.

2. Do not use neoprene pads thinner than 1/4-inch.

H. Wedge Inserts: Make wedge inserts for 5/8-inch and 3/4-inch bolts of ductile iron conforming to ASTM A 536.

I. Dovetail Anchors: Provide dovetail anchors of one of the following types:

1. Dovetail anchors having a 3/16-inch by 1-inch by 1/2-inch stainless steel dovetail section with 3/16-inch diameter stainless steel wire.

2. Dovetail anchor slots of 24 gauge galvanized steel 1-inch by 1-inch by 5/8-inch throat. Fill anchor slots.

J. Flashing Reglets: Provide flashing reglets of 24 gauge galvanized steel foam filled reglets.

PART 3 EXECUTION

3.1 INSTALLING OF WATERSTOPS

A. Assembly of Extruded Waterstops: Prefabricate corners and intersections for all waterstops. Make only butt joints in the field. Miter and assemble corners and intersections with approved equipment, as described for field joints.

1. Make field joints by cutting the ends of the sections to be spliced so they will form a smooth even butt joint. Heat the cut ends with the splicing tool until the plastic melts. Press the two ends together until the plastic cools. Do splicing in a way that limits damage to the continuity of the ribbed strips.

2. Carry waterstops in the walls into lower slabs and join them to the waterstops in the slabs. Make all waterstops continuous. Set waterstops accurately to the position and line shown. Hold edges securely fixed in position at intervals of not more than 24 inches so that they will not move during the placing of the concrete. Do not drive nails through the waterstops.

B. Prefabricated Stainless Steel Waterstops: Prefabricate corners and intersections for all stainless steel waterstops. Make only butt joints in the field. Miter and weld corners and intersections.

1. Provide field joints having a nominal 1-inch lap joint, with the exposed edge welded or brazed on each side.

2. Make field joints with PVC waterstops as shown.

3. At expansion joints, seal the base of the expansion section of the waterstop with at least one layer of 2-inch wide duct tape.

4. Carry waterstops in the walls into lower slabs and join them to the waterstops in the slabs. Make all waterstops continuous. Set waterstops accurately to the position and line shown. Hold edges securely fixed in position at intervals of not more than 24 inches so that they will not move during the placing of the concrete. Do not drive nails through the waterstops.

C. Splices: Use splices made in the manufacturer's plant where possible for rubber waterstops.

1. Use a preformed rubber union or fitting and splicing cement as recommended by the manufacturer when splices are made.

2. Carry waterstops in the walls into lower slabs and join them to the waterstops in the slabs. Make all waterstops continuous. Set waterstops accurately to the position and line shown. Hold edges securely fixed in position at intervals of not more than 24 inches so that they will not move during the placing of the concrete. Do not drive nails through the waterstops.

D. Joint Filler Placement: Place joint filler for expansion joints against the completed portion of the work before the concrete for the next section is placed.

1. Fasten the filler to the hardened concrete with a compatible adhesive in accordance with manufacturer's instructions. Extend the filler through the thickness of the wall or slab and make it flush with the finished surface, except where a preformed joint seal or joint sealant is shown.

2. In joints having a waterstop, fit the filler accurately on each side of the waterstop to prevent the intrusion of concrete.

E. Preparation of 2-Component Sealants: Mix 2-component joint sealant using a slotted paddle and slow speed mixer for 5 to 8 minutes, continually working paddle from top to bottom until the sealant color is uniform. Scrape down the side of the container and paddle blade several times during the mixing operation to ensure uniform mixing.

1. Properly prepare joint surfaces by removing all foreign matter and concrete laitance so that concrete surfaces are structurally sound, clean, dry, and free of all oil, grease, wax, waterproofing compounds or form release materials prior to the application of primer and sealant.

2. Prime all concrete joint surfaces and all surfaces exposed to water prior to sealing, with no exceptions. Prime all other surfaces as recommended by the manufacturer of the sealant. Provide the prime as recommended by the manufacturer of the sealant, subject to approval. Apply the primer by either brushing or spraying on the joint surfaces. Apply and install the sealant within 2 to 24 hours after the application of primer.

3. For horizontal joints, install the sealant by pouring directly from a suitable shaped can or by flowing from a bulk-loading gun.

4. Fill vertical joints from a gun, starting from the bottom, to avoid bridging and the formation of air voids.

5. Fill overhead joints from a gun, by laying a bead along each side of the joint and then filling the middle. Immediately after installation, tool in the sealant in order to establish firm contact with joint surfaces and to provide a smooth sealant surface. Tool in accordance with the manufacturer's instructions.

6. Control joint depth with the use of joint fillers and backup materials. Make joint widths and sealant depths as shown. Do not exceed 1/2-inch for sealant depth.

F. Preformed Joint Seal Surface Preparation: Properly prepare joint surfaces by removing all foreign matter and concrete laitance so that concrete surfaces are structurally sound, clean, dry, and free of all oil, grease, wax, water-proofing compounds or form release materials.

1. Blast clean or saw cut all existing concrete surfaces to expose a clean bare concrete surface. Allow new concrete to be well cured, and attain a minimum of 80 percent of the specified strength before installing sealant.

2. Apply bonding adhesive, as recommended by the manufacturer to the concrete surfaces in strict compliance with the manufacturer's recommendations. Install the joint material under a compression of 25 percent and in one continuous operation, in accordance with manufacturer's recommendations. Do all splices and directional changes using heat welding method as recommended by the manufacturer.

G. Unbonded Joints: Use unbonded horizontal joints as shown or required where slabs of beams must be prevented from bonding to footings, walls, columns or other rigid parts of the structure.

1. Prevent bonding by use of structural grade neoprene pads placed over the bearing surface of the footing, wall or other supporting part of the structure so as to isolate it from the new concrete being placed.

H. Encasing Inserts: Encase wedge inserts, flashing reglets and dovetail anchor slots in the concrete as shown. Take special care to place and maintain them to the proper lines and grades and to compact concrete thoroughly around them to prevent the passage of water. Set these items before placing concrete and thoroughly brace them to prevent movement during the progress of the work. Provide dovetail anchor slots spaced not more than 16 inches apart for all concrete walls faced with masonry.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing concrete reinforcement as shown and specified herein. Reinforcement includes all steel bars, wire and welded wire fabric as shown and specified.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 31 00 - Cast-In-Place Concrete

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ACI SP66	-	ACI Detailing Manual
2.	ACI 318	-	Latest edition "Building Code Requirements for Reinforced Concrete"
3.	ASTM A 185	-	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
4.	ASTM A 615/A615M	-	Deformed and Plains Billet-Steel Bars for Concrete
5.	ASTM A 706/A706M	-	Low Alloy Steel Deformed Bars for Concrete Reinforcement
6.	ASTM A 775/A775M	-	Epoxy Coated Reinforcing Steel Bars
7.	AWS D1.4	-	Structural Welding Code - Reinforcing Steel

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

1. Product Data and Information: Submit manufacturers literature with product data, and material description of fusion bonded epoxy coating for reinforcement and reinforcement accessories, including manufacturer's recommendations for field touch-up of mars and cut ends.

2. CONTRACTORS' Shop Drawings: Submit checked Working Drawings, including bar lists, schedules, bending details, placing details and placing plans and elevations for fabrication and placing reinforcing steel conforming to "ACI Detailing Manual - 2004".

    a. Do not bill wall and slab reinforcing in sections. Show complete elevations of all walls and complete plans of all slabs, except that, when more than one wall or slab are identical, only one such elevation or plan is required. These plans and elevations need not be true views of the walls or slabs shown. Bill every reinforcing bar in a slab on a plan. Bill every reinforcing bar in a wall on an elevation. Take sections to clarify the arrangement of the steel reinforcement. Identify all bars, but do not bill on such sections.

    b. For all reinforcing bars, unless the location of a bar is clear, give the location of such bar or bars by a dimension to some structural feature which will be readily distinguishable at the time bars are placed.

    c. Make the reinforcing steel placing drawings complete for placing reinforcement including the location of support bars and chairs, without reference to the design drawings.

    d. Submit Detailer certification that every reinforcing steel placing drawing and bar list is completely checked and corrected before submittal for approval.

    e. If, after reinforcing steel placing drawings and bar lists have been submitted for approval, a review reveals that the drawings and lists obviously have not been checked and corrected they will be returned for checking and correcting by the Detailer.

3. Samples: Submit the following samples when epoxy coated reinforcement is specified to be used.

    a. 12-inch long epoxy-coated steel reinforcing bar, of any size typical to this Project

    b. One of each type of epoxy-coated reinforcement accessory used on this Project

    c. 12-inch long, nylon coated tie wire

4. Certificates: Test certificates of the chemical and physical properties covering each shipment of reinforcing steel bars.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Delivery Requirements: Have reinforcing steel delivered to the work in strongly tied bundles. Identify each group of both bent and straight bars with a metal tag giving the identifying number corresponding to the reinforcing steel placing drawings and bar lists.

2. Storage: Properly store all bars in an orderly manner, with all bars completely off the ground. Keep bars clean after delivery to the site of the work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Mechanical connections

a. Dowel Bar Splicer/Dowel-In System and Coupler Splice System of the Richmond Screw Anchor System

b. Cadweld Rebar Splice by Erico Products Inc.

c. Bar Grip Splice by Barsplice Products Inc.

2.2 MATERIALS

A. Steel Bars: Use new billet steel bars, deformed bars, meeting the requirements of ASTM A 615/A625M Grade 60 for reinforcing steel bars.

1. Roll all reinforcing steel bars with special deformations or identifying marks indicating the ASTM Specification and Grade.

2. Use bars free from defects, kinks and from bends that cannot be readily and fully straightened in the field.

3. Supply reinforcing bars in lengths which will allow convenient placement in the work and provide the required lap of joints as shown. Provide dowels of

proper length, size and shape for tying walls, beams, floors, and the like together.

B. Epoxy Coating: Conform fusion bonded epoxy coated reinforcing steel bars to ASTM A 775/A775M when used. Leave portions of the reinforcing steel bars uncoated where mechanical connections are shown.

C. Welded Wire Fabric: Use welded wire fabric of the electrically welded type, with wires arranged in rectangular patterns, of the sizes shown or specified and meeting the requirements of ASTM A 185.

D. Supports and Accessories: Provide bar supports and other accessories and, if necessary, additional supports to hold bars in proper position while concrete is being placed.

1. Use side form spacers against vertical or sloping forms to maintain prescribed side cover and cross position of bars.

2. Use individual hi-chairs with welded cross ties or circular hoops to support top bars in slabs thicker than 8 inches.

3. Bolsters, chairs and other accessories:

a. Use hot-dipped galvanized or provide plastic coated legs when in contact with forms for surfaces of concrete other than architectural surfaces.

b. Use stainless steel when in contact with forms for architecturally exposed surfaces.

c. Use epoxy coated bolsters, chairs and accessories including wire ties for epoxy coated reinforcing bars.

d. Use chairs of an approved type and space them properly to support and hold reinforcing bars in position in all beams and slabs including slabs placed directly on the subgrade or work mat. Do not use continuous hi-chairs for supporting of top bars in slabs over 8 inches in thickness.

E. Mechanical Connections: Provide mechanical connections that develop at least 125 percent of the specified yield strength of the bar in tension.

2.3 FABRICATION

A. Drawing Review Prior to Fabrication: Do not fabricate any material before final review and approval of shop drawings.

B. Bending and Cutting: Cut bars to required length and bend accurately before placing. Bend bars in the shop unless written approval for field bending is obtained. If field bending is permitted, do it only when the air temperature, where the bending operation is performed, is above 30 degrees F. Do not field bend bars which have been partially embedded in concrete.

C. Splices: Use lapped splices for tension and compression splices unless otherwise noted.

D. Cleaning: Clean and bend reinforcement in accordance with ACI 315 and ACI 318.

PART 3 EXECUTION

3.1 INSTALLATION

A. Placement: Place all bars in accordance with CRSI "Recommended Practice for Placing Reinforcing Bars".

B. Tolerances: Place bars used for top reinforcement in slabs to a vertical tolerance of plus or minus 1/4-inch. Place all other reinforcement to the tolerances given to ACI 318.

C. Cleaning: Have reinforcing steel delivered without rust other than that accumulated during transportation to the work. At all times, fully protect reinforcing steel from moisture, grease, dirt, mortar and concrete. Before being placed in position, thoroughly clean reinforcing steel of all loose mill scale and rust and of any dirt, oil, grease coatings, or other material that might reduce the bond. If there is a delay in depositing concrete, inspect and satisfactorily clean the steel immediately before the concrete is placed.

D. Bar Positioning: Place bars in the exact positions shown with the required spacing and cross wire bars securely in position at intersections to prevent displacement during the placing of the concrete. Fasten the bars with annealed wire of not less than 17 gauge or other approved devices.

E. Bar Extension Beyond Formwork: On any section of the work where horizontal bars extend beyond the length of the forms, perforate the form or head against which the work ends or at the proper places to allow the bars to project through a distance at least equal to the lap specified.

F. Unacceptable Materials: Do not place reinforcing steel with damaged, unsuitably bonded epoxy-coating or rusting. If approved, mars, exposed threads of mechanical connections and cut ends may be field coated with approved epoxy coating material.

G. Review of Placement: Have reinforcing placement reviewed by the ENGINEER before concrete is placed.

H. Welding - Not Approved: Do not use reinforcing bar assemblies made by welding of any kind, or accessories of any kind which require field welding to reinforcing bars.

I. Welding - Approved: Where welding of reinforcing steel is shown, AWS D1.4 "Structural Welding Code - Reinforcing Steel" applies.

J. Tension and Compression Lap Splices: Conform tension and compression lap splices to ACI 318 with all supplements. Avoid splices at points of maximum tensile stress wherever possible. Provide temperature bars with the clear spacing shown. Stagger all bar splices in hoop tension bars in circular tanks with not more than 50 percent of the bars spliced in any one direction. Have welded splices made by certified welders in accordance with AWS D1.4.

K. Welded Wire Fabric: Place welded wire fabric in the positions shown, specified or required to fit the work. Furnish and place suitable spacing chairs or supports, as specified for bars, to maintain the fabric in the correct location. Where a flat surface of fabric is required, provide flat sheets, when available. Otherwise reverse roll the fabric or otherwise straighten to make a perfectly flat surface before placing. Obtain approval for the length of laps not indicated.

L. Concrete Cover: Place reinforcing steel and welded wire fabric and hold in position so that the concrete cover, as measured from the surface of the bar or wire to the surface of the concrete, is as shown or specified.

END OF SECTION

SECTION 03 31 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Providing cast-in-place concrete as specified herein to form concrete to profiles as shown on the plans including the following work:

1. Setting of anchor bolts, base plates, floor grating and plate, frames, stop log grooves, and other steel and aluminum members embedded in concrete as indicated

2. Furnishing and setting of sleeves, inserts and other embedded accessories for mechanical and electrical equipment.

3. Furnishing concrete fill for steel pan stair treads, landings and associated items.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 20 00 - Concrete Reinforcement
3. Section 03 15 00 - Concrete Accessories
4. Section 03 60 00 - Grout

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ACI 212 - Chemical Admixtures for Concrete

2. ACI 301 - Specifications for Structural Concrete for Buildings

3. ACI 303R - Guide to Cast-In-Place Architectural Concrete

4. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete

5. ACI 305R - Hot Weather Concreting

6. ACI 306R - Cold Weather Concreting

7. ACI 308 - Practice for Curing Concrete

8. ACI 503R - Use of Epoxy Compounds with Concrete

9. ASTM C 31 - Practice for Making and Curing Concrete Test Specimens in the Field

10. ASTM C 33 - Specifications for Concrete Aggregates

11. ASTM C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens

12. ASTM C 42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

13. ASTM C 94 - Specifications for Ready Mixed Concrete

14. ASTM C 143 - Test Method for Slump of Hydraulic Cement Concrete

15. ASTM C 150 - Specifications for Portland Cement

16. ASTM C 157 - Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

17. ASTM C 171 - Specification for Sheet Materials for Curing Concrete

18. ASTM C 172 - Practice for Sampling Freshly Mixed Concrete

19. ASTM C 173 - Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method

20. ASTM C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete

21. ASTM C 618 - Specification for Coal Fly Ash and Raw Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

22. ASTM C 881 - Specification for Epoxy-Resin-Base Bonding Systems for Concrete

23. ASTM C 989 - Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

24. ASTM C 1116 - Specification for Fiber-Reinforced Concrete and Shotcrete

25. ASTM E 1155 - Standard Test Method for Determination of F_F

26. ASTM C 1218 - Test Method for Water-Soluble Chloride in Mortar and Concrete

27. ASTM C 1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

1. Notarized certificates of manufacture as evidence that the cement, fly ash and ground granulated blast furnace slag conform to the specified requirements. Include in these certificates the mill-test reports on the cement.

2. Samples of aggregates, sieve analyses and manufacturers data showing conformance to the specified requirements.

3. Concrete mix designs for each type of concrete.

4. Test reports for laboratory and field cured cylinders.

5. Air content tests in accordance with ASTM C 138 or C 173 with mix design data.

6. Drying shrinkage tests for each class of concrete with mix design data. Test shrinkage in accordance with Section 3.3.H.

7. Detailed field report records of ready-mixed-concrete.

8. Manufacturers' Literature: Material description and application or installation instructions for curing compound, vapor barrier, floor hardener, floor sealer, epoxy adhesives, synthetic fibers, admixtures, polymer modified nonsag mortar, and corrosion-resistant coatings.

9. Certified reports of tests made for maximum water soluble chloride ion concentration of design mix hardened concrete.

10. Test reports of floor flatness (F_F) and floor levelness (F_L) conforming to ASTM E 1155.

1.4 QUALITY ASSURANCE

A. Codes: The following specific codes and standards apply:

1. ACI 318 - Latest Edition, "Building Code Requirements for Reinforced Concrete".

2. ASTM - as referred to in the various subsections herein.

B. Testing Requirements: Testing laboratory provided by OWNER is responsible for conducting tests as required in Division 1.

C. Testing Assistance: Cooperate with the laboratory personnel, provide access to Work, and manufacturer's operations. Provide and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used which require testing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Cement: Store cement delivered in bulk to the batching plant in weathertight bins and batch using an appropriate weighing device, in accordance with ASTM C 94.

a. Store cement in weathertight buildings, bins or silos which will exclude moisture and contaminants. Do not use cement that has deteriorated from storage. Retest, before use, cement stored for a period longer than 6 months after the previous testing and reject it if it fails to meet all of the specified requirements. Do not use accepted cement that has been in storage for more than one year from the time of original acceptance.

b. Store cement delivered to the job site in strong, well-made bags plainly marked with the brand, name of manufacturer and net weight. Reject packages received in a damaged condition.

2. Aggregates: Keep aggregates clean and free from all other materials during transportation and handling. Keep them separated from each other until measured in batches and placed in the mixer.

a. Stockpile aggregates in a manner to prevent segregation unless finish screening is provided at the batch plant.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cement Requirements: Provide a cement which is a domestic product from an approved source. Use standard portland cement meeting the requirements of ASTM C 150 Type I or Type II.

1. Provide portland cement used in the manufacture of concrete pressure pipe which does not have an air-entraining agent. Also, use a nonplastic (0 slump) mix if portland cement without air-entraining agent is used in the manufacture of concrete sewer pipe.

B. Cementitious Material Requirements:

1. Fly Ash Requirements: Provide fly ash with a uniform light color from a source approved by the ENGINEER and with cementitious properties conforming to the requirements of ASTM C 618 Class C or F, with the following exceptions:

Loss on ignition - 5 percent maximum
Sulfur trioxide - 4 percent maximum

Store fly ash at the concrete mixing plant separate from the cement and do not intermix cement and fly ash prior to being added to the concrete mix.

2. Slag Requirements: Provide ground granulated blast furnace slag with cementitious properties conforming to the requirements of ASTM C 989, Grade 120, from an approved local product for normal weight concrete. Provide material having a uniform light color. Do not intermix cement and ground granulated blast furnace slag prior to being added to the concrete mix.

C. Synthetic Fiber Requirements: Provide synthetic fibers for inclusion in portland cement normal weight concrete of Caprolan -RC nylon fibers as manufactured by Allied Signal Inc., Petersburg, VA or approved equal.

1. Provide synthetic fibers exhibiting the following material, dimensional and strength characteristics:

a. Material: Nylon (100 percent)
b. Weight: 6 to 8 Denier per filament
c. Filament diameter: 23 microns
d. Specific gravity: 1.16
e. Fiber length: 3/4-inch minimum
f. Melting point: 435 degrees F
g. Tensile strength: 130,000 psi

h. Young's modulus: 750,000 psi
i. Toughness: 125,000 psi

2. Provide synthetic fibers manufactured by extrusion to the dimensions specified and not produced by slitting or chopping of sheet material or any other process.

D. Fine Aggregate Requirements: Provide fine aggregate of natural sharp sand meeting the requirements of ASTM C 33 for normal weight concrete, except as modified herein. Provide fine aggregate subjected to the test for organic impurities that will not produce a color darker than standard.

1. Provide fine aggregate meeting the requirements of the soundness test set forth in Paragraph 7.1 of ASTM C 33. The exceptions stated in Paragraphs 7.2 and 7.3 do not apply.

E. Coarse Aggregate Requirements: Provide coarse aggregate consisting of crushed stone, processed from natural rock or stones, meeting the requirements of ASTM C 33 for normal weight concrete.

1. The limits for deleterious substances and physical property requirements given in Table 3 of ASTM C 33 apply for each concrete class designation without exception.

2. Grade coarse aggregate according to Size No. 467 or No. 57 in Table 2 of ASTM C 33 for Class C concrete and Size No. 57 for Class B concrete.

F. Lightweight Aggregate Requirements: Provide lightweight aggregate meeting the requirements of ASTM C 330 for Class E Concrete as defined in Section 2. Design Mix.

G. Admixture Use: Limit the use of admixtures to the following:

1. Air-entraining admixture conforming to ASTM C 260

2. Water-reducing admixture conforming to ASTM C 494 Type A

3. Water reducing set retarders conforming to ASTM C 494 Type D

4. Use water-reducing and set-retarding admixtures only after obtaining written permission. Provide test data indicating that the concrete containing the admixtures has improved workability and does not show any abnormal behavior such as premature stiffening or slump loss for at least 30 minutes after mixing has been completed, or any other abnormal differences when compared with concrete made without the admixture. Base such test data on fresh concrete from the proposed supplier, using batching equipment proposed for use on the project.

5. Do not use admixtures containing calcium chloride, thiocyanates or more than 0.05 percent chloride ion. Obtain written conformance to the above requirements and the chloride ion content of each admixture from the admixture manufacturer prior to mix design review.

6. When more than one admixture is used, dispense each admixture separately into the mix, and at different times during mixing, in accordance with the recommendation of ACI Committee 212. After system approval, make no changes in batching equipment or concrete constituents without approval.

H. Water: Use clean water in mixing concrete which does not contain deleterious amounts of acids, alkalies or organic materials, furnished only from water from approved sources.

I. Curing Covers: Provide water curing blankets consisting of an outer covering of burlap or cotton or other approved material, and needled, punched or sandwiched inner layer of cotton batting or other approved material, in all weighing not less than 20 ounces per square yard. Use curing blankets by Midwest Canvas Corporation, Chicago, Illinois, by Max Katz, Indianapolis, IN or approved equal.

1. Use curing water having a temperature that is within 20 degrees F of the concrete's surface temperature.

J. Waterproof Paper and Film: Provide waterproof paper or polyethylene film both meeting the requirements of ASTM C 171 for use as sheet material curing covers**.**

1. Provide waterproof paper consisting of one ply of an approved type of fiber, reinforced waterproof building paper, consisting of cross fibers embedded in asphalt, between two layers of waterproof building paper, the whole being combined under heat and pressure to form a monolithic sheet.

2. Provide polyethylene film consisting of white opaque sheeting manufactured from virgin resin and containing no scrap or additives. Do not use a film of less than 4 mils in thickness.

K. Residual Acrylic Curing and Sealing Compound Membrane: Provide a clear curing and sealing compound: "Super Aqua-Cure VOX" by The Euclid Chemical Company; "Masterkure® N-Seal-HS" by ChemRex/ MBT®; or “Cure & Seal 1315” by Symons Corporation. Provide a compound of a clear styrene acrylate type, 25 percent solids content minimum, which shall have test data from an independent testing laboratory indicating a maximum moisture loss of 0.040 grams per square centimeter. when applied at a coverage rate of 300 square feet per gallon, in accordance with ASTM C 1315 Class A or Class B.

L. Dissipating Resin Type, Membrane Forming, Curing Compound: Provide a dissipating resin type curing compound, conforming to ASTM C 309 Type 1D Class B, "Kurez DR" with The Euclid Chemical Co., Resi-Chem Clear Cure by Symons or equal. Use film having a chemical break down of a four-to-six-week period.

M. Chemical Floor Hardener: Provide chemical floor hardener consisting of magnesium and zinc fluosilicate such as "Lapidolith as manufactured by L. Sonneborn Sons, Inc., "Saniseal" as manufactured by Master Builders Co., or Fluosilicate by Symons or equal.

1. Alternatively, where chemical hardening is required, substitute a natural, nonmetallic aggregate surface hardener at the time the floor is placed, in which case omit the latter application of chemical floor hardener. Obtain the hardening by incorporating into the surface of the freshly floated concrete a dry shake of Master Builders Mastercron Pre-Mixed, Procron as made by Protex Industries, Inc., Hard Top as made by Symons Corporation or equal, at the rate as recommended by the manufacturer. Perform all preparation, application procedures, curing and precautions in strict compliance with the manufacturer's recommendations and instructions submitted for approval prior to use. Use this material for interior applications only and limit air content for the design mix to 3 percent.

N. Nonslip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for nonslip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rust-proof, and nonglazing, and is unaffected by freezing, moisture, and cleaning materials.

O. Epoxy Adhesives: Provide epoxy adhesives as follows:

1. Sikadur 32 Hi-Mod by Sika Corporation, Richmond, VA or Euco 452 MV by Euclid Chemical Co., Cleveland, OH, Rescon 649 by Rescon Technology Corporation or equal. Use a two component, solvent-free, moisture

insensitive, structural epoxy adhesive, conforming to ASTM C 881, Type I and II, Grade 2, Class B and C, epoxy resin adhesive.

2. Sikadur 31, Hi-Mod Gel by Sika Corporation, Richmond, VA or Euco No. 452 Gel by Euclid Chemical Co., Cleveland, OH, Rescon R306 by Rescon Technology Corporation or equal. Use a 2-component solvent-free, moisture insensitive, high modulus, high strength, structural epoxy paste adhesive, conforming to ASTM C 881, Type I and II, Grade 3, Class B and C, epoxy resin adhesive.

P. Nonsag Mortar: Provide Polymer Modified Nonsag Mortar as follows:

1. Sikatop 123 by Sika Corporation, Richmond, VA, Rescon R626 by Rescon Technology Corporation or equal. Use a 2-component, fast setting, nonsag, patching mortar, specifically formulated for application by trowel on vertical and overhead surfaces.

Q. Corrosion-Resistant Coating: Use Sika Armatec 110 by Sika Corporation, Richmond, VA, Rescon R-504 by Rescon Technology Corporation or equal as a corrosion-resistant coating.

2.2 DESIGN MIX

A. Concrete Mix Classifications: Furnish and place concrete of the type divided into various classes according to use and compressive strength.

1. Use Class A concrete for all precast concrete units.

2. Use Class B concrete for all reinforced concrete structures designed for high strength and watertightness; and for columns, walls, beams, slabs, stairs, and, in general, wherever formwork other than simple forms are required.

3. Use Class C concrete for all reinforced concrete structures designed for high strength and watertightness; and for bottoms of structures, electrical duct encasement, and, in general, where concrete is deposited directly on the bottoms of slopes of excavations and where only simple forms are required.

4. Use Class D concrete for low-strength concrete, plain or reinforced, used for work mats beneath structures, soil stabilization, pipe cradles and encasement, filling, and other similar purposes. Clean boulders or fragments of rock excavated during construction may be embedded in large volumes of Class D concrete to provide added bulk. Use care in placing the boulders or rock fragments so that there will be no voids in the concrete.

5. Use Class E concrete for sand/lightweight concrete slabs placed over metal decks.

B. Compressive Strength: Provide, as a minimum, the specified compressive strength of concrete in pounds per square inch for the classes previously described as follows. Designate the 28-day strength as f'_c.

Class	7-Day Test	28-Day Test
A	3,400	5,000
B	3,000	4,500
C	3,000	4,500
D	1,300	2,000
E	2,700	4,000

1. Proportion and produce concrete to provide an average 28-day compressive strength in excess of the specified compressive strength, f'_c. Base the required proportions on tests of cylinders made, cured and tested as specified.

2. Prepare mix designs for each type of concrete required and submit for approval. Concrete which will be placed by pumping methods will require a separate mix design and mix design approval, as described herein, in addition to the mix design approval required for other placement methods.

C. Concrete Proportions: Select concrete proportions to provide the required strength and durability and to provide workability and consistency so that the concrete can be worked into forms and around reinforcement without segregation or excessive bleeding.

1. Provide concrete for all structures which is watertight. Do not allow the maximum water-cementitious material ratio to exceed 0.45 by weight of the total cementitious constituent. Measure the quantity of water to be the total quantity, including free surface moisture contained in the aggregates.

2. Do not allow the amount of fly ash to exceed 20 percent by weight of the cement plus fly ash, while maintaining a minimum cement content of 450 pounds per cubic yard.

3. Do not allow the amount of ground granulated blast furnace slag contained in Class B and C concrete to exceed 30 percent by weight of the cement plus slag, while maintaining a minimum cement content of 450 pounds per cubic yard.

4. Provide Class B and C concrete which also contains a minimum of 1-pound of synthetic fibers per cubic yard. Conform fiber reinforced concrete to the requirements of ASTM C 1116 unless otherwise specified.

5. Establish concrete proportions including the water-cementitious material ratio on the bases of field experience or trial mixtures with the materials to be used in accordance with Section 5.3 of ACI 318.

6. Provide sand/lightweight concrete with a dry weight not more than 115 pounds per cubic foot.

D. Air Entrainment:

1. Provide Class A, B and C concrete with an average total air content of 5 percent. Allow a tolerance of plus or minus 1.5 percent on air content as delivered.

E. Slumps: When tested in accordance with ASTM C 143, provide a concrete mix design with slumps within the following limits:

Concrete Placement	Minimum and Maximum Slump in Inches	
	Class B, C and E	Class D
Normal	3 to 4	3 to 5
Pumped	4 to 6	4 to 6

1. Base the mix design slump on the concrete mix with water reducing admixture. For production concrete, allow no more than 1-inch increase in slump by use of specified water reducing admixtures. Measure slump at the end of the hose for pumped concrete.

2. Grade the combined aggregates for the design mix such that when a sample of the mix is separated on No. 4 standard sieve, the weight passing the sieve is not less than 30 percent nor greater than 40 percent of the total, unless otherwise specified.

F. Chloride Ion Concentration: Provide a maximum water soluble chloride ion concentration, percent by weight of cementitious materials, with two 28 day tests of design mix hardened concrete as follows:

1. Cast-in place concrete, exposed to moisture, water or sewage in service 0.10.

2. Cast-in-place concrete that will be dry or protected from moisture in service 1.00.

G. Shrinkage Control: Select materials and proportion mix to achieve an average 21 day drying shrinkage less than:

1. 0.036% for liquid-containing structures.

2. 0.048% for all other structures.

Provide one test (3 specimens) for each design mix in accordance with Section 3.3.H.

H. Measurement and Mixing: Measure and mix concrete in accordance with the recommendations of ACI 304R, as modified.

1. Measure cement, and fine and coarse aggregates separately by weight by equipment providing an accuracy within one percent of the net load weighed. Measure cement and water within 1 percent accuracy by weight. Measure aggregates within 2 percent accuracy. Measure admixtures within 3 percent accuracy by weight.

2. Use weighing equipment meeting the requirements of the United States Bureau of Standards. Make available standard testing weights and other necessary equipment at all times for testing the equipment.

3. Mix concrete in a rotary, batch-type mixer of adequate design to produce a thorough mix, homogeneous in composition and uniform in color. Mix each batch of one cubic yard or less not less than 1-1/2 minutes after the last of the ingredients have been added to the mixer. Increase the mixing time 15 seconds for each cubic yard or fraction thereof.

2.3 CONCRETE WORKMATS

A. As a working base for all new, reinforced-concrete structural foundation elements supported on soil, rock, select fill, backfill stone, drainage stone and the like, provide a Class D concrete workmat having a minimum thickness of 2 inches.

2.4 READY MIX CONCRETE

A. Ready Mix Requirements: For ready-mixed concrete meet the requirements of ASTM C 94, except as modified in the following paragraphs, and subject the mix to all provisions herein relative to materials, strength, proportioning, consistency, and testing. Article 18 of ASTM C 94, however, does not apply. In the event of low strengths, procedures outlined in Section 3.01 "Low Concrete Strength Test Results" apply.

B. Delivery: Provide the rate of delivery of the mixed concrete such that the interval between placing of fresh concrete in contact with concrete already placed from previous batches does not exceed 45 minutes. Do not allow the elapsed time between the introduction of mixing water to the cement and aggregates and depositing concrete in the work to exceed 60 minutes, including mixing and agitating time.

C. Agitation: Do not deliver concrete in nonagitating equipment.

D. Field Records: Prepare a detailed concrete field record in which the following information is identified:

1. Number of concrete batches produced.

2. Proportions of materials used.

3. Approximate location of final deposit of each batch in the structure.

4. Time and date of mixing and placing.

PART 3 EXECUTION

3.1 PLACING CONCRETE

A. General: Place concrete only in the presence of the ENGINEER. Where the procedure is not specified, place concrete in accordance with the recommendations of ACI 304R.

B. Continuous Operation: Place no concrete after its initial set has occurred, and do not use retempered concrete under any conditions. Make concreting operations continuous until the section, panel, or scheduled placement is completed. Should the concreting operations be unavoidably interrupted, provide construction joints formed at proper locations as specified.

C. Minimum Handling: Convey and place concrete with minimum handling and deposit the concrete in the forms as close as possible to its final position and in no case more than 5 feet in a horizontal direction therefrom. Do not rehandle concrete.

D. Horizontal Layers: Place concrete in horizontal layers shallow enough so that the previous layer is still soft when the next layer is added and the two layers can be vibrated together. Do not exceed 18 inches in depth for each layer.

E. Use of Chutes: Deposit wall and column concrete through heavy duck canvas or galvanized steel chutes equipped with suitable hopper heads. Provide chutes of variable lengths so that the free fall of concrete does not exceed 3 feet. Provide illumination where required, inside the forms so that the concrete is visible from the deck and runways at the point of deposit.

F. Protection Against Elements: Protect freshly placed exposed concrete against damage from the elements or other sources.

G. Hot Weather Placement: For placement of concrete during hot weather, follow the recommendations of ACI 305R.

1. Place no concrete if the temperature of the concrete at the time of placement exceeds 90 degrees F.

2. When the temperature of the concrete at the time of placement is consistently above 75 degrees F and a noticeable decrease in slump or an increase in mixing water demand occurs, use a retarding admixture, after obtaining written permission to do so.

3. Protect unformed surfaces of concrete placed during hot weather from drying by continuous moist curing for at least 24 hours. Start curing as soon as the concrete has hardened sufficiently to withstand surface damage. If moist curing is not carried beyond 24 hours, cover the surface while damp with a suitable heat-reflecting plastic membrane or spray exterior surfaces with a white pigmented dissipating curing compound in accordance with Section 3.5 Curing. Use curing water having a temperature that is within 20 degrees F of the concrete's surface temperature.

4. Protect formed surfaces of concrete placed during hot weather from drying as recommended in ACI 305 R.

H. Cold Weather Placement: For placement of concrete during cold weather, follow the recommendations of ACI 306R, except that set-accelerators will not be permitted.

1. Before placement of concrete, completely remove all ice, snow and frost from all surfaces to be in contact with the concrete. Do not place concrete on a frozen subgrade. Heat surfaces to be in contact with the concrete to a temperature as near as practical to that of the concrete being placed.

2. When mean daily temperatures at the site are below 40 degrees F provide concrete at a temperature, as placed, of not less than 50 degrees F, except for mass concrete provide a temperature of the concrete as placed of not less than 45 degrees F. Heat aggregates or mixing water or both to obtain these placement temperatures. Do not permit the concrete temperatures as mixed to exceed the placement temperature by more than 10 degrees F for air temperatures of 0 degrees to 30 degrees F, nor by more than 15 degrees F for air temperatures below 0 degrees F.

3. Maintain concrete in place at a temperature of 50 degrees F by keeping forms in place, covering with insulated blankets, heated enclosures or combinations of these for the following minimum time intervals, except that forms shall not be removed in less than the time specified in Section 03100.

    a. Footings and walls below grade and slabs

	on grade	2 days
b.	Exposed walls and columns carrying no load	3 days
c.	Exposed floor slab, beams and girders above grade and partially loaded	6 days

4. Protect exposed surfaces of new concrete from drying out. When dry heating is used for protection against low temperatures, cover exposed concrete surfaces with an approved sheet material or membrane as specified in Section 03310 subsection "Curing". Use water curing only if icing problems can be avoided. During periods of very cold weather, continue the protection against low temperature for an extended curing period as required to prevent freezing of the concrete.

5. Permit concrete which is to be exposed to freezing temperatures to undergo some drying just prior to and during the period of adjustment to ambient cold-weather conditions. When protection against low temperatures is removed, do not allow the resulting temperature drop in any part of the concrete to exceed 5 degrees per hour nor 40 degrees F for the first 24 hour period.

I. Concrete Embedments:

1. Encase pipes, anchor bolts, sleeves, steps, castings, floor drains, manhole frames, cast-in reglets, dovetail anchor slots, and other inserts in concrete as shown. Take special care to place and maintain them to the proper lines and grades and to compact concrete thoroughly around them to prevent the passage of water. Insofar as possible, set them before placing concrete and thoroughly brace to prevent movement during the progress of the work.

2. Space dovetail anchor slots vertically not more than 16 inches apart on all concrete walls faced with masonry.

3.2 VIBRATING CONCRETE

A. Use of Vibrators: Consolidate all concrete by means of mechanical internal vibrators applied directly into the concrete in a vertical position in accordance with the recommendations of ACI 309.

B. Vibrator Size: Provide a sufficient intensity and duration of vibration to cause concrete to combine with previously placed concrete, to fill corners, to compact thoroughly and to embed reinforcement, pipes, conduits, and similar work completely. Insert vibrators into and withdraw from the concrete vertically at close intervals. Do not use vibrators to move concrete laterally.

C. Spare Units: Have on hand a sufficient number of vibrators to assure that the incoming concrete can be properly compacted within 15 minutes after placing. Provide reserve vibrators for use when others are being serviced. Do not start the placement of any concrete unless more than one vibrator is available.

3.3 CONCRETE TESTS

A. Compression Testing: Test concrete test cylinders in compression at the laboratory designated.

B. Samples: Take samples for strength tests of laboratory cured cylinders for tests of each class of concrete placed each day consisting of four cylinders from the same batch of concrete. Test two cylinders at 7 days and two at 28 days. Determine concrete strength by the average of the two cylinder strengths determined at either age. Take samples not less than once a day nor less than once for each 150 cubic yards of concrete, or 5,000 square feet of area.

C. Field Curing: Take samples for field cured cylinders to determine concrete compressive strength for form removal time as required.

D. Laboratory Curing: Sample fresh concrete in accordance with ASTM C 172. Mold and laboratory cure cylinders for strength tests in accordance with ASTM C 31.

E. Slump Tests: Perform slump tests in accordance with ASTM C 143, at the same time cylinders are made. Make tests to determine air content of fresh concrete twice daily, at least 4 hours apart, in accordance with either ASTM 173 or with an approved testing device. Concrete with excessive slump or improper air content will be rejected. Deliver no additional concrete until the cause of the deficiency is determined and corrected.

F. Test Requirements: Test cylinders in accordance with ASTM C 39 for both the 7-day and the 28-day compressive strength.

G. Successful Testing Requirements: Consider the strength level of the concrete mix for each individual class of concrete satisfactory when:

1. The average of all sets of three consecutive 28-day strength tests (average of two cylinders) equal or exceed the specified compressive strength (f'_c).

2. No individual 28-day strength test (average of two cylinders) falls below f'_c by more than 500 psi.

3. If either of these requirements are not met, make changes in the mix proportions immediately to achieve the required strength.

H. Shrinkage Tests: Perform drying shrinkage test on each 1000 cubic yards placed. Test in accordance with ASTM C157, modified as follows:

1. Make three (3) 4-inch x 4-inch x 11-inch specimens for each test.

2. Remove specimens from molds at an age of 23 hours ∀ 1 hour. Immediately submerge in water at 73 degrees F ∀ 3 degrees F for at least 30 minutes and measure within 30 minutes thereafter to determine original length. Then immediately submerge in lime-saturated water in accordance with ASTM C 157. After 7 days, remove specimens from lime-saturated water and measure. Use this measurement as the base length to determine shrinkage deformation. After measuring, immediately store in a humidity-controlled room maintained at 73 degrees F ∀ 3 degrees F and 50% ∀ 4% relative humidity for the remainder of the test measurements. To determine shrinkage take measurements, expressed as percentage of base length, and report separately for 7, 14 and 21 days ∀ 4 hours.

3. Results of the drying shrinkage on test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age by more than 0.004 percent, the results of that specimen shall be disregarded.

3.4 LOW CONCRETE STRENGTH TEST RESULTS

A. Test Cores: If it is determined that the serviceability of the concrete is significantly reduced by low concrete strength test results, take test cores from the area in question. Drill and test cores in accordance with ASTM C 42 except as noted. Take three cores for each strength test more than 500 psi below the specified f'_c.

B. Acceptable Levels of Strength: Concrete in the area represented by core tests will be accepted if the average of three cores is equal to or greater than 0.85 f'_c and no single core is less than 0.75 f'_c.

C. Unacceptable Concrete: Remove and replace concrete which does not meet the core test requirements or strengthen the concrete to the satisfaction of the ENGINEER.

3.5 CURING

A. General: Generally follow the recommendations of ACI 308 for curing concrete.

B. Protection: Protect concrete surfaces normally exposed to the atmosphere against too rapid drying by curing for a minimum period of 7 days. For hot weather concreting and cold weather concreting follow the recommendations of ACI 305R and ACI 306R for curing concrete. Commence the curing period

immediately following the placing of the concrete. Accomplish curing by one of the following methods. Should there be any delay in the application of the method of curing used, cover the concrete with moistened burlap held in complete contact with the surface or kept wet by continuous sprinkling. Use curing water having a temperature that is within 20 degrees F of the concrete's surface temperature.

1. Accomplish water curing by the use of curing blankets wetted and applied to the concrete surface as soon as the forms have been removed, or in the case of slabs, as soon as the concrete has set up sufficiently to prevent marring of the surface. Maintain the covering material in a thoroughly saturated condition and maintain the presence of free water between the mat and the surface of the concrete at all times throughout the curing period.

2. Accomplish sheet material curing by use of waterproof paper or polyethylene film applied to the concrete surface as soon as it has set sufficiently hard to prevent marring. First, thoroughly wet the concrete surface, and then place the sheet materials in direct contact and anchor thereto in a manner to assure continuous contact throughout the curing period. Lap the sheet materials a minimum of 3 inches with the seams taped, cemented, or glued. Discoloration is objectionable on floors which have been steel troweled to a hard finish. Do not use polyethelene film on these floors.

3. Accomplish curing by using clear residual acrylic curing and sealing compound membranes on all interior concrete floor surfaces that do not receive a finish, overlays or hardener, and on stairs, landings and walking surfaces. Accomplish membrane curing immediately after removal of forms or in the case of unformed surfaces, immediately after final finishing. Uniformly coat the entire exposed surface with a clear curing compound membrane by means of an approved pressure spray distributor at the rate of 300 square feet per gallon of material. Apply the material so that the concrete surface is completely coated and sealed with one application. Do not apply the membrane to faces of construction joints or other surfaces against which additional concrete will be placed. Keep such surfaces continuously wet by other means.

4. Accomplish curing by using dissipating resin type curing compounds. Apply to all concrete surfaces except those listed in paragraph 3.5.B.3. Start curing immediately after removal of forms as in the case of unformed surfaces, immediately after final finishing while the concrete surface is still moist. Coat the entire exposed surface by means of approved pressure spray distributor at the rate of 200 square feet per gallon of material. Apply the material so that the concrete surface is uniformly coated with one application. Do not apply to the faces of construction joints or other surfaces against which additional concrete will be placed. Keep such surfaces wet by other means.

3.6 JOINTS AND BONDING

A. Joints: Make construction joints where shown or permitted. Locate such joints to ensure stability, strength, and watertightness, and provide a waterstop where shown. Build all corners monolithically, and continuously concrete on either side to points shown.

B. Timing Between Placement: Provide at least 2 hours of elapsed time after placing concrete in the columns or walls before depositing concrete in beams, girders, or slabs supported thereon. Consider beams, girders, brackets, column capitals, and haunches as part of the floor system and place them integrally with the floor.

C. Horizontal Keyways: Build horizontal keyways to permit flushing water to escape from the keyways.

D. Keyway Description: Provide continuous, straight, and regular keys or grooves in joints. Bring exposed concrete surfaces to a true level line at the top of every horizontal construction joint. Provide the exposed construction joints with a row of form ties located in the concrete at from 4 to 6 inches from the joint to tighten the forms for subsequent sections. Set reinforcement to extend into subsequent sections of construction, as shown. If required, provide water stops having watertight splices and corner intersections and meet the requirements as specified. Remove all bulkheads or other joint forming material before placing adjacent concrete.

E. Continuous Placement Procedure: Carry on continuous placing of concrete between the construction joints shown. If for any reason it becomes necessary to stop the placing of concrete at locations other than those indicated, such locations and the manner of making the joint are subject to approval.

F. Grout Use Between Surfaces: Thoroughly clean and wet concrete surfaces against which the new concrete is to be placed. Just prior to placing new concrete, slush horizontal surfaces and joints with at least 2 inches of cement grout of the same mixture as the concrete but with coarse aggregate omitted. Use special care in placing and puddling concrete at vertical joints to ensure a bond with existing concrete. Do not make vertical construction joints in watertight construction, unless shown or approved in writing.

G. Contraction (Control) Joints in Slabs-on-Ground (for walkways and pavements outside the structure or building): Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/8" x 1/4 slab depth or inserts 1/4" wide x 1/4 of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab

surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

a. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.

2. If no joint pattern is shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third-bays).

3.7 CONCRETE FLOOR SURFACES

A. Floor Surfaces: Construct the concrete floor surfaces monolithicly with the structural slab being finished as indicated in the following schedule, unless otherwise shown or as specified:

1. Bottoms of structures and other surfaces not to be used as walkway areas - screeded, wood floated, steel troweled.

2. Bottoms of structures to receive grout topping swept in by mechanisms - screeded, wood floated.

3. Exterior walkways and platforms over tanks to be used as walking areas - screeded, wood floated, steel troweled, broomed.

4. Exterior sidewalks - screeded, wood floated, divided into panels, steel troweled, broomed.

5. Reservoir bottoms - screeded, wood floated.

B. Panel Construction: Construct panels, where required, approximately 10 feet square using an edger to form dummy joints 1/4-inch deep.

C. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, as otherwise indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if the area is small or inaccessible to power units. For nonsloping level surfaces check and level the surface plane to tolerances

of F_F 18 and as determined by ASTM E 1155. For sloping surfaces check the surface planes to a tolerance of F_F 18 as determined by ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Check the floors flatness (F_F) and levelness (F_L) on an area of 400 square feet for level floors and 400 square feet of sloping floors or tanks to be selected by the ENGINEER.

D. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.

1. After floating, begin first trowel finish operation using a power-driven trowel. For nonsloping level surfaces check and level the surface plane to tolerances as determined by ASTM E 1155. Cut down high spots and fill low spots. For sloping surfaces check the surface planes to a tolerance of $F_F = 20$ as determined by ASTM E 1155. Check the floor flatness (F_F) and levelness (F_L) on an area of 400 square feet for level floors 400 square feet for sloping floor or tanks to be selected by the ENGINEER. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances specified. Grind smooth surface defects which would telegraph through applied floor covering system.

E. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

F. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere, where indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with the ENGINEER before application.

G. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floor slabs that do not receive a floor covering. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water (parts of hardener/water as follows), and apply in 3 coats; first coat, 1/3-strength; second coat, 1/2-strength; third coat, 2/3-strength. Evenly apply each coat, and allow 24 hours for drying between coats.

1. Apply proprietary chemical hardeners, in accordance with the manufacturer's printed instructions.

2. After the final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

H. Nonslip Aggregate Finish: Apply the nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere where indicated.

1. After completion of float finishing, and before starting trowel finish, uniformly spread 25 pounds of dampened nonslip aggregate per 100 square feet of surface. Tamp aggregate flush with surface using a steel trowel, but do not force it below the surface. After broadcasting and tamping, apply trowel finishing as specified.

2. After curing, lightly work the surface with a steel wire brush, or an abrasive stone and water to expose nonslip aggregate.

I. Protection: Cover all finished floors, walkways, and slabs with boards, canvas, heavy paper or similar covering to protect them from damage.

3.8 CONCRETE SURFACES

A. Beveling Edges: Finish top edges of walls and equipment pads with a 1/2-inch beveled edge, unless other details are shown, and rub off any burrs remaining upon removal of the forms.

B. Form Removal Inspection: Immediately after stripping the forms, inspect all concrete surfaces. Remove all fins, offsets, burrs, ridges, or other unsightly marks from the exposed concrete.

C. Patching: Patch placement joints, voids, stone pockets, or other defective areas before the concrete is thoroughly dry. Chip away defective areas to a depth of not less than 1 inch with all edges perpendicular to the surface. Wet the area to be patched, including at least 5 inches of the adjoining surface, prior to placing the patching mortar. Then scrub onto the surface a grout of equal parts of cement and sand mixed to a brushing consistency followed immediately by the patching mortar. Make the patch of the same material and of approximately the same proportions as used for the concrete, except omit the coarse aggregate. For exposed concrete, substitute white cement for part of the gray cement so that the patch will match the color of the surrounding concrete. Determine the proportion of white and gray cement by making a trial patch. Use as little water as consistent with requirements of handling and placing. Mortar: Do not retemper mortar. Thoroughly compact and screed off the mortar so as to leave the patch slightly higher than the surrounding surface. Then leave it undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. Finish the patch to match the adjoining surface and cure as specified for the original concrete.

D. Tie Hole Patching: Patch tie holes before the concrete is thoroughly dry. Plug tie holes flush with the surface using portland cement mortar. Prewet tie holes with clean water and apply a neat cement slurry bond coat. Densely tamp mortar of a dry-tamp consistency into the tie holes exercising care so as not to smear mortar onto the finished concrete surface. Included sufficient white cement in the mortar mix to cause the plugged holes to blend in with the adjacent surfaces. Make sample patches with different mixes to assure that this requirement is met.

3.9 CONCRETE STAIR TREADS AND LANDINGS

A. Tread and Landing Application: Construct treads and landings of all exterior and interior concrete stairs by applying a nonslip surface which is applied as an integral cement finish before the initial set of the slab has taken place, unless abrasive nosings or other finish is indicated. Compound and apply the finish consisting of 1/2-inch layer of stiff, thoroughly mixed mortar comprising 1 part cement and 2 parts sand to which is added carborundum grit in the amount of 1/4 to 1/2 pound per square foot of finished surface. Screed and trowel the mortar to a smooth and even surface.

3.10 EPOXY ADHESIVE

A. Epoxy Adhesives for Bonding: Use epoxy adhesive for bonding fresh concrete to existing concrete where shown and grouting dowels into vertical holes.

B. Recommendations: Mix and apply epoxy adhesive in accordance with the manufacturer's recommendations and in accordance with the requirements of the "Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive - ACI 503R.

C. Surface Preparation: Roughen existing concrete, by sandblasting. Provide all surfaces free of standing water and clean as required.

3.11 EPOXY GEL

A. Epoxy Gels for Dowels: Use epoxy gel for grouting dowels into horizontal holes.

B. Application: Apply epoxy gels in accordance with the manufacturer's recommendations.

3.12 POLYMER MODIFIED NONSAG MORTAR

A. General: Mix and apply material in accordance with the manufacturer's recommendations.

B. Surface Preparation: Clean existing concrete that is to receive the material of all loose concrete, dirt, oil, grease and bond-inhibiting materials and mechanically roughen to obtain an aggregate-fractured surface with a minimum profile of 1/16-inch.

C. Mortar Placement: At the time of application, saturate existing concrete such that it is surface dry with no standing water. Scrub mortar into the substrate filling all pores and voids. Force the material against the edges of repairs, working it toward the center. After applying material, consolidate and then screed. Do not place the material in lifts greater than 1-inch. Where multiple lifts are required to achieve the required thickness, score the top surface of each lift to produce a roughened surface for the next lift. Allow the preceding lift to reach final set, 30 minutes minimum before applying fresh material. Scrub fresh mortar into the preceding lift. Allow mortar to set to desired stiffness and then finish with wood or sponge float for a smooth surface.

D. Curing Requirements: Moist cure with a fine mist spray of water, wet burlap, or nonsolvent-based curing compound. If necessary, protect newly applied material from rain. To prevent freezing, cover with insulating material.

3.13 CORROSION-RESISTANT COATING

A. Blast Cleaning: Blast clean existing exposed reinforcing steel to white metal color and immediately coat reinforcement with two 10 mil thick coats of corrosion-resistant coating applied in accordance with the manufacturer's recommendations.

3.14 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place, and cure concrete as specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide a monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing machines and equipment.

END OF SECTION

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SECTION 03 60 00

GROUT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnishing non-shrink grout under column and beam bearings and under equipment bases.

2. Furnishing non-shrink grout around handrail posts and base plates of handrail posts.

3. Furnishing grout topping and fillet grout in bottoms of concrete tanks.

4. Furnishing grout around tunnel liners and around pipes in tunnels.

B. Related Work Specified in Other Sections Include, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 31 00 - Cast-In-Place Concrete

1.2 REFERENCES

A. Codes and Standards Referred to in this Section:

1. ASTM C 33 - Specifications for Concrete Aggregates

2. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. [or 50 mm] Cube Specimens).

3. CRD C-619 - Specification for Grout Fluidifier.

4. CRD C-621 - Specification for Non-Shrink Grout.

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1:

1. Submit notarized certificate of manufacturer as evidence that pre-packaged non-shrink grout conforms to specified requirements. Include manufacturer's literature.

2. Submit mix design, for each class of grout, as specified in Section 03 31 00 "Cast-In-Place Concrete".

3. Submit the following test reports:

   a. Compression tests on cylinders for grout topping and fillet grout, as specified in Section 03 31 00, Subsection 3.3 "Concrete Tests".

   b. Compression tests, on mortar cubes for non-shrink grout and for tunnel liner and pipe grout, as specified in Section 03 31 00, Subsection 3.3 "Concrete Tests".

   c. Air content tests, for grout topping and fillet grout, as specified in Section 03 31 00 "Cast-In-Place Concrete".

   d. Slump tests, for grout topping and fillet grout and for tunnel liner and pipe grout, as specified in Section 03 31 00, Subsection 3.3 "Concrete Tests".

4. Test results showing that in projects of similar scope and size, the effective bearing area (EBA) under column bearings, beam bearings and equipment bases is between 95 and 100 percent.

5. Detailed field records for ready-mixed grout as specified in Section 03 31 00.

1.4 QUALITY ASSURANCE

A. Testing Requirements: Testing laboratory provided by OWNER is responsible for conducting tests required in Division 1.

B. Testing Assistance: Cooperate with the laboratory personnel, provide access to Work, and manufacturer's operations. Provide and deliver to the laboratory adequate quantities of representative samples of materials proposed to be used which require testing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1, and as follows:

1. Pre-packaged, Non-shrink Grout:

Deliver in unopened packages. Store in a dry place protected from moisture.

2. Portland Cement, Aggregates:

Deliver, store and handle as specified in Section 03 31 00.

PART 2 PRODUCTS

2.1 MATERIALS

A. Non-Shrink Grout:

1. Furnish a flowable, pre-packaged non-shrink grout without dependence on gas expansion forces or enlargement of metal particles for its non-shrinkage characteristics and conforming to CRD C-621.

2. Furnish one of the following:

a. Masterflow 928, as manufactured by MasterBuilders, Incorporated.
b. Multipurpose, as manufactured by Symons Corporation.
c. Sika grout 212, as manufactured by Sika Corporation.
d. Or equal.

B. Grout Fluidifier:

Furnish grout fluidifier conforming to CRD C-619.

C. Portland Cement, Aggregates, Admixtures.

1. Furnish as specified in Section 03 31 00.

2. Use air-entraining admixture in all grout.

2.2 GROUT MIXES

A. Non-Shrink Grout:

1. Add water to pre-packaged grout material and mix, as recommended by the manufacturer, to produce a flowable, non-shrink grout having a minimum compressive strength of 3000 psi in 24 hours.

2. Provide grout which when exposed to weather will be free of discoloration, without the necessity of special surface treatments.

B. Bonded Grout Topping and Fillet Grout for Tank Bottoms:

1. Grout to be proportioned from cement, fly ash, fine aggregate and ASTM C33, size no. 7 coarse aggregate with a water-reducing admixture.

2. Proportion to provide a grout having the following properties:

   a. A minimum compressive strength of 4000 psi in 28 days.

   b. An average air content of 5 percent ∀ 1.5 percent.

   c. Minimum and maximum slumps:

      (1) Fillet grout: 2-4 inches.
      (2) Grout topping: 3-5 inches.

   d. A maximum water-cementitious material ratio of 0.45 by weight of the total cementitious material.

3. Prepare design mixes, for each class of grout, as specified in Section 03 31 00 “Cast-In-Place Concrete”.

C. Tunnel Liner and Pipe Grout:

1. Tunnel liner grout:

   Mix grout for backfilling the space between the tunnel liner and tunnel or other locations as specified or directed in the proportion of 1 part Portland cement to 1 part sand by volume.

2. Pipe grout:

   Mix lean grout for backfilling the space surrounding the pipe sections in tunnel or other areas as specified or directed in the proportion of 1 part Portland cement to 12 parts sand by volume.

3. Mix grout to a consistency that can be pumped into the space between the tunnel liner or pipe and tunnel. Use a grout fluidifier to reduce water quantity and improve workability.

4. Prepare design mixes, for each class of grout, as specified in Section 03 31 00 “Cast-In-Place Concrete”.

D. Measurement and Mixing

Measure and mix material as specified in Section 03 31 00 “Cast-In-Place Concrete.”

PART 3 EXECUTION

3.1 INSPECTION

A. Substrate Condition:

Examine the substrate and conditions under which grout is to be placed and notify the ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the OWNER.

3.2 INSTALLATION

A. General:

1. Place grout as shown and in accordance with the manufacturer's instructions. Notify the OWNER if manufacturer's instructions conflict with the Specifications. Do not proceed with installation until directed by the OWNER.

2. Drypacking will not be permitted.

3. Have manufacturers of proprietary products make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions. The cost of this service, if any, shall be borne by the Contractor.

4. Conform grout placement to temperature and weather limitations in Section 03 31 00 "Cast-In-Place Concrete".

B. Columns, Beams and Equipment Bases:

1. After shimming columns, beams and equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the non-shrink grout.

C. Handrails and Railings

1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink grout. Bevel grout at juncture with post so that moisture flows away from post.

D. Grout Topping and Fillet Grout for Concrete Tanks:

1. Prior to proceeding with Work, ensure that tank equipment has been checked for accurate adjustment.

2. Use a metal screed on the tank mechanism to check the surface elevation of the base slab and to ensure that at least the thickness of grout shown can be placed. If there is insufficient room for this grout, remove the high spots in the concrete or adjust the mechanism, or both, as necessary to provide proper grout thickness and equipment clearance.

3. Prior to placement of grout, remove all laitance, debris and loose and foreign material from the base slab. Use waterblasting, sandblasting or other methods acceptable to the City.

4. Thoroughly wet the base slab at least 24 hours before placing the grout.

5. Roughen the concrete surface to receive the grout with a rolling tamp. Prior to placing the grout, the surface must be wetted and cleaned as described above. Apply a cement water paste to the surface with a stiff broom.

6. Where recommended by manufacturer, use the tank mechanism to screed the grout on the tank floor and sweep grout into fillets as it is placed. Have a representative of the equipment manufacturer be present during the screeding operation, unless otherwise approved. Screed in accordance with manufacturer's instructions.

7. Cure and protect the grout as specified in Section 03 31 00 "Cast-In-Place Concrete".

8. Level the grout topping to comply with requirements of Section 03 31 00.

9. Float finish topping as specified in Section 03 31 00.

E. Grout Tunnel Liners and Pipes in Tunnels:

1. Force grout through pipes or holes located in the crown of the liner or pipe every 20 feet, to completely fill all voids between the liner or pipe and tunnel, using such pressure as necessary to ensure that the voids have been completely filled. Drill additional grout holes and grout at additional locations in necessary to facilitate completely filling all voids.

2. Grout tunnel liners immediately after installation of the liner.

3. Grout pipes or holes immediately after installation of the pipe.

3.3 TESTS

A. Sample and test grout for compressive strength, air content and slump as specified in Section 03 31 00 “Cast-In-Place Concrete”, except as follows:

1. Non-shrink grout and tunnel liner and pipe grout: Prepare and test standard 2-inch mortar cubes in accordance with the requirements of ASTM C109. Make a minimum of one set of 6 cubes for each day of work or each 150 cubic yards of grout for each type of grout. Test two cubes for compressive strength at 7 days, one at 14 days and two at 28 days.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 05 05 13

GALVANIZING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: All galvanizing of metals when such coating is specified, except as otherwise shown, specified or required.

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM A 123 - Specification for Zinc-Coated (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. ASTM A 153 - Specification for Zinc Coating (Hot-Dip) On Iron and Steel Hardware

3. ASTM A 924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

4. ASTM A 385 - Practice for Providing High-Quality Zinc-Coatings (Hot-Dip)

5. ASTM A 392 - Specification for Zinc-Coated Steel Chain-Link Fence Fabric

6. ASTM A 53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

7. ASTM A 121 - Specification for Zinc-Coated (Galvanized) Steel Barbed Wire

8. ASTM A 143 - Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

9. ASTM A 384 - Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanization of Steel Assemblies

10. ASTM B 6 - Specification for Zinc (Slab Zinc)

11. MIL-P-21035B - Paint High Zinc Dust Content, Galvanizing Repair

12. MIL-P-26915C - Primer Coating Zinc Dust Pigmented for Steel Surfaces

PART 2 PRODUCTS

2.1 MATERIALS

A. Standard: Meet the requirements of ASTM B 6 and "Prime Western" grade, or equal, for zinc for galvanizing, zinc coating or plating.

PART 3 EXECUTION

3.1 PREPARATION

A. General: Blast clean or grind smooth wrought metals and castings. Tumble and grind flush all high spots when a smooth coat is required for castings. Normalize castings to prevent cracking.

B. Base Metal Cleaning: Thoroughly clean base metal. Remove all welding slag and burrs. Remove surface contaminants and coatings which would not be removable by the normal chemical cleaning process in the galvanizing operation, by blast cleaning, by immersion in a caustic bath, acid pickle and flux or other approved method.

C. Product Preparation: Fabricate structural steel products and assemblies to be galvanized in accordance with ASTM A 143, A 384, A385 and Class I guidelines as shown in "Recommended Details of Galvanized Structures" as published by American Hot-Dip Galvanizers Association, Inc.

3.2 APPLICATION

A. Hot Dip: Use the hot-dip process for galvanizing as required by the appropriate ASTM and American Hot-Dip Galvanizers Association, Inc. specifications.

1. Do not allow the dipping to come in contact with or rest upon the dross during the operation.

2. Do not use procedures tending to agitate the dross.

B. Required Facilities: Perform the galvanizing and coating in a plant having the required facilities to produce the quality of coatings specified and with ample capacity for the volume of work required. Handle and ship galvanized material in a manner which will avoid damage to the zinc coating.

C. Requirements: Perform galvanizing in accordance with the requirements of the following specifications:

	Item	ASTM
1.	Iron and steel products	A 123
2.	Iron and steel hardware	A 153
3.	Chain for chainwheel operators	A 153
4.	Chainwheels and Guides	A 123
5.	Steel sheets	A 924
6.	Assembled products	A 385 & A 123
7.	Steel chain link fence fabric	A 392 Class II
8.	Steel pipe	A 53
9.	Steel barbed wire	A 121

3.3 INSTALLATION

A. Field Coating for Touch-Up: Coat all field welds, abraided areas where damage is more than 3/16-inch wide or uncoated cut edges in material more than 1/10-inch thick with an organic zinc-rich paint complying with MIL-P-21035B or MIL-P-26915C in multiple coats to dry film thickness of 8 mils.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Columns, girders, beams, lintels, frames for openings and removable slabs, baffle supports, weirs and weir angles, pipe supports and hangers, inserts, pins bolts, nuts and washers and similar work.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 05 50 00 - Metal Fabrications
2. Section 05 51 00 - Metal Stairs
3. Section 05 52 00 - Handrails and Railings
4. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM A 325 - High-Strength Bolts for Structural Steel Joints
2. ASTM A 490 - Heat-Treated, Steel Structural Bolts
3. ASTM A 6/A6M - General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
4. AWS D1.1 - Structural Welding Code - Steel
5. AISC M 016 - Manual of Steel Construction - "Allowable Stress Design"
6. AISC S 335 - Specifications for Structural Steel Buildings
7. AISC S 303 - Code of Standard Practice for Steel Buildings and Bridges
8. SSPC SP1 - Solvent Cleaning
9. SSPC SP2 - Hand Tool Cleaning

10. SSPC SP3 - Power Tool Cleaning

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Drawings: Provide complete fabrication and erection details and schedules. Conform the numbering of columns, beams, and the like, as shown on detail drawings to the numbering on erection drawings.

C. Placement Listings: Submit erector's complete placement list of all field bolts - including grip, bolt length, and location.

D. Mill Reports: Submit certified mill reports for ASTM A 36 steels as requested. Submit certified mill reports for all steels other than ASTM A 36.

E. Setting Plans: Submit complete setting plans for use by others to set anchor bolts, setting plates, weir anchors and the like.

F. Welding Certifications: Submit reports that confirm that all welders have been certified within the last year by a nationally recognized laboratory to make groove and fillet welds in all positions.

G. Weld Inspection Reports: Submit reports of visual inspections of all structural steel welds for size, length and defects.

H. Tension Test Reports: Submit direct tension test reports of high strength bolted connections designated on the plans as slip critical connections or direct tension connections.

1.4 TESTING SERVICE

A. General: Provide a testing laboratory responsible for inspecting, conducting and interpreting tests as required in Division 1 and for performance of at least the following inspections and tests:

1. Ascertain that all welders have been certified within the last year by a nationally recognized laboratory to make groove and fillet welds in all positions.

2. Visually inspect all structural steel welds for minimum size and length and for defects. Where specified, shown or required, radiographic, magnetic particle, or ultrasonic inspection of welds will be performed. Inspection will conform to the inspection requirements of the AWS Structural Welding Code (D1.1).

3. Mechanically test the high-tensile bolted connections selected at random by checking for minimum tension and torque in 10 percent of all bolts or 2 bolts per connection, whichever is greater.

B. Cooperation: Cooperate with the laboratory personnel, provide access to work and manufacturer's operations, and provide and deliver to the laboratory adequate quantities of representative samples of materials proposed to be used which require testing.

C. Additional Testing: Assume sole responsibility for expense of additional testing where work does not comply with the Contract Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Handle all steel with a crane or derrick. Do not drop or dump material from truck. Return bent or damaged sections to the fabrication shop.

2. Store and cover materials in areas set aside for such use. Store materials on skids or platforms above the ground and protected from corrosion and deterioration.

3. Store materials so that they are not distorted or otherwise damaged in any way.

4. Assume full responsibility for replacement of damaged or unsatisfactory materials.

PART 2 PRODUCTS

2.1 MATERIALS

A. Structural Steel: Provide structural steel as follows:

1.	Provide shapes, plates and anchor bolts	ASTM A 36
2.	Provide mild steel plate	ASTM A 283, Grade C or D

B. Bolts: Provide bolts as follows:

1.	Provide high-strength bolts	ASTM A 325

2. Provide standard bolts ASTM A 307

3. Stainless steel anchor bolts ASTM A 276 Type 304

4. Provide miscellaneous bolts of steel, bronze, aluminum, stainless steel with hexagonal nuts and standard flat plate washers with threads that are clean cut, unified standard series meeting the requirements of ANSI B1.1.

C. Direct Tension Indicators: ASTM F 959, type as required

D. Headed Stud-Type Shear Connectors: ASTM A 108, Grade 1015 or 1020, cold-finished carbon steel with dimensions complying with A15C specifications

E. Welding Electrodes: Conform welding electrodes to requirements in AWS A5.1 or A5.5, 7000 series.

F. Expansion Anchors: Use Hilti Kwik Bolts by Hilti, Inc., or approved equal, for expansion anchors.

G. Adhesive Anchors: Use Hilti HVA Adhesive Anchors, by Hilti, Inc., or approved equal, for adhesive type anchors.

H. Bearing Surfaces: Manufacture TFE (polytetrafluoroethylene) bearing surfaces from a filled TFE sheet bonded to a stainless steel substrate conforming to the requirements of Section 27, Division 2 of the AASHTO Standard Specifications for highway bridges.

2.2 FABRICATION

A. General: Conform fabrication to AISC "Code of Standard Practice for Steel Buildings and Bridges".

1. Properly mark and match-mark materials where field assembly so requires. Expedite the sequence of shipments to minimize the field handling of material.

2. Mill or saw cut columns at bearing ends and protect all such surfaces from corrosion.

3. Make allowances for draw in all tension bracing.

4. Camber beams, girders and trusses as indicated.

5. Drill or punch holes for connection bolts 1/16-inch larger than the nominal diameter of the bolts. Make holes for anchor bolts in column base and setting plates 5/16-inch larger than bolt size. Make holes for bolts in weir plates and the like as shown.

6. Provide all holes required in members to permit the connection of work of other trades who will furnish the necessary templates or such information as may be required.

7. Provide built-up sections assembled by welding free of warpage, and with all axes having true alignment.

8. Be responsible for any errors of fabrication and for the correct fitting of the various members. Errors in fabrication will cause the piece to be rejected. Supply a new and properly fabricated piece at no expense to the OWNER.

B. Connections: Provide connections with a minimum of two bolts. Use two-sided connections unless otherwise shown. Where the reactions are indicated, size and detail connections for those reactions. Unless otherwise shown, provide bolts with 3/4-inch diameter in slip critical connections.

1. Provide connections for noncomposite beams with uniform loads having a capacity not less than half the AISC total tabulated uniform load capacity for the given shape and span, and steel specification for the particular beam tabulated in the "Allowable Uniform Load Tables" with the AISC "Manual of Steel Construction" (Ninth Edition), nor less than the reaction noted, if any. Consider the effect of concentrated loads and make an analysis of loading and end reactions if necessary.

2. Shop connections may be welded or bolted. If bolted, use ASTM A 325 bolts in slip critical connections.

3. Provide bolt, field connections using ASTM A 325 bolts in slip critical connections, unless otherwise shown. Use welding only where indicated.

4. For bolted connections, provide one hardened washer under either head or nut, whichever is turned to tighten. Use the turn-of-the-nut method for tightening. The substitution of direct tension indicators or calibrated impact wrenches for the turn-of-the-nut method is permitted only with previous approval. Determine proper bolt length for each field connection determined from the "Erector's Placement List".

C. Welded Connections: Use welded connections only where shown or as approved. Substitution of welded connections for shown bolted connections will not be permitted without written approval.

1. Furnish certificate issued by an approved testing laboratory, for all welders, to make groove and fillet welds in all positions. Provide documentation showing that all welders have practiced welding continuously since certification. Submit certification prior to any welding operations.

2. Unless otherwise shown, provide welded connections equal in strength to bolted shear connections. Provide minimum welds when not indicated, 1/4-inch fillet all around.

D. Miscellaneous bolts and nuts: Provide bolts and nuts of steel, bronze, aluminum, stainless steel or other materials as shown for uses other than those specified above for structural framing connections.

1. Assume the expense of drilled and grouted anchor bolts which are installed after concrete is placed.

2. Provide all bolts and nuts which are submerged or subject to periodic wetting of stainless steel, unless shown or specified otherwise.

E. Expansion Anchors: Provide expansion anchors of the size indicated and of the type specified. Lead expansion anchors will not be permitted.

F. Adhesive Anchors: Provide adhesive anchors of the size indicated and of the type specified.

G. TFE Surfaces: Install TFE (polytetrafluoroethylene) bearing surfaces to the dimensions and at the locations shown.

PART 3 EXECUTION

3.1 ERECTION

A. Field Verification: Verify all dimensions for connections to existing structures or to new structures already in place in the field. Assume sole responsibility for the correctness of all shop and field fabrication fits.

B. Bracing: Provide temporary bracing and guy lines to properly protect all persons and property and to ensure proper alignment. Comply with all federal, state and local laws which govern safety requirements for steel erection. Provide all necessary additional bracing, beams, temporary struts, ties, guys, clip angles, and the like, as required to take care of all loads to which the structure may be subjected before it is in finished condition. Remove all such erection aids after completion of steel erection, unless otherwise directed.

C. Coordination: Coordinate the location of supports for derricks, hoists, rigging and the like.

D. Templates: Furnish templates where shown, specified or required. Furnish shim plates, or developed fills where necessary to transfer load, where required, to obtain proper fit and alignment. Accurately set anchor bolts using a steel or wood template as necessary to maintain elevation and location.

E. Reaming: Unfair holes mismatched less than one-half fastener diameter may be reamed, and a proper size fastener installed with hardened washer under both head and nut, as directed. Mismatched holes greater than one-half fastener diameter will be considered as a fabrication error. Replace the piece affected as specified.

F. Leveling: Unless otherwise noted, level and plumb individual steel members to an accuracy of 1 to 500. Do all leveling and plumbing based on the mean operating temperature of the structure. Make allowances for the differences in temperature at the time of erection and the mean temperature at which the structure will be when completed and in service.

G. Stiffening of Structure: Do no welding or bolt tightening until as much of the structure as will be stiffened by the welding or bolting has been properly aligned.

H. Burn Holes: Burning of holes is permitted only with written approval. Any burning of holes without such written approval will be cause for the rejection of all parts involved.

I. Variations: Report immediately any variation from the Contract Documents which may occur during erection. Do not continue work affected by such variation without written approval.

J. Protection: Protect anchor bolt threads during placement of concrete.

3.2 INSPECTION AND TESTS

A. Rejection of Work: Work which does not comply with the Contract Documents will not be accepted. Take sole responsibility and assume the expense of all corrective measures, including additional and more extensive testing related to such work.

3.3 PAINTING

A. For surface preparation and painting of structural steel not encased in concrete see Section 09 96 00.

B. Structural steel encased in concrete shall be cleaned by removing all rust, loose mill scale, oil, grease and dirt in accordance with Steel Structures Painting Council SSPC-SPI, SP2 or SP3.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Ornamental light iron, steel, aluminum and stainless steel items, including nosings, ladders, safety posts, thresholds, anchors, bolts and accessories required for the attachment of items specified herein, and other items shown, to complete the Work in accordance with the Contract Documents.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-In-Place Concrete
2. Section 05 05 13 - Galvanizing
3. Section 05 12 00 - Structural Steel
4. Section 05 52 00 - Handrails and Railings
5. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ASTM A 36/A36	-	Structural Steel
2.	ASTM A 193/A193M Grade MT316	-	Stainless Steel Bolts
3.	ASTM A 283/A283M	-	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
4.	ASTM A 554	-	Welded Stainless Steel Mechanical Tubing
5.	ASTM B 137	-	Method for Measurement of Mass of Coating on Anodically Coated Aluminum
6.	ASTM B 244	-	Method for Measurement of Thickness of Anodic Coatings on Aluminum and Other Nonconductive Coatings on Nonmagnetic Basic Metals with Eddy-Current Instruments
7.	FS FF-S-325	-	Expansion Shields for Masonry Anchorage

8. FS FF-B-588 - Toggle Bolts

9. ANSI A14.3 - Safety Requirements for Fixed Ladders

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Certification: Submit certificates in triplicate for anodic treatment of aluminum. Certificates shall be properly attested by the aluminum fabricator stating that the aluminum has been treated as herein specified.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Nonslip nosings for interior concrete stairs

a. Wooster Products, Inc., Wooster, OH
b. Safe-T-Metal Company, Inc. Style Ax., Garden City Park, NY

2. Ladder Safety Post

a. The Bilco Company, New Haven, CT, Model 2 Ladder Up

3. Ladder Rungs

a. Safe-T-Metal Co., Inc. Style LR

4. Thresholds

a. Wooster Products, Inc., Wooster, OH, Type 115S - Exterior
Type 115 - Interior

2.2 MATERIALS

A. Standards: Provide metal items meeting the requirements of the following standards:

1. Structural steel, shapes and plates, except plates to be bent or cold-formed ASTM A 36/A36M

2.	Steel plates, bent or cold-formed	ASTM A 283/A283M, Grade C
3.	Steel bars and bar size shapes	ASTM A 36/A36M
4.	Sheet aluminum and extrusions	As required for color (3003 Alloy with mill finish)
5.	Aluminum castings thresholds and the like ornamental	Alloy 356-T6 Alloy 214-F
6.	Aluminum screw machine parts	Alloy 2024-T4
7.	Structural aluminum	Alloy 6061-T6
8.	Aluminum bar	Alloy 6061-T6511
9.	Stainless steel sheet	U.S. Steel 16-10, Grade MT316
10.	Pipe, stainless steel	ASTM A 554 Grade MT304
11.	Bolts: stainless steel	ASTM A 193/A193M, Grade MT316 85 percent copper, 5 percent lead, tin and zinc, unless otherwise specified

12. Provide steel which is to be hot-dip galvanized after fabrication, that has a silicone content in the range of 0 to 0.04 percent or 0.15 percent to 0.25 percent unless otherwise approved.

13. Provide lead expansion anchors for concrete meeting the requirements of FS FF-S-325, wedge type, Group II, Type 4, Class 1 or 2; self-drilling type, Group III, Type I or nondrilling type, Group VIII, Type 1 or 2.

14. Provide bolt anchor expansion shields for masonry meeting the requirements of FS FF-S-325, lag shield type, Group II, Type I, or split shield type, Group II, Type 3, Class 3.

15. Provide expansion bolts of Grade 316MT stainless steel.

16. Provide gauges specified to refer to U.S. Standard gauge for sheet steel, plate iron and steel, and to Brown & Sharp Gauge for wire and sheet aluminum.

17. Provide stainless steel screws, bolts, nuts and similar items used in connection with galvanized exterior Work.

18. Anodically treat aluminum to meet the test requirements of ASTM B 137 for weight and ASTM B 244 for thickness.

B. Nosings: Provide nonslip nosings on all interior stairs, that are 4 inches wide and 6 inches less in length than the length of the tread and of cast abrasive aluminum

No. 101. Finish the top surface flush with the cement finish. Install nonslip nosings at the edge of each interior stair landing and platform. Provide a minimum of three anchors to each nosing.

C. Ladders: Provide ladders made of aluminum bar rails 2-1/2 inches by 1/2-inch as shown. Space rungs uniformly and at not more than on 12-inch centers. Provide flat top rungs with serrated abrasive surface. Provide ladders that comply with the latest edition of OSHA and ANSI A14.3 requirements.

1. Secure ladders to concrete or masonry walls and stiffen with aluminum brackets. Fasten to concrete or masonry with stainless steel expansion bolts, unless otherwise indicated. Weld connections between brackets and rails of ladders.

2. Construct protective cages of aluminum as shown.

D. Ladder Safety Post: Install a ladder safety post at the top of all fixed ladders and cast-in ladder rungs below floor and sidewalk doors and roof hatches. Provide the device manufactured of high-strength galvanized steel and include a telescoping section that locks automatically when fully extended. Control upward and downward movement by a spring balancing mechanism with the spring of a special corrosion-resistant alloy. Assemble the unit completely and install it in strict accordance with the manufacturer's instruction. Coat contact surfaces between dissimilar metals as specified in Section 09 96 00.

E. Thresholds: Provide thresholds for door openings of cast abrasive aluminum, and extruded aluminum, unless otherwise shown or specified. Provide 5-inch wide thresholds of the types indicated. Make thresholds the full width of door openings, ends notched to fit the door jambs, and secured to the concrete base with lead expansion shields and stainless steel bolts.

F. Aluminum Finishes: Provide aluminum finishes specified below in strict compliance with the National Association of Architectural Metal Manufacturers (NAAMM) aluminum finish designations, unless otherwise indicated or specified.

1. Provide miscellaneous aluminum angles and cover moldings which are indicated to be painted with a mill finish.

2. Provide aluminum finishes as follows:

a. Exterior aluminum items, unless otherwise specified: NAAMM Architectural Class 1, AA-A41 clear coating

b. Interior aluminum items, unless otherwise specified: NAAMM Architectural Class 2, AA-A31 clear coating

G. Stainless Steel Finish: Provide stainless steel with a No. 4 satin finish unless otherwise shown.

H. Galvanizing: Galvanize in accordance with Section 05 05 13.

I. Painting: Metal fabrications shall be shop painted in accordance with Section 09 96 00.

2.3 FABRICATION

A. General: Form all Work true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, and free from defects impairing strength or durability. Precision fitting and jointings are required for all Work. Perform all welding in a way to prevent pitting or discoloration.

B. Welding: Weld joints of such character and assemble so that they will be as strong and rigid as the adjoining section. Select wire for welding to prevent discoloration and to insure sound structural welds. Continuously weld exposed joints their entire length unless otherwise shown or specified. Provide all exposed welded face joints dressed flush and smooth.

C. Surface Flaws: Remove surface flaws on aluminum before the anodic coating is applied.

D. Structural Steel: Provide structural steel plates, shapes, bars, sheets and other metal items meeting the requirements of Section 05 12 00.

E. Miscellaneous: Perform all drilling, tapping, cutouts, and reinforcement required to attach, insert or fit thereto, fixtures and fittings in accordance with the drawings templates or instruction for the fixtures and fittings. Do not begin fabrication of metalwork until all drawings, templates or instructions are available.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install metal fabrications in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Alignment: Install all items and set plumb, square, level and true at their proper elevation and plane, and located in true alignment with all Work.

C. Fastening: Securely anchor, ready for operation in every respect. Unless indicated otherwise, fasten metalwork to solid masonry and concrete with expansion bolts and to void areas of unit masonry with toggle bolts.

D. Examine metal Work after installation, painting and glazing have been completed as required. Adjust, repair and replace metalwork as required. Clean and retouch exposed surfaces of metal Work where necessary to bring the color of the finished surfaces reasonably uniform and free from scratches and other surface blemishes.

END OF SECTION

SECTION 05 51 00

METAL STAIRS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. At the East Bank Junction Structure: Engineered and fabricated aluminum stairs including aluminum grating treads, riser, aluminum structural framing members for stairs, aluminum

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 05 12 00 - Structural Steel
2. Section 05 52 00 - Handrail and Railings
3. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM A 36/A36M - Structural Steel

2. ASTM A 193/A193M - Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service

3. ASTM B 308/B308M - Aluminum - Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded

4. AWS D1.1 - Structural Welding Code - Steel

5. FF-5325 - Expansion Shields

1.3 DESIGN REQUIREMENTS

A. Engineer and fabricate complete stair systems including treads, stringers supports, anchors, platforms to support a live load of 100 pounds per square foot with a deflection of the stringers or landing framing not to exceed L/240 of the span.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit shop drawings for approval, indicating all the sizes and shapes of the stringers, headers, tees, carrier angles, clip angles, cast treads, landing platforms, bracing, stiffeners, hangers, supports, fascias and anchors as required.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Stair Treads

a. Wooster Products, Inc.; Type 105
b. Safe-T Metal Co., Inc.; Type KK

2. Stile and Ships Ladder Treads

a. Wooster Products, Inc.; Type 106A
b. Safe-T Metal Co., Inc.; Type D1

3. Platforms

a. Wooster Products, Inc.
b. Safe-T Metal Co., Inc.

2.2 MATERIALS

A. Aluminum Sections: Provide ASTM B 308/B308M aluminum sections including: stringers, headers, tees, carrier angles, clip angles and angles, bracing, stiffeners, supports and bearing plates, in sizes as shown.

B. Aluminum Plates: Provide ASTM B 209 aluminum riser.

C. Stair Treads: Provide stair treads of grating, in width and length and of thickness recommended by the manufacturer for the required length.

D. Stair Platforms and Landings: Provide stair platforms and landings of grating, with truss ribs, and toeplates and nosings, matching the treads, recommended by the manufacturer for the required length.

E. Welding Materials: Provide AWS D1.1 welding for type required for materials being welded.

F. Expansion Bolts: Provide ASTM A 193/A193M expansion bolts with washers and nuts, stainless steel type.

2.3 FABRICATION

A. General: Fit and shop assembly the stairs, ships ladders, platforms and stiles in the largest practical sections for delivery to the job site.

B. Stringers: Miter the stringers at changes in direction with joints tightly fitted and secured by continuous welds. Grind all exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight. Ease exposed edges to a small uniform radius.

1. Close and fit the ends of stringers at the floor or landing to the floor surface. On landings and platforms where they are part of the stair framing, carry the wall stringers around and above the finished level of the platform to form a base of the height as shown.

C. Treads: Fasten treads for stairs, ships ladders and stiles to steel or (aluminum) carrier angles, welded to steel or (aluminum) stringers.

D. Fasteners: Use Type MT 316 stainless steel complying with ASTM A 193/A193M for fastening treads to the carrier angles and for expansion bolts. Provide closed-end, bottom bearing expansion shields in accordance with the requirements of FF-B-5325.

2.4 FINISHES

A. Surface Preparation: Prepare surfaces to be primed and painted in accordance with Section 09 96 00.

B. Aluminum Coatings: Provide aluminum stairs, ships ladders, and stiles, excluding treads and platforms, with a NAAMM, Architectural Class II, AA-C22A31, clear natural coating (interior) or (Architectural Class I, AA-C22A41, clear natural coating (exterior).

C. Dissimilar Materials: Coat aluminum in contact with dissimilar metals, masonry or lime products, in accordance with Section 09 96 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Cleaning: Clean and strip primed steel items to bare metal, where site welding is required.

3.2 INSTALLATION

A. General: Install metal stairs in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Alignment: Install and set plumb, square, level and true the stairs, ships ladders and stiles at their proper elevation and plane, and located in true alignment with all the Work.

C. Fastening: Securely bolt the stairs, ships ladders, platforms and stiles to, or hang from, the structural framing with approved anchors, struts, or hangers.

D. Alignment: Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

E. Welding: Field weld components indicated on the shop drawings. Perform field welding to meet AWS D1.1.

END OF SECTION

SECTION 05 52 00

HANDRAILS AND RAILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. East Bank Junction Structure: Aluminum welded railings and handrails with stainless steel anchors, bolts, sleeves and accessories.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

   1. Section 03 31 00 – Cast-In-Place Concrete
   2. Section 05 05 13 – Galvanizing
   3. Section 05 51 00 – Metal Stairs
   4. Section 05 50 00 – Metal Fabrications

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

   1. ASTM B 241/B241M - Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

   2. ASTM A 554 - Specification for Welded Stainless Steel Mechanical Tubing

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Fabricate and install the railing or handrail assembly as shown. Space posts not to exceed 4 feet 6 inches on center.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Samples: Submit three samples of handrail and post intersection indicating welded connection and finish.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify with field measurements the locations of all sleeves prior to fabrication of pipe railings and posts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Quick setting grout compound

a. Quik-Rod, by Preld Industries, Ltd., Plainview, NY
b. Pol-Rok, by the Hallemite Mfg. Co., Cleveland, OH

2.2 MATERIALS

A. Construction: Fabricate aluminum railings and posts of 1-1/2-inch Schedule 40 aluminum pipe conforming to ASTM B 241/B241M, 6063-T6. Reinforce aluminum end posts with Type 6061-T6 aluminum bars 24-inches long.

B. Welding Materials: Provide AWS D1.2 welding for type required for materials being welded

C. Finish: Finish exterior and interior aluminum pipe railings with a NAAMM Architectural Class I AA-A41 clear coating.

2.3 FABRICATION

A. General: Fit and shop assemble components in the largest practical sizes for delivery to the site. Provide removable sections where shown and provide for expansion and contraction.

B. Exposed Joints: Grind exposed joints flush and smooth with adjacent finish surfaces. Make exposed joints such that they are butt tight, flush and hairline. Ease exposed edges to small uniform radius.

C. Posts: Corner posts will not be allowed. Set back post as shown.

D. Bends and Splices: Where practical, make bends in pipe without the use of fittings. Do not exceed a spacing of 20 feet between railing splices. Fabricate railings and posts in the same plane with continuous 360-degree welds at all intersections.

E. Handrail: Provide single rail handrails turned 90 degrees to terminate 1/8-inch from walls. Provide manufactured brackets made of 1-1/2-inch aluminum pipe welded to an aluminum flange plate secured to the wall with two stainless steel expansion bolts. Mount terminal brackets not more than 12 inches from the end of the handrails.

F. Protection: Deliver railings to the job site protected in polyethylene tubing with a minimum wall thickness of 0.05 inches. Remove tubing after construction has been completed and when directed.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install handrails and railings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Erection: Recess and set railing posts with quick-setting grout compound into pipe sleeves. Install railing posts required to be anchored to vertical concrete surfaces, with a 6- by 6- by 1/4-inch thick aluminum plate fastened with four stainless steel anchor bolts 5/8-inches in diameter. Close the bottom of the posts with a welded cap. Anchor railing posts to the top flange of stair stringers, with a 3/8-inch thick aluminum plate of the profile and size shown welded to the bottom of the post and fastened to the stringer with two stainless steel 1/2-inch diameter bolts.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Furnish the services of a qualified representative of the railing manufacturer to supervise and inspect the railing installation.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 07 90 00

JOINT SEALERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Sealing for perimeter joints around all frames, pressure relieving joints, masonry joints, and joints at the perimeter of ducts and conduits at walls and partitions and at all joints requiring weathertight sealing.

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM C 920 - Specification for Elastomeric Joint Sealants

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Product Data: Catalog sheets, specifications and manufacturer's installation instructions for each type of product indicated. Submit. Indicate special procedures, surface preparation, perimeter conditions requiring special attention, and written recommendations for primer, backup materials and solvents.

C. Samples for Verification: For each type and color of joint sealant required, provide samples with joint sealants in 1/2-inch wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.5 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: TDiv 7wo years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.

2. Disintegration of joint substrates from natural causes exceeding design specifications.

3. Mechanical damage caused by individuals, tools, or other outside agents.

4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer

C. Mockups: Build mockups incorporating samples of each type of joint to demonstrate aesthetic effects and set quality standards for materials and execution. The approved samples shall show workmanship, bond and color of materials as specified or selected for the work and shall be minimum standard of quality on the entire project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Sealant:

a. Pecora Corporation, Harleysville, PA - Dynatrol II
b. Sonneborn by Degussa Building Systems

2. Expanding Foam

a. Emseal Joint Systems, LTD, Westborough, MA – Backerseal

2.2 MATERIALS

A. Sealant: Provide sealant based on liquid polyurethane polymer. Deliver the sealant to the job site in sealed containers bearing the manufacturer's name and product designation. Provide a two component elastomeric sealant conforming to ASTM C 920, Type M, Grade NS, Class 25. Match the color of the sealant to that of the adjacent surface.

B. Expanding Foam: Provide precompressed closed cell expanding foam binary seal with cured silicone facing in color to match adjacent surfaces.

2.3 ACCESSORIES

A. Primer: Provide primer of the nonstaining type, recommended by sealant manufacturer to suit the application. Test the primer for staining and durability on samples of the actual surface to be sealed.

B. Backup Materials: Provide nonstaining backup materials and preformed joint fillers, compatible with sealant and primer, and of a resilient nature, such as closed cell polyethylene rod, closed cell urethane or neoprene rod, or elastomeric tubing or rod. Do not use materials impregnated with oil, bitumen or similar materials. Do not allow sealant to adhere to the backup material.

C. Bond Breakers: Provide bond breakers, where required, of polyethylene tape.

D. Solvents: Provide solvents and cleaning agents compatible with the joint compound, backup material and bond breakers.

E. Manufacturers' Recommendations: Provide primer, backup materials, bond breakers and solvents recommended by the sealant manufacturer in writing.

PART 3 EXECUTION

3.1 PREPARATION

A. Cleaning: Thoroughly clean all joints and openings of all foreign matter, such as dust, oil, grease, water, and surface dirt, and remove frost. Mechanically clean porous materials, such as concrete, masonry or stone, by water blast cleaning, acid

washing or a combination of these methods as required to provide a clean, sound base surface for adhesion of the caulking compound.

B. Concrete Surfaces: Determine that concrete is fully cured and free of laitance, loose aggregate, form release agents, curing compounds, water repellents, and other surface treatments. Test for adhesion before proceeding with the caulking and sealing if surface treatments are present.

C. Nonporous Surfaces: Clean nonporous surfaces, such as metal and glass, by approved mechanical means. Remove protective coating on metallic surfaces by a solvent that will not stain the metal or leave a residue. Protect joint areas with masking tape or film and clean after removal of tape or film.

3.2 INSTALLATION

A. Install sealant in accordance with manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Joint Size: Provide joints of a minimum of 1/4-inch wide by 1/4-inch deep, unless otherwise approved.

1. Provide joints seals in concrete, masonry and stone as follows:

Joint Width	Depth of joint seal
Up to 1/2-inch	Equal to width of joint
1/2- to 1-inch	1/2-inch
1 to 2 inches	1/2 of the joint width

2. Provide joints in metal, glass and other nonporous surfaces a minimum depth of one-half the applied sealant width, and not to exceed the applied sealant width.

C. Procedures: Install backup materials or joint filler of the type and size specified or shown at the proper depth in the joints to provide sealant dimensions specified. Provide backup material of suitable size and shape so that when compressed, 25 to 50 percent, it will fit in joints as required. Do not apply the sealant without backup material and, if necessary, bond breaker strip. When using backup rod stock, roll the material into the joint to avoid lengthwise stretching. Do not twist or braid the rod stock. Do not use bond breaker strips between sealant and supporting backup material. Do not use bond breaker strips in joints where there is not sufficient room for backup.

D. Joint sealing: Perform all sealing Work with workers meeting the requirements of paragraph 1.6.A and in strict conformance with the sealant manufacturer's recommendations. Apply masking tape, where required, in continuous strips in

alignment with joint edge. Apply the sealant with a power-actuated gun or other approved means. Apply joint fillers with a gun nozzle of approved size and provide sufficient pressure to completely fill the joints as detailed. Neatly point or tool all joint surfaces to provide the contour of recess indicated on the details. Provide all watertight joints.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 08 31 00

SIDEWALK DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Stainless steel floor sidewalk doors

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-in-Place Concrete

1.2 DESIGN REQUIREMENTS

A. Provide floor sidewalk doors designed to withstand a minimum live load of 300 pounds per square foot.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Floor Sidewalk Doors:

a. Xylem – Safe Hatch
b. The Bilco Co. - Type JD-SS
c. Acudor Products Inc.

2.2 MATERIALS

A. Sidewalk Doors: Provide floor sidewalk doors fabricated of diamond tread plate and stainless steel hardware. Provide Type 316 stainless steel hinges. Provide doors with compression spring operators enclosed in tubes, that open 90 degrees, lock automatically and have slam lock and safety chains. Provide latch with interior handle and removable exterior key handle.

2.3 FALL PROTECTION GRATING SYSTEM

A. Grating: Provide fiberglass panels, molded in one piece, with load bearing bars in both directions to allow for use without continuous side support. Designed grating to support a 300 PSF live load.

B. Lift assistance: Provide type 316 stainless steel torsion rod incorporated into the grating panel design to provide lift assistance when opening the grating panel.

C. Hold open feature: Provide type 316 stainless steel hold open arm provided to lock the cover in the fully open 90 degree position. Provide a release handle to allow the grating panel to be closed.

D. Hardware: Type 316 stainless steel for all hardware, including mounting brackets, hinges, torsion rod, hold open arm, padlock loop, and fasteners.

E. Grating system panels shall meet the following performance characteristics:

1. High visibility safety yellow in color.

2. Lock in the fully open position.

3. Lift assistance for ease of operation.

4. UV and corrosion resistant construction with a twenty-five year manufacturer’s warranty.

5. Locking to prevent unauthorized opening.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install floor sidewalk doors in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

FLOOR SIDEWALK DOOR SCHEDULE

Location	Size W x H (Inches)	Quantity	Remarks
East Bank Junction Structure	48 x 96	1	Double leaf w/ Fall Protection Grating System
East Bank Junction Structure	48 x 48	2	Single leaf w/ Fall Protection Grating System
West Bank Junction Structure	48 x 96	3	Double leaf w/ Fall Protection Grating System
Diversion Facilities Valve Vault	36 x 36	1	Single leaf w/ Fall Protection Grating System

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 09 93 00

PROTECTIVE LINING SYSTEM FOR CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. This specification covers all labor, materials, equipment and services necessary to complete the installation of interior corrosion protection for both the East and West Bank Junction Structures as herein specified and shown on the Contract Drawings.

B. Contractor shall provide cleaning, surface preparation, and application of high performance coatings for vertical walls and the underside of the top concrete slab in both the East and West Bank Junction Structures.

1.2 REFERENCES

A. General: Codes and standards referred to in this section are:

1. ASTM D4258 — Standard Practice for Surface Cleaning Concrete for Coating
2. ASTM D4259 — Standard Practice for Abrading Concrete
3. ASTM D4263 – Standard Method for pH of Concrete Surfaces
4. ASTM D638 - Tensile Properties of Plastics.
5. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
6. ASTM D695 - Compressive Properties of Rigid Plastics.
7. ASTM D4541 - Test Method for Pull-off Strength of Coatings Using a Portable Adhesion Tester.
8. ASTM D7234 – Test Method for Pull-off Strength of Coatings on Concrete Using Portable Pull-off Adhesion Testers.
9. ASTM D2584 - Volatile Matter Content.
10. ASTM D543 - Resistance of Plastics to Chemical Reagents.
11. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.

12. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.

13. ACI 305R – Hot Weather Concreting

14. Use of Epoxy Compounds for Coating Concrete.

15. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.

16. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.

17. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.

18. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
    1. SP-1 - Solvent Cleaning.
    2. SP-2 - Hand Tool Cleaning.
    3. SP-3 - Power Tool Cleaning.
    4. SP-5 - White Metal Blast Cleaning.
    5. SP-6 - Commercial Blast Cleaning.
    6. SP-7 - Brush-Off Blast Cleaning.
    7. SP-10 - Near White Metal Blast Cleaning.
    8. SP-11 - Power Tool Cleaning to Bare Metal.
    9. SP-12 - Surface Preparation and Cleaning of Metal.
    10. SP-13 - Surface Preparation of Concrete.
    11. Steel Structures Painting Manual, Volumes 1 and 2.
    12. SSPC-Vis 1 - Pictorial Surface Preparation for Painting Steel Surfaces.
    13. SSPC PA2 – Measurement of Dry Paint Thickness With Magnetic Gages

19. International Concrete Repair Institute (ICRI)
    1. ICRI Technical Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

20. Los Angeles County Sanitation District — Evaluation of Protective Coatings for Concrete.

21. American National Standards Institute (ANSI)

1. A159.1 – Surface Preparation Specifications

22. SSPWC 210-2.3.3 - Chemical resistance testing published in the Standard Specifications for Public Works Construction (otherwise known as "The Greenbook").

1.3 DEFINITIONS

A. Dry Film Thickness: Thickness of fully cured coating, measured in mils; DFT.

B. Repair product: Refers to a product that is applied directly to the concrete substrate to prepare its surface for the future application of a coating product.

C. Coating product: Refers to a product that is applied directly to concrete surfaces that have not required repair, or to those concrete surfaces that have received an application of a prior repair product.

1.4 PERFORMANCE REQUIREMENTS

A. Coating and repair product materials shall be especially adapted for use in a municipal wastewater environment.

1.5 DESIGN CONDITIONS

A. The following design conditions shall be assumed:

	Parameter	Design Requirement
1.	Structure Condition	Fully Deteriorated
2.	Soil Type	Saturated
3.	Design Thickness	ASTM 1216-09 or Flat Wall Beam Analysis
4.	Soil Load	120 lbs/cu ft
5.	Traffic Load	AASHTO HS-20-44 Highway
6.	Soil Modulus	Between 500 and 1000 psi
7.	Factor of Safety	2.0
8.	Soil Cover	Distance from grade to top elevation of JB-782 top slab
9.	Water Table	Within one (1) feet of grade

B. Wall thickness design calculations utilizing specified protective lining system must be submitted with all qualified bids along with supporting formulas that document that version of formula used. Product specific strength values, including the short and long term flexural modulus must be substantiated by third party testing which will be submitted with all qualified bids. Products utilized shall be of a quality equal to or better than the

products used in the long term test with respect to the initial flexural modulus, and the long term reduction factor used in design.

1.6 SUBMITTALS

A. General: Provide all submittals including the following, as specified in Division 1.

B. Product Data:

1. Provide project specific data for construction and repair materials to be top coated with the coating product(s) including compatibility with the specified coating product(s).

2. Prior to ordering materials, submit a complete schedule of materials to be used. Include manufacturer's brand name, product name, and designation number for each coat of each system to be used.

3. Prior to commencing work, submit a detailed list of all surfaces and equipment items which the Contractor intends to apply protective coatings.

4. Provide the following information on each product:

a. Abrasion Resistance, ASTM D4060, 1 kg load at 1000 cycles, CS-17 wheel.

b. Impact Resistance, ASTM D2794, direct and reverse.

c. Moisture vapor transmission, ASTM F1249.

d. Adhesion, ASTM D7234 or ASTM D4541.

5 Substitutions: The specified corrosion protection lining is the minimum standard of quality for this project. Equivalent materials of other manufacturers may be substituted only by approval of Engineer. Requests for material substitutions shall be in accordance with requirements of the project specification.

a. Manufacturers of "or equal" products shall provide direct property comparison with the materials specified in addition to complying with all other requirements of these Specifications. "Or equal" products shall employ the same generic materials and system components as the corrosion protection lining specified. "Or equal" products shall provide equivalent performance as the specified corrosion protection lining.

6. If materials other than those listed are submitted, submit additional information to fully define the proposed substitution. The Engineer may further require the Contractor to furnish additional test results from an independent paint laboratory comparing the proposed substitution with one

of the named products, at no additional cost to the Owner. For substituted materials, provide a list of references, including contact person and phone number, where proposed substitute paint system has been used in similar exposures. Provide a minimum of five references (no duplicate owners or agencies).

7. Manufacturer's Instructions: Submit the following information for each product used:

    1. Special requirements for transportation and storage.
    2. Mixing instructions.
    3. Shelf life.
    4. Pot life of material.
    5. Precautions for applications free of defects.
    6. Surface preparation procedures.
    7. Method of application.
    8. Drying time.
    9. Curing time.
    10. Recommended thinners, when recommended.
    11. Limits of ambient conditions during and after application.
    12. Required protection from sun, wind and other conditions.
    13. Touch-up requirements and limitations.
    14. Material Safety Data Sheet (MSDS).

C. Contractor Data:

1. Current documentation from repair and coating product manufacturer certifying Contractor's training and equipment complies with the Quality Assurance requirements specified herein.

2. Five (5) recent references of Contractor indicating successful application of coating product(s) of the same material type as specified herein, applied by spray application within the municipal wastewater environment.

3. Letter from the coating product manufacturer providing the name and qualification(s) of the Technical Representative to be on-site in accordance with this specification.

4. Current documentation that onsite personnel have satisfactorily completed five coating projects with confined space entry requirements.

5. All testing conditions and results.

D. Technical Representative Data:

1. The coating manufacturer's Technical Representative shall approve surfaces for application of coating at each stage.

   a. Letter providing the surface preparation method shall be submitted to the Engineer 10 days before work is to begin.

   b. Letter approving the completion of surface prep shall be submitted to the Engineer prior to concrete repair.

   c. Letter providing the concrete repair method recommended shall be submitted to the engineer prior to the start of the repair.

   d. Letter approving the completion of concrete repair shall be submitted to the Engineer prior to coating.

1.7 QUALITY ASSURANCE

A. Coating product(s) shall be capable of being installed and curing properly within the specified environment(s). Coating product(s) shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems; and, capable of adhering to the substrates and repair product(s).

B. Repair product(s) shall be fully compatible with coating product(s) including ability to bond effectively to the host substrate and coating product(s) forming a composite system.

C. Contractor shall utilize equipment for the spray application of the coating product(s) which has been approved by the coating product manufacturer; and, Contractor shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.

D. Contractor shall be trained by, or have their training approved and certified by, the coating product manufacturer for the handling, mixing, application and inspection of the coating product(s) to be used as specified herein.

E. Contractor shall utilize the services of the coating product(s) manufacturer's technical representative to provide on-site inspection at the following checkpoints during the project:

1. Completion of Section 3.2 - Surface Preparation
2. During installation of Repair Product(s) — Section 3.3
3. During installation of Coating Product(s) — Section 3.4

4. During Holiday Detection inspection — Section 3.5.B

F. Inspectors, including Contractor and coating product(s) manufacturer personnel performing inspection, shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the coating product(s) to be used as specified herein.

G. Contractor shall initiate and enforce quality control procedures consistent with the coating product(s) manufacturer recommendations and applicable NACE or SSPC standards as referenced herein.

H. Pre-Installation of Protective Liner Conference:

1. Pre-installation of Protective Liner Conference shall take place no less than two weeks prior to Contractor mobilization. All parties to have physical presence on the project during construction shall be present. Contractor, Installer and technical representative of the corrosion protection lining manufacturer shall meet on-site with Engineer to discuss approved products and workmanship to ensure proper application of the corrosion protection lining components and substrate preparation requirements.

2. Review foreseeable methods and procedures related to the corrosion protection lining of coating Work including but not necessarily limited to the following:
   (a) Review Project requirements and the Contract Documents.
   (b) Review required submittals.
   (c) Review status of substrate Work, including approval of surface preparations and similar considerations.
   (d) Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
   (e) Review required inspection and testing.
   (f) Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
   (g) Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
   (h) Review procedures required for the protection of the corrosion protection lining during the remainder of the construction period.

3. Record the discussions of the Pre-Installation of Protective Liner Conference and the decisions and agreements or disagreements reached, and furnish a copy of the minutes to each party attending.

Record any revision or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

4. Reconvene the conference at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.8 DELIVERY, HANDLING AND STORAGE

A. Deliver materials in manufacturer's original, unopened, and undamaged packages.

B. Clearly identify manufacturer's brand name, contents, color, batch number, and any personal safety hazards associated with the use of or exposure to the materials in each package.

C. Store materials in their original packaging.

D. Packages showing indications of damage that may affect condition of contents are not acceptable and will be replaced at no cost to the Authority.

E. Coating product(s) are to be kept dry, protected from weather and stored under cover.

F. Stack containers in accordance with manufacturer's recommendations.

G. Coating product(s) are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.

H. Coating products(s) are to be handled according to their material safety data sheets and in such a manner as to prevent damage to products or finishes.

1.9 WARNINGS

A. Be advised that application of paint, epoxy and protective coating materials may be hazardous. Take all necessary precautions to ensure the safety of workers and property.

B. Be advised that access to interior areas to be coated is limited. This may require the use of special equipment for abrasive blasting and coating.

C. Be advised that concrete surfaces will not be dry immediately after JB-782 has been dewatered. Contractor's cleaning operations may also impact moisture content of substrate.

D. Contractor shall become familiar with the existing site conditions and take all steps necessary to protect adjacent facilities and personnel, at no additional cost to the Owner.

E. Contractor shall provide dust control and lighting facilities to control dust and provide visibility during all phases of cleaning and surface preparation operations.

F. Perform abrasive blasting activities in a manner that will not cause a nuisance to adjacent public and private property.

1.10 SITE CONDITIONS

A. Contractor shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

B. Confined space entry, flow diversion and/or bypass plans shall be presented by Contractor to Authority as necessary to perform the specified work.

1.11 SPECIAL WARRANTY

A. Contractor shall warrant all work against defects in materials and workmanship for a period of five (5) years, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said five (5) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Authority.

B. Coating and repair product suppliers shall warrant all products for a period of five (5) years from the date of final acceptance, unless otherwise noted, to be free of manufacturing defects, and products will meet current published physical properties when applied and tested in accordance with the manufacturer's standards. If, within said five (5) year period, any product does not meet the physical properties or is defective in manufacture, the manufacturer will either replace the defective product, or refund the product purchase price including all applicable taxes, and delivery charges to the Authority.

PART 2 PRODUCTS

2.1 EXISTING PRODUCTS

A. Materials, regardless of type or quantity, used to fill voids, anchor attachments or otherwise alter the surface material of concrete structures scheduled to receive coating product(s) shall be compatible with the specified coating product(s). Prior to use, technical data, material safety data sheets and proof of compatibility with the specified coating product(s) of all such materials shall be submitted to the Engineer for approval. Any materials used without prior written approval shall be

removed and replaced with approved materials by Contractor without cost to Authority.

1. Standard Portland cement or new concrete (not quick setting high strength cement) shall be cured a minimum of 28 days prior to application of the coating product(s). If earlier application of coating materials is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred.

2. Remove existing coatings prior to application of new protective coating product(s) which may affect the performance and adhesion of the new protective coating product(s). Contractor shall maintain strict adherence to the protective coatings manufacturer's recommendations and applicable NACE and SSPC recommendations with regard to proper surface preparation and compatibility with existing coatings.

3. Thoroughly clean and prepare existing products to effect a seal with the protective coating product(s).

2.2 REPAIR PRODUCTS

A. Repair products shall be used to fill voids, bugholes, concrete surface anomalies, and/or smooth transitions between components prior to the installation of the coating product(s). Repair materials must be compatible with the specified coating product(s) and shall be used and applied in accordance with the manufacturer's recommendations.

2.3 PROTECTIVE COATING PRODUCTS

A. The protective coating material shall be 100% solids, polymer-based, solvent-free, high build and used to form a spray applied, structurally enhanced monolithic liner covering all interior surfaces of JB-782, including the interior surface of the existing 4' x 4' concrete overflow conduit, and the bottom surfaces of the new removable precast concrete top slabs. **The minimum dry film coating thickness of the finished liner for corrosion protection shall be 125 mils.** The benches and inverts of JB-782 shall **not** be coated. The finished liner shall conform to the minimum physical requirements listed below.

	Physical Requirement	Test Method	Unit
1.	Compressive Strength	ASTM D695	18,000 psi
2.	Tensile Strength	ASTM D638	7,500 psi
3.	Bond (Concrete)	ASTM D7234 or Substrate Failure	200 psi
4.	Bond (Steel)	ASTM D4541	1,600 psi
5.	Flexural Modulus (Initial)	ASTM D790	700,000 psi

6. Density 87 lb/cu ft
7. Chemical Resistance ASTM D543/G20

The protective coating material shall also meet the chemical resistance standards of the Sanitation District of L.A. County Coating Evaluation Study.

The physical requirements must be verified by an independent, certified, third party testing laboratory within the last five (5) years and must be submitted with the Contractor's bid package. **Any bid package not including the verifiable, independent, third party testing shall be ruled non-responsive, and will be rejected.**

B. Manufacturers: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810, 918-615-0020 or FAX 918-615-0140; Sprayroq Protective Lining Systems, Pelham, Alabama, 800-634-0504, 205-957-0020 or FAX 205-957-0021, Sauereisen, Pittsburgh, Pennsylvania 412-963-0303, or approved equal.

C. Polymer-based Coating System. Polymer-based coating system shall be Raven 405, SprayWall, SewerGard No. 210X, or approved equal.

D. Primer Product(s): Primer must be compatible with the specified protective coating product(s) and shall be used and applied in accordance with manufacturer's recommendations.

2.4 COATING APPLICATION EQUIPMENT

A. Manufacturer approved heated plural component spray equipment.

B. Hard to reach areas, primer application and touch-up may be performed using hand tools.

PART 3 EXECUTION

3.1 EXAMINATION

A. Appropriate actions shall be taken by Contractor to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety during work.

B. All structures to be coated shall be readily accessible to Contractor.

C. New Portland cement concrete structures shall have endured a minimum of 28 days since manufacture prior to commencing coating installation.

D. Any active flows shall be dammed, plugged or diverted as required to ensure all liquids are maintained below or away from the surfaces to be coated.

E. Coating product(s) application shall not occur unless the temperature of the surface to be coated is between 40 and 120 deg F.

F. Specified surfaces should be shielded to avoid exposure of direct sunlight or other intense heat source.

G. Surface temperature logs shall be maintained by Contractor and used to identify when temperatures vary greater than 5°F. Coating product(s) application shall be scheduled when the temperature is falling versus rising.

H. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Authority, in writing, of any noticeable disparity in the site, structure or surfaces which may interfere with the work, use of materials or procedures as specified herein.

3.2 SURFACE PREPARATION

A. Concrete surfaces to receive coating shall be inspected prior to surface preparation to determine the condition of the surfaces specified to receive the coating product(s) and the appropriate method or combination of methods to be used for surface preparation to meet the requirements of the coating system(s) to be applied.

B. The Manufacturer's Representative shall approve surfaces for application of coating at each stage. Any material that is coated prior to the Authority's approval shall be stripped back and recoated.

C. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed per ASTM D-4258.

D. Concrete fins, protrusions, burrs, sharp edges and concrete spatter shall be corrected by grinding or scraping.

E. Unless otherwise submitted and approved by the Engineer, surfaces to receive coating shall be abrasive blasted per ASTM D-4259 to remove laitance and weak concrete to expose subsurface voids, open honeycomb and air pockets. After blasting, surfaces shall be cleaned of all loose blast grit, dust and other debris by sweeping, vacuuming, air blasting and washing as necessary.

F. Surface preparation method(s) used shall be performed in a manner that provides a uniform, sound clean neutralized surface suitable for the specified coating product(s).

G. Infiltration shall be stopped by using a material which is compatible with the repair products and is suitable for top-coating with the coating product(s).

3.3 APPLICATION OF REPAIR PRODUCTS

A. Repair products shall-be-used to-fill all voids, honeycombs, bug holes, spalls, cracks and other surface anomalies which may affect the performance or adhesion of the coating product(s) including their use to smooth or rebuild surfaces with rough profiles to provide a minimum profile of coarse (60) abrasive paper comparative to ICRI Replicas 4-6 (ICR1 Guideline 03732) and suitable for the coating product(s) to be applied.

B. Repair products shall be handled, mixed, installed and cured in accordance with manufacturer guidelines.

C. All repaired surfaces shall be inspected for cleanliness and suitability to receive the coating product(s). Additional surface preparation may be required prior to coating application.

3.4 APPLICATION OF COATING PRODUCT(S)

A. Application procedures shall conform to the recommendations of the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment and methods.

B. Spray equipment shall be specifically designed to accurately ratio and apply the coating product(s) and shall be in proper working order.

C. Contractors qualified in accordance with Section 1.4 of these specifications shall perform all aspects of coating product(s) installation.

D. Prepared surfaces shall be primed by application of the waterborne epoxy primer described herein at an application rate of 200 square feet per gallon (8 mils wet film thickness). The primer shall be allowed to dry to a tack free state. The solvent-free polymer-based topcoat described herein shall then be spray applied to a minimum dry film thickness of 125 mils.

E. No more than 12 hours shall be permitted to pass between each application of the waterborne epoxy, the solvent-free epoxy primer and the epoxy topcoat. Subsequent top-coating or additional coats of the coating product(s) shall occur within the product's recoat window as adjusted for temperature extremes. Additional surface preparation procedures will be required if this recoat window is exceeded.

F. Coating product(s) shall interface with adjoining construction materials throughout the structure to effectively seal and protect concrete substrates

from infiltration and attack by corrosive elements. Procedures and materials necessary to effect this interface shall be as recommended by the coating product(s) manufacturer.

G. Surfaces not to receive the coating shall be masked or otherwise protected to prevent overspray or feathering of the coating termination. Termination points of the coating product(s) shall be made at joints and a minimum of 1" interfacing with each pipe penetration, and/or as shown within Project Drawings and Specifications.

3.5 TESTING AND INSPECTION

A. During application a wet film thickness gauge, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented and attested to by Contractor for submission to Authority.

B. After the coating product(s) have set in accordance with manufacturer instructions, all surfaces shall be inspected for holidays with high-voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection. All detected holidays as indicated by the audible or visual signal of the test apparatus shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations. Documentation on areas tested, results and repairs made shall be provided to Authority by Contractor.

C. A minimum of three (3) 20-mm test dollies shall be placed and pulled to evaluate adhesion/bond of the coating to the substrate. Testing shall be conducted in accordance with ASTM D4541 as modified herein. Authority's representative shall select the location of the dolly placement including at least one test in each rehabilitated manhole. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of the coating product and permitted to cure in accordance with manufacturer recommendations. The coating and dollies shall be adequately prepared to receive the adhesive. Failure of the dolly adhesive shall be deemed a non-test and require retesting. Prior to performing the pull test, the coating shall be scored through approximately 90% of the coating thickness by mechanical means without disturbing the dolly or bond within the test area. Two of the three adhesion pulls shall exceed 200 psi or concrete failure with more than 50% of the subsurface adhered to the coating. Should a structure fail to achieve two successful pulls as described above, additional testing shall be performed at the discretion of the Authority or Engineer. Any areas detected to have inadequate bond strength shall be evaluated by the Engineer. Further bond tests may be performed in that area to determine the

extent of potentially deficient bonded area and repairs shall be made by Contractor.

D. Before final cleanup, a final inspection of the project shall be made of the project for deviations in specifications. Deficient work should be corrected in accordance with repair procedures as approved by the Authority's Representative. The following is a list of qualities or properties that are defined and agreed upon prior to installation and should be inspected in the course of application and after completion.

1. Uniform color
2. Straightness and neatness of termination lines
3. Depressions of humps which could affect liquid flow
4. Smooth transitions at cove radii, internal and external corners, intersections and terminations
5. Spatter of cured and uncured resinous materials on surfaces not being coated
6. Complete coverage

E. The municipal sewer system may be returned to full operational service as soon as all final repairs have set dry to the touch and the final inspection has taken place.

END OF SECTION

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SECTION 09 96 00

HIGH PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Preparation of surfaces, shop painting of items furnished, field painting of new and existing structures, piping, conduit, ductwork, and equipment. For painting of gypsum board systems, wood trim, and other architectural finishes, reference Section 09900 – Painting.

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. SSPC - The Society for Protective Coatings

a. SSPC SP 1 - Solvent Cleaning

b. SSPC SP 2 - Hand Tool Cleaning

c. SSPC SP 3 - Power Tool Cleaning

d. SSPC SP 5 - White Metal Blast Cleaning

e. SSPC SP 6 - Commercial Blast Cleaning

f. SSPC SP 10 - Near-White Blast Cleaning

g. SSPC SP 11 - Power Tool Cleaning to Bare Metal

h. SSPC SP 13 - Surface Preparation of Concrete

i. SSPC SP 16 - Brush-off Blast Cleaning of Non-Ferrous Metals

2. NSF/ANSI Standard 61 - Drinking Water System Components

3. ANSI/AWWA D102 - Standard for Coating Steel Water-Storage Tanks

4. ASME A13.1 - Scheme for the Identification of Piping Systems

5. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

6. ASTM E-1795 - Standard Specification for Non-Reinforced Liquid Coating Encapsulation Products for Leaded Paint in Buildings

7. NACE SP0178 - Standard Practice for Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service

8. NAFP 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

1. Submit manufacturer's standard color chart for color selection.

2. Where equipment is customarily shipped with a standard finish, submit samples of the proposed color and finish for approval prior to shipping.

3. Furnish affidavits from the manufacturer certifying that materials furnished conform to the requirements specified and that paint products have been checked for compatibility.

4. Submit a supplementary schedule of paint products with mil thickness and solids by volume, including all paint applied in the shop and in the field. Provide a schedule that is in accordance with the recommendations of the paint manufacturer.

5. Furnish affidavits from the manufacturer certifying that coatings in immersion service contain no water soluble solvents or corrosion inhibitive (active) pigments with slight water solubility.

1.4 PAINTING REQUIREMENTS

A. Shop Primed and Finished Items: Furnish the following items with the manufacturer's standard prime and finish coats applied in the shop: pumps, motors, gears, gear housings, air compressors, temperature control and instrument panels, engines, filters, strainers, air dryers, meters, generators, switchgears, switchboards, motor control centers, panelboards, transformers, industrial control panels (except stainless steel or fiberglass), condensing units, air handling units, air conditioning unit heaters, cabinet heaters, wood seats, lockers, metal toilet partitions, metal urinal screens, aluminum fascia, aluminum light standards,

hoisting equipment, acoustic panels, thickening centrifuge. Coat steel reinforcing bars for concrete in accordance with Section 03200.

B. Shop Primed and Field Painted Items: Furnish the following items shop primed and field painted: steel water storage tank, structural steel and wrought metals, steel joists and joist girders, composite metal floor deck, pipelines, hangers and supports, , valves, , guard housings, air filter equipment, effluent strainers, air receivers, tanks, air silencing equipment, gas domes, steel stair framing, steel lintels.

C. Field Primed and Finished Items: Field prime and finish, where exposed to view, all items not shop primed or shop finished. This Work generally includes, but is not limited to, the following: gypsum wallboard, interior concrete block, interior concrete walls, columns, beams and ceilings, covering over insulation on piping, galvanized steel electrical conduit systems, cast iron electrical boxes, small piping and copper tubing, ducts, covering over ducts, exterior PVC piping valves, and fittings, drain piping.

D. Unpainted Items: Do not paint the following items, unless otherwise specified: interior structural steel not exposed to view, registers, grilles, dampers and linkage, name and identification plates and tags, floor gratings, brass pipe and fittings, brass valves, stainless steel, fiberglass and fiber reinforced polymer enclosures, wood, cast-iron piping installed underground, stop log panels, spray-on fireproofing steel to receive spray-on fireproofing, surfaces to receive field welding, faying surfaces of high strength bolted connections, steel to be embedded or in contact with cast-in-place concrete.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows:

B. Delivery and Storage: Deliver and store paint at the site from the approved manufacturer only.

C. Packaging and Labeling: Prepare, pack and label paints, stains, varnish or ingredients of paints to be used on the job. Deliver all material to the site in original, unbroken containers.

D. Storage: Store the painting materials at the site in accordance with applicable codes and regulations and in accordance with manufacturer's instructions. Keep the storage space clean at all times. Take every precaution to eliminate fire hazards.

1.6 QUALITY ASSURANCE

A. Observe all applicable local, state and federal rules and regulations for removal, storage and disposal of existing reservoir coating systems and sandblast residue, and for application of the new reservoir coating systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Paint - General:

a. AkzoNobel (Ceilcote, Devoe, Enviroline, International).

2. Paint - Bituminous:

a. Carboline.

2.2 MATERIALS

A. General: Furnish paint and other materials of the type and quality of the manufacturer on which the painting schedule specified herein is based.

1. Provide compatible shop and field coats.

2. Provide all coats of paint for any particular surface from the same manufacturer.

3. Provide coatings, including paints, primers and materials in contact with potable water listed by NSF International under Standard 61 for materials and products in contact with potable water.

4. Provide paint of approved color as selected from the manufacturer's standard range of colors.

B. Paint Schedule: Provide all painting in accordance with the following schedule with the number of coats not less than the number shown on the schedule.

Class of Work	Surface Preparation	Field Coats			Total
		1st	2nd	3rd	DFT
Steel-Structural, Tanks, Pipe, and Equipment:					
Interior	SSPC-SP 6	F	F		8.0-16.0
Exterior	SSPC-SP 6	E	F	C	8.5-15.0
Below Grade Immersion	SSPC-SP 10	B	B	B	12.0-18.0
Structural Steel: Exposed to Potable Water					
Exterior of Tank	SSPC-SP 6	A	C		6.0-11.0
Interior of Tank	SSPC-SP 10	B	B		8.0-12.0
Nonferrous Metal and Galvanized Steel:					
Interior	SSPC-SP 16	G	F		6.0-11.0
Exterior	SSPC-SP 16	G	C		4.0-6.0
Immersion	SSPC-SP 1 & SSPC-SP 10	B	B		8.0-12.0
Ductile or Cast Iron,-Pipes, Pumps, and Valves:					
Interior & Exterior Exposed	NAFP 500-03	G	F	C*	8.0-14.0
Below Ground	NAFP 500-03	H	H		32.0-40.0
Immersion	NAFP 500-03	B	B		8.0-12.0
*Optional					
PVC:					
Exterior Exposed	Scarify	G	C		4.0-6.0
Interior Exposed	Scarify	G	F		6.0-11.0
Insulated Piping:					

Class of Work	Surface Preparation	Field Coats			Total
		1st	2nd	3rd	DFT
Interior/Exterior Exposed	SSPC-SP 10	I	I		8.0-12.0
Concrete Walls (Cast and Precast):					
Below Grade	SSPC SP-13	H			16.0-20.0
Interior Exposed	SSPC SP-13	M	F	F	8.0-16.0
Exterior Exposed	SSPC SP-13	M	L	L	7.0-10.0
CMU Walls:					
Interior Exposed (General Service)	SSPC-SP 13	J	K	K	4.0-8.0
Interior Exposed (High Humidity & Moisture)	SSPC-SP 13	J	F	F	8.0-16.0
Exterior Exposed	SSPC-SP 13	J	L	L	4.0-6.0
Existing Painted Brick to be Re-painted	SSPC-SP 13	N	N	L	6.0-9.0
Concrete Floors:					
Light Traffic/Low Impact (Epoxy Finish)	SSPC SP-13	D	F	F	9.0-17.5
*Optional					

C. Schedule of Paints: Alphabetical designations in the following list are given solely for the purpose of indicating the type and quality of materials desired. Equivalent material from other approved manufacturers may be submitted for approval.

Symbol	Product Name and Number	Volume Solids %	Dry Film Thickness Mils Per Coat	VOCs (g/L)
A	International Paint-Devoe Coatings Bar-Rust 231	71	4.0-8.0	271
B	International Paint-Devoe Coatings Bar-Rust 233H	80	4.0-6.0	170
C	International Paint-Devoe Coatings Devthane 379	63	2.0-3.0	311
D	International Paint-Devoe Coatings Pre-Prime 167	100	1.0-1.5	95
E	International Paint-Devoe Coatings Cathacoat 302H	78	2.5-4.0	282
F	International Paint-Devoe Coatings Devran 224V	77	4.0-8.0	28
G	International Paint-Devoe Coatings Devran 201H	58	2.0-3.0	327
H	International Paint-Devoe Coatings Devtar 5A-HS	79	16.0-20.0	98
I	International Paint-Devoe Coatings Intertherm 228HS	70	4.0-6.0	265
J	International Paint-Devoe Coatings Tru-Glaze 4015	53	9.0-11.0	99
K	International Paint-Devoe Coatings Tru-Glaze-WB 4428	36	2.0-4.0	43
L	International Paint-Devoe Coatings Devcryl 1448 – Semi-gloss	38	1.5-4.0	98
M	International Paint-Devoe Coatings Devran 203	45	3.0-4.0	91
N	International Paint-Devoe Coatings Devcryl 1440	44	2.0-3.0	77

2.3 BITUMINOUS PAINT

A. Provide bituminous paint where indicated in other specification sections to prevent corrosion of metals in contact with concrete or dissimilar metals.

B. Acceptable bituminous paint includes:

1. Carboline Bitumastic 300 M, 16 Mill DFT.

2. Other manufacturer's equivalent product.

C. Install in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 REPAIR

A. Fill all pits in concrete having a depth in excess of 1/8 of an inch with a 100 percent solids epoxy repair compound. Provide fill material in compliance with NSF Standard 61 for materials and products in contact with potable water and from the same manufacturer.

B. Notify the ENGINEER of all pits with a depth greater than 1/4 inch to determine whether structural repairs are necessary. Repair such pits in a manner approved by ENGINEER.

3.2 PREPARATION

A. Inspection: Prior to surface preparation perform the following:

1. Verify that surface substrate conditions are ready to receive Work as instructed by the product manufacturer.

2. Examine specifications for all Work and become thoroughly familiar with all provisions regarding painting.

3. Document conditions of substrate prior to beginning work. Indicate any damaged or deficient substrates requiring repair and report findings to the ENGINEER.

B. Surface Preparation: After inspection and prior to painting, perform the following:

1. Inspect all Work prior to application of any paint or finishing material.

2. Brush and wash concrete and masonry surfaces. Remove all loose dirt, free lime, form oil, curing compounds and other foreign matter by approved methods such as SSPC SP13. Patch concrete surfaces requiring repair and spackle and repair surfaces to receive paint. Acid etch concrete surfaces to be painted as recommended by the manufacturer of the coating to be applied, to produce a slightly granular surface required for adherence of the

paint to the concrete unless otherwise indicated. Determine that concrete and concrete masonry is thoroughly dry prior to painting per ASTM D4263.

3. Thoroughly clean surfaces to be given protective coatings.

4. Refinish shop-coated equipment that has scratches and abrasions.

5. Do not begin field painting prior to approval of the surface preparation.

6. Thoroughly clean wood surfaces to remove all foreign matter. Properly fill and smooth cracks and nail holes. Finish exposed wood with sandpaper to a fine finish and wipe clean of dust.

7. Prepare and clean all surfaces prior to painting, as specified and required. Verify that surfaces are dry before any paint is applied. Perform special surface preparation work as directed by the manufacturer of the paint specified to be applied to the surface.

8. Clean the surface of structural steel, exterior and interior dry surfaces of water storage tanks and steel encased in concrete, masonry or spray-on fireproofing by removing all rust, mill scale, oil, grease or dirt in accordance with SSPC-SP6.

9. Prior to painting metals other than steel, grind smooth all welds, beads, blisters of protuberances, other than identification markings, and remove other imperfections. Solvent clean all nonferrous metals, galvanized steel and stainless steel whether shop primed or field primed, in accordance with SSPC-SP-1 prior to the application of the primer.

10. Prime cleaned metal the same day immediately after sandblasting to prevent rusting.

11. Remove all adhering debris on pipe and duct covering and smooth out indentations or unsightly spots and brush clean.

12. Remove all bituminous or asphaltic coating from cast iron drain and soil pipe prior to painting.

13. Remove all adhering debris on PVC, roughen surface with sandpaper and brush clean.

3.3 INSTALLATION

A. General: Install all painting and coatings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Refer to manufacturer's guidelines as it relates to minimum/maximum allowable temperatures for application.

2. The surface temperature of the steel shall be at least 5 degrees F above the dew point.

3. Paint surfaces in accordance with the material painting schedule included in this Section.

4. Completely cover all surfaces to be painted. Cover by additional coats when color on undercoats shows through the final coat of paint, until paint is of uniform color and appearance and coverage is complete.

5. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

6. Provide sufficient temporary ventilation during painting operations in enclosed areas to remove moisture and solvents, and to keep the atmosphere safe from harmful or dangerous fumes and dust levels for personnel.

B. Touch-Up Shop-Primed and Finished Items: Touch-up all damaged portions and imperfections in shop-primed and finished items. Use the same paint as used for the shop prime and finish. Prepare the surface prior to touch-up by wire brushing and sanding to remove rust, scale and loose paint per SSPC SP 2, 3, or 11, as determined by each situation.

C. Castings: Castings, such as manhole covers, frames, curb and area inlets and valve boxes are as specified under Section 05560.

D. Steel Pipe: Applicable to insulated and uninsulated steel pipe. Immediately after installation, prime pipe not furnished with a shop coat.

E. Field Painting: Perform field painting at the job site as follows:

1. Mix all paints and similar materials in approved containers of adequate capacity.

2. Mix all paint thoroughly before being taken from the containers. Keep mixed while painting. Apply all ready-mixed paint exactly as received from the manufacturer without addition of any kind of drier or thinner, except as specified, to mix colors to conform to approved color schedule. Tint successive coats of paint to make various coats easily distinguishable. Tint undercoats of paint to the approximate shade of the final coat of paint.

3. Use only skilled painters on the Work, and employ specialists where required. Apply paint by brush, roller or sprayer in accordance with the manufacturer's recommendation.

4. Paint top and bottom edges of doors. Thoroughly and uniformly sand undercoats on hollow metal Work with No. 00 sandpaper or equal abrasive to remove all surface defects and provide a smooth, even surface. Do not allow brush marks or other irregularities on finished surfaces.

5. Perform painting as a continuous and orderly operation to facilitate adequate inspection. Prime coat and paint materials subject to weathering or corrosion before erection. Perform all paint application methods in accordance with the instructions of the paint manufacturer and as approved. Do not field paint equipment, such as electrical control cabinets, motors, unit heaters and similar items which are shipped with a final baked enamel finish and having received prior approval unless the finish is damaged in transit or installation. Paint access panels, pipe, pipe covering, ducts and other building appurtenances built into adjoining walls the same color as adjacent walls, unless color coding applies. Remove or protect hardware and accessories, fixtures and similar items placed prior to painting during painting and replace them upon completion of painting.

6. Paint piping up to and including the flanges attached to mechanical equipment. Paint electrical conduit up to and including the flexible conduit connected to equipment.

7. Paint all wall surfaces which will be concealed by equipment before equipment installation.

8. Paint all existing wall surfaces newly exposed to view due to removal of existing equipment or other demolition work. Paint to match adjacent surfaces.

9. Fully protect areas under and adjacent to painted work at all times and promptly remove dripped or spattered paint.

10. Repair, refinish and repaint any adjacent surfaces that have been damaged or discolored by overspray.

11. Do not paint when the air or surface temperature is below that recommended by the manufacturer, or in dust-laden air, or until moisture on the surface has completely disappeared. If necessary, provide sufficient heating and ventilation to keep the atmosphere and all surfaces to be painted dry and warm until each coat of paint has hardened.

12. Remove any painting found defective. Touch-up and provide remedial painting as directed and as required until completion and acceptance of final work.

F. Color Coding: For colors to be used for identification of mechanical and electrical piping, tubing and conduit see the following:

1. Section 15075 - Mechanical Identification

2. Section 16075 - Electrical identification

G. Equipment Colors: Furnish the following equipment in their respective groups to be shop or field painted in the colors herein specified.

Equipment Description (Groups)	Color
Hoisting Equipment	Medium Yellow 339
Instrumentation and Control	White 311

1. Provide chart of standard colors offered by each equipment manufacturer. Coordinate color selection.

2. Furnish all electrical equipment shop painted in a color selected from the manufacturer's standard colors.

3.4 HEALTH AND SAFETY

A. Introduction:

1. Products listed in this specification and used in high-performance coatings situations contain high volume solids; the aerosol droplets/particulates produced during airless spray of some of these materials may form an explosive mixture with air and additionally may contain materials which may necessitate personal protection against potential health hazards. A summary of the main precautions to be taken includes:

- Danger of explosion or fire
- Provision of a suitable breathing environment for workers.
- Prevention of skin irritation problems.
- Use of paints which have been specially formulated for use in tanks.

B. Consult with manufacturer prior to commencing work to review recommended Health and Safety procedures.

3.5 QUALITY CONTROL

A. General Coatings:

1. At least daily, check temperature, humidity, and Dew Point as to time and readings obtained. Submit "Paint Inspection: Daily Coating Inspection Report" to ENGINEER on a daily basis. See Supplement below.

2. Perform daily wet film thickness readings or spreading rate checks to make certain that proper film thickness is being achieved. If proper film thickness is not being achieved more frequent checks may be required by the ENGINEER at their discretion. Provide daily written report to ENGINEER. Correct any deficiencies in film thickness by application of additional paint. See Supplement below.

3.6 CLEANING AND FINAL TOUCH UP PAINTING

A. Touch up and restore any damaged finish. Remove paint or other finishes spilled, splashed or splattered from all surfaces taking care not to mar any surface or item being cleaned.

3.7 SUPPLEMENT

A. The supplement listed below is a part of this Specification:

1. Paint Inspection: Daily Coating Inspection Report.

END OF SECTION

Paint Inspection:

Daily Coating Inspection Report

Project/Client:	Date: / / M T W Th F S Su	Pg. Of
Location:	Project #:	COPY To: ☐ QC Mgr ☐ Owner
Description:	Inspector:	☐ Contr ☐ _____
Requirements:		Attachments: ☐ DFT Sheet ☐ NCR/CAR ☐ _____
Contractor:	Spec #	Revision #

Description of Areas & Work Performed

Hold Point Inspections Performed

- ☐ 1 Pre Surface Pep/Condition & Cleanliness
- ☐ 2 Surface Preparation Monitoring
- ☐ 3 Post Surface Preparation/Cleanliness & Profile
- ☐ 4 Pre Application Prep/Surface Cleanliness
- ☐ 5 Application Monitoring/Wet Film Thickness (WFT)
- ☐ 6 Post Application/Application Defects
- ☐ 7 Post Cure/Dry Film Thickness (DFT)
- ☐ 8 Nonconformance/Corrective Actions Follow-up
- ☐ 9 Final Inspection

Approved By: _____

Surface Conditions

- ☐ New ☐ Maint ☐ Primer/Paint ☐ Age/Dry/Cure_____
- ☐ Steel ☐ Galvanize ☐ Concrete ☐ Other_____
- ☐ Hazard _____ ☐ Sample Report # _____
- ☐ Degree of contamination: _____
- Test: ☐ Cl_____ µg/cm² / ppm ☐ Fe ____ppm ☐ pH _____
- ☐ Degree of Corrosion: _____
- ☐ Scale ☐ Pitting/Holes ☐ Crevices ☐ Sharp Edges
- ☐ Weld _____ ☐ Moisture ☐ Oils ☐ Other_____
- ☐ Painted Surface Condition: _____
- Dry to: ☐ Touch ☐ Handle ☐ Recoat
- ☐ Dry/Over Spray ☐ Runs/Sags ☐ Pinholes ☐ Holidays
- ☐ Abrasion ☐ Fall Out ☐ Other _____

Surface Preparation

Start Time: Finish Time: Est Sq/ft:

- ☐ Solvent Clean ☐ Hand Tool ☐ Power Tool
- ☐ HP Wash PSI_____ ☐ Other _____
- ☐ Abrasive Blast ☐ Abrasive Type _____ ☐ Sample
- ☐ Blast Hose Size _____ ☐ Nozzle Size / PSI _____
- ☐ Air Supply CFM _____ ☐ Air Supply Cleanliness
- ☐ Water/Oil Trap Check ☐ Equipment Condition Check

Surface Cleanliness & Profile Measurement

- ☐ Job Specification ☐ SSPC/NACE - SP- _____
- ☐ SSPC/NACE Spec / Visual Stds ☐ _____
- Profile Check: _____ ☐ Disc ☐ Tape ☐ Gauge
- ☐ Specified _____mils avg. / Achieved _____mils
- ☐ Surface effect on DFT Gauge/BMR _____mils

Dry Film Thickness

Gage Type / Model	Gage Serial #	Gage Calib. Verified	Spec Avg. DFT	Total Avg DFT	DFT Last Coat	DFT This Coat

Ambient Conditions

Time (Indicate AM or PM)	:	:	:	:
Dry Bulb Temp° (C/F)	°	°	°	°
Wet Bulb Temp° (C/F)	°	°	°	°
% Relative Humidity	%	%	%	%
Surface Temp° (C/F) Min/Max	/ °	/ °	/ °	/ °
Dew Point Temp° (C/F)	°	°	°	°
Wind Direction/Speed				
Weather Conditions:				

Application

Start Time : Finish Time : Est. Sq/ft.

☐ Primer ☐ Intermediate ☐ Topcoat ☐ Touch-up

Generic Type:	Qty Mixed:
Manuf.:	Mix Ratio:
Prod Name:	Mix Method:
Prod #:	Strain/Screen:
Color:	Material Temp: °F
Kit Sz/Cond.:	Sweat-in Time: Min/Hrs
Shelf Life:	Pot Life: Min/Hrs
Batch #'s	Reducer #:
(A)	Qty Added: Pt/Qt/Gal
(B)	% by Vol: %
(C)	Specified WFT Avg: Mils
Reducer:	Achieved WFT Avg: Mils

☐ Airless/Conv. Spray ☐ Brush ☐ Roller ☐ Other _____

Pump Pot	Hose Dia.	Air Check
Ratio/Size	Hose Lng.	SEP/Trap
GPM/CFM	Spray Gun	Filter
PSI	Tip Sz.	Agitator

Inspector's Signature Date

SECTION 22 14 29

SUMP PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing sump pumps with capacities and details as scheduled, and installed as shown with controls, control panels and all accessories necessary for complete installation.

B. Section Includes:

1. Explosion Proof Duplex Submersible Sump Pumps
2. Magnetic Starters
3. Lubrication of Equipment
4. Spare Parts

C. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 – High Performance Coatings
2. Section 26 05 19 - Wire Cable - 600 Volts and Below
3. Section 26 05 50 - Electrical Requirements for Shop-Assembled Equipment
4. Section 26 05 80 - Electric Motors
5. Section 40 05 01 - Supports and Anchors
6. Section 40 05 18 - Miscellaneous Pipe and Fittings

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Shop Drawings: Provide shop drawings, including arrangement of equipment and control equipment, details of control panel, schematic control diagrams, electrical connections, complete description of control system, and equipment characteristics. Include following:

1. Certified pump curves, including flow, head, brake horsepower, and efficiency

2. General arrangement drawing showing location of pumps and control panel

3. Cross-section drawings

4. Parts list with materials of construction identified

5. Motor performance characteristics

C. Operation and Maintenance Manuals: Furnish operator and maintenance manuals for the pumps, valves and controls

1.3 QUALITY ASSURANCE

A. Furnish all sump pump equipment specified in this Section from single pump equipment manufacturer if available.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows.

B. Acceptance: Accept pump equipment on-site in factory packing. Inspect for damage.

1.5 SPARE PARTS

A. General: Provide following spare parts for each pump delivered and securely wrapped or boxed, indexed and tagged with complete information for use and recording.

1. One set double mechanical seals
2. One set O-rings and gaskets

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Hydromatic Pumps

2.2 MATERIALS

A. Duplex Submersible Pumps for the New Diversion Facilities Valve Vault.

1. Contractor to provide and install explosion-proof submersible sump pump system, including two Hydromatic Pumps Model HPGX, or equal, heavy

duty 1 1/4" discharge submersible sump pump explosion proof Class 1, Division 1, Group C & D. Pump shall be constructed with double opposed mechanical seals consisting of carbon and ceramic upper seal and lower seal, 416 stainless steel shaft, ball bearings, class "F" insulation, oil filled without exception, cast iron impeller and 20 ft. cable. Pump to have oil filled, 2 hp, 3450 rpm, 60 HZ, three phase, 460 volt non-overloading motor. Pumps shall be provided as a packaged system. Pump shall have seal fail and motor heat sensors. Pump controls and accessories shall be supplied by one source to maintain consistency and uniformity of the system.

2. Control panel shall be Hydromatic Pump, or equal, NEMA-7 simplex intrinsically safe construction, UL Listed, with a main disconnect, starter, O.L. block, H-O-A switch, run light and alarm horn and light with silence push-button, and dry remote alarm contact. Provide GFCI convenience receptacle, 3 KVA control transformer, alarm beacon, and other accessories with the control panel as shown on the Contract Drawings. All switch's and light's shall be exterior mounted. Float control shall be, three Hydromatic 3900, or equal, intrinsically safe submersible floats mounted with wall bracket to control pump "off", "on", and "high water alarm" level.

3. Provide motor as specified in Section 26 05 80

4. Provide liquid level controls consisting of NEMA 7 rated, intrinsically safe sealed non-mercury float switches for pump start and pump stop and high water alarm (2-pole type for remote alarm circuit) with height adjustable on 1-inch stainless steel support rod. Position float switches for liquid level controls and alarm as follows and at levels as indicated.

   Switch No. 1 - Float switch opens control holding circuit on liquid drop.

   Switch No. 2 - Float switch closes and starts pump.

   Switch No. 3 - High water alarm wired to operate audible and visual alarm on pump control panel, start lag pump and send an alarm signal to SCADA system.

   Pumps continue to operate until Float Switch No. 1 opens control holding circuit.

5. Provide prewired control panel for wall mounting with top of cabinet 6 feet above floor.

6. Provide heavy-duty waterproof power cables rated at 600 volts and control cables rated at 600 volts with sufficient slack to permit pump removal from the sump for servicing without disconnecting the cables.

7. Provide seal fail and hear sensor relays in the control panel. The seal fail relay will not shut down the but will activate a alarm light.

B. Magnetic Starters: Provide magnetic starters that meet the requirements of Section 26 05 50.

C. Lubrication of Equipment: Bearings shall be lubricated by the motor oil.

1. Lubricate prior to start-up, and at recommended intervals before turning equipment over to the OWNER. Provide linen tag or heavy duty shipping tag attached to each piece of equipment showing date of lubrication and name and number of lubricant used. Provide typewritten list, in triplicate, of each item lubricated and type of lubricant used.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install pump units in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Clean before pump installation.

2. Complete all piping and wiring, make adjustments to equipment to provide complete operating system.

3. Provide specified rubber flap type or ball type check valve, union and plug valve in each pump discharge pipe in manner to permit pump unit to be disconnected and removed separately.

4. Provide check valve with flanged connection and with full pipe area when open, quick closing and quiet in operation, and recommended for sewage service by manufacturer. Provide Series 100 replaceable reinforced Buna-N rubber flapper swing check valve as manufactured by APCO/Valve and Primer Corp., or equal.

5. Provide sump pump discharge pipe and fittings having threaded (screwed) or flanged joints, or both, up to the gravity collector line.

3.2 FIELD QUALITY CONTROL

A. Control System: Demonstrate that pump equipment operates as specified with the control system.

END OF SECTION

SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: General requirements for providing basic electrical materials and methods.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Certain equipment, control devices, conduit and wiring are shown on electrical drawings, but are specified in other sections pertaining to plumbing, heating, ventilating, air conditioning, temperature control systems, process equipment, process control systems and instrumentation. Install and connect these items to the electrical system as indicated or required in accordance with the Contract Documents.

C. Overall Application of Specifications: This Section applies to all Division 26 sections and to other sections that include requirements for electrical equipment. Irrespective of where the electrical requirements are specified, provide and install all materials necessary for a complete operational system.

D. Temporary Requirements: This Section applies to any temporary circuits, overcurrent devices, conduit, wiring, and other equipment required during changeover from the existing electrical system to a new electrical system. This Section also applies to temporary rewiring of lighting circuits, power circuits, instruments and devices.

1.2 DEFINITIONS

A. Hazardous Areas: Hazardous areas as defined by the NEC as Class I, Division 1, Group D, or Class I, Division 2, Group D. The following areas are designated hazardous:

1. Class 1, Division 1, Group D

a. An existing wastewater vent will be piped outside of building under this Contract, refer to Contract Drawings. Area surrounding vent pipe opening outside of the Grit Handling Building is Class I, Division 1, Group D extending 0.9 m (3 ft.) radially from vent opening.

2. Class 1, Division 2, Group D

a. The interior space of the following valve vaults is Class I, Division 2, Group D:

(1) S136-VLT5 – FEB Valve Vault No. 7

B. Corrosive Areas: The following areas are designated corrosive areas:

1. The area directly above the following valve vaults, where control panels for these vaults will be refurbished and installed:

a. S136-VLT1 – FEB Valve Vault No. 7

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design requirements are specified in the applicable sections.

B. Performance Requirements: Performance requirements are specified in the applicable sections.

1.4 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01.

B. Product Data and Information: Furnish a complete list of electrical equipment and materials to be furnished that shows the manufacturer, catalog number, size, type, capacity, voltage rating and other pertinent information related to each item on the list.

1. Furnish catalog data for the manufacturer's standard equipment and materials. Clearly identify the equipment and devices specifically being proposed on manufacturers' catalog data sheets.

2. Identification: Furnish a complete schedule or listing of system and equipment identification labels with legends.

C. CONTRACTOR's Shop Drawings: Furnish shop drawings on items manufactured for the Contract.

1. Furnish connection and schematic diagrams for each piece of electrical equipment where applicable. A manufacturer's standard connection or schematic diagram showing more than one method of wiring is not acceptable unless, the intended method is clearly marked.

2. Furnish diagrams that show connections to field equipment. Clearly differentiate between manufacturer's and field wiring.

3. Furnish raceway layout drawings that show conduits, boxes, and panels which contain the conductors to be provided. Include schedules listing conduit sizes, conductor content and identification.

4. Where additions and modifications are made to existing equipment, furnish drawings which clearly identify remaining existing equipment and the new Work.

D. Coordination Drawings: Furnish coordination drawings that have a scale of 1/4"=1'-0" or larger; that show major elements, components, and systems of electrical equipment as they relate to other systems, installations, and building components. Indicate locations where access space is limited and where sequencing and coordination of installations are required for the efficient flow of the Work, including but not limited to the following:

1. Indicate the proposed locations of major raceway systems, equipment and materials. Include the following:

a. Clearances for servicing equipment, including space for equipment disassembly as required for periodic maintenance.

b. Exterior wall and foundation penetrations.

c. Fire-rated wall and floor penetrations.

d. Equipment connections and support details.

e. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. Prepare reflected ceiling plans to coordinate the installation of air outlets and inlets, light fixtures, communications systems components, fire alarm devices, sprinklers, and other ceiling-mounted devices.

E. Record Documents: Furnish record documents, and in addition to the requirements specified in Division 1, indicate installed conditions for:

1. Interior and exterior major raceway systems' sizes and locations; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker sizes and arrangements.

2. Exposed and concealed equipment locations dimensioned from prominent building lines.

3. Approved substitutions, and actual equipment and materials installed.

F. Maintenance Manuals: Furnish maintenance manuals, and in addition to the requirements specified in Division 1, include the following information for equipment items:

1. Functional description, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and catalog numbers of replacement parts. Where a Bill of Materials is provided, include a manufacturers' data sheet for each component and device listed therein.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

1.5 QUALITY ASSURANCE

A. Codes: Provide all electrical Work in accordance with applicable local codes, regulations and ordinances. If there is a conflict between the requirements specified in the Contract Documents and the codes, follow the more stringent requirements as determined and approved.

B. Testing: As a minimum, provide standard factory and field tests for each type of equipment. Other tests may be specified in the applicable equipment section.

C. Labeling: Provide electrical equipment and materials that are listed and approved by Underwriters Laboratories or other OSHA recognized testing laboratories with the testing agency's label attached.

D. Standard Products: Unless otherwise indicated, provide electrical materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest

standard design that conforms to these Specifications. Provide the products of the same manufacturer when two or more units of the same class of material and equipment are required.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

B. Shipping and Packing: Provide materials and equipment suitably boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Clearly label such boxes, crates or enclosures with manufacturer's name, and name of material or equipment enclosed.

C. Acceptance at Site: Conform to acceptance requirements as required in Division 1.

1. Repair or replace all materials and equipment damaged by handling and storage as directed at no additional Contract cost.

D. Storage and Protection: Protect materials and equipment from exposure to the elements and keep them dry at all times. Handle and store to prevent damage and deterioration in accordance with manufacturer's recommendations. Provide temporary power to space heaters where provided with equipment to prevent condensation from developing.

1.7 PROJECT CONDITIONS

A. General: The Drawings indicate the extent and general arrangement of the principal electrical elements, outlets, devices and circuit layouts. Install and connect all electrical elements and devices to form a complete workable system as required by the Contract Documents, regardless of whether all system components are specifically stated in the Specifications or shown. Provide necessary materials and installation wherever required to conform to the specific requirements of the furnished equipment and for proper installation of the Work.

B. Physical Layouts: In general, the routing of feeders show general arrangement and are not intended to show exact routing and locations of raceways. Verify actual and final arrangement, equipment locations, and prepare circuit and raceway layouts before ordering materials and equipment. Equipment locations are approximate and are subject to modifications as determined by approved equipment dimensions.

C. Coordination of Work: Coordinate the Work so that the electrical equipment may be installed without altering building components, other equipment or installations.

D. Departure from Design: If departures from the design are deemed necessary due to structural conditions, obstructions or other problems, provide details of such

departures and the reasons for requesting approval. Submit variations as soon as practical but no later than the submittal of the required raceway layout drawings. Do not depart from the design without written approval.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 ROUGH-IN

A. Final Location: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by taking field measurements.

3. Arrange for chases, slots, and openings in other building components as construction progresses to provide for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide all required connections for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the ENGINEER for resolution.

9. Where installed exposed in finished spaces, install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

10. Provide electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

11. Provide access panels or doors where units are concealed behind finished surfaces.

12. Install systems, materials, and equipment providing right-of-way priority to systems required to be installed at a specified slope.

13. All wiring specified, scheduled, noted or shown is to be installed in conduit unless identified otherwise.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching as specified in Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

a. Uncover Work to provide for installation of ill-timed Work.

b. Remove and replace defective Work.

c. Remove and replace Work not conforming to requirements of the Contract Documents.

d. Remove samples of installed Work as specified for testing.

e. Install equipment and materials in existing structures.

f. Locate existing structural reinforcing with a pachometer where core drilled penetrations are required so as not to cut the steel reinforcing.

2. Cut, remove, and properly dispose of selected electrical equipment, components, and materials as indicated. Included are the removal of electrical items indicated to be removed and items made obsolete by the new Work. Deliver all removed serviceable apparatus to the OWNER as directed.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Provide and maintain adequate temporary partitions or dust barriers that prevent the spread of dust and dirt to adjacent areas.

5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

6. Patch finished surfaces and building components using new materials that are compatible with the original installation and applied by experienced installers.

END OF SECTION

SECTION 26 05 19

WIRES AND CABLES - 600 VOLTS AND BELOW

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing all wires and cables rated at 600 volts and below for complete electrical systems as shown.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 53 - Electrical Identification
3. Section 26 80 00 - Electrical Testing Requirements

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM B 3 - Standard Specifications for Soft or Annealed Copper Wire
2. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. TIA/EIA 568-B - Commercial Building Telecommunications Cabling Standard
4. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01 and Section 26 05 00.

B. Product Data and Information: Furnish manufacturer's catalog data for each type of wire and cable furnished.

1.4 QUALITY ASSURANCE

A. General: Furnish wire and cable in accordance with applicable IEEE and NEMA standards and meeting the applicable requirements of the NEC and UL.

B. Tests: Furnish factory tested cables prior to shipment in accordance with ICEA standards for the insulation specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle wire and cable in accordance with the manufacturer's instructions and as specified in Division 01.

B. Storage: Store cable reels on concrete, 2x4 wood laggings or other hard surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Wire and Cable

   a. Southwire Company
   b. The Okonite Company
   c. General Cable Corporation

2. Instrumentation Cable

   a. Belden
   b. Dekoron Wire and Cable
   c. The Okonite Company

3. Multiconductor Cable

   a. The Okonite Company
   b. Southwire Company

4. Wire Connectors

   a. Thomas & Betts/ABB Group

b. 3 M/Electrical Products Division

c. Ideal Industries

5. Color Coding Marker

a. W. H. Brady Company

b. Thomas & Betts/ABB Group

2.2 MATERIALS

A. Conductors: Provide soft drawn or annealed copper conductors with 98 percent minimum conductivity, meeting requirements of ASTM B 3 (solid) or ASTM B 8 (stranded). Use stranded conductors except solid No. 12 and No. 10 AWG may be used in lighting fixture and convenience outlet wiring.

B. Insulation: Provide wires and cables with insulation as follows:

1. Power, control and lighting wiring

a. Single Conductor: Provide insulation as follows:

NEC Type Letter	Insulation Material
XHHW	Cross-linked Polyethylene

b. Multiconductor Cables: Insulate individual conductors with 15 mils of polyethylene or PVC and 4-mil nylon jacket. Wrap the conductors with type binder and an outer jacket not less than 45 mils of PVC. Use ICEA Method 1 for color coding wires.

2. Instrumentation Wiring: The manufacturers' name and catalog number shown below are for the purpose of establishing quality and general configuration.

a. Two conductor or single pair: Stranded No. 16 AWG wire, 600 volt polyethylene insulation, twisted conductors, tinned copper drain wire, overlapped metalized tape overall shield providing 100 percent shield coverage and outer jacket of PVC. Belden Cat. No. 8719.

b. Three Conductor: Stranded No. 16 wire, 600 volt polyethylene insulation, twisted conductors, tinned copper drain wire, overlapped metalized tape overall shield providing 100 percent shield coverage and outer jacket of PVC. Belden Cat. No. 8618.

c. Multiple Pairs or Triads: Provide individually shielded pairs or triad of stranded No. 16 AWG wire with overall shield. Insulate each wire for 600 volts with 15 mils of PVC and a 4-mil nylon jacket. Assemble pairs or triads with tinned copper drain wire and metalized tape shield providing 100 percent shield coverage. Cable pairs or triads together with tinned copper drain wire and overall metalized tape shield.

3. Data (Local Area Network) Cable: The manufacturers' name and catalog number shown below are for the purpose of establishing quality and general configuration.

a. Category 6: Provide cable having third party verification to TIA/EIA 568-B.2-1 Category 6 requirements and constructed of four pair of solid No. 23 AWG solid copper wire, polyolefin insulation, film tape separator and outer jacket of black industrial grade sunlight and oil resistant PVC. Belden Cat. No. 2412.

C. Printed Data on Covering: Provide the following information printed on the surface of all wires and cables at regular intervals throughout the entire length.

1. Manufacturer or trade name.
2. Size of conductor.
3. Type of insulation.
4. Voltage classification.

2.3 WIRE CONNECTIONS AND CONNECTING DEVICES

A. Connectors for No. 10 AWG and Smaller: Provide insulated compression type butt connectors.

B. Connectors for No. 8 AWG and Larger: Provide UL, Inc. listed compression type tube connectors for parallel or butt splices. Provide companion preformed plastic insulating covers or tape to provide insulation equal to conductor insulation.

C. Miscellaneous Connectors: Provide preinsulated spring connectors for lighting and receptacle splices and pigtails.

D. Solderless Lugs: Provide solderless terminal lugs for stranded and multiple solid conductors at connection to terminals or use UL listed crimp tool compression style lugs.

E. Control Wire Terminations: Provide spade lug or pressure type control conductor connection terminations for control wiring terminations. Provide lug bolting at devices or bus bars with a flat washer, a Belleville washer and a locknut.

2.4 COLOR CODING

A. General: Use a vinyl impregnated cloth tape resistant to oil, dirt and heat for conductor color coding.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Swab new and existing conduits to be used to clear debris and remove moisture before conductor installation. Install conductors in raceways with no splices between boxes.

B. Pulling Equipment: Pull conductors using proper equipment without exceeding manufacturer's recommendation for maximum pulling tension. Protect conductor insulation jacket at all times from twists, kinks, scrapes, punctures and other damage. Replace damaged conductors. Pull wires and cables into ducts and conduit without the use of lubricants, except where such use is necessary and approved by the cable manufacturer and the ENGINEER. Use UL listed lubricating compound compatible with the conductor insulated jacket and with the raceway.

Use lines of nylon or polypropylene, propelled by carbon dioxide, or compressed air, to snake or pull wire and cable into conduits. Do not use flat steel tapes or steel cables.

C. Conductor Support: Support conductors in vertical risers with woven grips to prevent loading on conductor connectors.

D. Seals: Provide a seal between the conductor and conduit for conduits entering buildings or from areas where the temperature change may cause condensation or moisture. Seal the conduits after the conductors are in place.

E. Identification: Identify all cables as specified in Section 26 05 53.

F. Color Coded Tape: Apply color coding tape at all terminations and splices with overlapping turns for a minimum length of two inches, starting two inches back from the termination point. Provide color code tape in all boxes and manholes.

Provide color coding throughout the entire network for service, feeder, branch, control and low energy signal circuit conductors. Use the following color code for conductors.

	COLOR CODING				
SYSTEM	PHASE A	PHASE B	PHASE C	NEUTRAL	GROUND
208/120 three phase	Black	Red	Blue	White	Green
480/277 three phase	Brown	Orange	Yellow	White	Green
Control and low-energy signal	Red	---	---	White	Green
Gas and Fire De-tection Systems	Pink	---	---	---	---
Instru-mentation	Gray	---	---	---	---
dc circuits	Blue	---	---	---	White with blue stripes

G. Terminations: Leave a minimum of six inches of free conductor at each connected outlet and a minimum of nine inches at unconnected outlets.

H. NEC Requirements: Install wiring in accordance with applicable provisions of National Electrical Code, local codes having jurisdiction and as indicated.

I. Conductor Sizing: Size conductors in accordance with the NEC, local codes having jurisdiction and the following:

1. Size for branch lighting circuits so that the greatest voltage drop between lighting panel and center of load does not exceed two percent at rated load.

2. Size conductors to limit the maximum conductor temperature to less than 75 degrees C, except where specifically stated otherwise.

3. Use minimum conductor sizes as follows:

   a. Power and lighting branch circuits, No. 12 AWG.

   b. 120-volt control circuits, No. 14 AWG.

   c. Instrumentation and signal wiring, 2 or 3 conductors No. 16 AWG stranded shielded.

4. Conductor Derating: Derate the conductor ampacity for installation in an ambient temperature of 40 degrees C.

5. Size conductors as shown or as required by the actual load to be served, whichever is larger.

J. Splicing: Install continuous cables without splices in all duct systems.

K. Instrumentation wiring: Install instrumentation wiring as follows:

1. Wherever possible provide continuous instrumentation wiring without splices from field device to instrument. Where connections are required, make all connections in terminal boxes.

2. Terminate instrumentation wiring at terminal blocks only.

3. Where instrumentation wire is required to be connected in a terminal box, provide an isolated terminal for each shield.

4. Ground instrumentation shields and drain wires only at the panel end of loop.

5. Install clear, heat-shrink, seamless tubing over exposed shields and drain wires in all terminal boxes, junction boxes, panels and field devices.

L. Hazardous Areas: Seal all conduits in hazardous areas before admission of possible hazardous gases to the area.

M. Accuracy of Information: The number and sizes of wires and conduits indicated are for guidance only and are not necessarily the correct number and sizes necessary for actual equipment installed. Install as many wires and conduits of the required size as necessary for a complete electrical system, and provide adequately for the equipment actually installed.

3.2 CONDUCTOR IDENTIFICATION

A. Labeling: Label each wire at both termination points and at each splice point in junction boxes. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards.

B. Identification: Where the total number of control and signal wires is three or more and no terminal board is provided, identify each wire in junction boxes and cabinets by means of plastic slip-on wire marker.

C. Plastic Tags: In manholes, identify each wire by laminated plastic tag located so it can be easily seen.

D. Color Coordination: Connect circuit conductors of the same color to the same phase throughout the installation.

3.3 WIRE AND CABLE CONNECTIONS TO EQUIPMENT

A. General: Provide electrical connections to all equipment in strict accordance with the manufacturer's approved wiring diagrams, the Plans, or as approved. Repair or replace any damaged equipment resulting from erroneous connections.

3.4 CONNECTOR AND TERMINAL LUG INSTALLATION

A. UL Requirements: Install all connectors and terminal lugs in accordance with UL requirements and manufacturer's recommendations.

3.5 QUALITY ASSURANCE

A. Field Tests: Test the following 600-volt wires and cables after installation but before final connections are made up:

1. All feeders supplying 480/277V distribution panels.

2. All feeders supplying the primary side of dry-type transformers.

3. All feeders from dry type transformers to lighting panels.

4. For the above listed cables, apply a test voltage of 1,500 volts AC for a period of 1 minute between all conductors in the same conduit, and between each conductors and ground.

B. Test Results: Make all tests and submit certified test results. Replace any cables that fail the tests.

C. Continuity Test: Perform continuity test to demonstrate proper cable connection.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 26

GROUNDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing a complete grounding system as specified and shown. Grounding includes but is not limited to: electric equipment enclosures, raceway systems, transformers, switchboards, motor control centers, panelboards, ground grid systems, grounding rods, grounding conductors, bonding jumpers, water pipe connections, and structure metal frames as required.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 33 - Electrical Raceway Systems
3. Section 26 05 19 - Wires and Cables - 600 Volts and Below
4. Section 26 08 00 - Electrical Testing Requirements

1.2 REFERENCES

A. Codes and Standards: The following codes and standards are referred to in this Section:

1. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01.

B. Product Data and Information: Furnish manufacturer's catalog data for the following:

1. Grounding and grounded conductors
2. Grounding connectors, clamps and bushings
3. Grounding rods
4. Bonding jumpers

C. Shop Drawings: Furnish shop drawings showing the locations and length of grounding rods. Denote the size and material used for grounding rods. Furnish details pertaining to the installation of grounding electrode conductors, grounding and grounded conductors, grounding connections, grounding enhancement materials and the ground grid for buildings, structures, lighting units, manholes and handholes.

D. Quality Control: Furnish a field report stating the results of the system ground impedance test.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Construct a complete grounding system in accordance with applicable ANSI, IEEE Standards, the NEC and local codes.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Grounding and Grounded Conductors

a. Okonite Company

b. Southwire Company

2. Ground Plates

a. Burndy/ Hubbell IncorporatedO-Z Gedney/Emerson Industrial Automation

b. Eritech Grounding Products

c. Thomas & Betts/ABB Group

2.2 MATERIALS

A. General: Provide conductor sizes as shown or required.

B. Materials: Provide conductors in accordance with the requirements specified in Section 26 05 19.

C. Bare conductors: Provide bare copper conductor where buried in earth, embedded in concrete or exposed.

D. Insulated Conductors: Provide copper conductor with green color insulation rated at 600 volts where installed in conduits or other enclosed raceways.

2.3 CONNECTORS

A. Grounding Clamps and Bolted Connectors: Provide grounding clamps and bolted connectors suitable for devices or cables being connected.

B. Ground Plates: Provide two-hole, cast, copper alloy, ground plates suitable for installation in concrete. Fabricate the ground plates with two ½-inch diameter threaded holes and a 4/0 stud for connection to the grounding system.

C. Welding: Provide the exothermic welding process for buried, concealed and accessible connections to structural members, ground rods, and case grounds. Clean and paint welds embedded in the ground or encased in concrete with asphalt base paint.

D. Bolted Connectors: Provide bolted connectors for grounding to ground buses and equipment.

E. Pipe Grounding: Provide copper, brass, or bronze grounding clamps for grounding pipes. Do not provide strap type clamps.

F. Grounding Bushings: Provide grounding bushings for conduits where conduits are not effectively grounded by firm contact to the grounded enclosure.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install conductors to preclude exposure to physical damage.

2. Install connections firm and tight.

3. Arrange conductors and connectors without placing strain on the connections.

4. Bury equipment grounding conductors as shown, or at a minimum of 12 inches below grade.

5. Bring loops or taps up for connection to equipment or other items to be grounded.

6. Install an insulated grounding conductor in all conduits.

7. When raceways are used to contain and protect grounding conductors, install in accordance with Section 26 05 33 and NEC.

8. Where conductors are installed in nonmetallic raceway, provide the grounding conductor in addition to the neutral wire, sized in accordance with NEC or as scheduled.

9. Perform exothermic welding with properly sized molds.

B. Grounding Rod Installation:

1. Install grounding rods as shown with the top of the rod a minimum of 12 inches below grade.

2. Drive grounding rods into permanently moist soil.

3. Provide additional ground rod sections as required to reach permanently moist soil.

4. Provide junction box without bottom for access to grounding rod and conductor where shown.

C. Equipment Grounding: Ground each piece of electrical equipment using a conductor in the raceway feeding the equipment in accordance with NEC.

1. Unless specified otherwise, connect transformer enclosures and neutrals to the grounding system. Connect the neutral ground connection at the transformer terminal. Make the connection from the ground grid to the ground bus and enclosures of switchboards, switchgears and motor control centers, lighting and distribution panelboards, and control, relay and instrumentation panels.

2. Provide two separate, independent, diagonally opposite connections for power transformers so removal of one connection will not impair continuity of the ground system. Provide ground plates that are imbedded in the concrete pad so that transformers can be removed without damaging grounding system. Install a copper ground connect between ground plates and the transformers.

D. Grounding Conductors: Connect the grounding conductor between the equipment and the grounding system. Where a ground bar is furnished with the panelboard, connect the grounding conductor to the bar.

E. Miscellaneous Grounding: Provide grounding for the following:

1. Ground receptacles and switches and their metal plates through positive ground connection to the yoke/strap, outlet box and grounding system grounding wire installed in the conduit.

2. Ground racks, supports, frames, covers and metal parts in manholes or handholes, controllers, motor frames, surge capacitors, arrestors, lighting fixtures, metal structures, exposed noncurrent carrying metal, mechanical equipment, hoist beams, cranes and similar items.

3. Provide ground connections to equipment using ground plates imbedded in the concrete pad so that the equipment can be removed without damaging grounding system. Provide a copper ground connection between ground plates and the equipment.

4. Ground motor shaft protection for motors operating on adjustable frequency drives where provided.

3.2 FIELD QUALITY CONTROL

A. Tests: Conduct a witnessed test to determine the ground impedance for the entire system using a ground loop impedance tester. Provide a maximum impedance of 2 ohms at any point of the test. Add additional grounding rods if necessary to meet this requirement.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 33

ELECTRICAL RACEWAY SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing electrical raceway systems as indicated, in accordance with the Contract Documents.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 – High Performance Coatings
2. Section 26 05 00 - Basic Electrical Materials and Methods
3. Section 26 05 43 - Underground Electrical Distribution System

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ANSI C80.1	-	Rigid Steel Conduit
2.	ANSI C80.3	-	Electrical Metallic Tubing,
3.	ANSI C80.5	-	Specifications for Aluminum Rigid Conduit
4.	ANSI C80.6	-	Electrical Intermediate Metal Conduit
5.	ANSI/NFPA 70	-	National Electrical Code
6.	NEMA RN1	-	Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
7.	NEMA TC2	-	Electrical Polyvinyl Chloride (PVC) Conduit
8.	UL 1	-	Standard for Flexible Metal Conduit
9.	UL 6	-	Standard for Rigid Metal Conduit-Steel
10.	UL 360	-	Standard for Liquid-Tight Flexible Steel Conduit

11. UL 651 - Standard for Schedule 40 and 80 Rigid PVC Conduit

12. UL 797 - Standard for Electrical Metallic Tubing-Steel

13. UL 1242 - Standard for Intermediate Metal Conduit-Steel

14. NFPA 70 - National Electrical Code (NEC)

15. Federal Specification WW-C-540C - Conduits, Metal, Rigid (Electrical, Aluminum)

16. Intertek ETL SEMKO PVC-001 - High Temperature H2O PVC Coating Adhesion Test Procedure

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01 and Section 26 05 00.

1.4 QUALITY ASSURANCE

A. Codes: Provide all materials and workmanship in accordance with the requirements of the National Electrical Code and local codes having jurisdiction.

B. Regulatory Requirements: Provide UL listed components.

C. Installers of PVC coated rigid steel conduit are to be factory certified.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Rigid steel and intermediate metal conduits and electrical metallic tubing:

a. Allied Tube and Conduit
b. Wheatland Tube Company/JMC Steel Group

c. Republic Conduit Manufacturing

2. PVC coated steel conduits fitting and boxes:

   a. Plasti-Bond/Perma-Cote/KorKap-Robroy Industries
   b. Ocal – Thomas & Betts Corp.
   c. Perma-Cote Industries

3. Rigid nonmetallic conduits:

   a. Carlon– Thomas & Betts /ABB Group
   b. Cantex Inc.
   c. National Pipe & Plastics, Inc.

4. Aluminum Conduits:

   a. Allied Tube and Conduit
   b. Wheatland Tube Company/JMC Steel Group
   c. Sapa Extrusions North America

5. Liquidtight and flexible steel conduit:

   a. Electri-Flex Company
   b. The International Metal Hose Co.
   c. Southwire
   d. Anamet Electrical, Inc.
   e. Thomas & Betts /ABB Group

6. Conduit Fitting and Connectors

   a. Appleton /Emerson Industrial Automation
   b. Thomas & Betts/ABB Group
   c. Eaton’s Cooper Crouse-Hinds
   d. O-Z Gedney/Emerson Industrial Automation
   e. Hubbell - Killark
   f. AdaletPLM/Scott Fetzer Company

7. Boxes and Enclosures:

   a. Appleton /Emerson Industrial Automation

b. –Raco/A Hubbell Company

c. Eaton’s Cooper Crouse-Hinds

d. Thomas & Betts/ABB Group

e. Hoffman

f. Hope Electrical Products Company

g. O-Z Gedney/Emerson Industrial Automation

8. Strut Channel and Fittings

a. Allied Tube and Conduit

b. Eaton’s Cooper B-Line Systems, Inc.

c. Thomas & Betts /ABB Group-SuperstrutEnduro Composites Inc.

d. Strut Tech Systems

e. Unistrut

9. Fire Stop System

a. 3M/Electrical Products Division

b. Acoustical Solutions Inc.

c. Nelson Fire Stop Products/Emerson Industrial Automation

10. Terminal Blocks

a. Phoenix Contact

b. ABB - Entrelec

c. Weidmuller

2.2 RACEWAYS

A. General: Provide minimum 3/4-inch raceways.

B. Raceway Requirements: Provide raceways meeting the following requirements:

1. Provide rigid steel, heavy wall, hot-dip galvanized in accordance with the requirements of UL-6 and ANSI C80.1.

2. Provide PVC coated rigid steel in accordance with the requirements for rigid steel raceway herein and with 40 mils bonded PVC exterior coating meeting requirements of UL-6 and NEMA RN1. Provide PVC coated rigid steel conduit that is listed and performance verified to ETL PVC-001 for 200

hours. Provide a nominal 2 mil urethane interior coating and a clear urethane coating over the galvanized threads.

3. Provide rigid heavy wall aluminum alloy 6063T-1 conduit in accordance with the requirements of UL 6, Federal Specification WW-C-540C and ANSI C80.5.

4. Provide rigid nonmetallic Schedule 40 PVC in accordance with requirements of NEMA TC2 and UL 651 with solvent cement joints.

5. Provide liquidtight flexible single strip steel, hot-dip galvanized conduit with PVC jacket in accordance with requirements of UL 1. Provide a continuous copper bonding conductor wound spirally between convolutions on the inside of the conduit meeting requirements of UL 360 for conduit sizes 1-1/4-inch and smaller.

6. Provide flexible steel conduit constructed of continuous interlocked, zinc coated steel strip in accordance with the requirements of UL 1. Provide in a minimum 1/2 inch electrical trade size.

7. Provide explosion-proof, heavy duty construction, flexible conduit, with internal insulation liner for Class I, Division 1, Group D hazardous areas.

2.3 FITTINGS

A. General: Provide fittings of similar material as raceways.

B. Fittings Requirements: Provide fittings meeting the following requirements:

1. Set screw or indenter type fittings are not acceptable. Provide threaded connectors for all rigid or intermediate metal conduits.

2. Provide solvent cement connections for all rigid nonmetallic conduits.

3. Provide gland compression type fittings for all electrical metallic tubing. Provide insulated type connectors.

4. Provide insulated connectors for liquidtight flexible conduit.

5. Expansion/Deflection Fittings:

a. Provide a deflection and expansion coupling for rigid and intermediate metal conduits that have a ¾ inch movement in all directions from normal and a 30 degree angular deflection. Provide coupling that includes internal bonding jumper.

b. Provide a nonmetallic expansion coupling for nonmetallic conduits that have a 4-inch maximum expansion.

6. Bushings

a. Provide insulated nonmetallic bushing rated 105 degrees C for all installations where bonding is not required.

b. Provide insulated metallic grounding and bonding bushing rated 150 degrees C where bonding is required.

7. Fittings for Hazardous Locations:

a. Provide fittings that conform to the requirements of NEC Chapter 5 for Class I, Division 1or 2, Group D hazardous locations as defined in Section 26 05 00 or as shown.

b. Provide seal fittings designed for 40 percent fill capacity suitable for either horizontal or vertical installation.

2.4 WALL AND FLOOR PENETRATIONS

A. Watertight:

1. For conduit penetrations in new exterior walls or floors provide watertight sealing sleeves consisting of a steel sleeve with pressure ring and clamps.

2. For conduit penetrations in existing walls or floors, provide watertight sealing bushing consisting of a neoprene sealing ring between two PVC coated steel pressure discs. Provide stainless steel captive screws for sealing ring compression.

B. Fire-proofing Through Fire Rated Construction:

1. Provide a permanent fire stop system for all penetrations through fire-rated walls, partitions and floors.

2. Design fire stop system to maintain the integrity of the wall or floor assembly for its rated time period.

3. Arrange fire stop system to allow normal pipe movement without being displaced.

4. Do not utilize asbestos in fire stop systems.

5. Provide an intumescent fire stop system when exposed to flame or heat.

2.5 BOXES AND CABINETS

A. Outlet Box Requirements:

1. Provide cast aluminum boxes for aluminum conduit systems.

2. Provide galvanized cast iron boxes for galvanized rigid steel and intermediate metal conduit systems.

3. Provide nonmetallic boxes and covers in PVC conduit systems.

4. Provide PVC coated boxes and covers in PVC coated conduit systems.

5. Provide pressed steel boxes and covers in electrical metallic tubing conduit systems.

6. Provide boxes located in Class I, Division 1 hazardous areas meeting NEMA 7 requirements.

7. Provide corrosion-resistant fiberglass reinforced polyester boxes with stainless steel hardware in corrosive areas as defined in Section 26 05 00 or as shown.

8. Provide watertight gasketed covers held with nonferrous screws for all cast metal boxes.

B. Junction and Pull Box Requirements:

1. Provide cast aluminum boxes with mounting lugs, threaded hubs and gasket covers for surface mounted boxes

2. Provide fabricated sheet metal boxes when cast metal box weight exceeds 50 pounds. Construct box from 1/8-inch thick galvanized sheet steel or aluminum with sides return channel flanged around cover opening. Provide angle or channel supporting frame. Provide continuously welded and ground smooth seams. Provide mounting lugs and threaded conduit hubs.

3. Provide cast steel or fabricated 10-gauge Type 316 stainless steel for boxes either partially or fully encased in concrete. For partially encased boxes provide sides return channel flanged around cover opening. For fully encased boxes provide flush covers. Provide continuously welded and ground smooth seams. Provide mounting lugs and threaded conduit hubs.

4. Provide watertight gasketed covers held with stainless-steel captive screw slot bolts.

5. Provide two padlocking hasps for boxes containing medium voltage cables.

6. Provide steel barriers in all boxes that isolates instrumentation wiring from all other wiring systems

7. Provide fabricated boxes located indoors in non-corrosive areas and conditioned spaces -meeting NEMA 12 requirements.

8. Provide all boxes located outdoors, in corrosive areas or where otherwise indicated meeting NEMA 4X, 316 stainless steel requirements.

9. Provide boxes located in Class I, Division 1 hazardous areas meeting NEMA 7 requirements.

C. Terminal Box Requirements:

1. Provide minimum 12 gauge stainless steel fabricated box with mounting lugs, floor stand, and hinged doors.

2. Provide the door with continuous piano hinge and 3 point lockable latch. Provide print pocket on inside of door.

3. Provide back plate fabricated from 12 gauge minimum steel with white enamel finish for mounting terminals and wire troughs.

4. Provide wire troughs consisting of plastic ducts with snap slot design and removable covers. Run all wiring within wire troughs.

5. Furnish a schedule of terminals with the following information

   a. Source

   b. Type of Signal

   c. Function

6. Provide removable jumpers to allow operation of the equipment.

7. Separate analog terminals from all other terminals.

8. Provide number of terminals shown. Where the number of terminals are not shown, provide sufficient terminals for each wire entering the terminal box plus 20 percent but not less than 10 spare terminals.

9. Terminals:

   a. All catalog numbers refer to Phoenix Contact Type for the purpose of establishing the standard of quality and general configuration desired.

b. Provide symmetrical type steel mounting rails, NS-35.

c. Analog Signals: Provide terminals in enclosed housing suitable for wires from 22 to 12 AWG rated 600 volts with gray body, knife disconnect and test connection socket on both sides of disconnect, Phoenix Contact Type UK 5-MTK-P/P.

d. Control and Alarm Signals: Provide terminals suitable for wires from 24 to 10 AWG rated 18 amperes at 600 volts, blue body, Phoenix Contact Type UK5N BU.

e. 120-Volt Power Wiring: Provide terminals suitable for wires from 18 to 10 AWG rated 30 amperes at 600 volts, hot (black body), neutral (white body), ground (green body) , Phoenix Contact Type UK5N BK, UK5N WH & UK5N GN, respectively.

10. Enclosures:

a. Provide enclosures meeting the same NEMA criteria for the various areas as specified under Junction and Pullboxes.

2.6 SUPPORTING DEVICES

A. Raceway Supports: Provide raceway supports meeting the following requirements:

1. Do not use perforated straps or plumbers tape for conduit supports.

2. Provide expansion bolts or inserts for fasteners in concrete, toggle bolts for hollow masonry or frame construction, and preset inserts for prestressed concrete.

3. Conduit Straps and Backs:

a. For metallic conduits, provide steel or malleable iron.

b. For nonmetallic and PVC coated conduits, provide PVC coated malleable iron with stainless steel anchors and bolts.

4. Conduit Hangers

a. For metallic conduits, provide steel adjustable conduit hangers or clevis hangers.

b. For nonmetallic and PVC coated conduits, provide PVC coated adjustable conduit hangers with stainless steel hardware.

5. Beam Clamps:

   a. For metallic conduits, provide malleable iron with steel bolt.

   b. For nonmetallic and PVC coated conduit, provide PVC coated malleable iron with stainless steel bolt.

6. Trapeze Hangers:

   a. For metallic conduits provide 12 gauge 1-1/2-inch square steel channels with steel channel straps to secure conduits.

   b. For nonmetallic or PVC coated conduit, provide either PVC coated 12 gauge 1-1/2-inch square steel channels or 1-5/8-inch square fiberglass channels. Provide PVC coated straps with stainless steel bolts for securing conduits.

   c. Provide addition channels welded together to limit the deflection to 1/240th of span.

7. Threaded Rod

   a. Provide threaded rod with the minimum size as follows:

      (1) Conduit Hangers

         (a) 3/4-inch to 1-1/2-inch conduit: 1/4-inch thread rod

         (b) 2-inch to 3-1/2-inch conduit: 3/8-inch thread rod

         (c) 4-inch and larger: 1/2-inch thread rod

      (2) Trapeze Hangers: Provide thread rod of sufficient size to support the load. Provide a minimum of 3/8-inch thread rod.

   b. For Metallic Conduit Systems: Provide continuous threaded galvanized steel rod.

   c. For Nonmetallic or PVC Coated Conduit Systems: Provide continuous threaded stainless steel rod.

PART 3 EXECUTION

3.1 PREPARATION

A. General: Install electrical equipment and material of the size, type and general routing as shown or required.

B. Coordination with Reinforcing: Install raceway, fittings, boxes and cabinets free from direct contact with reinforcing steel.

C. Alignment: Provide fasteners, anchor bolts, anchorage items and supports as required to insure proper and rigid alignment. Attach equipment with fasteners sized according to size and weight of the equipment and the thickness of the supporting surface.

D. Aluminum Coating: Where aluminum is placed in contact with dissimilar metal or concrete, separate contact surfaces with gasket, nonabsorptive tape or coating as specified in Section 09 96 00 to prevent corrosion.

E. Grounding: Make metallic raceways electrically and mechanically continuous and ground as required. Install conduits continuous between outlets, boxes, cabinets and panels.

3.2 INSTALLATION

A. General: Unless otherwise indicated, install conduits exposed, parallel or perpendicular to building floors, ceilings and walls, to avoid interference with other work. In architecturally finished areas, conceal conduits within finished walls, ceilings and floors. Cut conduits square and deburr the cuts to the same degree as the conduit manufacturer. Fasten conduit securely to outlets, junction, pull and terminal boxes. Provide caps and seals to prevent the entrance of foreign material and moisture during installation and before pulling wire.

1. Where conduit size is not shown, provide conduits one size larger than indicated in Table 4, Chapter 9 of the NEC.

2. Saw cut aluminum conduit to prevent reduction in internal area.

3. Support raceways concealed above suspended ceilings from the slab above suspended ceiling in same manner as exposed raceways. Do not support raceways from suspended ceiling supports.

4. Keep conduit at least six inches away from high temperature piping, ducts, flues and surfaces. For mounting on concrete and masonry surfaces provide a minimum of 1/4 inch air space between conduit and mounting surface. Support and fasten conduit to building structural members spaced in

accordance with electrical codes. Support conduit at least every eight feet or less in accordance with NEC requirements.

5. When two or more exposed conduits are in the same general routing, provide parallel installation with symmetrical bends and for three or more provide trapeze hangers. Size trapeze hangers with space for 25 percent additional conduits.

6. Make changes in direction with bends or fittings. Use factory-made bends or elbows wherever possible. Make field bends and offsets with a hand bender or conduit-bending machine. Provide a bending radius not less than 36-inches for conduits containing medium voltage cables.

7. Run conduit in buildings with no more than the equivalent of three 90 degree bends between pull points. Provide no more than 125 feet of conduit runs between pull points. Provide pull boxes where shown, specified or wherever required to install conductors and to meet the above requirement.

8. Install pull and junction boxes in accessible locations with working space in front of and around the installation. Obtain approval to locate boxes in finished areas.

9. Install an expansion fitting when a conduit crosses a structural expansion joint.

10. Unless otherwise approved, install conduits to cross at right angles to building structural expansion joints.

11. Where approved for encased installation, install conduits in slabs as close to the middle of concrete slabs as practicable without disturbing reinforcement. Do not use conduit with an outside diameter exceeding one-third of the slab thickness. Do not place conduits closer than three diameters on centers, except at cabinet locations where the slab thickness is increased.

12. Pitch conduits to outlet boxes to avoid trapping moisture. Where dips are unavoidable in exposed conduit runs, install drain fitting at low point.

B. Conduit Material Types: Provide conduit as follows:

1. Provide aluminum conduit in all exposed indoor and outdoor installations, except as described below.

2. Provide rigid steel conduits in all installations concealed in structures, concrete encased within structures or under structures.

3. Provide electrical metallic tubing in all installations above suspended ceilings and in partition constructed walls.

4. Provide rigid steel conduits for all instrumentation, and electronic equipment signal wiring in all exposed or concealed noncorrosive installations.

5. Provide rigid nonmetallic Schedule 40 conduits underground, concrete encased or direct buried, unless specifically detailed otherwise.

6. Corrosive Locations

   a. Corrosive locations are defined in Section 26 05 00 or as shown:

   b. Provide PVC coated rigid steel conduit in all installations in corrosive locations.

7. Hazardous Locations:

   a. Hazardous locations are defined in Section 26 05 00 or as shown.

   b. Install all conduits and appurtenances in accordance with the requirements of Chapter 5 in NEC.

   c. Provide seal fittings for all conduits that enter or leave a hazardous location.

C. Connections to Equipment

1. Provide double locknuts and bushing for all boxes, enclosures and cabinets located in dry areas.

2. Provide watertight hub fittings for all boxes, enclosures and cabinets located below grade or in wet, damp or corrosive areas.

3. Provide rigid conduit connection where equipment is fixed and not subject to adjustment, mechanical movement or vibration. Provide union fittings to permit removal of equipment without cutting or breaking conduit.

4. Provide liquidtight flexible conduit connection where equipment is subject to adjustment, mechanical movement or vibration.

5. Provide flexible steel conduit connections to lighting fixtures installed in accessible suspended ceilings.

6. Coat all threads in steel conduit runs with zinc dust in oil or other corrosion-preventive compound before making connections.

7. Coat all threads in aluminum conduit runs with graphite or other corrosion preventive compound.

D. Underground Conduits: Provide underground conduits meeting the requirements of Section 26 05 43.

E. Penetrations: Make concealed penetrations for single conduits not more than 1/4-inch larger than the diameter of the conduit. Make penetrations through walls, ceilings and floors other than concrete for exposed conduits not more than 1/4-inch larger than the diameter of the conduit. Fill the voids around conduit with caulking compound and finish the surface the same as the wall, ceiling or floor.

1. Where a conduit enters through a concrete roof or membrane waterproofed wall, floor or ceiling, provide a watertight sealing sleeve that can be tightened from one or both sides. If the sealing sleeve is not placed with the concrete, core drill the proper size hole to provide a mechanically watertight installation.

2. Where a conduit enters through a concrete non-waterproofed wall, floor or ceiling, provide a Schedule 40, galvanized steel sleeve and fill the space between the conduit and sleeve with a plastic expandable compound. If the sleeve is not placed with the concrete, drill the hole not less than 1/2-inch and not more than one inch larger than the sleeve, center the sleeve and grout the sleeve for the total depth of penetrated concrete with non-shrink grout, polyurethane or silicone sealant.

F. Spare Conduit: Provide spare conduits for future use as shown or required. Provide a minimum 200 pound strength nylon pull line in each spare conduit and identify the origin and termination of the conduit at each end. Terminate spare conduits in equipment, boxes or by couplings plugged flush with the inside of building surfaces.

G. Boxes: Provide boxes of the proper dimensions for the size and quantity of conductors enclosed.

1. For boxes mounted on steel, concrete and masonry surface, provide a minimum 1/4-inch non-metallic spacer to hold the box away from the surface.

2. Provide pressed metal boxes in all partition constructed walls.

3. Provide separate support for boxes and bolt units to buildings with expansion anchors, toggle bolts or appropriate screws. For lighting fixture outlet boxes, provide supports adequate to support the weight of the fixture to be mounted on the box.

4. Remove debris including dust, dirt, wire clippings and insulation from the interior of boxes. Replace boxes with open conduit holes. Repair or replace damaged boxes as directed.

5. Unless otherwise indicated, mount outlet boxes flush with the finished wall or ceiling with the long axis vertical. Unless otherwise shown or specified, provide mounting heights measured from the finished floor to centerline of the outlet box as follows:

   a. For switches: 3'-2". Mount the box for lighting switches on the strike side of the door.

   b. For duplex convenience outlets: Finished areas 12 inches and unfinished areas 2 feet.

   c. For clock receptacles outlets: 8 feet.

   d. For fixtures and equipment: As shown.

   e. For desk telephone outlets: 12 inches.

   f. For wall telephone outlets: 48 inches.

3.3 CLEANING AND PAINTING

A. Touch Ups: Touch up all PVC coatings on conduit, fittings and boxes where scratched, marred or otherwise compromised during handling and installation per the manufacturer's instructions.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 43

UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing underground electrical raceway system consisting of concrete encased conduits, direct buried conduits, cables, handholes, and outdoor electrical equipment pads as shown.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 20 00 – Concrete Reinforcement
3. Section 03 21 00 - Reinforcing Steel
4. Section 03 30 00 - Cast-In-Place Concrete
5. Section 26 05 00 - Basic Electrical Materials and Methods
6. Section 26 05 33 - Electrical Raceway Systems
7. Section 26 05 19 - Wire and Cable - 600 Volts and Below
8. Section 26 05 26 - Grounding
9. Section 31 23 16 - Excavation - Earth and Rock
10. Section 31 23 23 - Backfilling
11. Section 32 90 00 - Landscaping Work

1.2 SYSTEM DESCRIPTION

A. Design Requirements: Provide precast manholes and handholes capable of withstanding earth and hydrostatic pressures and vehicular loads of 20,800 lbs total equaling H20 AASHTO truck loading, rear wheel load of 16,000 lbs plus a 30 percent impact load of 4,800 lbs.

B. Performance Requirements: Arrange and route conduits as shown to allow pulling-in of conductors without exceeding the conductor's tension limits.

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 1.

B. Product Data and Information: Furnish manufacturer's data for conduits, manholes, handholes and all accessories.

C. CONTRACTORS' Shop Drawings: Furnish working drawings for underground electrical raceway system showing conduits, concrete encasement, manholes, handholes, electrical equipment pads and reinforcing. Indicate the designation, type, size, location, elevations and slopes of the system. Provide scaled profile drawings as needed to resolve conflicts among the various disciplines and existing infrastructure. Profile drawings are to be scaled 1"=20'-0" horizontal and 1"=5'-0" vertical.

D. Quality Control: Furnish a signed and sealed certification from a professional engineer registered in Oklahoma stating that the design calculations and drawings for the precast concrete manholes and handholes were prepared by that professional engineer or under his direct supervision.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

1.5 PROJECT CONDITIONS

A. Existing Conditions: Examine record drawings to determine the location of all obstructions along the conduit or cable route and at the sites of manholes, handholes and outdoor electrical equipment pads. Contact the local underground utility locator service and confirm the location of all existing utilities prior to excavating for new work.

B. Field Measurements: Field survey, and in critical areas, excavate test pits to verify locations of probable obstacles along the conduit or cable route and at the sites of manholes, handholes and outdoor electrical equipment pads.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Conduit Spacers

    a. Carlon -Thomas & Betts/ABB Group

    b. Underground Devices, Inc.

2. Precast Handholes

    a. Penn-Cast Products, Inc.

    b. Hartford Concrete Products, Inc.

    c. Jensen Precast

    d. Rockway Precast

    e. Oldcast Precast

3. Handhole Frames and Covers

    a. Neenah Foundry Co.

4. Buried warning tape

    a. Ezcode - Thomas & Betts/ABB Group

    b. W. H. Brady Company

2.2 MATERIALS

A. Conduit: Provide conduits meeting the requirements of Section 26 05 33.

B. Cable: Provide cables meeting the requirements of Section 26 05 19 and 26 05 13.

C. Spacers: Provide rigid plastic, conduit spacers to maintain conduit separation as indicated.

D. Reinforcing Steel: Provide reinforcing steel meeting the requirements of Section 03 20 00.

E. Concrete: Provide concrete meeting the requirements of Section 03 31 00. Dye “red” the top layer of concrete for duct bank encasements.

F. Handhole Frames and Covers: Provide waterproof cast iron manhole and handhole frame and solid bolted cover suitable for H-20 truck load. Cast the word "ELECTRIC" in the cover. Provide frame with a clear opening of 36 inches, unless otherwise shown.

G. Precast Handholes: Provide precast manholes and handholes meeting the following criteria:

1. Submit shop drawings showing reinforcing in accordance with ACI-SP-66.

2. Submit detailed plans and sections showing all specified features and components.

3. Submittals shall bear the seal of the registered professional structural engineer who oversaw the design of the manholes and handholes.

4. Units shall comply with ASTM C478 and C478M.

5. Construct units using precast monolithic or assembled sections. Base and first riser shall be monolithic.

6. Provide tongue and groove joints for interlocking adjoining components. Seal all joints watertight using preformed plastic or rubber materials conforming to ASTM C990 or GSA SS-S-210A.

7. Provide lifting devices cast into units.

8. Identify all structures with the manufacturers' name embedded or otherwise permanently attached to an interior wall surface.

9. Provide window openings in walls to accept duct banks as shown on the plans. Terminate and make watertight all duct bank terminations.

10. Provide a sump pit in the floor at one corner for drainage.

11. Provide a circular centered opening in the roof suitable for accepting precast collars with frame and cover specified. Provide water stops at framed cold joints.

12. Provide a floor sleeve at a corner of the manhole for the onsite driving of a ground rod. Seal to make watertight after installing ground rod.

13. Provide a 1/4 X 2 inch continuous copper ground bus installed 12 inches above the floor and mounted on suitable standoffs along the interior perimeter of thel manhole for grounding of all metal parts within. Terminate all ground connections with exothermic welds. Where manholes consist of multiple compartments, provide a bonding conductor jumper between the ground buses in each adjacent compartment.

H. Grounding: Provide grounding meeting the requirements of Section 26 05 26.

I. Underground Warning Tape: Provide 6-inch wide detectable type plastic tape in red (electric), yellow (utility) and orange (communications) colors with suitable warning describing the type of buried electrical lines.

PART 3 EXECUTION

3.1 CONDUIT INSTALLATION

A. General: Install underground, concrete encased and direct buried conduits as indicated.

B. Conduit Route: Establish and mark exactly conduit or cable routing. Resolve routing near existing obstacles and coordinate with other sitework. Maintain a 12-inch minimum longitudinal clearance from the conduit bank encasement or direct buried conduit to adjacent utility lines. Maintain a 6-inch minimum vertical clearance from the conduit bank encasement or direct buried conduit to utility lines at crossovers. Adhere to lines, grades, elevations and dimensions as shown.

C. Trench Excavation: Perform excavation work in accordance with the requirements of Section 31 23 16.

D. Workmat: Install concrete mat on trench bottom to provide an even base for concrete encased conduit bank in accordance with the requirements of Section 03 31 00.

E. Bedding: Provide a sand cover on trench bottoms to create a firm and smooth surface for direct buried conduits.

F. Spacers: Locate spacers at intervals of approximately four feet and stagger locations at each conduit tier to provide not less than 12-inches of longitudinal separation.

G. Conduit: Place conduit in straight lines and with a minimum slope of 0.25 percent (3 inches per 100 feet). Slope conduit down to manholes, handholes and structures. Install expansion fittings in straight runs exceeding 100-feet. Secure conduits in place to prevent floating and movement. Provide innerducts with pull strings installed in all conduits scheduled for the routing of instrumentation wiring (Cat 5E, fiberoptic, twisted shielded, etc.) Provide spare innerducts to the maximum allowable capacity of the conduit size being used. Spare innerducts are to be of the same size used for the scheduled wiring.

H. Bends: Install 12-foot minimum radius bends in horizontal turns and vertical deflections. For bends used at ends of conduit runs install elbows with 4-foot

minimum radius for 6-inch and 5-inch conduits, and elbows with 3-foot minimum radius for 4-inch and smaller conduits.

I. Inside Cleaning: Pull a standard flexible mandrel not less than 12-inches long, having a diameter approximately 1/4-inch less than the inside diameter of the conduit, through each conduit, then pull a brush with stiff bristles through each conduit. Replace conduit runs that do not allow the passage of the mandrel at no increase in Contract Price. Use the pneumatic method to draw into conduit the nylon or polypropylene pull line. Plug and seal all conduits after cleaning.

J. Concrete Reinforcing: Install concrete reinforcing meeting the requirements of Section 03 20 00. Provide ductbanks with No. 5 reinforcing, spaced 12 inches on centers, top and bottom, with No. 3 ties at 18 inches, unless otherwise shown.

K. Concrete Formwork: Install concrete formwork meeting the requirements of Section 03 10 00.

L. Outside Cleaning: Remove dirt, sand and debris around conduits and from workmat, prior to concrete placement.

M. Concrete Placement: Place concrete meeting the requirements of Section 03 31 00. Color the top layer for all duct bank encasements with a “red” sprinkled on dye, raked and vibrated in evenly.

N. Connections to Structures: Install as shown.

-

O. Backfilling: Backfill meeting the requirements of Section 31 23 23. Provide a cover layer of sand that is 6 inches deep above direct buried conduits or cables.

P. Underground Warning Tape: Provide one underground warning tape for each trench up to 18 inches wide. For trenches wider than 18 inches provide two underground warning tapesinstalled at each edge of the trench. Place the tape or tapes 12 inches below the finished grade.

Q. Markers: Provide 4-inch round, 6-inch thick, concrete markers identified with the letter "E" and directional arrows. Place these markers approximately every 200 feet along straight portions of conduit and cable runs, at each change in direction and at the conduit run end. Install markers to protrude 1-inch above adjacent ground. Allow markers to protrude 1/2-inch in finished lawns. Do not place conduit markers at structures and at conduit risers.

R. Surface Finish: Restore existing pavements and curbs with materials and construction to match existing. Restore landscaped areas meeting the requirements of Section 32 90 00.

3.2 HANDHOLES

A. General: Provide precast reinforced concrete handholes as shown.

B. Location: Establish and mark handhole locations exactly. Resolve locations near existing obstacles and coordinate with other sitework. Adhere to orientation, elevations and dimensions as indicated.

C. Hole Excavation: Install hole excavations meeting the requirements of Section 31 23 16.

D. Backfilling: Backfill meeting the requirements of Section 31 23 23.

E. Accessories: Install pulling-in-irons, cable racks with supports and insulators, grounding system and other items as indicated or otherwise required.

3.3 OUTDOOR ELECTRICAL EQUIPMENT PADS

A. General: Provide reinforced concrete pads for supporting Outdoor Electrical Equipment as shown.

B. Location: Establish and mark pad locations exactly. Resolve locations near existing obstacles and coordinate with other sitework under this Contract. Adhere to orientation, elevations and dimensions as shown.

C. Site Excavation: Provide site excavation meeting the requirements of Section 31 23 16.

D. Pad Construction: Install pad construction meeting the requirements of Sections 03 10 00, 03 20 00 and 03 31 00.

E. Conduit Entrances: Install conduit risers and laterals under pads prior to placement of pads. Separate conduits from pads as shown.

F. Grounding: Install grounding conductors through pads meeting the requirements of Section 26 05 26.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing materials for the identification of electrical equipment, components, conduits, cables and wiring, and furnishing and installing safety signs.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 – High Performance Coatings
2. Section 26 05 00 - Basic Electrical Materials and Methods

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ANSI C2	-	National Electrical Safety Code (NESC)
2.	ANSI Z535.1	-	Safety Color Code
3.	ANSI Z535.2	-	Environmental and Facility Safety Signs
4.	ANSI Z535.3	-	Criteria for Safety Symbols
5.	OSHA	-	Occupational Safety and Health Act

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01.

B. Product Data and Information: Furnish manufacturers' catalog data for safety signs, nameplates, labels and markers.

1. Furnish manufacturers' instructions indicating applicable conditions and limitations of use, storage, handling, protection, examination and installation of product.

C. CONTRACTOR's Record Drawings: Furnish CONTRACTOR's record drawings accurately showing the actual location and elevation of underground ducts, handholes and manholes at the completion of the Project.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

1.5 SPARE PARTS

A. Packaging: Package spare parts in containers bearing labels clearly identifying the contents. Provide all spare parts with information needed for reordering. Deliver spare parts in original factory packaging.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. W. H. Brady Company
2. Seton
3. Thomas & Betts/ABB Group

2.2 MATERIALS AND COMPONENTS

A. General: Provide identification materials listed and classified by UL or tested by an acceptable Electrical Testing Company certifying the equivalence of the materials to UL listing requirements and OSHA approved.

B. Laminated Plastic Nameplates: Provide engraved three layer laminated plastic nameplates with black letters on white background and fastened with corrosion-resistant screws. Do not use mounting cement for fastening nameplates.

1. Provide nameplates with 1-inch high lettering for switchboards, motor control centers, control panels, relay panels, contactor panels, panelboards, and similarly grouped equipment, transformers and disconnect switches.

2. Provide nameplates with 1/2-inch high lettering for individual components of a group such as main breakers, switchgear units, switchboard units, motor control center units and similar devices.

3. Provide nameplates with 1/4-inch high lettering for remote motor controllers, control stations, relays and similar equipment.

4. Provide nameplates for each motor identifying service or function and lettering of an appropriate size to suit each motor.

5. Provide approved laminated directories of circuits with typewritten designations of each branch circuit in each panelboard.

6. Provide smaller lettering for a neat, legible nameplate where the amount of lettering causes excessively large nameplates.

C. Wire Markers: Identify wire bundles and each individual wire.

1. Wire bundles: Provide a brass or rigid fiber identifying tag attached with nylon self locking "Ty-Raps".

2. Wire identification markers: Provide a printed white, heat-shrink, seamless tubing type with black bold lettering for wires size No. 10 AWG and smaller. Provide a printed self-laminating white, vinyl type with black bold lettering for wires No. 8 AWG and larger.

D. Conduit Marking Paint: Provide conduit marking paint meeting the requirements of Section 09 90 00.

E. Safety Signs: Provide safety signs in accordance with OSHA standard meeting the requirements of ANSI C2, ANSI Z535.1, ANSI Z535.2 and ANSI Z535.3.

1. Provide safety signs manufactured from vinyl having a minimum thickness of 60 mils with red and black letters and graphics on a white background.
2. Size: 10 inches by 14 inches except signs 7-inch by 10-inch may be provided where the larger size cannot be applied.

3. Mount safety signs using corrosion-resistant screws. Do not use mounting cement.

F. Working Space Floor Markers

1. Provide paint or tape to mark the working space on the floor at electrical equipment.

a. Tape: 2-inch wide, 5-mil pressure-sensitive vinyl tape, black and white stripes with clear vinyl overlay. Manufacturer: 3M Safety Stripe Tape 5700.

b. Paint: Black and white to be applied in 2-inch wide stripes or checkers. Refer to Specification Section 09 96 00 – High Performance Coatings.

G. Working Space Labels

1. Provide labels indicating required working clearance at electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.

a. Material: Self-adhesive polyester with pressure-sensitive adhesive back. Outdoor labels shall be suitable for a high-UV environment.

b. Dimensions: Approximately 6-3/4 x 2 inches.

c. The top line on the label is to read “NOTICE” in a 48 point white italic font letters on a safety blue background.

d. Provide message wording in a 24 point black or safety blue font letters on a white background.

(1) Message wording for 208Y/120-volt equipment: “KEEP AREA IN FRONT OF THIS ELECTRICAL EQUIPMENT CLEAR FOR 3 FEET. OSHA-NEC REGULATIONS.”

(2) Message wording for 480-volt and 480Y/277-volt equipment: “KEEP AREA IN FRONT OF THIS ELECTRICAL EQUIPMENT CLEAR FOR 3-1/2 FEET. OSHA-NEC REGULATIONS.”

e. Manufacturer: Brady, Brother, Seton.

H. Underground Warning Tape

1. Provide underground warning tape for underground cables, conduits and duct banks.

2. Use 6 inch wide, 0.004 inch thick, polyethylene underground warning tape with black lettering and background colors as follows:

a. Electric: Red.

b. Telephone/Data: Orange.

3. Provide lettering that indicates the type of buried service.

a. Electric: "CAUTION ELECTRIC LINE BURIED BELOW"

b. Telephone/data: "CAUTION TELEPHONE LINE BURIED BELOW"

4. Manufacturer: Utility Safeguard, LLC.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation: Degrease and clean surfaces to receive nameplates, labels and marking paint.

3.2 INSTALLATION

A. General: Install nameplates on the front of equipment, parallel to the equipment lines and secured with corrosion resistant screws. Caulk all screw holes with clear silicone caulk prior to attaching nameplates on NEMA 4X enclosures.

1. Install laminated nameplates identifying:

a. Each electrical equipment enclosure

b. Individual equipment and devices

B. Wire Markers: Identify wire bundles and each individual wire with identification tags as follows:

1. Wire Bundles: Install an identifying tag engraved with the conduit number where conduits enter motor control centers, switchgear, switchboards, control panels, terminal boxes and the like.

2. Wire identification markers: Provide wire identification markers on each wire at all termination points.

a. On power and lighting circuits: The branch circuit or feeder number as indicated on drawings

b. On control circuits terminated in motor control centers, switchgears, control panels and alike: The field device and terminal number of the opposite end connection.

c. On control circuits at each field device: The panel or compartment number and terminal number of the opposite end connection.

3. Oversize wire markers so that after heat shrinking the wire marker can be rotated on the wire. Rotate wire markers so that wire identification number is visible.

C. Conduit Markers: Paint colored marking bands on each conduit that is longer than 6 feet at intervals of 20 feet on centers to identify the wiring voltage system contained in the conduit or for identifying the different conduit systems as follows:

1. 480-Volt System
2. 208/120-Volt System
3. 240/120-Volt System
4. 24/48/125-Volt dc System

D. Safety Signs: Provide safety signs as follows or as shown including existing locations and equipment not signed per current industry standards and being modified or reused under this Contract:

1. Type DS-2

    a. Wording: "DANGER - ELECTRICAL EQUIPMENT, AUTHORIZED PERSONNEL ONLY"

    b. Location: At each entrance to electrical rooms, and enclosed outdoor electrical equipment.

2. Type DS-5

    a. Wording: "DANGER - POWERED FROM MORE THAN ONE SOURCE"

    b. Location: Outside all equipment that operates from more than one power source.

3. Type DS-6

    a. Wording: "NOTICE - KEEP DOOR CLOSED"

    b. Location: On all doors with another safety sign installed.

4. Type DS-7

    a. Wording: "CAUTION - CONTROLS & INTERLOCKS POWERED FROM MULTIPLE SOURCES"

    b. Location: On all control panel doors.

E. Working Space Floor Markers

1. Install floor marking tape or paint on the floor at the locations listed below to indicate working space required by the NEC.

    a. Front and rear of each medium-voltage switchgear.

    b. Front of each medium-voltage transformer.

    c. Front and rear of each free-standing low-voltage switchgear or switchboard section.

    d. Front of each low-voltage transformer, switchboard, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor controller enclosure including those furnished with mechanical equipment.

    e. Any other equipment likely to require examination, adjustment, servicing, or maintenance while energized.

2. Dimensions of working space area are to be as follows:

    a. Width: the greater of the width of the equipment or 30 inches.

    b. Depth:

        (1) Systems 600V and Below: In accordance with NEC Table 110.26(A)(1)

        (2) Systems Over 600V: In accordance with NEC Table 110.31

3. Thoroughly prepare floor surface to receive tape or paint.

4. Where marking tape is used, outline working space with tape then infill with diagonal tape stripes placed 6 inches on center.

5. Where paint is used, cover working space area with alternating 3 to 6 inch wide black and white diagonal stripes.

F. Working Space Labels

1. Provide working space labels at the following locations positioned at the optimal height for reading when standing facing the equipment:

    a. Front and rear of each medium-voltage switchgear.

    b. Front of each medium-voltage transformer.

c. Front and rear of each freestanding low-voltage switchgear or switchboard section.

d. Front of each low-voltage transformer, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor controller enclosure, including those furnished with mechanical equipment.

e. Any other equipment likely to require examination, adjustment, servicing, or maintenance while energized

G. Underground Warning Tape

1. Install underground warning tape in the trench above underground conduits, 1 foot below the finished grade.

END OF SECTION

SECTION 26 05 60

ELECTRICAL REQUIREMENTS FOR SHOP-ASSEMBLED EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing, installing and testing shop-assembled equipment as indicated, in accordance with the Contract Documents. Shop-assembled equipment panels and other items may be specified under the driven equipment sections and/or on the contract drawings and may require external field connection to ancillary devices and other system components for interlocks and alarms. Provide all field wiring as required by the system and equipment specified under the driven equipment sections. This field wiring may not be specified or shown. This equipment includes but is not limited to the following:

1. Valve operators

B. Related Work Specified in Other Sections, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-in-Place Concrete
2. Section 09 96 00 – High Performance Coatings
3. Section 26 05 00 - Basic Electrical Materials and Methods
4. Section 26 05 33 - Electrical Raceway Systems
5. Section 26 05 19 - Wires and Cables - 600 Volts and Below
6. Section 26 27 26 - Wiring Devices
7. Section 26 05 80 - Electric Motors
8. Section 26 05 53 - Electrical Identification
9. Section 26 05 26 - Grounding
10. Section 26 29 53 - Control Components and Devices

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

2. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

3. UL 508A - Industrial Control Panels

4. NEC Article 409 - Industrial Control Panels

5. NFPA-70E - Standard for Electrical Safety in the Workplace

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Provide the Shop Assembled equipment using Components and Appurtenances meeting the requirements specified in Division 26. Provide shop assembled equipment constructed and labeled to meet the requirements of all referenced and otherwise applicable codes and standards.

1.4 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01.

B. Product Data and Information: Furnish manufacturer's data on all equipment and devices in the assembly, including voltages, number of phases, current ratings, capacities and other relevant data.

C. Shop Drawings: Furnish shop drawings for the shop-assembled equipment, including the following:

1. Layout drawings of the assembly showing accurately scaled basic equipment sections, auxiliary compartments and combination sections. Show special relationships of assemblies to associated equipment, including plan and front views of the equipment. Furnish a device summary.

2. Furnish wiring diagrams for assemblies that show connections to electrical power. Clearly differentiate between shop-installed and field installed wiring.

3. Furnish construction drawings for equipment requiring field assembly. Clearly differentiate between shop-assembled and field assembled elements of the assembly.

4. A manufacturer’s standard connection diagram or schematic showing more than one method of connection is not acceptable unless, the intended method is clearly identified.

5. Furnish short circuit ratings on control panels and data demonstrating the rating is appropriate for the available fault current in accordance with NEC Article 409 and UL 508A.

D. Quality Control: Furnish manufacturer's test reports and certified performance records of all equipment installed. Furnish field test reports after equipment is installed.

1.5 QUALITY ASSURANCE

A. Codes: Comply with local codes and all other applicable codes.

B. Regulatory Requirements: Comply with applicable Regulatory Agency requirements.

C. Certification: Certify that the panels' construction complies with the following:

1. List and label panel in compliance with UL-508A.

2. Label panel with its' designed and constructed Short Circuit Current Rating (SCCR) indicating compliance with UL 508.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

PART 2 PRODUCTS

2.1 FABRICATION

A. General: Provide shop-assembled equipment as standard products manufactured by companies regularly engaged in the manufacture of such equipment.

B. Provide panels constructed as follows:

1. Minimum of #12 AWG copper control wires at 120V.

2. Minimum of #14 AWG copper control wires at 24V.

3. Where main terminal and/or intermediate distribution blocks are used, provide blocks suitable for copper cables with ampere ratings at the rated voltage and related UL Short Circuit Current Rating (SCCR)/Ampere Interrupting Current Rating (AIC) as specified herein.

4. Isolate or barrier 120/24V (LV) controls from 208 through 600V (HV) line voltage equipment and wiring.

5. Isolate all HV equipment and wiring in the main control panel using wireways and internal sub-enclosures so as to allow the opening of the main control panel under "Work Permit" conditions to access low voltage component enclosures without being exposed to the (HV) equipment and wiring.

6. Provided a main control panel main breaker listed per UL-489.

   a. Less than 400A: thermal magnetic fixed trip or adjustable where available for the particular size furnished.

   b. 400A and larger: electronic solid state adjustable trip.

7. Where 3-phase magnetic motor starters are included, provide in combination with a motor circuit protector sized for the applicable horsepower.

8. Provide a warning label to read "WARNING-CONTROL VOLTAGE MAY BE PRESENT AFTER OPENING MAIN DISCONNECT" were control voltages are present from an external source.

9. Provide minimum Short Circuit Current Ratings (SCCR) as follows:

   a. LV control enclosures – 5KAIC

   b. HV enclosures as follows:

      (1) 208V, 3-phase – 22KAIC
      (2) 480V, 3-phase – 35KAIC

10. Increase minimum SCCR ratings to satisfy the requirements of the Projects Power System Study at no additional cost.
11. Panel shall utilize the following construction features:
    a. NEMA rated enclosure with internal subplate
    b. Wireducts with removable covers
    c. Identified terminal strips
    d. 600 VAC rated insulation, color coded
    e. ground terminals
    f. ground strap from panel to panel door
    g. panel door with print pocket
    h. finger safe construction

C. Factory Assembled Requirements: Provide control panels for shop-assembled equipment as complete factory assembled units that require only external

connections for installation including main disconnect and all electrical features necessary for the proper operation of the units.

D. Controls:

1. Motors 1/2 Hp and Larger:

a. Provide motors suitable for 480-volt, 3-phase, 60-hertz operation, with all controls at 120 volts or less.

b. Provide a combination circuit breaker along with all required control transformers, relays, timers, heaters and other necessary incidentals to form a complete functioning unit.

c. Provide NEMA Size 1 or larger starters.

2. Motors less than 1/2 Hp:

a. Provide motors suitable for 120-volt, single phase operation.

b. Provide manual motor starter with neon pilot light.

3. Provide all controls and equipment as specified in Section 26 30 00.

E. Control Components: Install principal control components in NEMA 250 rated enclosures as follows:

AREA	ENCLOSURE
Above grade indoor	NEMA 12 - Industrial
Outdoor and below grade elevation indoor	NEMA 4X - Watertight
Corrosive areas as defined in Section 26 05 00 or as shown.	NEMA 4X - Watertight and corrosion-resistant stainless steel with stainless steel external hardware. Provide all external operators made of the same materials as that of the enclosures
All areas listed Class I, Division 1 or 2, Group D as defined in Section 26 05 60 or as shown.	NEMA 7 - Explosion-proof

F. Miscellaneous Controls:

1. Provide float switches, pressure switches, limit switches, thermostats and other auxiliary control devices to satisfy the intended service.

2. Provide contacts rated at 10-amperes, 120 volts, 60-hertz ac, unless otherwise specified.

3. Provide limit switches that function in accordance with contact development charts.

G. Panel Accessories:

1. Provide panels with auxiliary heaters, fans or integral air conditioners as specified for specific equipment.

2. Provide corrosion inhibitors and breather assemblies to prevent corrosion and condensation within NEMA 4 and 4X rated panels.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install shop-assembled equipment as indicated, in accordance with manufacturer's written instructions.

B. Coordination: Coordinate cabling and wiring as necessary to interface installation of shop-assembled equipment.

C. Torque Requirements: Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals in accordance with UL Standard 486A.

D. Grounding Connections: Make equipment grounding connections for the shop-assembled equipment as specified and shown. Tighten connections in accordance with UL Standard 486A to assure permanent and effective grounding.

E. Adjustments: Make all necessary adjustments to the equipment to provide complete and satisfactory operation upon completion of the Contract.

F. Power Supplies: Provide an external power supply where required for panel integral air conditioners.

3.2 CLEANING AND PAINTING

A. Shop Painting: Paint the shop-assembled equipment enclosures as specified in Section 09 96 00.

B. Field Painting: Clean and touch up scratched and marred surfaces to match original finish.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 80

ELECTRIC MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for electric motors as specified.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 – High Performance Coatings
2. Section 26 05 00 - Basic Electrical Materials and Methods
3. Section 26 05 33 - Electrical Raceway Systems
4. Section 26 05 53 - Electrical Identification
5. Section 26 35 33 - Power Factor Correcting Capacitors
6. Section 26 05 26 - Grounding

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AFBMA 10 - Metal Balls
2. NEMA CP1 - Shunt Capacitors
3. NEMA MG1 - Motors and Generators
4. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01 and Section 26 05 00.

B. Product Data and Information: Furnish manufacturer's catalog data for each motor.

C. Shop Drawings: Furnish shop drawings for each motor detailing arrangement, wiring, conduit boxes, and motor application.

D. Certificate of Compatibility: For each motor controlled by an adjustable frequency drive, furnish a certificate that the motor is compatible with the adjustable frequency drive and the driven equipment load.

E. Quality Control: Furnish test reports for motors as follows:

1. Certified standard commercial test reports for motors.

2. Witnessed test reports as specified.

F. Operations and Maintenance Manuals: Furnish operation and maintenance manuals for all motors as specified in Division 1.

1.4 QUALITY ASSURANCE

A. Codes: Comply with all local and applicable codes.

B. Regulatory Requirements: Comply with the requirements of the Regulatory Agencies having jurisdiction over this Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. General Electric Company

2. Magnetek

3. Baldor/ABB Group

4. Siemens

5. U.S. Motors

6. TECO/Westinghouse Motor Company

7. Hyundai Ideal Electric Co.

8. Aegis/ElectroStatic Technology Inc. (Bearing Protection Ring)

2.2 MATERIALS

A. General: Provide motors and accessories with the equipment as specified under the equipment sections.

B. Motor Requirements: Unless otherwise specified, provide motors as follows:

1. Polyphase motors of the high energy efficiency and high power factor type.

2. Motor nameplate horsepower as specified for the driven equipment.

3. Motors that operate continuously over the entire load range of the driven equipment without loading motor in excess of nameplate rating and its specified temperature limit.

4. For motors rated ½ hp to 200 hp operating at 460 volts, 3-phase, 60-hertz, provide squirrel cage induction type.

5. For motors rated over 200 hp, operating at 460 volts or higher voltages, 3-phase, 60-hertz, provide squirrel cage induction or synchronous type, as specified.

6. For motors less than ½ hp, provide 115-volt, single phase, 60-hertz type.

7. Motors that are suitable for continuous operation with a line voltage variation within ± 10-percent of rated voltage.

8. Motors that operate continuously in a 40 degrees C ambient.

9. Inverter duty motors when powered from an adjustable frequency drive.

10. Motor Grounding Shaft Protection for Motors Operating on Adjustable Frequency Drives:

a. Where motors are part of a specialized/hazardous process design, the motor grounding shaft protection shall be provided integral to the manufactured assembly.

b. For vertical mounted motors provide protection as follows:

(1) Top Bearing (NDE): Bearing journal installed must be insulated or insulated ceramic or hybrid ceramic.
(2) Drive End (DE): Install one AEGIS™ SGR Bearing Protection Ring on drive end.
(3) AEGIS™ SGR can be installed internally on the back of the bearing cap or externally on the motor end bracket.

(4) Colloidal Silver Shaft Coating (PN CS015) is required for this type of application

11. Provide a certificate of compatibility signed by both the motor and ground ring manufacturer confirming the ground ring being installed per the manufacturer's requirements with no detriment to proper motor operation.

C. Frequent Start Requirements: Provide motors for frequent starting as specified.

2.3 MECHANICAL PROTECTION

A. Indoor Locations:

1. For motors located in dry, clean and well ventilated areas provide open drip-proof type.

2. For motors located below grade, provide totally-enclosed, fan-cooled type with removable drain plug.

3. For motors located in wet, damp or dusty areas, provide totally-enclosed, fan-cooled type with removable drain plug.

4. In corrosive areas as defined in Section 26 05 00 or as shown, provide totally-enclosed, fan-cooled type with removable drain plug.

B. Outdoor Locations: For motors located outdoors, provide a totally-enclosed, fan-cooled type with removable drain plug.

C. Hazardous Locations: As defined in Section 26 05 00 or as shown or required by the NEC.

1. Class 1, Division 1 Area: Provide totally enclosed fan-cooled explosion-proof motor.

2. Class I, Division 2 Areas: Provide totally enclosed fan-cooled without brushes, switching mechanisms or other arc-producing devices.

D. Submersible Locations: For motors that operate submerged or operation in a location for the potential to be submerged, provide a completely sealed submersible motor.

2.4 BOXES

A. General: Provide oversized conduit boxes on motors to facilitate conductor installation and auxiliary components as required.

1. Provide separate boxes for motor power leads, accessory terminals and RTD leads.

2. Make conduit box NEMA enclosure ratings compatible with motor enclosures.

3. Where shown, provide additional space in the power terminal box for the mounting and wiring of the current transformers furnished under the motor protection system.

2.5 NEMA DESIGN AND INSULATION

A. Design Classification: Provide NEMA Design B, unless otherwise specified with NEMA Class F moisture resistant insulation and NEMA Class B, 80 degrees C temperature rise at rated nameplate load.

B. Variable Speed Operation: Provide insulation to protect against adverse affects of a nonsinusoidal waveform.

2.6 WINDINGS

A. General: Provide copper windings unless otherwise specified.

2.7 BEARINGS

A. Ball and Roller Bearings: Use antifriction ball or roller type bearings at manufacturer's option, unless otherwise specified.

B. Regreasable Bearings: Use regreasable bearings with support side thrust loadings, with an AFBMA B-10 bearing life rated at least 100,000 hours, based on a reliability of 90 percent.

2.8 SERVICE FACTOR AND LOADINGS

A. Service Factor: Provide 1.15 service factor for sinusoidal voltage waveforms and 1.0 for nonsinusoidal voltage waveforms unless otherwise specified. Where motors with a 1.0 service factor are furnished, provide motors rated at least 15 percent greater than required brake horsepower.

B. Shaft Loading: Provide steady state shaft loading not to exceed 100 percent of full load rating under maximum load, excluding the service factor, unless otherwise specified.

2.9 SPEED

A. General: Provide motor speed as specified or as shown for the driven equipment.

B. Multispeed: Provide multispeed motors as specified for the driven equipment.

C. Adjustable Speed: Provide inverter duty motors specifically designed and rated for use with the adjustable speed device furnished.

2.10 TORQUE

A. General: Provide breakdown torque of 200 percent or more of motor full load torque.

B. Locked Rotor: Provide locked rotor torque of 80 percent or more of motor full load torque.

C. Inertia: Provide necessary WK^2 data for special loads to coordinate with motors.

D. Special Motors: Supply special motors where torque requirements exceed standard design.

2.11 SLIDE RAILS AND SOLE PLATES

A. General: Provide slide rails and sole plates as required for proper installation.

2.12 SINGLE PHASE FRACTIONAL HORSEPOWER MOTORS

A. Small Motor Requirements: Provide capacitor or open split phase start, for smaller than 1/2 hp motors unless otherwise specified.

2.13 THREE-PHASE MOTORS

A. Induction Motors: Provide horizontal or vertical squirrel cage induction motors for continuous duty with full voltage starting except as otherwise specified.

2.14 EFFICIENCY

A. General: Provide motors one horsepower and larger meeting the requirements as stated in Table 12-12, Full Load Efficiency for NEMA Premium Efficiency Electric Motors, in NEMA MG 1, Part 12.

2.15 POWER FACTOR

A. General: Provide motors having the following minimum power factor ratings:

Motor Power Factor - Minimum		
	Percent	
Horsepower	At 1800 RPM Power Factor	At 1200 RPM Power Factor
1	74.3	69.7
1-1/2	76.5	62.0
2	70.3	70.1
3	79.9	73.7
5	83.8	75.8
7-1/2	82.4	78.2
10	85.0	76.4
15	85.0	81.1
20	84.6	81.9
25	84.5	82.0
30	84.2	82.5
40	84.2	83.3
50	85.0	84.9
60	86.8	85.7
75	86.6	86.0
100	88.3	86.4
125	89.3	85.8
150	88.5	87.5
200	88.5	87.9

B. Power Factor Correction: Provide motors 75-hp and larger with capacitors to correct the no-load power factor to unity in accordance with Section 26 35 33. Do not provide capacitors for motors controlled by adjustable frequency drives or started by solid-state reduced voltage starters.

Provide capacitors in accordance with the latest NEMA CP-1.

2.16 NOISE

A. General: Limit motor machine noise to sound power levels listed in NEMA MG 1-12.

2.17 ACCESSORIES

A. Identification: Provide identification meeting the requirements with Section 26 05 53.

B. Space Heaters: Where specified or shown, provide motor space heaters to prevent moisture condensation when the motor is not operating. Provide space heaters suitable for 115-volt, single phase, 60-hertz operation.

C. Thermal Detectors: Where specified or shown, provide motor winding temperature switches or thermal devices.

2.18 SOURCE QUALITY CONTROL

A. Shop Tests: Include standard commercial and additional tests listed below, and special tests listed in other sections.

B. Standard Commercial Tests: Perform the following tests in accordance with NEMA standards.

1. No load running current and speed

2. Locked rotor current

3. Dielectric routine tests

4. Motor efficiency tests

5. Motor power factor tests

C. Additional Testing: Perform the following additional tests in accordance with NEMA standards.

1. Winding resistance

2. Bearing inspection

3. Power factor at full, 3/4 and 1/2 load

4. Efficiency at full, 3/4 and 1/2 load

5. Motor starting torque

6. Bearing currents testing per manufacturer’s specifications

7. Motor frame grounding

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install motors in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1. Make all necessary adjustments to equipment to provide a complete operational system.

B. Install additional grounding connections where shaft grounding protection is applied.

3.2 FIELD QUALITY CONTROL

A. Inspections and Tests: Perform field preliminary and final inspection and testing for motors as specified in Division 01 and as follows:

1. Preliminary Inspection:

a. Demonstrate that each motor has been properly connected.

b. Check for proper rotation by bumping prior to connecting motor to driven equipment.

2. Final Test:

a. Measure motor applied voltage and current with equipment operating at full load.

b. Operate equipment as specified.

3.3 CLEANING AND PAINTING

A. Field Painting: Clean and touch up marred surfaces to match the original finish.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 08 00

ELECTRICAL TESTING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for field acceptance testing of materials and equipment provided under various other sections to determine suitability for installation and energization. Requirements of field testing and certification of electrical equipment and materials provided under various other sections to assess their equivalence to UL Inc. listing/labeling.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 19 - Wires and Cables – 600V and Below
2. Section 26 05 26 - Grounding
3. Section 26 05 60 - Electrical Requirements for Shop-Assembled Equipment
4. Section 26 05 80 - Electric Motors
5. Section 26 22 00 - General Purpose Dry Type Transformers
6. Section 26 24 16 - Panelboards
7. Section 26 24 19 - Motor Control Centers

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. NETA - Inter National Electrical Testing Association
2. NIST - National Institute of Standards and Technology

1.3 SUBMITTALS

A. General: Furnish all submittals including the following, as specified in Division 01 and Section 26 05 00.

1. Acceptance Testing Reports: Furnish acceptance testing reports for all equipment and materials. Include the following information:

a. Summary of the test

b. Description of material or equipment tested

c. Description of test including acceptable test values

d. Test results

e. Analysis of test results with recommendations

2. UL Testing: Furnish standard test parameters in accordance with the acceptable codes and standards for all the equipment and materials tested for equivalence to UL listing.

3. UL Test Reports and Certificates: Submit for approval test reports and certificates for all equipment and materials tested for equivalence to UL listing.

PART 2 PRODUCTS

2.1 TESTING COMPANIES

A. Acceptable Testing Companies: Acceptable testing companies are as listed below:

1. MET Electrical Testing Co. Inc.

2. ASET Power Systems Services Inc.

3. Electric Power Systems Inc.

4. Electro-Test and Maintenance Inc.

5. High Voltage Maintenance Corp.

6. UL Underwriters Laboratories Inc.

7. Other OSHA and NETA approved testing facilities

2.2 SOURCE QUALITY CONTROL

A. Tests: Furnish all testing and certification in accordance with the latest NETA, ANSI, IEEE and NEMA Standards to meet the UL requirements, NFPA Standards and NEC.

B. Test Equipment: Furnish all testing equipment, cables and appurtenances required to perform all tests and certifications in accordance with the following:

1. Use instruments that have been calibrated, to assure that they are within rated accuracy in accordance with NIST.

2. Select test instruments that are appropriate for the variable being measured.

PART 3 EXECUTION

3.1 UL TESTING AND CERTIFICATION

A. General: Furnish the test reports and certifications for UL equivalence prior to acceptance of all materials and equipment requiring such tests and certifications.

3.2 ACCEPTANCE TESTING

A. General: Furnish acceptance test reports prior to acceptance of all materials, equipment and installations requiring such tests.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for modifying existing motor control centers.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 79 00- Training
2. Section 09 96 00 – High Performance Coatings
3. Section 26 05 00 - Basic Electrical Materials and Methods
4. Section 26 05 26 - Grounding
5. Section 26 05 53 - Electrical Identification
6. Section 26 08 00 - Electrical Testing Requirements
7. Section 26 05 19 - Wires and Cables - 600 Volts and Below
8. Section 26 29 53 - Control Components and Devices

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. IEEE C37.90 - IEEE Standard for Relay and Relay Systems Associated With Electrical Power Apparatus
2. IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits
3. IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
4. MIL-STD-220A - Method of Insertion-loss Measurement 12/1/59; with N1 and N2 (Fed/mil H-q)
5. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Not More than 2000 Volts AC or 750 Volts DC.

6. NEMA ICS 3 - Industrial Control and Systems Factory Built Assemblies

7. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

8. UL 486A - Wire Connectors and Soldering Lugs for Use With Copper Conductors

9. UL 845 - Motor Control Centers

10. UL 1283 - Electromagnetic Interference Filters

11. UL 1449 - Transient Voltage Surge Suppressors

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Provide equipment capable of operating in an ambient temperature range of 0 to 40 degrees C and humidity of up to 90 percent noncondensing.

1. Provide motor control centers designed for 480-volt, three-phase, three-wire, 60-hertz operation.

2. Provide all control devices in the center suitable for operation at 120-volts, 60-hertz, unless specifically noted otherwise.

3. Provide all control equipment and devices that meet the requirements of the 600-volt insulation class.

4. Provide motor control centers to include the indicated number of 20 or 21-inch deep sections and the components arranged as shown.

5. Arrange the equipment for convenient and ready accessibility from the front for inspection and maintenance of devices, terminals and wiring.

6. Where shown or required, label the motor control center suitable for use as service entrance equipment.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1 and Section 26 05 00.

B. Product Data and Information: Provide catalog data for all associated equipment and devices.

C. Shop Drawings: Provide shop drawings customized to the project for motor control centers to include the following:

1. Outline drawings showing dimensions, weights, arrangement, elevations, identification of components and a nameplate schedule for all units.

2. Bill of materials including manufacturers' name and catalog number.

3. Interconnecting wiring diagrams, where required.

4. Individual schematic and wiring diagrams for each compartment.

5. Furnish instruction booklets and time-current curves for each circuit breaker supplied.

D. Quality Control: Furnish the following test reports and certificates as specified in Division 01:

1. Certified Shop Test Reports for motor control centers and related components. Provide a minimum of 15 days written notice prior to shop tests.

2. Detailed field test reports of all tests indicating test performed as specified, discrepancies found, and corrective action taken.

E. Operation and Maintenance Manuals: Furnish operation and maintenance manuals as specified in Division 01.

1.5 QUALITY ASSURANCE

A. Standards: Provide motor control centers in accordance with NEMAICS 2, ICS 3, and UL Standard No. 845.

B. Codes: Provide motor control centers in accordance with the NEC and local codes.

C. UL Label: Provide a UL Label on each vertical section of each motor control center.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store, and handle all products and materials as specified in Division 01.

B. Shipping and Packing: Provide all structures, equipment and materials rigidly braced and protected against weather, damage, and undue strain during shipment.

C. Storage and Protection: Store all equipment and materials in a dry, covered, heated and ventilated location. Provide any additional measures in accordance with manufacturer's instructions.

1.7 SPARE PARTS

A. General: Furnish the following spare parts:

1. One current transformer of each type and each rating.

2. One set of contact tips, control power transformers and operating coils.

3. One auxiliary contact unit or one set of auxiliary contact tips.

4. Two complete control, latching and timing relays of each type used in motor control centers.

5. One complete reset and repeat cycle timer of each type and rating used in motor control centers.

6. Two complete replacements of overload heater units for each catalog number installed in motor control centers and motor starters.

7. Two complete replacements of all LED indicating lamps and fuses used in the installation.

8. One complete magnetic starter with motor circuit protector for each size required.

9. Two sets of replacement indicating light color lenses of each color furnished.

10. One circuit breaker test unit.

11. Three 12-ounce spray cans of the final finish for touch-up

B. Packaging: Pack spare parts in containers bearing labels clearly designating contents and related pieces of equipment. Deliver spare parts in original factory packages. Identify all spare parts with information needed for reordering.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Motor Control Centers:

a. Confirm the manufacturer and model number in the field prior to selecting refurbishment equipment for S104-LIFT-MCC0.

2.2 MOTOR CONTROL CENTER

A. Hardware: Provide hinges, screws, bolts, circuit breaker operating mechanisms, nameplate mounting screws and other metallic appurtenances with a noncorrodible metal covering.

B. Individual Units:

1. Provide units of the plug-in or nonremovable type in accordance with the manufacturer's standard for type and size of controller.

2. Provide plug-in units within-plated, pressure-type line disconnecting stabs of high strength copper alloy. Hold each plug-in unit in place and arrange the units such that they can be removed or remounted readily without access to the rear of the structure.

3. Provide units that are totally enclosed and effectively baffled to isolate ionized gases that may occur within each unit. In addition, ventilate each unit so that it can be located anywhere within the structure using the same overload heaters for the same load.

4. Provide automatic shutter mechanism to cover the vertical bus stub area when a unit is removed.

5. Provide spaces for future equipment in unit structures with blank hinged doors and removable metal barriers for isolation of the vertical buses.

6. Construct doors to be drip-proof and dust-tight. Provide all doors with hinges and screw fasteners for holding the doors closed. Fabricate each door as a part of the structure and not part of the unit.

7. Equip the doors for motor control compartments with a motor circuit protector operating mechanism, thermal overload relay reset mechanism, controls and indicating lights and other required devices as shown.

8. Equip the doors for branch feeder equipment with a circuit breaker operating mechanism.

9. Provide mechanical interlocks between the compartment door and circuit breaker operating mechanism to prevent opening of the door unless the breaker is in the OFF position, and to prevent closing the breaker unless the door is fully closed.

10. Provide circuit breaker operating mechanisms or handles that are padlockable in the OFF position with room for a minimum of three padlocks.

11. Provide units having devices that are serviceable from the front, without provisions for rear access.

12. Provide control power transformers, relays, timers, alternators and accessories for each unit as shown or specified.

C. Wiring:

1. Provide NEMA Class II Type B wiring for the motor control centers, including internal interlock and internal wiring between controller units and devices.

2. Provide internal wiring runs for interconnecting units with stranded switchboard wire having 600-volt rated, flame-resistant, type SIS insulation. Provide No. 14 AWG wire for control interconnections. Provide power connections as required for the service.

3. Provide No. 10 AWG or larger stranded copper wire with NEC Type SIS insulation for all current transformer secondary wiring.

4. Provide wire markers at each end of all wires.

5. Where wiring connections are made to equipment mounted on hinged doors, provide connections with extra flexible wires suitably cabled together and cleated.

6. Provide the wiring of all control connections to individual terminal blocks at each motor starter. Locate terminal blocks for front access.

7. Provide interlocking wiring between units of a motor control center or between units of grouped centers as internal wiring with terminals provided for external connections.

8. Provide sufficient pull apart terminal blocks for all devices external to the motor control center.

9. Provide communication cables from the microprocessor-based metering system and microprocessor-based overload protection systems to a single terminal block located in the incoming line structure.

D. Magnetic Starters: Provide 480-volt, 3-phase, 60-hertz across-the-line combination motor circuit protector and magnetic starters having individual control power transformers.

1. Provide full-voltage nonreversing; full voltage reversing; full voltage two-speed nonreversing two-winding; and full voltage two-speed nonreversing one-winding starters as required.

2. Provide starter contacts of the replaceable, spring-loaded, wedge type with silver-cadmium oxide-plated contact surfaces. Provide replaceable coils of the epoxy sealed type.

3. Thermal Overload Elements: Provide each magnetic starter unit with a Class 20 thermal overload element and all required accessories. Provide size five and larger starters with current transformer operated overload relays.

a. Provide overload relays of the bimetallic type with an adjustment knob that allow plus or minus 15 percent adjustment of the nominal heater rating.

b. Provide and adjust overload relays to match the associated motor nameplate running current rating. Size the overload relays after approval of the corresponding motor.

c. Provide a set of isolated normally-open and normally-closed contacts for each overload relay.

4. Replaceability: Provide starters having component parts that are easily replaceable.

5. Equip each starter with all required auxiliary contacts.

E. Motor Circuit Protectors: Provide a motor circuit protector for each combination starter using molded-case, air-break type designed for 600-volt, 60-hertz service with an interrupting capacity of 65,000 rms symmetrical amperes at 480 volts. Provide three-pole motor circuit protectors with magnetic, adjustable-trip units actuating a common tripping bar to open all poles when an overload or short circuit occurs. Provide motor circuit protectors with no thermal elements. Provide magnetic trip units capable of being adjusted from 700 to 1,300 percent of the motor full load amperes.

F. Contactors: Provide NEMA sized, 30 ampere minimum, contactors for electric heating and other nonmotor loads equal to the motor starters except without overload relays or heaters.

G. Feeder Circuit Breakers: Provide molded-case type, two- or three-pole feeder circuit breakers as shown, with a minimum voltage rating of 600-volt ac.

1. Interrupting Ratings: Provide an interrupting capacity of 65,000 rms symmetrical amperes at 480 volts. Base interrupting rating on the IEEE and NEMA Standard duty cycle for this class of equipment.

2. Provide circuit breakers trip units as follows:

a. Provide individual, thermal-magnetic trip units for all frame sizes smaller than 400 amperes.

b. Provide solid-state trip units for all frame sizes 400 amperes and larger.

c. Provide trip units that actuate a common tripping bar to open all poles when an overload or short circuit occurs on any one.

d. Provide trip elements with inverse time tripping and instantaneous tripping at about ten times the normal trip device rating.

e. Provide circuit breakers with trip-free handles.

H. Instrument Transformers: Provide transformers in an accuracy class to meet the requirements of ANSI Standards, and for the secondary burdens connected to the transformers.

1. Provide dry-wound type, current transformers with fully coordinated insulation for 600-volt insulation class.

2. Provide window-type, current transformers for ground sensing where shown.

3. Provide potential transformers rated at 480 to 120 volts.

I. Control Power Transformers: Provide individual control power transformers for each starter to derive the 120 volts for the unit's control circuit meeting the requirements of Section 26 30 00. Ground the unfused leg of the secondary to the enclosure.

J. Push Buttons, Selector Switches and Indicating Lights: Provide push buttons, selector switches and indicating lights including legend plates having the same

type, appearance, shape and catalog number throughout each motor control center meeting the requirements of Section 26 30 00.

K. Control Components: Provide control components including elapsed time meters, control relays, latching relays, time delay relays, reset timers, repeat cycle timers, alternators, phase failure and undervoltage relay and ground fault protection relays meeting the requirements of Section 26 30 00.

L. Feeder Cable Terminals: Provide closed-end, compression-type, solderless connectors and terminals, suitable for copper conductors for terminating cables in accordance with Section 26 05 19.

M. Wiring Schematic: Provide a schematic wiring diagram of each unit and affix it to the inside of the door of that unit.

N. Identification: Provide nameplates having the same type, appearance and shape throughout each motor control center in accordance with the requirements of Section 26 05 53.

2.3 ACCESSORIES

A. Provide rubber work mats meeting the requirements of Section 26 29 53.

2.4 SOURCE QUALITY CONTROL

A. Tests: Shop test each motor control center in accordance with IEEE and NEMA standards.

1. Operational Tests: After the equipment has been completely assembled, perform operational tests to determine the general operating conditions and circuit continuity. Also, perform high potential tests and other standard tests for that particular class of equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all equipment in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 01.

B. Adjustments: Set all motor circuit protectors and circuit breakers for the approved short circuit and coordination study.

C. Overloads: Adjust the thermal overloads on each phase of the starter units to the actual motor installed.

D. Cable Connections: Terminate and label all field wiring per the approved diagrams.

E. Torque Requirements: Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening recommendations. Where manufacturers' torquing requirements are not available, tighten connectors and terminals in accordance with UL Standard 486 A.

3.2 FIELD QUALITY CONTROL

A. Inspections: Inspect, adjust and check the installation for physical alignment, cable terminations and ventilation.

B. Tests: Perform the following field tests:

1. Close and open each circuit breaker and motor circuit protector to test operation.

2. When site conditions permit, energize and de-energize each equipment item served by each motor control center, testing the complete control sequence of each item.

3.3 OPERATION DEMONSTRATION

A. Manufacturer’s Representative: Furnish the services of a qualified, factory-trained service engineer to assist in installation, start-up, field testing, calibration, placing into operation and provide training of each motor control center, as specified in Section 01 79 00.

1. Furnish the services of a service engineer when the equipment is placed into operation.

2. Furnish the services of a service engineer at job site as often as necessary until all problems are corrected and the equipment installation and operation are satisfactory.

B. Operation and Maintenance: Furnish operation and maintenance instructions as specified in Division 1.

3.4 CLEANING AND PAINTING

A. Shop Painting: Provide standard shop finish.

B. Field Painting: Clean and touch up any scratched or marred surface to match original finish.

C. Work Mats: Thoroughly clean the floor in front of the motor control center and install the rubber work mats.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing wiring devices and appurtenances as indicated, in accordance with the Contract Documents.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 33 - Electrical Raceway System
3. Section 26 05 26 - Grounding

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	Fed Spec WC 596	-	Electrical Power Connector, Plug, Receptacle and Cable Outlet
2.	Fed Spec WS 896	-	Toggle and Lock, Flush Mounted Switches
3.	CSA C22.2-182.1	-	Industrial-type, Special-Use Attachment Plugs, Receptacles and Connectors
4.	UL 20	-	General - Use Snap Switches
5.	UL 498	-	Attachment Plugs and Receptacles
6.	UL 508	-	Industrial Control Equipment
7.	UL 894	-	Switches for Use in Hazardous (Classified) Locations
8.	UL943	-	Ground Fault Circuit Interrupters
9.	UL 1010	-	Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

10. UL 1682 - Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type

11. UL 1686 - Standard for Pin and Sleeve Configurations

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 01 and Section 26 05 00.

B. Product Data and Information: Provide manufacturers' catalog data for each device type, plate and cover type.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

1.5 SPARE PARTS

A. General: Furnish spare parts as required to support installation.

B. Packaging: Package spare parts in containers bearing labels clearly designating contents. Identify all spare parts with information needed for reordering. Deliver spare parts in original factory packages.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Standard of Quality and General Configuration: Use of manufacturer's name and model or catalog number is for the purpose of establishing the desired.

B. Configuration And Rating: Provide NEMA specification grade wiring devices in the type, color, configuration and electrical rating for the service indicated.

C. Symbols: See the electrical symbol list shown for identification of all device types.

D. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Hubbell Wiring Device-Kellems
2. Hubbell/Bryant
3. Pass & Seymour/Legrand
4. Cooper Wiring Devices by Eaton
5. Leviton
6. Emerson Industrial Automation/Appleton
7. Crouse-Hinds by Eaton
8. Meltric Corporation
9. Lutron
10. NSI Industries/Tork
11. Hubbell/Tay Mac
12. Thomas & Betts/ABB Group

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all wiring devices in accordance with manufacturer's recommendations and approved shop drawings as specified in Division 01.

B. Grounding: Ground all devices in accordance with the requirements specified in Section 26 05 26.

END OF SECTION

(NO TEXT ON THIS PAGE)

SECTION 26 28 16

DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing and installing enclosed fused and nonfused safety switches for use as feeder and branch circuit switching and disconnect devices for motors and equipment.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 – High Performance Coatings
2. Section 26 05 00 - Basic Electrical Materials and Methods
3. Section 26 05 53 - Electrical Identification
4. Section 26 05 26 - Grounding

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. NFPA 70 - National Electrical Code (NEC)
2. NEMA KS1 - Enclosed Switches
3. UL 198E - Class R Fuses
4. UL 486A - Wire Connectors and Soldering Lugs for Use With Copper Conductors

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1 and Section 26 05 00.

B. Product Data and Information: Provide manufacturers' data indicating disconnect switch ratings and dimensions. Provide manufacturer's data on fuses including time-current curves.

1.4 QUALITY ASSURANCE

A. Codes: Provide disconnect switches meeting the requirements of NFPA, the National Electrical Code and local codes.

B. Regulatory Requirements: Provide all disconnect switches designed, manufactured and tested in accordance with latest ANSI, IEEE and NEMA Standards, and UL listed.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01 and Section 26 05 00.

1.6 SPARE PARTS

A. General: Provide the following spare parts:

1. Twelve of each size and type fuse installed.

B. Packaging: Pack spare parts in containers bearing labels clearly identifying the contents. Deliver spare parts in original factory packages. Identify all spare parts with information needed for reordering.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are as listed below. Other manufacturers of equivalent products may be submitted for review.

1. Disconnect Switches

a. Square D /Schneider Electric

b. Eaton/CutlerHammer

c. Hubbell/Killark

2. Fuses

a. Eaton/Bussmann

b. Littelfuse

2.2 DISCONNECT SWITCHES

A. General: Provide disconnect switches of the NEMA KS-1, heavy-duty, load–interrupter, enclosed-knife switch type with externally operating handle interlocked to prevent opening of the front cover with the switch in the ON position. Provide an interlock that is defeatable and operable from the front of the switch. Provide handle lockable in the OFF position.

B. Disconnect Switch Ratings: Provide disconnect switches rated for 600-volts as applicable and horsepower rated when used in motor circuits. Current ratings are as indicated.

C. Interrupting Rating: If the approved short circuit and coordination study indicates that the available fault current at any disconnect switch exceeds the interrupting rating of the switch, provide a fused disconnect switch with rejection feature. Size the fuses for the load served.

D. Small Three Phase Motor Disconnect Switches: Provide a fusible switch for each small three phase motor where the branch feeder breaker directly upstream of the motor cannot provide overcurrent protection in accordance with NEC Table 430.52.

E. Service Entrance: Where shown, provide disconnect switches suitable for service entrance.

F. Disconnect Switches for Use with Adjustable Frequency Drives: Provide disconnect switches with auxiliary contacts for interlocking with the associated AFD permissive start circuit. Confirm whether normally open or normally closed contacts are required per logic being provided.

G. Fusible Switches: Provide switches with rejection feature to allow only Class R fuses to be installed.

H. Disconnect Switch Housings: Provide disconnect switches housed in NEMA rated enclosures as follows:

AREA	ENCLOSURE
All areas listed Class I, Division 1 and 2, Group D as defined in Section 26 05 00 or as shown.	NEMA 7 - Explosion-proof
Outdoor and below grade elevation indoors	NEMA 4 – Watertight
Corrosive areas as defined in Section 26 05 00 or as shown	NEMA 4X- Corrosion-resistant fiberglass reinforced thermal setting polyester formulation with stainless steel external hardware. Provide external operators of the same material as that of the enclosures
Above grade indoor	NEMA 12 – Industrial

2.3 FUSES

A. Characteristics: Provide UL 248 listed Class RK1 dual element, time-delay fuse with an interrupting rating of 200,000 rms symmetrical amperes.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install disconnect switches as shown or required. Comply with requirements of NEC and local electrical codes.

B. Provide fuses in the fusible disconnect switches sized to protect the associated motor in accordance with the NEC and per the nameplate rating of the approved equipment. Provide an adhesive label attached to the inside of the switch cover indicating the replacement fuses type and size.

C. Coordination: Coordinate with other work including cabling and wiring work.

D. Torque Requirements: Tighten electrical connectors and terminals including screws and bolts in accordance with equipment manufacturers' published torque tightening recommendations. Where manufacturers' torquing requirement are not available, tighten connectors and terminals in accordance with UL Standard 486A.

END OF SECTION

SECTION 26 29 53

CONTROL COMPONENTS AND DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing manual starters, motor controllers and remote control stations. In addition, the requirements for control components and devices for use in equipment provided under various other sections.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 - High Performance Coatings
2. Section 26 05 00 - Basic Electrical Materials and Methods
3. Section 26 05 19 - Wires and Cables - 600 Volts and Below
4. Section 26 05 60 - Requirements for Shop-Assembled Equipment
5. Section 26 05 53 - Electrical Identification
6. Section 26 05 26 - Grounding
7. Section 26 24 19 - Motor Control Centers

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
3. UL 486A - Wire Connectors and Soldering Lugs for Use With Copper Conductors
4. UL 1449 - Standard for Surge Protective Devices

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Provide equipment capable of operating in an ambient temperature range of 0 to 40 degrees C and humidity of up to 90 percent noncondensing.

B. Motor Controllers: Provide motor controllers suitable for 480-volt, three-phase, three-wire, 60-hertz operation.

C. Control Devices: Provide control devices suitable for operation at 120-volts, 60-hertz, unless specifically noted otherwise.

D. Insulation Class: Provide control equipment and devices that meet the requirements of the 600-volt insulation class.

1.4 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Division 01 and Section 26 05 00.

B. Product Data and Information: Furnish catalog data for all associated equipment and devices.

C. Shop Drawings: Furnish shop drawings customized to the project for manual starters, motor controllers and remote control stations that include the following:

1. Outline drawings showing dimensions, identification of components and a nameplate schedule for all units.

2. Bill of materials including manufacturers' name and catalog number.

3. Individual schematic and wiring diagrams for each motor controller

D. Equipment Ratings: Obtain and enter full performance details on all motors and other equipment being served on the above drawings.

1.5 QUALITY ASSURANCE

A. Codes: Provide manual starters, motor controllers and remote control stations that are in accordance with NEMA ICS 2.

1. Provide manual starters, motor controllers and remote control stations that are in accordance with the NEC and local codes.

B. UL Listing: Provide UL-listed manual starters, motor controllers and remote control stations.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store, and handle all products and materials as specified in Division 01.

B. Storage and Protection: Store all equipment and materials in a dry, covered, heated and ventilated location. Provide any additional measures in accordance with manufacturer's instructions.

1.7 SPARE PARTS

A. General: Furnish the following spare parts:

1. Two control stations of each type provided.

2. Three of each type of manual starter.

3. One of each type of motor controllers.

B. Packaging: Pack spare parts in containers bearing labels clearly designating contents and related pieces of equipment. Deliver spare parts in original factory packages. Identify all spare parts with information needed for reordering.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Manual Starters, Motor Controllers and Remote Control Stations:

a. Eaton/Cutler-Hammer

b. ABB/GE Electrification Products

c. Square D/Schneider Electric

d. Emerson Industrial Automation/Appleton

e. Eaton/Crouse-Hinds

f. Rockwell Automation/Allen-Bradley

2. Control Relays:

a. Eaton/Cutler-Hammer

b. Square D/Schneider Electric

c. General Electric Company

d. Rockwell Automation/Allen-Bradley

3. Timing Relays:

a. TE Connectivity/Agastat 7000 Series

b. Danaher Specialty Products/Eagle Signal

4. Reset and Repeat Cycle Timers:

a. Danaher Specialty Products/Eagle Signal

b. Marsh Bellofram/Automatic Timing and Controls

5. Alternators

a. Time Mark Corp. Model 261

b. ABB Group/ SSAC Inc. Series ABP

6. Current Switches

a. Veris Industries Inc.

7. Surge Protection Devices (SPD)

a. Thomas & Betts/Current Technologies, Inc.

b. Eaton/Cutler-Hammer

8. Rubber Work Mats

a. Salisbury by Honeywell

b. North American Mat

c. White Equipment

2.2 MANUAL MOTOR STARTERS

A. Manual Motor Starters: Provide toggle-type, thermal-switch, manual, motor starters with pilot lights for all 120-volt, single-phase motors rated less than ½ hp.

1. Where shown or required, provide starters complete with a HAND/OFF/AUTO selector switch.

2. Provide starter enclosures as specified under the section Remote Control Stations.

2.3 MOTOR CONTROLLERS

A. General: Provide 480-volt, 3-phase, 60-hertz, across-the-line, combination motor circuit protector magnetic starters with individual control power transformers.

B. Magnetic Starters: Provide magnetic starters as follows:

1. Full voltage non-reversing or full voltage reversing, as required.

2. Starter contacts of the replaceable, spring-loaded, wedge type with silver-cadmium oxide plated contact surfaces.

3. Provide replaceable coils of the epoxy sealed type.

4. Thermal Overload Elements: Class 20 thermal overload element and all required accessories. Provide size five and larger starters with current transformer operated overload relays.

a. Bimetallic type with an adjustment knob which allow plus or minus 15-percent adjustment of the heater's nominal rating.

b. Size the overload relays after approval of the corresponding motor.

c. Provide and adjust overload relays that match the associated motor nameplate running-current rating.

d. Provide a set of isolated, normally-open and normally-closed contacts for each overload relay.

C. Motor Circuit Protectors: Provide a motor circuit protector for each combination starter as follows:

1. Molded-case, air-break type designed for 600-volt, 60-hertz service with an interrupting capacity of 65,000 rms symmetrical amperes at 480 volts.

2. Three-pole motor circuit protectors with magnetic, adjustable-trip units actuating a common tripping bar to open all poles when an overload or short circuit occurs.

3. No thermal elements.

4. Magnetic trip units capable of being set from 700 to 1,300 percent of the motor full-load amperes.

D. Control Components: Provide push buttons, switches, indicating lights, transformers, relays and timers as specified herein under paragraph 2.5.

E. Enclosures: Provide motor controllers installed in NEMA 250 rated enclosures as follows:

AREA	ENCLOSURE
All areas listed Class 1, Division 1 and 2, Group D as defined in Section 26 05 00 or as shown.	NEMA 7 - Explosion-proof
Outdoor and below grade elevation indoors	NEMA 4X 316 Stainless Steel
Corrosive areas as defined in Section 26 05 00 or as shown	NEMA 4X 316 Stainless Steel
Above grade indoor	NEMA 12 – Industrial

2.4 REMOTE CONTROL STATIONS

A. General: Provide heavy-duty, oiltight remote control stations, consisting of push buttons, indicating lights, and selector switches with double-break silver contacts meeting the requirements specified under the section Control Components.

B. Enclosures: Provide motor controllers installed in NEMA 250 rated enclosures as follows:

AREA	ENCLOSURE
All areas listed Class 1, Division 1 and 2, Group D as defined in Section 26 05 00 or as shown.	NEMA 7 - Explosion-proof
Outdoor and below grade elevation indoors	NEMA 4X 316 Stainless Steel
Corrosive areas as defined in Section 26 05 00 or as shown	NEMA 4X 316 Stainless Steel
Above grade indoor	NEMA 12 – Industrial

C. Lockout Attachments: Where shown, provide lockout attachments as follows:

1. Push buttons with padlockable attachment that holds the button depressed.

2. Selector switch with a padlockable attachment that covers the selector switch operators and allows the switch to be set in any position. Selector switch operators that use a removable key are not acceptable.

2.5 CONTROL COMPONENTS

A. Push Buttons, Selector Switches and Indicating Lights:

1. Provide heavy-duty, oiltight, 30.5 mm, push-button or selector switch control stations arranged for flush-panel mounting.

2. Provide the additional switches, relays, and other electrical accessories necessary to control and safeguard the operation of the associated equipment.

3. Provide 30.5 mm, low-voltage, push-to-test, LED type indicating lights suitable for operation at 120-volt, 60-hertz ac control circuit voltages.

4. Color code indicating lights as follows:

Red - Motor running or valve open
Green - Motor off or valve closed
Amber - Capable of operation from this point
Blue - Alarm or trouble condition

B. Control Power Transformer: Provide an individual, control power transformer for each starter to derive the 120 volts for the unit's control circuit. Provide transformers with sufficient capacity to meet the energy demands for all related control components including relays, solenoids and other indicated items. Provide dual fuses on the primary and one fuse on the secondary. Ground the unfused leg of the secondary to the enclosure.

C. Elapsed Time Meters: Provide non-reset-type elapsed time meters to register up to 99,999.9hours, having square cases suitable for panel mounting and having coils for 120-volt, 60-hertz operation.

D. Control and Latching Relays: Provide control and latching relays of 600-volt class, machine-tool quality with convertible contacts. Provide relay-operating contacts rated at a minimum of 10 amperes, 120 volts, 60 hertz.

E. Timing Relays: Provide four-pole, double-throw, timing relays with timing ranges and ON/DELAY or OFF/DELAY operation as required. Provide contacts rated a minimum of 10 amperes at 120 volts, 60 hertz.

F. Long Distance Relays: Provide long distance induction type relays with two normally open and one normally closed contacts rated 25 amperes resistive at 120V, 60 hertz.

G. Reset and Repeat Cycle Timers: Provide electromechanical or solid-state type reset and repeat cycle timers, with timing ranges and functions as indicated. Provide contacts rated at a minimum of 10 amperes, 120 volts, 60 hertz. Solid-state output contacts are not acceptable.

H. Current Switches: Provide current switches as follows:

1. General: Provide electric current switches to accomplish specified control functions.

2. Construction: Provide current switches of a solid state type with compatible current and voltage ratings. Provide sensors complete with in-rush delay, single set joint adjustment, power and status LED's and adjustable trip set point with accuracy of +/- 2 percent of range. UL listing and NEMA 12 sealing is required. Provide with two normally open dry contacts.

3. Design: Provide switches designed for a 5 to 185 degree F and 0 to 95 percent humidity, and of a power induced type. Sensors with external power supply are not acceptable.

I. Alternators: Provide alternators suitable for 120-volt, 60-hertz operation.

1. Provide alternator-operating double pole, double throw cross wired contacts rated at minimum of 7 amperes at 120 volts, 60 hertz.

2. Provide alternators suitable for circuit design requiring alternating "lead-lag" operations.

3. Provide 8-pin plug-in alternator with an 8-pin socket.

J. Phase Failure and Undervoltage Relay: Provide a 3-phase, power monitor to detect phase failure, phase reversal, phase unbalance and undervoltage, suitable for operation at 480 volts. Provide an adjustable, drop-out voltage range of 380 to 500 volts and an adjustable time delay from 0.2 to 20 seconds. Provide a normally-open and normally-closed alarm contact rated 10 amperes at 120 volts with automatic reset.

K. Ground Fault Protection Relay: Provide a manually-reset, ground-sensing relay suitable for use with a window-type current transformer. Provide an adjustable

time delay and pickup settings. Provide single-pole, double-throw, alarm contacts rated 10 amperes at 120 volts.

2.6 SURGE PROTECTION DEVICES (SPD):

A. Provide SPD equipment that complies with UL 1449.

B. Provided units with a maximum continuous operating voltage that exceeds 115 percent of the nominal system operating voltage.

C. Provide SPD equipment suitable for wye configured systems.

D. Provide SPD equipment having directly connected suppression elements between line-neutral (L-N), line-ground (L-G) and neutral-ground (N-G).

E. Provide SPD equipment that distributes the surge current to all MOV components to ensure equal stressing and maximum performance and provides equal impedance paths to each match MOV.

F. Provide high-performance EMI/RFI noise rejection filters that attenuate the electric line noise at least 55dB at 100 kHz using MIL-STD-220A insertion loss test method.

G. Wire internal components with connections utilizing low impedance conductors and compression fittings.

H. Provide a monitoring panel for each system that incorporates the following features:

1. Green/Red solid state indicator lights to indicate which phase(s) have been damaged.

2. A flashing trouble light to indicate fault detection.

3. Transient event counter.

4. Audible alarm.

5. Form C contacts for remote monitoring of the unit status.

I. Provide SPD suitable for location application and minimum surge current per mode as follows:

1. 480V and 480Y/277V Panelboard: UL 1449, Type 1/2, 150kA

2. 120/240V and 208Y/120V Panelboard: UL 1449, Type 2, 80kA

J. Location: Install SPD as follows:

1. Panelboard: Mount SPD internally or externally to minimize lead length. Provide a branch circuit breaker disconnect sized in accordance with the manufacturer's recommendations. Locate the SPD unit branch circuit breaker immediately downstream of the main circuit breaker or main lugs.

2.7 RUBBER WORK MATS:

A. Provide a three foot wide rubber work mat on the floor in front of each switchgear, switchboard and motor control center. The mat will be long enough to cover the full length of the line-up.

B. Provide mats that are 1/4 inch thick with beveled edges, canvas back and solid type with corrugations running the entire length. Mats will be guaranteed to be free from cracks, blow holes or other defects detrimental to their mechanical and electrical strengths. Mats will meet all OSHA requirements and those of ANSI/ASTM J6.7 – 1935 (R1971) / D178, Type 2, Class 2.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all equipment in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Mounting: Mount manual starters, motor controllers and remote control stations 4 feet 6 inches from the finished floor up to their centerlines, unless otherwise shown. Mount all devices at least ½ inch away from concrete wall surfaces.

C. Adjustments: Set all motor circuit protectors and circuit breakers based on the approved short circuit and coordination study.

D. Overloads: Adjust the thermal overloads on each phase of each starter unit for the actual motor installed.

E. Cable Connections: Terminate and label all field wiring per the approved diagrams.

F. Torque Requirements: Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening recommendations. Where manufacturers' torqueing requirements are not available, tighten connectors and terminals in accordance with UL Standard 486 A.

3.2 FIELD QUALITY CONTROL

A. Inspections: Inspect, adjust and check the installation for physical alignment, cable terminations and ventilation.

B. Operation and Maintenance: Furnish operation and maintenance instructions as specified in Division 01.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for clearing of all areas within the Contract limits and other areas shown, including work designated in permits and other agreements, in accordance with the requirements of Division 1.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 02 41 00 - Demolition
2. Section 31 23 23 - Backfilling
3. Section 32 90 00 - Landscaping Work

1.2 DEFINITIONS

A. Clearing: Clearing is the removal from the ground surface and disposal, within the designated areas, of trees, brush, shrubs, down timber, decayed wood, other vegetation, rubbish and debris as well as the removal of fences.

B. Grubbing: Grubbing is the removal and disposal of all stumps, buried logs, roots larger than 2 inches, matted roots and organic materials.

PART 2 MATERIALS

Not Used

PART 3 EXECUTION

3.1 TREE REMOVAL

A. Tree Removal Within Construction Limits: Remove trees and shrubs within the limits of construction as required to facilitate construction of the Work unless otherwise indicated.

1. Grub and remove tree stumps and shrubs felled within the construction site to an authorized disposal site. Fill depressions created by such removal with material suitable for backfill as specified in Section 31 23 23.

B. Tree and Shrub Removal Outside Construction Limits: Do not cut or damage trees outside the limits of construction unless shown to be removed or unless written permission has been obtained from the property owner. Furnish three copies of the written permission before removal operations commence.

3.2 CLEARING AND GRUBBING

A. Clearing: Clear all items specified to the limits shown and remove cleared and grubbed materials from the site.

1. Do not start earthwork operations in areas where clearing and grubbing is not complete, except that stumps and large roots may be removed concurrent with excavation.

2. Comply with erosion, sediment control and storm management measures as specified in Division 1.

B. Grubbing: Clear and grub areas to be excavated, areas receiving less than 3 feet of fill and areas upon which structures are to be constructed.

1. Remove stumps and root mats in these areas to a depth of not less than 1 foot below the subgrade of sloped surfaces.

2. Fill all depressions made by the removal of stumps or roots with material suitable for backfill as specified in Section 31 23 23.

C. Limited Clearing: Clear areas receiving more than 3 feet of fill by cutting trees and shrubs as close as practical to the existing ground. Grubbing will not be required.

D. Burning: Burning will not be allowed.

3.3 TOPSOIL

A. Stripping: Strip existing topsoil from areas that will be excavated or graded prior to commencement of excavating or grading and place in well-drained stockpiles in approved locations. Place silt screen around all stockpiles.

END OF SECTION

SECTION 31 23 16

EXCAVATION - EARTH AND ROCK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for performing opencut excavations to the widths and depths necessary for constructing structures, pipelines and conduits including excavation of any material necessary for any purpose pertinent to the construction of the Work.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-in-Place Concrete
2. Section 31 10 00 - Site Clearing
3. Section 31 23 23 - Backfilling
4. Section 31 41 00 - Shoring, Sheeting and Bracing

1.2 DEFINITIONS

A. Earth: "Earth" includes all materials which, in the opinion of the ENGINEER, do not require blasting, barring, or wedging for their removal from their original beds. Specifically excluded are all ledge and bedrock and boulders or pieces of masonry larger than one cubic yard in volume.

B. Rock: "Rock" includes all materials which, in the opinion of the ENGINEER, require blasting, barring or wedging for removal from their original beds and which have compressive strengths in their natural undisturbed state in excess of 300 psi. Boulders or masonry larger than one cubic yard in volume are classed as rock excavation.

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Dewatering Excavation Plan: Develop an excavation dewatering plan that considers site ground and groundwater conditions, the type and arrangement of the equipment to be used and the proper method of groundwater disposal. Prepare the dewatering plan before beginning excavations below groundwater. Maintain one copy of the dewatering plan at the project site to be available for inspection while all dewatering operations are underway.

1.4 SITE CONDITIONS

A. Geotechnical Investigation: A geotechnical investigation and report was prepared by Terracon Consultants, Inc. and was intended only for use by the OWNER and ENGINEER in preparing the Contract Documents.

1. The geotechnical investigation report may be examined for what ever value it may be considered to be worth. However, this information is not guaranteed as to its accuracy or completeness.

2. The geotechnical investigation report is not part of the Contract Documents.

B. Geotechnical Baseline Report: A geotechnical baseline report was prepared by the ENGINEER and was intended for use by the CONTRACTOR for establishing the existing rock conditions for constructing the Third River Crossing by means of Microtunneling.

1. The geotechnical baseline report is a part of the Contract Documents.

C. Actual Conditions: Make any geotechnical investigations deemed necessary to determine actual site conditions.

D. Underground Utilities: Locate and identify all existing underground utilities prior to the commencement of Work.

E. Quality and Quantity: Make any other investigations and determinations necessary to determine the quality and quantities of earth and rock and the methods to be used to excavate these materials.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

A. Clearing: Clear opencut excavation sites of obstructions preparatory to excavation. Clearing in accordance with Section 31 10 00, includes removal and disposal of vegetation, trees, stumps, roots and bushes, except those specified to be protected during trench excavation.

B. Banks: Shore or slope banks to the angle of repose to prevent slides or cave-ins in accordance with Section 31 41 00.

C. Hazardous Materials: If hazardous materials not specifically shown or noted are encountered, proceed in accordance with General Conditions Article 4.06, Hazardous Environmental Condition at Site.

3.2 STRUCTURE EXCAVATION

A. Excavation Size: Provide excavations of sufficient size and only of sufficient size to permit the Work to be economically and properly constructed in the manner and of the size specified.

B. Excavation Shape: Shape and dimension the bottom of the excavation in earth or rock to the shape and dimensions of the underside of the structure or drainage blanket wherever the nature of the excavated material permits.

C. Compaction: Before placing foundation slabs, footings or backfill, proof roll the bottom of the excavations to detect soft spots.

1. For accessible areas, proof roll with a ten wheel tandem axle dump truck loaded to at least 15 tons or similarly loaded construction equipment.

2. For small areas, proof roll with a smooth-faced steel roller filled with water or sand, or compact with a mechanical tamper.

3. Make one complete coverage, with overlap, of the area.

4. Overexcavate soft zones and replace with compacted select fill in accordance with Section 31 23 16.

3.3 TRENCH EXCAVATION

A. Preparation: Properly brace and protect trees, shrubs, poles and other structures which are to be preserved. Unless shown or specified otherwise, preserve all trees and large shrubs. Hold damage to the root structure to a minimum. Small shrubs may be preserved or replaced with equivalent specimens.

B. Adequate Space: Keep the width of trenches to a minimum, however provide adequate space for workers to place, joint and backfill the pipe properly.

1. Do not allow the clear width of the trench at the level of the top of the pipe to exceed the sum of the outside diameter of the pipe barrel plus 20 inches for pipe 4 through 24 inches in diameter nor the outside diameter of the pipe barrel plus 2 feet for pipe more than 24 inches in diameter, unless otherwise approved.

2. In sheeted trenches, measure the clear width of the trench at the level of the top of the pipe to the inside of the sheeting.

3. Should the maximum trench widths specified above be exceeded without written approval, provide concrete cradle or encasement for the pipe as directed. No separate payment will be made for such concrete cradle or encasement.

C. Depth: Excavate trenches to a minimum depth of 6 inches below the bottom of the pipe or the bottom of encasement for electrical ducts, unless otherwise shown, specified or directed, so that bedding material can be placed in the bottom of the trench and shaped to provide a continuous, firm bearing for duct encasement, pipe barrels and bells.

D. Unstable Materials: If unstable material is exposed at the level of the bottom of the trench excavation, excavate the material in accordance with the subsection headed "Authorized Additional Excavation".

1. When in the judgment of the ENGINEER the unstable material extends to an excessive depth, the ENGINEER may advise, in writing, the need for stabilization of the trench bottom with additional select fill material or a crushed stone or gravel mat or the need to provide firm support for the pipe or electrical duct by other suitable methods.

2. Payment for such trench stabilization will be made under the appropriate Contract Items or where no such items exist, as a change in the Work.

E. Length of Excavation: Keep the open excavated trench preceding the pipe or electrical duct laying operation and the unfilled trench, with pipe or duct in place, to a minimum length which causes the least disturbance. Provide ladders for a means of exit from the trench as required by applicable safety and health regulations.

F. Water: Allow no water to rise in the trench excavation until sufficient backfill has been placed to prevent pipe or duct flotation.

3.4 ROCK EXCAVATION

A. Rock Excavation: Excavate rock within the boundary lines and grades as shown, specified or required.

1. Rock removed from the excavation becomes the property of the CONTRACTOR. Transport and dispose of excavated rock at an off site disposal location. Obtain the off site disposal location.

2. Remove all shattered rock and loose pieces.

B. Structure Depths: For cast-in-place structures, excavate the rock only to the bottom of the structure, foundation slab, or drainage blanket.

C. Trench Depth: For trench excavation in which pipelines or electrical ducts are to be placed, excavate the rock to a minimum depth of 6 inches below the bottom of the pipe or duct encasement and refill the excavated space with pipe bedding material. Include placing, compacting and shaping pipe bedding material in the appropriate Contract Items.

D. Manhole Depths: For manhole excavation, excavate the rock to a minimum depth of 8 inches below the bottom of the manhole base for pipelines 24 inches in diameter and larger and 6 inches below the bottom manhole base for pipelines less than 24 inches in diameter. Refill the excavated space with pipe bedding material. Include placing, compacting and shaping pipe bedding material for manhole bases in the appropriate Contract Items.

E. Over-excavated Space: Refill the excavated space in rock below structures, pipelines, conduits and manholes, which exceeds the specified depths with Class D concrete, crushed stone or other material as directed. Include refilling of over-excavated space in rock as part of the rock excavation.

F. Other Requirements: Follow, where applicable, the requirements of the subsections on "Trench Excavation" and "Structure Excavation".

G. Payment: Rock excavation, including placing, compacting and shaping of the select fill material, will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

H. Blasting: Blasting is not allowed for removal of difficult rock. Difficult rock shall be removed by methods such as barring, wedging, or other approved methods at no additional cost to the OWNER.

3.5 FINISHED EXCAVATION

A. Finish: Provide a reasonably smooth finished surface for all excavations, which is uniformly compacted and free from irregular surface changes.

B. Finish Methods: Provide a degree of finish which is ordinarily obtainable from blade-grade operations, except as otherwise specified in Section 31 23 23.

3.6 PROTECTION

A. Traffic and Erosion: Protect newly graded areas from traffic and from erosion.

B. Repair: Repair any settlement or washing away that may occur from any cause, prior to acceptance. Re-establish grades to the required elevations and slopes.

C. Other Requirements: Conduct all Work in accordance with the environmental protection requirements specified in Division 1.

3.7 AUTHORIZED ADDITIONAL EXCAVATION

A. Additional Excavation: Carry the excavation to such additional depth and width as authorized in writing, for the following reasons:

1. In case the materials encountered at the elevations shown are not suitable.

2. In case it is found desirable or necessary to go to an additional depth, or to an additional depth and width.

B. Refill Materials: Refill such excavated space with either authorized Class D concrete or compacted select fill material.

C. Compaction: Where necessary, compact fill materials to avoid future settlement.

D. Payment: Additional earth excavations so authorized and concrete or select fill materials authorized for filling such additional excavation and compaction of select fill materials will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

3.8 UNAUTHORIZED EXCAVATION

A. Stability: Refill any excavation carried beyond or below the lines and grades shown, except as specified in the subsection headed "Authorized Additional Excavation", with such material and in such manner as may be approved in order to provide for the stability of the various structures.

B. Refill Materials: Refill spaces beneath all manholes, structures, pipelines, or conduits excavated without authority with Class D concrete or compacted select fill material, as approved.

C. Payment: Refill for unauthorized excavation will not be measured and no payment will be made therefor.

3.9 SEGREGATION STORAGE AND DISPOSAL OF MATERIAL

A. Stockpiling Suitable Materials: Stockpile topsoil suitable for final grading and landscaping and excavated material suitable for backfilling or embankments separately on the site in approved locations.

B. Stockpile Locations: Store excavated and other material a sufficient distance away from the edge of any excavation to prevent its falling or sliding back into the excavation and to prevent collapse of the wall of the excavation. Provide not less than 2 feet clear space between the top of any stockpile and other material and the edge of any excavation.

C. Excess Materials: Transport and dispose of surplus excavated material and excavated material unsuitable for backfilling or embankments at an off site disposal location. Obtain the off site disposal location.

3.10 REMOVAL OF WATER

A. Water Removal: At all times during the excavation period and until completion and acceptance of the WORK at final inspection, provide ample means and equipment with which to remove promptly and dispose of properly all water entering any excavation or other parts of the WORK.

B. Dry Excavations: Keep the excavation dry.

C. Water Contact: Allow no water to rise over or come in contact with masonry and concrete until the concrete and mortar have attained a set and, in any event, not sooner than 12 hours after placing the masonry or concrete.

D. Discharge of Water: Dispose of water pumped or drained from the Work in a safe and suitable manner without damage to adjacent property or streets or to other work under construction.

E. Protection: Provide adequate protection for water discharged onto streets. Protect the street surface at the point of discharge.

F. Sanitary Sewers: Discharge no water into sanitary sewers.

G. Storm Sewers: Discharge no water containing settleable solids into storm sewers.

H. Repair: Promptly repair any and all damage caused by dewatering the Work.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 31 23 23

BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Backfill all excavation to the original surface of the ground or to such other grades as may be shown or required. For areas to be covered by topsoil, leave or stop backfill (12) inches below the finished grade or as shown. Obtain approval before backfilling against masonry structures. Remove from all backfill, any compressible, putrescible, or destructible rubbish and refuse and all lumber and braces from the excavated space before backfilling is started. Leave sheeting and bracing in place or remove as the work progresses.

B. Equipment Limitations: Do not permit construction equipment used to backfill to travel against and over cast-in-place concrete structures until the specified concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, the above restriction may be modified providing the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.

C. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 31 10 00 - Site Clearing

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

1.3 SUBMITTALS

A. Provide all submittals, including the following in accordance with Division 1.

1. Certified laboratory reports of all proposed backfill material.

PART 2 PRODUCTS

2.1 BACKFILL MATERIAL - GENERAL

A. General: Backfill with sound materials, free from waste, organic matter, rubbish, boggy or other unsuitable materials.

B. General Materials Requirements: Conform materials used for backfilling to the requirements specified. Follow common fill requirements whenever drainage or select fill is not specified. Determine and obtain the approval of the appropriate test method where more than one compaction test method is specified.

C. Frozen Materials: Do not use frozen material for backfilling.

2.2 DRAINAGE FILL

A. Materials for Drainage Fill: Use clean gravel, crushed stone, or other suitable material conforming to the gradation specified for drainage fill. Clay and fine particles are unacceptable in drainage fill. Provide drainage fill of a grade between the following limits:

U.S. Standard Sieve	Percent Passing by Weight
1-1/2 inch	100
1 inch	95-100
1/2 inch	45-65
#4	5-15
#16	0-4

2.3 SELECT FILL

A. Materials for Select Fill: Use gravel, crushed stone, limestone screenings or other granular or similar material as approved which can be readily and thoroughly compacted to 95 percent of the maximum dry density obtainable by ASTM D 1557.

1. Grade select fill between the following limits:

U.S. Standard Sieve	Percent Passing by Weight
2 inch	100
1-1/2 inch	90-100
1 inch	75-95

1/2 inch	45-70
#4	25-50
#10	15-40
#200	5-15

2. Very fine sand, uniformly graded sands and gravels, or other materials that have a tendency to flow under pressure when wet are unacceptable as select fill.

2.4 COMMON FILL

A. Materials for Common Fill: Material from on-site excavation may be used as common fill provided that it can be readily compacted to 90 percent of the maximum dry density obtainable by ASTM D 1557, and does not contain unsuitable material. Select fill may be used as common fill at no change in the Contract Price.

B. Granular Materials On-Site: Granular on-site material, which is fairly well graded between the following limits may be used as granular common fill:

U.S. Standard Sieve	Percent Passing by Weight
3 inch	100
#10	50-100
#60	20-90
#200	0-20

C. Cohesive Materials On-Site: Cohesive site material may be used as common fill.

1. The gradation requirements do not apply to cohesive common fill.

2. Use material having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.

D. Material Approval: All material used as common fill is subject to approval. If there is insufficient on-site material, import whatever additional off-site material is required which conforms to the specifications and at no additional cost.

2.5 PIPE BEDDING

A. Gradation for Small Piping: For pipe 18 inches or less in diameter, comprise pipe bedding of material 90 percent of which will be retained on a No. 8 sieve and 100

percent of which will pass a 1/2-inch sieve and be well graded between those limits.

B. Gradation for Large Piping: For pipe larger than 18 inches in diameter, use the same pipe bedding material as specified for smaller pipe or use a similar well graded material 90 percent of which will be retained on a No. 8 sieve and 100 percent of which will pass a 1-inch sieve.

PART 3 EXECUTION

3.1 ELECTRICAL DUCT AND PRECAST MANHOLE BEDDING

A. Bedding Compaction: Bed all electrical ducts and precast manholes in well graded, compacted, select fill conforming to the requirements except as otherwise shown, specified, or required. Extend electrical duct bedding a minimum of 6 inches below the bottom of the duct encasement for the full trench width. Compact bedding thickness no less than 6 inches for precast concrete manhole bases.

B. Concrete Work Mats: Cast cast-in-place manhole bases and other foundations for structures against a Class D concrete work mat in clean and dry excavations, unless otherwise shown, specified or required.

C. Bedding Placement: Place select fill used for bedding beneath electrical ducts and precast manhole bases, in uniform layers not greater than 9 inches in loose thickness. Thoroughly compact in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

D. Use of Select Fill: Bed existing underground structures, tunnels, conduits and pipes crossing the excavation with compacted select fill material. Place bedding material under and around each existing underground structure, tunnel, conduit or pipe and extend underneath and on each side to a distance equal to the depth of the trench below the structure, tunnel, conduit or pipe.

3.2 PIPE BEDDING

A. Hand Placement: Place select fill pipe bedding by hand from the bottom of the excavation to 1 foot over the top of the pipe in uniform layers not greater than 6 inches in loose thickness, unless otherwise shown on the Contract Drawings. Tamp under pipe haunches and thoroughly compact pipe bedding in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557 (Modified Proctor).

B. Stone Placement: Do not place large stone fragments in the pipe bedding or backfill to 1 foot over the top of pipes, nor nearer than 2 feet at any point from any pipe, conduit or concrete wall.

C. Unallowed Materials: Pipe bedding containing very fine sand, uniformly graded sands and gravels, or other materials that have a tendency to flow under pressure when wet is unacceptable.

3.3 CONTROLLED LOW STRENGTH MATERIAL (CLSM) (FLOWABLE FILL)

A. CLSM is a low strength cementitious material consisting of fine aggregate, water, cement, portland cement, and if desired coarse aggregate and flyash as defined in Section 702 of the Oklahoma Department of Transportation Standard Specifications except that the CLSM shall have a 28-day compressive of 300 psi. Coarse aggregate if used should meet the requirements of No. 8 type as specified in Section 701.6 of the ODOT Standard Specifications.

3.4 TRENCH BACKFILL

A. General: Backfill trenches from 1 foot over the top of the pipe, from the top of electrical duct bedding or as shown to the bottom of pavement base course, subgrade for lawns or lawn replacement, to the top of the existing ground surface or to such other grades as may be shown or required.

B. Materials: Provide select fill, suitable job-excavated material or other material, as specified and as approved for trench backfill.

C. Depth of Placement - General: Except under pavements, walkways, railroad tracks, and street or highway appurtenances, or as otherwise specified, place trench backfill in uniform layers not greater than 9 inches in loose thickness and thoroughly compact in place using suitable mechanical or pneumatic equipment. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

D. Depth of Placement - Traffic Areas and Under Utilities: Where pavements, walkways, railroad tracks and street or highway appurtenances are to be placed over trenches and under utilities or utility services crossing the trench, provide trench backfill using select fill placed in uniform layers not greater than 9 inches in loose thickness and thoroughly compacted in place with equipment as specified above. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

E. Depth of Placement - Undeveloped Areas: In nondeveloped areas and where select fill material or hand-placed backfill are not specified or required, place suitable job-excavated material or other approved backfill in lifts not exceeding 12 inches in loose thickness. When the trench is full, consolidate the backfill by jetting, spading, tamping or puddling to ensure complete filling of the excavation.

Mound the top of the trench approximately 12 inches to allow for consolidation of backfill.

F. Dropping of Material on Work: Do trench backfilling work in such a way as to prevent dropping material directly on top of any conduit or pipe through any great vertical distance. Do not allow backfilling material from a bucket to fall directly on a structure or pipe and, in all cases, lower the bucket so that the shock of falling earth will not cause damage.

G. Distribution of Large Materials: Break lumps up and distribute any stones, pieces of crushed rock or lumps which cannot be readily broken up, throughout the mass so that all interstices are solidly filled with fine material.

3.5 STRUCTURE BACKFILL

A. Use of Select Fill: Use select fill underneath all structures, and adjacent to structures where pipes, connections, electrical ducts and structural foundations are to be located within this fill. Use select fill beneath all pavements, walkways, and railroad tracks, and extend to the bottom of pavement base course or ballast.

1. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable approved mechanical or pneumatic equipment.

2. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

B. Use of Common Fill: Use common granular fill adjacent to structures in all areas not specified above, unless otherwise shown or specified. Select fill may be used in place of common granular fill at no additional cost.

1. Extend such backfill from the bottom of the excavation or top of bedding to the bottom of subgrade for lawns or lawn replacement, the top of previously existing ground surface or to such other grades as may be shown or required.

2. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable equipment, as specified above.

3. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

C. Use of Clay: In unpaved areas adjacent to structures for the top 1 foot of fill directly under lawn subgrades use clay backfill placed in 6-inch lifts. Compact clay backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

1. Use clay having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.

3.6 DRAINAGE BLANKET

A. Drainage Fill Placement: Provide a drainage blanket where shown consisting of drainage fill.

1. Place drainage fill underneath all structures and adjacent to structures where pipes, connections, electrical ducts and structural foundations located within this fill, in uniform layers not greater than 8 inches in loose thickness. Compact drainage fill with suitable mechanical or pneumatic equipment to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

2. Place drainage fill adjacent to structures in all areas not specified above in uniform layers not greater than 8 inches in loose thickness. Compact drainage fill with suitable mechanical or pneumatic equipment to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

3.7 COMPACTION EQUIPMENT

A. Equipment and Methods: Carry out all compaction with suitable approved equipment and methods.

1. Compact clay and other cohesive material with sheep's-foot rollers or similar equipment where practicable. Use hand held pneumatic tampers elsewhere for compaction of cohesive fill material.

2. Compact low cohesive soils with pneumatic-tire rollers or large vibratory equipment where practicable. Use small vibratory equipment elsewhere for compaction of cohesionless fill material.

3. Do not use heavy compaction equipment over pipelines or other structures, unless the depth of fill is sufficient to adequately distribute the load.

3.8 FINISH GRADING

A. Final Contours: Perform finish grading in accordance with the completed contour elevations and grades shown and blend into conformation with remaining natural ground surfaces.

1. Leave all finished grading surfaces smooth and firm to drain.

2. Bring finish grades to elevations within plus or minus 0.10 foot of elevations or contours shown.

B. Surface Drainage: Perform grading outside of building or structure lines in a manner to prevent accumulation of water within the area. Where necessary or where shown, extend finish grading to ensure that water will be carried to drainage ditches, and the site area left smooth and free from depressions holding water.

3.9 RESPONSIBILITY FOR AFTERSETTLEMENT

A. Aftersettlement Responsibility: Take responsibility for correcting any depression which may develop in backfilled areas from settlement within one year after the work is fully completed. Provide as needed, backfill material, pavement base replacement, permanent pavement, sidewalk, curb and driveway repair or replacement, and lawn replacement, and perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as approved.

3.10 INSPECTION AND TESTING OF BACKFILLING

A. Sampling and Testing: Sampling and testing of all in-place backfill will be provided by the OWNER as specified in Division 1. If initial testing reveals non-compliance with Contract requirements, all additional testing will be made at the Contractor's expense.

B. Correction of Work: Correct any areas of unsatisfactory compaction by removal and replacement, or by scarifying, aerating or sprinkling as needed and recompaction in place prior to placement of a new lift.

END OF SECTION

SECTION 31 25 00

SLOPE PROTECTION AND EROSION CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: The requirements for providing slope protection and erosion control practices for all areas within the contract limits and other area indicated, including work designated in permits and other agreements, as specified in Division 1.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 02 41 00 - Demolition
2. Section 31 23 23 - Backfilling
3. Section 32 90 00 - Landscaping Work

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Storm Water Pollution Prevention Plan: A Storm Water Pollution Prevention Plan will not be required as the total area for construction will be less than one acre.

C. Submit copies of all required permits to the OWNER and ENGINEER before performing any work.

D. Ordinances: Comply with all erosion and siltation control ordinances in effect and required by governing bodies having jurisdiction over the construction site and provide appropriate control measures as required.

E. Payment: Include the cost of the erosion control in the Contract Price. No separate payment will be made for these items unless otherwise specified.

PART 2 PRODUCTS

2.1 EROSION CONTROL MATERIALS

A. General Material Requirements: Provide materials conforming to the ODOT standard specifications.

B. Erosion Control Materials

1. Bale Barriers – refer to ODOT Section 222
2. Siltation Screens – refer to ODOT Section 223
3. Sedimentation Filters – refer to ODOT Section 224
4. Sediment Removal – refer to ODOT Section 226
5. Seeding – refer to ODOT Section 232
6. Mulching – refer to ODOT Section 233

PART 3 EXECUTION

3.1 EROSION AND SEDIMENT CONTROL

A. Provide necessary precautions and facilities to protect all indicated areas within the Contract limits from discharges resulting from construction operations, excessive erosion runoff of the construction site, silting and any other contamination resulting from construction work. Provide erosion control practices conforming to the specified requirements and to include but not limited to the following provisions:

1. Place all erosion and siltation control measures prior to or as the first step in grading.

2. Mulch and seed all storm and sanitary sewer trenches not in streets within 15 days after backfill. Do not allow more than 500 feet of trenches to be open at any one time.

3. Place all excavated material on the uphill side of trenches where possible. Do not place materials in stream beds. Seed any stockpiled material which remains in place longer than thirty days with temporary vegetation and mulch.

4. Mulch and seed all temporary earth berms, diversions, erosion barriers and temporary stockpiles with temporary vegetative cover within 10 days after grading.

5. Do not stockpile or otherwise place dredged, excavated or other material, at any time, in or near a stream bed which may increase the turbidity of the water. If turbidity producing materials are present, hold surface drainage

from cuts and fills within the construction limits and from borrow and waste disposal areas in suitable sedimentation ponds or grade surface drainage to control erosion within acceptable limits. Provide and maintain temporary erosion and sediment control measures such as berms, dikes, drains, or sedimentation basins, if required to meet the above standards, until permanent drainage and erosion control facilities are completed and operative. Hold to a minimum the area of bare soil exposed at any one time by construction operations.

6. Drain wet dredged material for a minimum of 7 days. Store the material for drainage to a maximum height of 4 feet.

7. Provide temporary erosion and sediment control measures to include but not be limited to the following:

   a. Installation (and ultimate removal) of silt screens.

   b. Straw bales and silt traps around construction areas for all required structures.

   c. Diked area with earth berm and silt trap for draining dredged material.

   d. Straw bales with silt traps along top of slope of fill area plus seeding and mulching of entire fill area not otherwise protected.

3.2 MAINTENANCE INSPECTION PROCEDURES

A. Inspections:

1. Inspect in place erosion control measures once a week.

2. Inspect in place erosion control measures within 24 hours after any storm event greater than 0.25 inches of rain per 24-hour period.

3. Qualified personnel shall conduct a weekly inspection of the construction site to identify areas contributing to storm water discharges associated with construction activity.

4. Disturbed areas, material storage areas, and equipment storage areas that are exposed to precipitation shall be inspected on a regular basis for evidence of, or the potential for, pollutants entering the drainage system.

5. Storm water discharge locations shall be inspected to determine if erosion control measures are effective in preventing significant impacts to receiving waters.

6. Erosion control devices installed as specified shall be observed to ensure that they are operating properly.

7. Haul routes and construction entrance to work areas shall be periodically inspected for evidence of off-site vehicle tracking of mud and dirt.

8. Contractor's staging area shall be inspected to ensure that solid and liquid wastes are being properly disposed of and not discharged into storm water runoff.

B. Maintenance: All erosion control measures shall be maintained throughout the project and until such time as the disturbed area has been completely stabilized or other provisions have altered the need for these measures. The Contractor shall:

1. Replace mulch materials to their original level when the level has been substantially reduced due to decomposition of the organic mulches and displacement or disappearance of both the organic and inorganic mulches.

2. Remove rubbish and channel obstructions from bare and vegetated channel within the project limits. The Contractor shall repair damage from scour or bank failure, rodent holes and breaching of diversion structures. Excessive wear, movement or failure of erosion control blankets shall be repaired immediately. Deposits of sediment shall be removed from the channel.

3. Repair any damage to silt fence barriers immediately and monitor barriers daily during prolonged rainfall.

4. Repair or replace any silt fence fabric that has decomposed or become ineffective prior to its expected usable life.

5. Remove sediment deposits after each storm event. Sediment must be removed when deposits reach approximately half the height of the silt fence barrier.

6. Till and smooth to match the existing grade and reseed any sediment deposits remaining in place after the silt fence barrier is no longer required.

7. Maintain the construction entrances, as shown and specified, in a condition to prevent tracking or flowing of sediment onto roads. This could require periodic top dressing with additional surface materials as required. Repair and clean out any features used to trap sediment and remove all sediment spilled, dropped, washed or tracked onto road and return to the point of likely origin. Sweep streets as required, or as directed by OWNER, to remove sediment from paved roads.

8. All temporary erosion and sediment control practices shall be removed and disposed of within thirty (30) days after site stabilization is achieved or after the temporary practices are no longer needed. Trapped sediment shall be permanently stabilized to prevent further erosion.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 31 41 00

SHORING, SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Work required for protection of an excavation or structure through shoring, sheeting, and bracing.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 31 23 16 – Excavation - Earth and Rock
2. Section 31 23 23 – Backfilling
3. Section 31 70 10 – Microtunneling

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Submittals:

1. Shafts for the Microtunneling Option, and excavation support for the junction structures for the Open Cut Option:

a. Working Drawings, showing sequencing of work and how construction will mitigate the ground and groundwater conditions the shafts will need to support.
b. Shop Drawings for support of excavation systems.
c. Product data.
d. Methods for maintaining watertight excavations, per requirements specified herein.
e. Methods for maintaining stability of the existing Junction Box 782.
f. Contingency plans for excessive water inflows or excessive ground movements adjacent to the excavations.
g. Qualifications for the CONTRACTOR’s Design Engineer. The Design Engineer shall be a Licensed Professional Engineer experienced in Structural Engineering and registered in the State of Oklahoma, and have a minimum of 5 year of experience designing similar excavation support systems.

2. For support for the Open Cut Option not associated with excavation support for the junction structures:
    a. Submit a CERTIFICATE (ONLY), signed and sealed by a Licensed Professional Engineer experienced in Structural Engineering and registered in the State of Oklahoma, that certifies that the Licensed Professional Engineer has a minimum of 5 years of experience designing similar excavation support systems and has evaluated and approved the CONTRACTOR's excavation plan and has prepared complete design calculations and working drawings for the shoring, sheeting and bracing, not specifically shown on the Contract Drawings, which will be used for excavation support. Provide a separate CERTIFICATE for each excavation before starting the excavation. Where commercially manufactured trench boxes are to be used, provide a CERTIFICATE from the CONTRACTOR's Licensed Professional Engineer stating the conditions under which the trench boxes will be used.

1.3 REFERENCES

A. Codes and standards referred to in this Section are:

1. All Federal, State and local laws and regulations applying to the design and construction of shoring, sheeting and bracing.

2. National Bureau of Standards Building Science Series 127 "Recommended Technical Provisions for Construction Practice in Shoring and Sloping Trenches and Excavations."

PART 2 PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

A. Use manufacturers and materials for shoring, sheeting and bracing as recommended by the CONTRACTOR's Design Engineer.
B. Where wood lagging is to be left in place use oak or treated fir or treated pine. Use only environmentally safe treatment for wood lagging.
C. Shafts for the Microtunneling Option, and excavation support for junction structures for the Open Cut Option:
    1. For king pile and sheet piles systems: ASTM A328 or ASTM A572.
    2. For secant pile systems:
        a. Concrete: Per Specification Section 03 31 00.
        b. Steel: As required by the CONTRACTOR's Design Engineer.

PART 3 EXECUTION

3.1 SHORING, SHEETING AND BRACING INSTALLATION

A. General: Provide safe working conditions, prevent shifting of material, prevent damage to structures or other work, and avoid delay to the work, all in accordance with applicable laws and regulations. Shore, sheet, and brace all excavations that are not cut back to a stable slope, as determined by the CONTRACTOR's Design Engineer.

1. Take sole responsibility for the design and adequacy of shoring, sheeting and bracing shown on the Contract Drawings, as well as required for Contractor's convenience.

2. Take sole responsibility for the methods of installation of the shoring, sheeting and bracing.

3. Take sole responsibility for controlling groundwater inflows into the excavations, either by dewatering or by using watertight excavation support systems. Watertight excavation support systems through the Fill and Alluvium soils are required for the shafts for the Microtunneling option, as well as excavation support systems for the junction structures for the Open Cut Option. Watertight excavation support systems must meet the following requirements:

    a. Maximum allowable aggregate shaft leakage of 25 gpm per shaft.
    b. Prevent loss of ground through the excavation support system.
    c. Possible systems include king pile and sheet pile system, secant piles, or similar.
    d. For the Open Cut Option, excavation support systems selected for the pipe and encasement must be compatible with watertight excavation support systems for the junction structures.

4. Provide clearances to final structures as required by the CONTRACTOR'S means and methods.

5. For the East Bank Junction Structure excavation support system, coordinate design and installation with the existing Junction Box 782, as well as the existing support of excavation still in place as shown on the Contract Drawings. Maintain stability of the existing junction box throughout construction.

6. Coordinate design and installation of the shoring, sheeting and bracing with the existing pipes and concrete encasements, as indicated on the Contract Drawings. Protect pipes and concrete encasement from damage during construction.

B. Arrange shoring, sheeting and bracing so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide required strength.

C. If the CONTRACTOR or its Design Engineer is of the opinion that at any time the CONTRACTOR's excavation plan, shoring, sheeting or bracing is inadequate or unsuited for the purpose, take immediate and appropriate action. Provide a new set of submittals per requirements above for watertight excavations, or a new CERTIFICATE if the CONTRACTOR's excavation plans, shoring, sheeting or bracing require modifications.

D. Monitoring:

1. Monitor horizontal and vertical deflections of sheeting, shoring and bracing at least twice a week during excavation adjacent to the sheeting, shoring and bracing, or at least once a week if excavation is not occurring. Limit movements of the excavation support systems to less than 1.5 inches, except as specified herein for Junction Box 782.

2. The CONTRACTOR's Design Engineer shall compare deflections to estimated values, and adjust procedures accordingly if deflections exceed these values.

3. For Junction Box 782 adjacent to the East Bank Junction Structure, horizontal and vertical deflections shall not exceed 0.75 inches as measured at the top of the structure for Monitoring Points shown on the Contract Drawings.

E. Accurately locate all underground utilities and take the required measures necessary to protect them from damage. All underground utilities shall be kept in service at all times as specified in Division 1.

F. Remove shoring, sheeting and bracing as the excavation is refilled in a manner to avoid the caving in of the bank or disturbance to adjacent areas or structures or pipe bedding.

1. Carefully fill voids left by the withdrawal of the shore, sheeting and bracing. No separate payment will be made for the filling of such voids.

2. If pipe bedding is disturbed, re-compact it to meet specified density requirements.

G. Permission for Removal: Obtain permission from the CONTRACTOR's Design Engineer before the removal of any shoring, sheeting or bracing.

END OF SECTION

SECTION 31 70 10

MICROTUNNELING AND CONTACT GROUTING

PART 1 MICROTUNNELING

1.1 SUMMARY

A. Microtunneling, as specified herein, is to be performed in general conformance with ASCE Standard 36-15, Standard Design and Construction Guidelines for Microtunneling.

B. This section specifies minimum design and performance requirements for jacking Fiber Reinforced Pipe (FRP) by microtunneling. In the event of a conflict between ASCE Standard 36-15 and these specifications, these specifications shall take precedence.

C. This section presents the requirements for contact grouting of the tunnel annulus and all voids that could result from over excavation of the shale rock outside the pipe during the microtunnel installation.

1.2 DEFINITIONS.

A. See below and in accordance with applicable definitions in ASCE Standard 36-15.

1. Annular Space: For Contact Grouting, the theoretical volume between the gauge cut and the outside radius of the jacking pipe times the length of the installation, equal to annulus x length.

2. Annulus: The theoretical area between the gauge cut and pipe outside diameter (OD) equal to (π x [gauge cut OD^2 – pipe OD^2]/4). It is the combined area created by the overcut and the shield cut.

3. Break-In and Break-Out: Access point through the jacking or receiving shaft wall through which the MTBM exits the ground into the shaft or exits the shaft and enters the ground, respectively.

4. Cohesive Soils: Earth materials containing 20 percent or more soil particles passing the No. 200 sieve. Furthermore, Atterberg Limits test on the fines defined by ASTM standards classify the fines as CL/CH.

5. Contact Grouting: Grout injected into the theoretical space between the jacking pipe and the ground after the drive is completed.

6. Emergency Recovery Shaft: See rescue shaft. An emergency recovery shaft is determined by construction necessity and typically will not have permanent civil structures constructed in the shaft.

7. Engineered Drilling Fluid (Drilling Fluid): Water that may contain additives, including bentonite, polymers, soda ash, surfactants, or other materials, to enhance stability and excavatability. If the drilling fluid contains additives and is designed to have specific properties, it is considered to be an engineering drilling fluid, whether specified by the engineer or selected by the CONTRACTOR. Some additives may increase the effectiveness of the drilling fluid and reduce adhesion of the spoils (cuttings). The drilling fluid is used in a closed-loop system for transporting spoils and for counterbalancing earth and groundwater pressures during microtunneling.

8. Geologic Contact: An abrupt and distinguishable interface between two geological strata that may or may not necessarily have similar engineering properties or behavior.

9. Geotechnical Baseline Report (GBR): Refer to ASCE Geotechnical Baseline Reports for Construction, latest edition. The GBR is Titled: East 53rd Street and Riverside Drive Relief Project, Geotechnical Baseline Report, dated April __ , 2020.

10. Guidance System: System that locates the actual position of the MTBM relative to the laser or other devices. The laser or other device should be referenced to the design line and grade.

11. Heading: The location where excavation is taking place.

12. Intermediate Jacking Station (IJS): A fabricated steel cylinder fitted with hydraulic jacks, which is incorporated into a pipeline between two specially fabricated pipe segments. Its function is to provide additional thrust in order to overcome skin friction and distribute the jacking forces over the pipe string on long drives.

13. Limits of Excavation: The outermost limit within which excavation takes place.

14. Lubricant: A fluid, normally bentonite and/or polymers and other additives, used to reduce the skin friction and jacking forces on the pipe during installation. The fluid fills the annular space of the pipe.

15. Microtunnel Boring Machine (MTBM): A remote controlled, steerable, laser or instrument-guided tunnel pipe jacking boring machine capable of providing continuous pressure to the face to counterbalance groundwater and earth pressures. The MTBM consists of an articulated boring machine shield and a rotating cutter head. Personnel entry into the MTBM is not required for the routine operation of the MTBM.

16. Microtunneling: A remote controlled and guided pipe jacking process that provides earth pressure balance in addition to applying hydrostatic counterbalancing pressure to the face to provide continuous face support. The jacked pipe provides continuous support to the tunnel.

17. Monitoring Points: Survey control points established at the ground surface along the pipe alignment and at specific structures for monitoring surface movement due to subsurface excavation.

18. Non-cohesive soils: Earth materials containing less than 20 percent or more soil particles passing the No. 200 sieve. Additionally, the Atterberg Limits test must have a Plastic Index less than 7 and a liquid limit less than 25.

19. Obstacle: A known buried object that lies either within or near the direct path of the MTBM or footprint of the shafts and is to be avoided, removed or relocated by other means.

20. Obstruction: Any buried object that lies completely or partially within the cross section of the microtunnel and that impedes continued forward progress along the design path and within allowable tolerances. Ground with an unconfined compressive strength (UCS) higher than that baselined in the GBR is also considered to be an Obstruction.

21. Portal/Shaft Portal (Exit Portal): Penetration in the shaft wall that provides access to the ground for launch of the tunneling equipment. Where launch seals are used to facilitate launch of the tunneling equipment, the seal is then considered the portal.

22. Principal Dimension: The largest of an obstruction's three mutually orthogonal measurements.

23. Rescue Shaft: An unplanned additional shaft required to remove an obstruction and/or retrieve or repair the MTBM. The rescue shaft may need to function as a jacking shaft to complete the drive.

24. Separation: Measured distance between buried objects either manmade or occurring naturally. The distance between two buried objects as measured between the closest outermost dimensions.

25. SF: Safety Factor

26. Unwater (unwatering): Removal of water isolated within a temporary or permanent underground structure that is not in communication with the groundwater or water source outside the structure. Unwatering does not lower the natural groundwater level.

1.3 SUBMITTALS.

A. Submit the following information for review in accordance with Division 1.

1. Submit qualifications and experience records for the following:

    a. Microtunnel Contractor performing the Work

    b. Microtunneling Project Superintendent

    c. MTBM Operators

    d. Microtunneling Engineer

    e. Surveyor

    f. Contact grouting Subcontractor or Personnel

2. Demonstrate that the proposed construction means and methods meet specified requirements:

    a. A general description and schedule of the microtunneling procedure, including equipment set-up, MTBM excavation, method of spoil removal, spoil disposal, disposal location, methods of protection and maintenance of project site, and groundwater control methods. Dispose of soil, water and drilling fluids in accordance with all local, State and Federal regulations.

    b. Preprinted machine specifications or a letter from the microtunneling machine manufacturer, in English, demonstrating that the selected machine(s) is capable of progressing through the anticipated ground conditions described in the GBR.

    c. Sample microtunneling reports from previous projects with written description interpreting actions that demonstrate:

        (1) Earth pressure balancing.
        (2) Simultaneous replacement of the excavated ground with jacking pipe.
        (3) Hydrostatic counterbalancing.
        (4) Balanced slurry flow.
        (5) Steering and guidance returning to line and grade.

3. Working Drawings:

    a. Layout of jacking and receiving shaft area sites including jacking equipment within the shaft and above ground equipment at the shaft and retrieval location. Provide a separate drawing superimposing permanent civil works within the jacking and receiving shaft.

    b. Working drawings of tunnel machine, including configuration of cutter head, overcut tolerances, and internal bulkheads, if needed. Cutter head drawing shall confirm that the machine is capable of excavating the bedrock baselined in the GBR. If required by the

CONTRACTOR's means and methods, indicate when, where, and how internal bulkheads would be installed.

c. Shaft ventilation system details including fan size and operating parameters.

d. Automatic pipe lubrication system details including capacity and operating parameters.

e. Electrical system, lighting system, and onsite power generation.

f. Process water and drilling fluid handling and disposal.

g. Grade and alignment control system operating parameters and monitoring requirements:

(1) Provide manufacturer's data on the guidance system, demonstrating compatibility with the tunnel length.
(2) Provide method to mount the guidance system on a support system that is independent of the shaft walls as well as the method of protecting the guidance system and support system from temperature differentials and physical disturbances.
(3) Provide a contemporaneous log of all guidance system set-ups and adjustments.

h. Thrust block design incorporated into the microtunneling support of excavation design along with supporting calculations for the thrust block design.

4. MTBM Work Plan:

a. Complete launch procedure commencing with any modification to the designed shoring and ending with first pipe jacked into the ground.

b. Complete retrieval procedure commencing with any modification to the designed shoring and ending with first jacked pipe penetrating into the receiving shaft.

5. Groundwater control provisions of the tunneling machine:

a. Details of slurry system and slurry separation methods, including proposed drilling fluid formulations by ground type, and calculations of the system capacity to handle flows at all proposed distances. Submit materials to be used in the drilling fluid.

b. Demonstrate that the slurry system has sufficient pressure and volume for drilling fluid to perform as intended and prevent inadvertent returns. Include pressure gauge and volumetric gauge locations.

c. Operational and drilling fluid formulation requirements for the ground conditions described in the GBR.

6. Groundwater/Lubrication control at shaft penetrations:

    a. Provide details and working drawings for the microtunnel shaft wall seals at the jacking and receiving shaft as specified herein.

7. The tunnel drive has a negative slope from the jacking shaft. Provide details of the sump system at the back of the microtunnel boring machine to sump drilling fluids or water inflow to prevent the accumulation and buildup of these fluids behind and into the machine.

8. Jacking system details, including method of operation, Maximum Anticipated Jacking Force, with calculations, and sleeve details, plus method of control to prevent the maximum allowable jacking force from being exceeded. If the calculated jacking force exceeds that of the pipe or main station capacities, install Intermediate Jacking Stations (IJS). Submit IJS designs and provide calculations and details including IJS working drawings, number of stations, location, jacking capacity installed in the IJS, proposed IJS spacing, and jacking pipe Specials A and B. State "not used" in the jacking force calculations if an IJS is not used as part of the jacking system and demonstrate through calculations and/or contractor means and methods how jacking forces will be maintained below that of the pipe or main station capacity.

9. Lubrication System: Description of lubrication mix equipment and procedure for lubricating the pipe during jacking operations, including estimated volume for the anticipated ground conditions. Submit description of the automatic lubricating system and how the volume and quantity of lubricant injections are controlled through the operator's control panel. Submit materials to be used for lubrication and for control of the rock's swell potential baselined in the GBR.

    a. Mix designs for jacking in the ground conditions described in the GBR including proportions, water quality, and pH. Submit final lubrication mix properties including pH, density, viscosity, and gel strength.

    b. Demonstrate that the automatic lubrication delivery system shall have sufficient pressure and volume for lubrication to perform as intended and prevent inadvertent returns. Submit information on the automatic lubrication system and supporting calculations as needed to demonstrate sufficiency of the system.

    c. Include pressure gauge and volumetric gauge locations.

    d. Sample lubrication log sheet acceptable to the ENGINEER and OWNER.

10. Contact Grout Work Plan after the pipe is installed as specified herein. Include the following items:
    a. A plan detailing the location of grout injection ports and proposed sequence of grouting to meet requirements as specified herein.
    b. Materials including grout mix design, unconfined compressive strengths, and set times.
    c. Certification that all admixtures are compatible with the design grout mix.
    d. Material Safety Data Sheets (MSDS) for all materials.
    e. Equipment including mixers, pumps, grout injection hoses, and grouting port connections, gauges, etc.
    f. Methods of grouting execution and sequences including injection pressures and methods of controlling grout pressure.
    g. Anticipated grout injection volumes and estimated excavated material volume.
    h. Calculated minimum and maximum grouting pressures at the port collar connection, prepared by the CONTRACTOR's Oklahoma Registered Professional Engineer. Calculations shall state the assumed factor of safety to determine the safe grouting pressure.
    i. Methods of monitoring and evaluating quality assurance including methods of grout sampling and compressive strength testing.
    j. Cleanup and restoration.
    k. Contingency plan for migration of grout to the surface or in the river bottom.

11. Include the pipe submittal for Section 33 05 61 with the submittal information of this section.

12. Operating procedures to overcome the contingency scenarios presented herein.

13. Notifications as specified herein.

14. Contingency plans for the following potential situations that may occur during microtunneling operations:
    a. Spoils do not separate with the equipment on site.
    b. Unable to advance the MTBM due to excessive tooling wear or other mechanical reason.
    c. Obstruction removal plan.

d. The guidance system is distorted by heat and/or humidity or has been knocked out of alignment.

e. The microtunneling machine is determined to be off line and grade.

f. The jacking pressures start to increase rapidly and reasonable concern exists for completing jacking operations.

g. An inadvertent return occurs with fluids reaching the ground surface or the water body being crossed.

h. Jacking pipe failure.

i. Encounter non-cohesive soils under mixed face conditions in the event of significant undulations in the rock surface.

j. Encounter non-cohesive soils under full face conditions in the event of extreme fluctuations in the rock surface.

k. Ground movements exceeding specified limits.

15. Survey drawings and information that includes:

a. The surveyed line and grade of the machine and jacking frame for the MTBM operations.

b. The location of utilities within 5 feet of the tunnel alignment.

c. The final as-built survey of the installed pipe.

16. Survey data during microtunnel construction:

a. The optical survey results of the pipe line and grade at the intervals specified herein.

b. Submit survey results on the same day the readings are taken and submit interpretation of the survey results the following working day.

17. Jacking Reports:

a. Provide a sample of manual logging reports and daily reports.

b. Provide a sample of automated record with information available for recording, variations in data acquisition frequency, and available formats for OWNER to select automated recording fields.

c. Submit jacking operations logs and reports daily.

18. Maintain and submit daily logs of Contact Grouting operations, including pressures, volumes, and grout mix pumped, time of pumping, and slump of grout mix.

19. Safety:

a. Provide written notice to the ENGINEER and OWNER of any OSHA actions that affect the project.

b. Provide a copy of any document provided by OSHA with the written notice.

1.4 PERFORMANCE REQUIREMENTS.

A. Launching and receiving of MTBM.

1. Control the ground so that no more than 1.0 cubic yard of ground enters the jacking and receiving shaft.

2. Prevent groundwater from entering the shaft at a rate greater than 5.0 gallons per minute. This excludes the short duration flush flow when the MTBM steering joint passes through the walls seals.

3. Prevent MTBM from deviating from the line and grade tolerance specified herein during launch.

B. Monitoring Points for ground or utility movement. Movement directly above the microtunnel alignment does not exceed the following limits:

1. For utilities above the tunnel: 0.75 inches.

2. For other locations: 1.0 inches.

3. For movements exceeding these limits, implement contingency plans.

C. Line and Grade. Construct the pipe within the following tolerances:

1. All other locations:

a. Horizontal tolerance – Plus or minus 6% of the MTBM diameter.

b. Vertical tolerance – Plus or minus 3% of the MTBM diameter.

D. Surveying.

1. Establish control points sufficiently far from the MTBM alignment so as not to be affected by ground movement or damaged by the Work on the project.

2. Record the coordinates and elevations with accuracy of 0.01 feet for each control point location.

3. During construction, perform an optical survey of the pipe line and grade after the heading is 100 feet, 500 feet, 1000 feet and 1500 feet from the jacking shaft, but in no case less than once a week.

4. Survey the machine target, locate a survey point at each pipe joint, and provide a cumulative line and grade record during construction.

5. After contact grouting, complete an optical survey of the final line and grade of the pipe. Include one point taken at each joint and from each end of the pipe. Provide results in both tabular and as an as-built AutoCAD drawing. Scale to be acceptable to the ENGINEER and OWNER.

E. Lubrication. Measure and record injection pressure and volume to sufficient accuracy so as to prevent an inadvertent return, pipe collapse, or ground heave.

F. Contact Grout Requirements:

1. Measure the injection pressure with gauge accuracy to one psi so as to prevent an inadvertent return, pipe collapse, or ground heave.

2. All voids between the outside of the pipe and the excavation surface shall be completely filled with contact grout.

3. Grouting shall advance from the low end to the high end in an orderly manner without missing or skipping grout ports. Grouting shall be advanced until completed.

4. Grout mix (water to cement ratios) shall be expressed in cubic feet of water per cubic feet of cement (94-pound bag). The water to cement ratio by volume shall be varied as needed to fill the voids outside the pipe. The range of water to cement ratios shall be between 1:1 and 2:1 by volume.

5. Grout shall consist of Portland cement, not more than 2 percent bentonite by weight of cement, fluidizer as necessary, and water in the proportions specified herein or acceptable to the ENGINEER. Sand may be added to the grout mix in instances of very high grout takes as accepted in writing by the ENGINEER, but in no case shall the grout mix contain less than six (6) sacks of cement per cubic yard of grout. The addition of sand may require the addition of water or fluidizer to the grout mix.

6. Dispose of unused grout including grout flushed from the lines and pumping equipment off-site in accordance with the submitted Contact Grouting Plan.

7. Do not inject wasted or flushed grout into the annular space.

8. Maintain direct communication between the grout pump operator and person injecting grout while grout is being injected.

9. Make a minimum of four (4) samples of each proposed grout mix in accordance with ASTM C 31 and determine twenty-four (24) hour and twenty-eight (28) day strengths in accordance with ASTM C 39 or C 109.

10. Grout Strength Tests

a. Prepare samples in accordance with ASTM C 31.

b. Test samples for twenty-four (24) hours, seven (7) days, and twenty-eight (28) days compressive strength tests according to ASTM C 39 for cylinders or ASTM C 109 for cubes, except as otherwise specified herein.

c. Take grout samples for the cylinders or cubes from the nozzle of the grout injection line. Provide at least one (1) set of four (4) samples for each 100 cubic feet of grout injected, but not less than one (1) set for each batch.

d. Provide grout with a minimum unconfined compressive strength of 50 pounds per square inch (psi) in twenty-four (24) hours 150 psi in twenty-eight (28) days.

11. Provide grout pressure calculations that are stamped and signed by the Microtunneling Engineer and specifically identify source of equation used. The CONTRACTOR's grout pressure must prevent inadvertent returns beneath the waterway crossings.

12. Provide fluidizers to hold the solid constituents of the grout in colloidal suspension, be compatible with the cement and water used in the grouting work, contain an expansive shrinkage compensator, and comply with the requirements of ASTM C 937.

1.5 QUALITY ASSURANCE.

A. Requirements outlined below shall be met at the time of bid and remain in force through completion of the project.

1. The CONTRACTOR performing the microtunneling work shall have a minimum of 5 years of qualifying experience installing pipelines using microtunneling methods and shall have successfully completed:

a. Five microtunneling projects, three of which shall be within the last three years, installing jacking pipe 42 inches OD or larger.

b. Two microtunneling projects using FRP pipe.

c. Two microtunneling projects in similar ground conditions and hydrostatic head, as baselined in the GBR.

d. A microtunnel drive with a drive length similar to the drive length required on this project.

2. Microtunnel Project Superintendent Qualifying Experience:

a. A minimum of five years of qualifying experience in the installation of pipelines using microtunneling methods.

b. A minimum of five projects, with each project consisting of at least 500 feet of pipe using microtunneling methods with one project at least 1,500 feet long.

c. Successfully completed two microtunneling projects installing jacking pipe 42 inches OD or larger.

d. Successfully completed two microtunneling projects using FRP.

e. Successfully completed two microtunneling projects in similar ground conditions and hydrostatic head, as anticipated on this project.

f. Successfully completed one microtunneling project that required the use of an intermediate jacking station, if used on this project.

3. MTBM Operator Qualifying Experience:

a. A minimum of five contiguous years of experience in the installation of pipelines using microtunneling methods.

b. A minimum of five projects, with each project having a drive length at least 80% of the drive length of this project using microtunneling methods.

c. Successfully completed two microtunneling projects installing jacking pipe 42 inches OD or larger.

d. Successfully completed two microtunneling projects installing FRP of the same or larger outside diameter as required for this project.

e. Successfully completed two microtunneling projects in similar ground conditions and hydrostatic head, as baselined in the GBR.

f. Operated an MTBM similar to the one proposed on this project.

g. Successfully completed one microtunneling project that required the use of an intermediate jacking station, if used on this project.

4. The Microtunneling Engineer shall be a Professional Engineer licensed by the State of Oklahoma. Experience shall include microtunneling design calculations on five microtunneling projects within the last five years.

5. Surveyor shall be a professional land surveyor licensed by the State of Oklahoma with experience in underground surveying. Experience shall include the transfer of points and line from the surface to below ground surface on three tunnel projects within the last five years.

6. Qualifying experience for CONTRACTOR's personnel or subcontractor that will perform the Contact Grouting include a minimum of two (2) projects. Documentation for each of the projects shall include:

a. Date, title, and location of each project.

b. Description of each project, including type and size of pipe, depth of pipe, number of pipe segments in each project, type of equipment used, geologic conditions, groundwater level and description of dewatering system, and description of any unusual difficulties and how they were resolved.

c. The name and address of the owner, name, and current telephone number of the owner's representative, original and final contract amounts, and a description of all claims or litigation.

d. Qualifying experience for the CONTRACTOR's superintendent and grouting machine operator or grouting subcontractor's superintendent and grouting machine operator. Each shall have a minimum of five (5) years of experience grouting trenchless pipeline installation projects, and shall have worked on a minimum of two (2) projects.

7. Experience Records shall list the five most recent microtunneling projects, including all microtunneling projects completed for this OWNER, and all projects demonstrating the specified experience. The experience record shall include name of project, the OWNER that contracted for the project, names of contacts including all contact information, jacking pipe material, jacking pipe outside diameter, ground conditions as measured by ground type, baselined rock strength, and hydrostatic head, longest drive planned and completed, and total footage planned and completed. The OWNER, at their option, may call and verify information provided on the Experience Record.

1.6 JACKING PIPE INFORMATION.

A. Maximum Allowable Jacking Force calculations are to be stamped and signed by the Microtunneling Engineer.

B. Jacking force calculations shall specifically identify source of equation, source of friction factor, friction factor, and the factor of safety. Equation and factors shall be from a widely accepted industry source acceptable to the ENGINEER.

C. Determine the maximum anticipated construction loads, including jacking forces, and ensure that the anticipated loads are implemented in the manufacturer's design of the pipe, subject to the OWNER's or ENGINEER's review.

D. Introduce IJSs in the pipe string when theoretical or actual jacking forces exceed pipe or main station capacity. Introduce IJSs as follows:

1. One IJS immediately behind the machine and push out at completion of the drive.

2. When the safe jacking capacity of the pipe is reached using a SF of 2.5 for FRP.

3. When 80% of the main station capacity is reached.

4. Based on the jacking force calculations, identify the number of IJSs needed and where in the pipe string they will be introduced.

E. Lubrication log shall include date, shift, number of batches mixed, and operator. Lubrication log shall include by pipe number, the volume, injection pressure, and operator.

F. Refer to FRP pipe requirements in Section 33 05 61. Incorporate the following tunneling requirements for the pipe.

1. FRP pipe manufactured specifically for jacking.

2. Manufacturer's dimensional tolerances in accordance with ASCE 36-15, Table 17-2.

3. Provide lubrication/grout ports at 25 feet on center alternating between the 10 and 2 o'clock positions. Incorporate check valves in the grout port as necessary.

1.7 JACKING REPORTS.

A. For the automated and manual jacking reports, include at a minimum the following information for each shift:

1. Date.

2. Project name.

3. Time of measurement.

4. Observations for settlement and heave.

5. Resetting or adjusting the guidance system and the effect to line and grade.

6. Printed name of operator and signature.

7. Number of each pipe installed and length of pipe.

8. Start and end time for each pipe joint including start and end times for stoppages lasting longer than 15 minutes during the pipe installation. Identify reason for stoppage.

9. Position of IJS in the installed pipeline, if used.

10. Start and finish times for each crew each day.

11. For each pipe joint installed:

a. Position of the MTBM in relation to design line and grade.

b. Maximum jacking force exerted by the main jacks.

c. Maximum jacking force exerted by each IJS.

d. Position of steering jacks and tonnage exerted through each jack.

e. Inclination and roll of the cutter head.

f. Torque on cutter head.

g. Face pressure of slurry.

h. Velocity and volume of slurry per time unit.

i. Earth pressure.

j. Total jacking distance in feet and jacking speed in inches per minute.

1.8 CONTEMPORANEOUS LOGS.

A. Maintain contemporaneous log of all line and grade checks during pipe installation including any resets and adjustments of the guidance system. Maintain logs independent of the jacking reports and include:

1. Date, time, pipe number, and person making adjustment.

2. Measurements from immediately before adjustment.

3. Measurements from immediately after adjustment.

4. Survey data if adjustment is performed based upon survey data.

5. Daily verification of design slope and person making verification.

6. Date, time, pipe number, and person resetting line and grade control.

1.9 OPERATIONAL PLANS

A. Prepare and submit the following operational plans.

1. A spoils separation plan that includes testing requirements for the drilling fluid and operating parameters that are observed and monitored to ensure that the drilling fluid is maintained within the CONTRACTOR's operational parameters and performing as intended. If not, include a discussion on the operational changes that will be made to the separation plant and/or drilling fluids to return the drilling fluid within the CONTRACTOR's operational parameters. Include in the separation plan testing requirements for pH, sand content, viscosity and gel strength.

2. The MTBM operational plan must include the observational and operational characteristics that are observed and monitored that indicate the MTBM is not advancing and possible causes. Include in the operational plan emergency recovery shaft construction and associated groundwater control, tunneling, water-tight tunnel initial support methods to effect recovery of the

machine. Design and construct an emergency recovery shaft in accordance with Section 31 41 00, if required.

3. Include in the Obstruction Removal Plan observational and operational characteristics that indicate the MTBM is not advancing due to an obstruction. The plan must include confirmation of the obstruction and a plan to remove or dislodge the obstruction by shaft sinking, tunneling, back-tunneling with water-tight tunnel initial supports, or other appropriate methods. Design and construct emergency recovery shafts in accordance with Section 31 41 00.

4. Include in the guidance plan the operational parameters observed, measured, and recorded to determine if the guidance system has moved or moves during jacking, has been distorted, or if the guidance system or its support system might be affected by heat distortion.

5. Include in the line and grade control the operational parameters observed, measured, and recorded to determine if the MTBM is off line and/or grade. The plan shall include a return to the design line and/or grade over the remaining portion of the drive and at a rate of not more than 1 inch per 25 feet.

6. Include in the jacking plan the operational parameters observed, measured, and recorded to determine if jacking force is increasing at a rate that would exceed the Maximum Allowable Jacking Force or the jacking force increases at a rate causing reasonable concern for completing the drive.

7. Include in the inadvertent return plan the cleanup methods, emergency telephone numbers, sources of equipment and materials needed for containment and clean-up, and corrective actions for reducing operating pressures and modifying the drilling fluid or lubricant. Include the operating parameters that are controlled and monitored with the intent of preventing an inadvertent return.

8. Include the repair methods acceptable to the pipe manufacturer for repair of damaged pipe.

9. Include a plan to address abrasivity of the ground for both the matrix and individual clast therein on the machine and its tooling. If the CONTRACTOR deems re-tooling is required during the drive, the plan must identify the proposed means and methods for providing a safe environment to undertake the re-tooling.

10. Provide a plan to mitigate ground movements in excess of limits specified herein. Address the operational parameters that will changed or modified, including replacing operators, drilling fluid/slurry modification, and other operational modifications deemed necessary to maintain ground movement with the limits specified herein. If utilities or other structures are damaged by excessive movements, provide repair or replacement plans at no additional cost to the Owner.

1.10 PROJECT CONDITIONS.

A. The anticipated project conditions along the microtunnel drive are set forth in the GBR.

B. Protect the existing utilities adjacent to the jacking and receiving shafts during shaft and microtunnel construction.

C. The jacking and receiving shaft must be built within the existing right-of-way and easements as shown on the Plans.

D. Do not use dewatering to lower the groundwater table on the outside of the jacking and receiving shafts. Short term localized dewatering to facilitate launching and receiving of the machine is acceptable.

E. Maintain traffic control for access of local pedestrian and vehicular traffic.

1.11 SAFETY.

A. The CONTRACTOR is responsible for safety on the job site. Methods of construction shall be such as to ensure the safety of the Work, Contractors and other employees onsite, and the public. Perform Work in accordance with current applicable regulations and safety requirements of the federal, state, and local agencies. Comply with all applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA.

1. The preconstruction underground classification according to OSHA is:

   "Potentially Gassy" for the Arkansas River crossing.
   Classifications may change during construction depending on monitoring results.

2. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are in the shaft or in the pipe. Perform all required air and gas monitoring. Ventilation system shall provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in all underground work areas.

3. In case of emergency or when work stoppages are likely to endanger the stability of the excavation or adjacent structures, maintain a full work force 24 hours per day, including weekends and holidays, until emergency or hazardous conditions no longer jeopardize stability and safety of the work.

PART 2 PRODUCTS.

2.1 MATERIALS.

A. Lubrication and drilling fluids are to consist of:

1. High yield sodium (NA) bentonite.
2. Water from a potable source.
3. All water shall be tested for pH and treated with soda ash, or accepted equal, to adjust the pH of the water as required in the accepted mix design(s).
4. Bentonite, polymers, and additives shall be NSF/ANSI Standard 060 or equal for clean water testing except for the soda ash.

B. Provide neoprene rubber wall seals to resist the hydrostatic pressures specified herein. Gum rubber seals cannot be used as the primary seal to resist hydrostatic pressures.

C. Contact Grout materials:

1. Cement: Cement shall be Type II or Type V Portland cement conforming to ASTM C 150. Type II cement shall meet Table 4 fast set requirements of ASTM C 150.
2. Bentonite: Bentonite shall be a commercially processed powdered bentonite, Wyoming type, such as Imacco-gel, Black Hills, or equal.
3. Sand: Conform to ASTM C-144.
4. Fluidizer: Holds the solid constituents of the grout in colloidal suspension and is compatible with the cement and water used in the grouting program. Compatible with the materials specified herein.
    a. Contains an expansive shrinkage compensator.
5. Admixtures: Other admixtures may be used subject to the acceptance of the ENGINEER to improve the ability to pump, to control set time, to hold sand in suspension, and to prevent segregation and bleeding.
6. Compressive Strength: Minimum strength of 50 psi in twenty-four (24) hours; maximum strength of 150 psi in twenty-eight (28) days.
7. Water: Potable.
8. Grout or lubrication port for grout injection: Install one-way check valves at the grout ports as required by the CONTACTOR'S means and methods.

2.2 MTBM AND COMPONENTS.

A. Provide a microtunneling system specifically designed and tooled for excavating, crushing, transporting, and separating the ground conditions baselined in the GBR.

B. Use a slurry MTBM that meets the requirements of this specification and is capable of handling the baselined ground conditions.

C. Maintain the tunnel face under wet, dry, and adverse ground conditions, and prevent the loss of ground through the machine during stoppages and shutdowns.

D. Provide earth pressure balancing support of the excavated face at all time.

E. Articulated and steerable.

F. Guided to a predetermined reference point.

G. Provide protection to the electric and hydraulic motors and operating controls against water damage.

H. Use bi-directional drive on the cutter wheel, and/or adjustable fins or other means, to control roll.

I. Control the volume of excavated material removed at the tunnel face and the MTBM advance rate to avoid over-excavation.

2.3 SLURRY SYSTEM.

A. Include with the MTBM an automated drilling fluid supply and slurry-based spoil removal system that balances the groundwater pressures by the use of a slurry pressure balance system. Ensure the system is capable of adjustments required to maintain face stability for the particular ground condition encountered in the Work. Monitor and continuously balance the ground water pressure to prevent an inadvertent return or uncontrolled groundwater inflow.

1. Manage the pressure at the excavation face by use of the slurry pumps which may operate at variable speeds, pressure control valves, and a flow meter.
2. Include a slurry bypass unit in the system to allow the direction of flow to be changed and isolated, as necessary.

2.4 SLURRY SEPARATION EQUIPMENT.

A. Separate the spoil from slurry so that slurry within the operating parameters can be returned to the cutting face for reuse. Use a mechanical separation plant, including scalping screens, shaker screens, de-sanding and de-silting cones, centrifuge, and clarifier tanks as deemed necessary by the operating parameters.

B. Use the type of separation process suited to the size of the tunnel being constructed, the ground type being excavated, and the workspace available at the jacking shaft.

C. Monitor the composition of the slurry to maintain the slurry weight, gel strength, sand content, and viscosity limits defined by the microtunnel plan.

D. Contain separated spoils for removal from the site.

2.5 PIPE JACKING EQUIPMENT.

A. Identify the Maximum Allowable Jacking Force to push the MTBM and the pipe string between the shafts as shown in the Plans.

B. Synchronize the cylinder extension rates with the excavation rate of the MTBM.

C. Evenly distribute jacking forces on the end of the pipe.

2.6 REMOTE CONTROL SYSTEM.

A. Allows for routine operation of the system without the need for personnel to enter the pipe.

B. Display available to the operator, showing the position of the MTBM in relation to a design reference together with other information such as roll, pitch, complete guidance system, valve positions, thrust force, cutter head torque, rate of advance, and installed length.

C. Integrates the system of excavation and removal of spoil and its simultaneous replacement by the pipe. As each pipe section is jacked forward, the control system synchronizes all of the operational functions of the system.

2.7 ACTIVE DIRECTIONAL CONTROL.

A. Controls line and grade by a calibrated guidance system.

B. Equipped with a high intensity laser or gyroscope.

C. Capable of maintaining line and grade to the tolerances specified in this section.

D. Provides active steering information that is monitored and transmitted to the operator. As a minimum, this information shall include location of the guidance system, target, and cutter head.

E. Provides positional and operational information to the operator.

F. Provides a reference laser, or other submitted device that indicates visually in the jacking shaft that the directional control guidance system has not been accidentally moved.

2.8 LUBRICATION SYSTEM.

A. Provide an automatic lubrication system. Introduce lubrication from the back of the machine and along the pipe through an automatic lubrication system controlled through the MTBM control panel. Record the pressure and volumetric take at each point of injection whenever lubrication is introduced to the pipe string.

2.9 CONTACT GROUTING EQUIPMENT.

A. Equipment for mixing and injecting grout shall be adequate to satisfactorily mix and agitate the grout and force it into the grout ports in a continuous flow at the desired pressure. Pumps shall be capable of continuously developing a sustained pressure at grout nozzle that shall not exceed the overburden load.

B. Two (2) pressure gauges shall be provided; one (1) at the grout pump and one (1) at the collar of each port being grouted. Gauges shall be calibrated in psi to the nearest 1.0 psi when the calculated pressure is less than or equal to 20 psi, and 5.0 psi when the pressure is greater than 20 psi. The accuracy of the gauges shall be periodically checked with an accurately calibrated pressure gauge.

C. Suitable stop valves shall be provided at the collar of each port for use in maintaining pressure as required until the grout has set.

D. The grouting equipment shall be provided with a meter to determine the volume of grout injected. The meter shall be calibrated in cubic feet to the nearest 1/10 of a cubic foot.

E. The grouting equipment shall be maintained in satisfactory operating condition throughout the course of the Work to ensure continuous and efficient performance during grouting operations.

F. Grout hoses shall be capable of withstanding the maximum water and grout pressures to be used.

G. Provide injection system with a grout re-circulation hose.

H. Provide a pump that provides a constant pressure at variable delivery volumes.

2.10 CONTACT GROUT QUALITY CONTROL

A. Slump Tests: Perform at least one (1) slump test from each truck load or batch of grout according to ASTM C 143.

B. Grout Strength Tests: Prepare samples for seven (7) day and twenty-eight (28) day compressive strength tests according to ASTM C 31 for cylinders or ASTM C 109 for cubes. Cylinder molds shall be at least 2 inches in diameter and 4 inches long. Grout cubes shall be either 2 inches or 50 millimeters on each side. Test samples according to ASTM C 39 or C 109 as applicable. Grout for the cylinders or cubes shall be taken from the nozzle of the grout injection line.

PART 3 EXECUTION.

3.1 JACKING AND RECEIVING SHAFT.

A. Construct the jacking and receiving shafts in accordance with Section 31 41 00.

B. Do not launch the MTBM until the receiving shaft is in-place.

3.2 WORK AREA PREPARATION AND MAINTENANCE.

A. Organize microtunneling surface equipment in such a manner as to enable proper operation at all times, to minimize impacts to property owners, and to maintain traffic control patterns as specified.

B. Any equipment operating with fuel, hydraulic, or lubrication oils shall be provided with suitable containment basins made of plastic lining and sand bags to ensure any fluid is contained.

C. All equipment shall be maintained and kept in working order. All oil, hydraulic, or fuel leaks shall be repaired upon discovery. Any leaking equipment shall not be used until repaired. Any fluid shall be contained and cleaned up upon discovery.

D. All lubricant and slurry spills shall be contained upon discovery, cleaned up, and disposed of properly.

3.3 INSTALLATION.

A. Check baseline and benchmarks with an optical survey before commencing excavation and immediately notify the ENGINEER in writing of any errors or discrepancies.

B. Use the baseline and benchmarks shown on the Drawings to furnish and maintain reference control lines and grades for the pipe installation.

C. Check the primary alignment control points used for the microtunneling system against the undisturbed above-ground survey reference points used to establish the alignment control points at least once each week or not greater than every 200 feet of pipe installed.

3.4 QUALITY CONTROL.

A. Implement contingency plans as specified herein.
B. Perform a verification survey with a transit or total station of the installed pipe from jacking shaft to the receiving shaft after removal of the MTBM. Document measured conformance to design line and grade of the pipe together with locations and deviation (distance and direction) of any out-of-tolerance locations.

3.5 NOTICES.

A. Immediately notify the ENGINEER in writing when the MTBM is off line or grade by 50 percent of the maximum allowed. Include written description of the operational changes being made to avoid attaining the maximum allowed.
B. Immediately notify the ENGINEER in writing when the MTBM is off line or grade by 80 percent of the maximum allowed. Include written description of the operational changes being made to avoid attaining the maximum allowed.
C. Immediately stop tunneling and notify the ENGINEER in writing when the MTBM is off line or grade by 100 percent of the maximum allowed. Include written description of the operational and personnel changes being made with ENGINEER and OWNER acceptance before the resumption of tunneling.
D. Notify the ENGINEER in writing immediately upon implementation of any contingency plan.

3.6 SPECIALS A AND B.

A. Provide an internal water-tight closure joint upon removal of the internal IJS components and collapsing of the joint, if used.

3.7 MTBM ACCESS.

A. Provide the ENGINEER or authorized representative with access to the MTBM control cabin and controls, shaft, guidance system, tunnel, MTBM, and slurry separation plant.

3.8 OBSTRUCTIONS DURING MICROTUNNELING.

A. Remove, clear, or otherwise make it possible for the microtunneling equipment and pipe to progress past or through a obstruction in accordance with the accepted contingency plan.
B. No additional compensation shall be paid for removing, clearing, or otherwise making it possible for the microtunneling equipment to progress past a buried object that is not an obstruction.
C. Payment for the rescue shaft, including the removal of an obstruction, shall be paid and subject to the following requirements:

    1. Notify the ENGINEER immediately in writing upon encountering a buried object that stops forward progress.

2. Upon written authorization by the ENGINEER, proceed with removal of the buried object by means of obstruction removal procedure.

3. No excavation shall be allowed within 5 feet of the MTBM or tunnel alignment without the ENGINEER being present.

3.9 ALTERNATIVE OBSTRUCTION REMOVAL PROPOSAL.

A. Any alternative proposed methods for removing, clearing or otherwise making it possible for the microtunneling equipment to progress past a buried object that does not allow for the direct observation and measurement of the buried object shall not be considered for additional payment.

3.10 PIPE INSTALLATION.

A. Test the pipe in accordance with Section 33 05 61.

3.11 CONTACT GROUTING

A. General

1. The CONTRACTOR shall gauge the volume of excavation material during installation to help estimate the required contact grout volume. Contact grout shall be used to fill any voids outside the pipe created by over excavation during installation. Contact grouting shall be performed as shown on the Drawings and as specified herein. An attempt must be made to hook up and pump grout at every grout hole or coupling unless acceptance is granted by the ENGINEER to skip selected holes.

2. Immediately after installing the pipe and stripping the tunnel, the CONTRACTOR shall inject grout through the grout connections in such a manner as to completely fill all voids outside the pipe resulting from the installation operations. Grout pressure shall be controlled to avoid damaging the pipe, to avoid movement of the surrounding ground or improvements, and to avoid migration of grout to ground surface or river bottom.

3. Grout Mixes: The CONTRACTOR shall develop one or more grout mixes designed to completely fill the void space outside the pipe and to provide acceptable strength and durability. All grout mix proportions and test results shall be submitted at least thirty (30) days prior to scheduled use for review and acceptance by the ENGINEER.

B. Mixing and Injection of Grout

1. All materials shall be free of lumps when put into the mixer, and the grout mix shall be constantly agitated. Grout shall flow unimpeded and shall

completely fill all voids. Grout not injected after ninety (90) minutes of mixing shall be wasted.

2. Placement of contact grout ports for the pipe is specified in the Microtunnel sections.

3. The grouting process shall be operated and controlled so that the grout will be delivered uniformly and steadily. Control the grout pressure to avoid damaging the pipe, and to avoid movement of the surrounding ground or damage improvements. Control grout pressure to prevent inadvertent return.

4. Grouting shall progress sequentially from grout port to grout port, from one end of the pipe to the other, or in the sequence indicated on the accepted shop drawings. Skip no grout port unless the contact grout has overflowed from that port.

5. Recirculate grout mixes when any new mix is batched or after adding new material to the batch. Re-circulate mix for at least five (5) minutes for every 300 incremental feet of tunnel grouted, or portion thereof, prior to pumping grout through grout port.

6. Provide the ENGINEER with access to the tunnel and grout equipment.

7. In general, grouting will be considered completed when less than 1 cubic foot of grout of the accepted mix and consistency can be pumped in fifteen (15) minutes under the specified maximum pressure. After the grouting is finished, the pressure shall be maintained by means of a stopcock, one-way valve or other suitable device until the grout has set to the extent that it will be retained in the grout port. Repair grout ports in accordance with manufacturer recommendations at the completion of contact grouting.

8. All grouting operations are to be performed in the presence of the ENGINEER. Notify the ENGINEER at least twenty-four (24) hours in advance of starting grouting operations.

9. Contact grout port fittings shall be sealed in accordance with manufacturer recommendations.

C. Cleanup

1. Take all necessary precautions to protect and preserve the interior surfaces of the pipe from damage. Grout spills shall be minimized and contained, and cleanup shall proceed immediately after grouting. Any damage to the pipe caused by or occurring during the grouting operations shall be repaired by a method approved by the ENGINEER at no additional cost to OWNER.

2. Remove and properly dispose of all waste grout resulting from grouting operations. Do not inject waste grout or wash water into the annular space.

END OF SECTION

SECTION 33 05 50

LAYING AND JOINTING BURIED PIPELINES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Installation of all underground pipelines. Provide pipeline materials, coatings and linings as specified and pipe of the types, sizes and classes shown or specified.

1. Use proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings.

2. Use suitable fittings where shown and at connections or where grade or alignment changes require offsets greater than those recommended and approved.

3. Lay all underground pipelines not supported on piles or concrete cradle in select fill bedding material.

4. Close off all lines with bulkheads when pipe laying is not in progress.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Tests
2. Section 31 23 16 - Excavation - Earth and Rock
3. Section 31 23 23 - Backfilling

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM C 12 - Practice for Installing Vitrified Clay Pipe Lines

2. ASTM D 2774 - Practice for Underground Installation of Thermoplastic Pressure Piping

3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

4. ASTM C 361 - Specification for Reinforced Concrete Low-Head Pressure Pipe

5. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile

6. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, C25, 125, 250, 800

7. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges

8. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

9. ASTM A 139 - Duplicate Entry, Specification Section 33 05 23

10. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Threaded Flanges

11. AWWA C206 - Field Welding of Steel Water Pipe

12. ASTM E 165 - Practice for Liquid Penetrant Examination

13. ASTM E 709 - Practice for Magnetic Particle Examination

1.3 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows.

B. Transportation and Delivery: Take every precaution to prevent injury to the pipe during transportation and delivery to the site.

C. Loading and Unloading: Take extreme care in loading and unloading the pipe and fittings.

1. Work slowly with skids or suitable power equipment, and keep pipe under perfect control at all times.

2. Under no condition is the pipe to be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe or coating.

D. Sling: When handling the pipe with a crane, use a suitable sling around the pipe.

1. Under no condition pass the sling through the pipe.

2. Use a nylon canvas type sling or other material designed to prevent damage to the pipe and coating.

3. When handling reinforced concrete pipe or uncoated steel or ductile iron pipe, steel cables, chain or like slings are acceptable.

E. Damaged Piping: If in the process of transportation, handling, or laying, any pipe or fitting is damaged, replace or repair in an approver manner such pipe or pipes.

F. Blocking and Stakes: Provide suitable blocking and stakes installed to prevent pipe from rolling.

1. Obtain approval for the type of blocking and stakes, and the method of installation.

G. Storage for Gaskets: Store gaskets for pipe joints in a cool place and protect gaskets from light, sunlight, heat, oil, or grease until installed.

1. Do not use any gaskets showing signs of checking, weathering or other deterioration.

2. Do not use gasket material stored in excess of six months without approval.

1.4 FIELD CONDITIONS

A. Repair of Sanitary Sewers and Services: Rebed, in compacted select fill material, sanitary sewers which cross over the new pipe or which cross under the new pipe with less than 12 inches clear vertical separation. Compact the bedding to densities required for new pipeline construction and extend bedding below the sewer to undisturbed earth. Reconstruct sewers damaged by pipeline construction.

1. Furnish and install all materials and do all work necessary for the reconstruction or repairs of sanitary sewers and services.

2. Provide pipe for reconstruction of sanitary sewers and services meeting the appropriate specification requirements.

3. Provide pipe of the same size as the existing sewer or when the same size is not available, use the next larger size of pipe. Obtain approval of joints made between new pipe and existing pipe.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Dry Trench Bottoms: Lay pipe only in dry trenches having a stable bottom.

1. Where groundwater is encountered, make every effort to obtain a dry trench bottom.

2. If a dry trench bottom has not been obtained due to improper or insufficient use of all known methods of trench dewatering, the order to excavate below grade and place sufficient select fill material, crushed stone, or Class D concrete over the trench bottom may be given.

3. If all efforts fail to obtain a stable dry trench bottom and it is determined that the trench bottom is unsuitable for pipe foundation, obtain an order, in writing, for the kind of stabilization to be constructed.

4. Perform trench excavation and backfill in accordance with Sections 31 23 16 and 31 23 23.

3.2 INSTALLATION

A. General: Install all piping in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Arrange miscellaneous pipelines, which are shown in diagram form on the Plans, clear of other pipelines and equipment.

B. Code Requirements: Provide pipeline installations complying with AWWA C600 for iron pipe, AWWA Manual M11 for steel pipe, AWWA Manual M9 for prestressed concrete cylinder pipe, ASTM C 12 for clay pipe, ASTM D 2774 for thermoplastic pressure piping 6-inch and smaller, and as modified or supplemented by the Specifications.

C. Pipe Laying - General:

1. For pipelines intended for gravity flow, begin pipeline laying at the low end of a run and proceed upgrade.

2. Generally, lay all pipe with bells pointing ahead.

3. Carefully place each pipe and check for alignment and grade.

4. Make adjustments to bring pipe to line and grade by scraping away or filling in select fill material under the body of the pipe.

5. Wedging or blocking up the pipe barrel is not permitted.

6. Bring the faces of the spigot ends and the bells of pipes into fair contact and firmly and completely shove the pipe home.

7. As the work progresses, clean the interior of pipelines of all dirt and superfluous materials of every description.

8. Keep all lines absolutely clean during construction.

9. Lay pipelines accurately to line and grade.

D. Pipe Laying - Trenches:

1. Lay all pipelines in trench excavations on select fill bedding, Class D concrete cradle or other foundations as shown, specified or ordered in writing.

2. Properly secure the pipe against movement and make the pipe joints in the excavation as required.

3. Carefully grade and compact pipe bedding.

4. Bell Holes:

a. Cut out bell holes for each joint as required to permit the joint to be properly made and allow the barrel of the pipe to have full bearing throughout its length.

b. Thoroughly tamp bell holes full of select fill material following the making of each joint.

E. Other Foundations: Install pipelines laid on other types of foundations as specified for such other foundations or as ordered in writing.

F. Ductile Iron Pipe Mechanical Joints:

1. Assembly: In making up mechanical joints, center the spigot in the bell.

a. Thoroughly brush the surfaces with which the rubber gasket comes in contact with a wire brush just prior to assembly of the joint.

b. Brush lubricant over the gasket just prior to installation.

c. Place the gasket and gland in position, bolts inserted, and the nuts tightened fingertight.

d. Tighten the nuts with a torque wrench so that the gland is brought up toward the pipe evenly.

e. Prime all bolts by dipping with a bituminous coating, except the threads. Coat threads immediately prior to installation of nuts.

2. Torques: Apply bolt torques complying with AWWA C600.

3. Remaking of Joints: If effective sealing is not obtained at the maximum torque listed above, disassemble and reassemble the joint after thorough cleaning.

G. Ductile Iron Pipe Rubber Gasket Joints:

1. Assembly: In making up the rubber gasket joint, brush the gasket seat in the socket thoroughly with a wire brush and wipe the gasket with a cloth.

a. Place the gasket in the socket with the large round end entering first so that the groove fits over the bead in the seat.

b. Apply a thin film of lubricant to the inside surface of the gasket that will come in contact with the entering pipe.

c. Brush the plain end of the pipe to be entered thoroughly with a wire brush and place it in alignment with the bell of the pipe to which it is to be joined.

d. Exert sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket to make the joint.

2. Positioning: Before proceeding with backfilling, feel completely around the joint using a feeler gauge to confirm that the gasket is in its proper position.

a. If the gasket can be felt out of position, withdraw the pipe and examine the gasket for cuts or breaks.

b. If the gasket has been damaged, replace it with a new one before re-installing the pipe.

3. Optional Mechanical Joints: Use mechanical joint fittings that meet the requirements of Section 33 05 55 with the rubber gasket joint pipe when specified or when rubber gasket fittings are not available.

H. Ductile Iron Pipe and Steel Pipe Joint Lining: For cement mortar lined ductile iron pipe greater than 30 inches in diameter, fill all interior joint recesses with mortar and make recesses smooth and flush with adjacent pipe interior walls in accordance with

AWWA C205, Appendix A.2. For cement mortar lined steel pipe 8 inches in diameter and larger, except sleeve type coupling joints, fill all interior joint recesses with mortar and make recesses smooth and flush with adjacent pipe interior walls in accordance with AWWA C205, Appendix A.2. Use Type II portland cement in mortar for interior joint finishing of wastewater pipelines.

I. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed, and in connections built into pipelines where adjoining pipelines or structures have not been completed and are not ready to be connected.

1. Remove bulkheads encountered in connecting sewers or structures included in this Contract, or in pipelines or structures previously built, when they are no longer needed or when ordered.

J. Sleeve Type Couplings: For sleeve type couplings, equally tighten diametrically opposite bolts on the connection so that the gaskets will be brought up evenly all around the pipe.

1. Torque Wrenches: Do the final tightening with torque wrenches set for the torque recommended by the coupling manufacturer.

K. Concrete Cradle

1. General: When a concrete cradle is shown, specified, or ordered in writing, lay the pipe to grade by supporting each section on concrete blocks located near each end.

a. Shape the tops of the blocks to fit the outside diameter of the pipe.

b. Set the blocks approximately 3/8 inch low.

c. Place the pipe on the blocks on a layer of stiff mortar of sufficient thickness to bring the pipes to exact grade.

d. Timber blocking, of a type approved, may be employed in place of concrete blocks.

2. Cradle: Place Class D concrete cradle, on one side only, until it has risen above the invert on the other side, after which deposit the remainder of the concrete on both sides to the pipe spring line.

a. Prevent movement of the pipe during concrete placement.

L. Concrete Encasement: When concrete encasement is to be provided, as shown, specified, or ordered in writing, lay and block the pipeline and place concrete as specified for concrete cradle.

1. Continue the placing of concrete to provide complete encasement to the dimensions shown, specified, or ordered.

M. Valve Box Setting: Install valve boxes vertical and concentric with the valve stem.

1. Satisfactorily reset any valve box which is moved from its original position, preventing the operation of the extension valve stem.

2. Replace any extension valve stem which has been damaged so that it can be operated.

N. Jacking:

1. General: Perform jacking as shown. After jacking is completed, seal the ends of the casing pipe with brick masonry.

2. Jacking Pit: Provide jacking pit of adequate length to provide room for the jacking frame, the jacking head, reaction block, the jacks, rig, and jacking pipe.

a. Construct the pit to be sufficiently wide to allow ample working space on each side of the jacking frame and sufficiently deep so that the invert of the pipe will be at the elevation desired for the completed line when placed on the guide frame.

b. Tightly sheet the pit and keep it dry at all times.

c. Provide adequate protective railings at the top of the pit at all times.

3. Jacking Frame: Design the jacking frame so that it applies a uniform pressure over the entire pipe wall area of the pipe to be jacked.

4. Reaction Blocks: Adequately design the reaction blocks to carry the thrust of the jacks to the soil without excessive soil deflection in a manner which avoids any disturbance of adjacent structures or utilities.

5. Hydraulic Jacks: Use hydraulic jacks in the jacking operation, and take extreme care to hold the casing pipe to exact line and grade.

6. Advance Excavation: Advance excavation by augering.

7. Casing Pipe: Furnish steel casing pipe, unless otherwise specified, conforming to ASTM A 139 with wall thicknesses and pipe diameters shown on the Plans. Provide full penetration butt welded pipe joints.

8. Fill Material: Use fill material, consisting of 1-1/4 pounds of Bentonite per gallon of water, during jacking to fill any voids between the casing pipe and the earth.

O. Erection:

1. Anchorage: Place anchorage of pipelines and appurtenances as shown or as ordered.

a. Accomplish anchorage by placing concrete to the dimensions shown between undisturbed earth and the fitting to be anchored.

2. Valve Setting: Erect valves carefully in their proper positions, free from all distortion and strain, with flanged, mechanical or push-on joints, and pack and leave in satisfactory operating condition.

3. Short Tunnel Construction: Joint pipes to be placed in short tunnels prior to being placed into position.

a. Place the pipe into position in a manner which keeps joints tight.

3.3 FIELD QUALITY CONTROL

A. Testing: Test pipelines in accordance with Section 01 45 50.

1. Test valves in place, as far as practicable, and correct any defects in valves or connections.

B. Inspection: Clean, inspect, and examine each piece of pipe and each fitting and special for defects before it is installed.

1. Cut away any lumps or projections on the face of the spigot end or the shoulder.

2. Do not use any cracked, broken, or defective pieces in the work.

3. If any defective piece should be discovered after having been installed, remove and replace this piece with a sound piece in a satisfactory manner at no increase in Contract Amount.

3.4 CLEANING

A. General: Thoroughly clean all pipe before it is laid and keep it clean until it is accepted in the completed work.

B. Removal of Materials: Exercise special care to avoid leaving bits of wood, dirt, and other foreign particles in the pipe. If any particles are discovered before the final acceptance of the work, remove and clean the pipe.

3.5 SCHEDULE

A. Definitions: Abbreviations used in the schedule are:

1. Pipe Materials:

a.	DI	Ductile Iron
b.	PVC	Polyvinyl Chloride
c.	FRP	Fiberglass Reinforced Plastic

2. Joints:

a.	FWC	Filament Wound Coupling
b.	MJ	Mechanical Joint
c.	RPO	Restrained Push-on Joint
d.	RRG	Restrained Retainer Gland
e.	SW	Solvent Weld

3. Coatings and Linings:

a.	CL	Cement-Mortar Lined
b.	CE	Ceramic Epoxy Lined (Protecto 401)
c.	E	Epoxy
d.	PEW	Polyethylene Wrapped

B. Schedule: Provide products as listed in the following schedule. Provide type of pipes not scheduled similar in type and quality to that provided for scheduled pipes that are to be used for similar purposes. Schedule is provided for convenience and accuracy is not guaranteed.

BURIED PIPING SCHEDULE

Service	Size (Inches)	Pipe Material	Protective Coatings Int.	Protective Coatings Ext.	Joints	Test Pressure (psig)	Pipe Class or Thickness	Remarks
OPTION A								
Third River Crossing	42	CCFRPM	E	--	FWC	15	See Section 33 05 61	(1, 2, 3)
OPTION B								
Third River Crossing	42	CCFRPM	E	--	FWC	15	See Section 33 05 61	(1, 2, 4)
FOR BOTH OPTIONS								
Interconnection	36, 42	CCFRPM	E	--	FWC	15	See Section 33 05 61	(1, 2)
ADDITIVE ALTERNATE NO. 1								
Sump Pump Discharge	2	PVC	--	--	SW	20	Schedule 80	(1, 2)
Sanitary Force Main	36	DI	CE	PEW	RRG, RPO, MJ	50	Class 53	(1,2, 5)

Remarks:

(1) Measure the test pressures shown in the schedule at the centerline of the pipeline's low point. Adjust test pressures measured at other locations accordingly.
(2) Perform all Leak Testing in accordance with Specification Section 01 45 00.
(3) Provide Concrete Encasement in accordance with the Contract Drawings
(4) Pipe size and class shown, shall be provided at a minimum. Final pipe size and class to be finalized based on meeting the requirements of Specification Section 31 70 10
(5) Provide restrained joints at all joints, including those at fittings, valves and between pipe segments.

END OF SECTION

SECTION 33 05 55

BURIED DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing buried ductile-iron pipe, fittings and appurtenances.

1. Provide ductile-iron pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation in and completion of the pipelines to be constructed.

2. Provide flanged, plain end or rubber gaskets (push-on or mechanical joint) of the types, sizes and classes shown or specified.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Test
2. Section 33 05 50 - Laying and Jointing Buried Pipelines

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C104/ A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3 In. Through 48 In., for Water and Other Liquids

4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

5. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Threaded Flanges

6. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids

7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings, 3 In. Through 64 In., for Water Service

8. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

9. AWWAC606 - Grooved and Shouldered Type Joints

10. ASTM A 307 - Carbon Steel Externally Threaded Standard Fasteners

1.3 SYSTEM DESCRIPTION

A. Design Standards: Provide ductile-iron pipe meeting the requirements of AWWA C151/A21.51.

1. Provide pipe of the various sizes as specified in the schedule or shown, except provide minimum Thickness Class 53 for pipe with threaded flanges. Locate restrained joints as specified in the schedule or shown.

2. Construct concrete encasements where shown.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Submit the following shop drawings:

1. Pipe joints, fittings, sleeves and cleanouts. Where special designs or fittings are required, show the Work in large detail and completely describe and dimension all items.

2. Fully dimensioned drawings of piping layouts, including fittings, couplings, sleeves, cleanouts, valves, supports and anchors. Label pipe size, materials, type, and class on drawings and include the limits of each reach of restrained joints. Provide cross sections showing elevations of cleanouts, pipes, fittings, sleeves, and valves.

3. Catalog data for pipe, joints, fittings, sleeves, harnessing and cleanouts.

C. Quality Control: Submit certificate of compliance for pipe, fittings, gaskets, lining, polyethylene encasement, coatings, specials, sleeves and cleanouts in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all pipe, fittings and appurtenances as specified in Division 1 and Section 33 05 50.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Manufacturers of equivalent products may be submitted.

1. Ductile-iron pipe and fittings.

    a. American Cast Iron Pipe Company
    b. McWane Incorporated
    c. United States Pipe and Foundry

2. Ductile-iron retainer glands.

    a. 3-inch through 24-inch diameter
        (1) Nappco, Inc. Series 1246
        (2) EBBA Iron, Inc. Series 100

    b. larger than 24-inch diameter
        (1) EBAA Iron, Inc. Megalug

3. Restrained push-on joints.

    a. U.S. Pipe and Foundry TR Flex
    b. McWane Inc. Super-Lock
    c. American Cast Iron Pipe Company Lok-Ring or Flex-Ring

4. Gaskets.

    a. John Crane, Inc.
    b. Garlock Packing Company
    c. U.S. Rubber Company
    d. American Cast Iron Pipe Company
    e. United States Pipe and Foundry
    f. McWane Inc.

5. Interior Pipe Lining.

    a. Protecto 401 Ceramic Epoxy

6. Approved Pipe Lining Applicators.

    a. Baumann Coatings, Inc., Bessemer, AL
    b. Vulcan Materials, Birmingham, AL
    c. Bredero Shaw Company, Houston, TX

2.2 MATERIALS

A. Rubber Gasket Joints: Provide mechanical joints and push-on type joints meeting the requirements of AWWA C111/A21.11.

B. Harnessing: For ductile-iron pipe and fittings with mechanical joints that require harnessing, provide ductile-iron mechanical joint retainer glands.

1. Coatings: Coat the assembly with two heavy coats of asphalt varnish conforming to AWWA C151/A21.51 after installation.

2. Joint Assemblies: Design the joint assemblies to resist pullout of the joints at the test pressures specified.

C. Sleeves: Provide mechanical joint solid sleeves meeting the requirements of AWWA C110/A21.10 where shown, specified or required for connection to existing facilities.

D. Cleanouts

1. Provide cleanouts where shown or specified.

2. Size: Provide not less than 6 inch diameter cleanout openings for pipe 8 inches in diameter or larger. Provide cleanout openings for pipe 6 inches in diameter or smaller of the same diameter as the pipe.

3. Cleanout Covers: Provide cleanout covers which are blind flanges meeting the requirements of AWWA C110/A21.10, except where conformation is required with the inside curvature of the pipeline, in which case the covers are flanged plugs of proper shape with American Standard flange drilling.

    a. Fasten covers by means of steel studs and bronze nuts. Drill and tapcovers for a 1-1/2-inch diameter pipe connection.

4. Plugs: Equip the flange of conformed plugs with a dowel or other suitable means for proper setting.

E. Wall Castings, Connecting Pieces, and Special Fittings

1. General: Provide wall castings and connecting pieces, such as bell and bell, bell and spigot, bell and flange, flange and flange, flange and spigot, and flange and flare, meeting the requirements of AWWA C110/A21.10.

2. Design: Provide special fittings, where required, of an approved design that have the same diameters and thicknesses as standard fittings, unless otherwise required, but their laying lengths and other functional dimensions are determined by their positions in the pipeline and by the particular piping materials to which they connect.

3. Intermediate Collar: Where watertightness is essential and at other locations where indicated, provide wall castings with an integrally cast intermediate collar located at the center of the wall.

F. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed and are not ready to connect.

1. Remove all temporary bulkheads when they are no longer needed.

G. Linings and Coatings

1. Ceramic Epoxy Interior Lining: Provide pipe with a ceramic epoxy lining not less than 40 mils nominal dry film thickness. Line exterior of spigot ends and interior of socket with ceramic epoxy 8 to 10 mils nominal dry film thickness. Pipe lining material shall be applied in accordance with the lining manufacturer recommendations.

2. Asphaltic Exterior Coating: Shop coat pipe that is to be buried with the standard asphaltic outside coating specified in AWWA C151/A21.51.

3. Polyethylene Encasement: Provide loose polyethylene encasement meeting the requirements of AWWA C105/A21.5, Method “A”. Install polyethylene encasement in accordance with pipe manufacturer’s recommendations.

4. Encased Pipe: Do not coat or paint the outside of fittings and pipe that are to be encased in concrete.

5. Labels: Paint the size, class designation, manufacture date, and control number in white on the outside of each pipe, fitting, and special casting after the shop coat has hardened.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all buried ductile iron pipe and fittings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1 and Section 33 05 50.

3.2 LEAKAGE TESTING

A. Cleaning: Flush clean and test all pipes after installation.

B. Testing: Test pipes for leaks and repair or tighten as required.

C. Procedures: Conduct tests in accordance with Specification Section 01 45 50.

3.3 SCHEDULES

A. Refer to the Schedules contained in Section 33 05 50 Laying and Jointing Buried Pipelines for information on the piping that is to be constructed using the pipe materials and methods specified herein.

END OF SECTION

SECTION 33 05 57

BURIED POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing buried PVC pipe, fittings and appurtenances.

1. Provide PVC pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation in and completion of the pipelines to be constructed.

2. Provide plain end or rubber gaskets (push-on or mechanical joint) of the types, sizes and classes shown or specified.

B. Related Work Specified In Other Sections Includes:

1. Section 01 45 50 - Leakage Testing
2. Section 33 05 50 - Laying and Jointing Buried Pipelines
3. Section 33 05 55 - Buried Ductile-Iron Pipe and Fittings
4. Section 40 05 18 - Miscellaneous Pipe and Fittings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 In., for Water Distribution

2. AWWA C905 - Polyvinyl chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. through 36 In.

3. ASTM D 2321 - Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity-Flow Applications

4. ASTM F 477 - Elastomeric Seals (Gaskets) For Joining Plastic Pipe

5. ANSI A21.10 - Ductile-Iron and Gray-Iron Fittings 3 inches through 48 inches, for Water and Other Liquids

6. ANSI A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray Iron Pressure Pipe and Fittings

1.3 SYSTEM DESCRIPTION

A. Design Standards: Provide 4-inch through 12-inch PVC pressure pipe meeting the requirements of ANSI/AWWA C900. Provide 14-inch through 36-inch PVC pressure pipe meeting the requirements of ANSI/AWWA C905. Provide mechanical joint ductile-iron pipe fittings for PVC pressure pipe meeting the requirements of Section 33 05 55. For PVC pressure pipe less than 4-inches, provide pipe meeting requirements of Section 40 05 18.

1. Provide pipe of the various sizes and classes as specified in the schedule or shown. Restrain all pressure pipe joints at fittings and within 50 feet of all fittings.

2. Construct concrete encasements where shown.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Submit the following shop drawings:

1. Pipe joints, fittings, sleeves and cleanouts. Where special designs or fittings are required, show the work in large detail and completely describe and dimension all items.

2. Fully dimensioned drawings of piping layouts, including fittings, couplings, sleeves, cleanouts, valves, supports and anchors. Label pipe size, materials, type, and class on drawings and include the limits of each reach of restrained joints. Provide cross sections showing elevations of cleanouts, pipes, fittings, sleeves, and valves.

3. Catalog data for pipe, joints, fittings, sleeves, harnessing and cleanouts.

C. Quality Control: Submit certificate of compliance for pipe, fittings, gaskets, coatings, specials, sleeves and cleanouts in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all pipe, fittings and appurtenances as specified in Division 1 and Section 33 05 50.

PART 2 PRODUCTS

2.1 MATERIALS

A. Joints for Pressure Pipe: Provide pipe with bell ends in accordance with AWWA C900 and AWWA C905. Provide joints with elastomeric gasket joints.

B. Elastomeric Gasket Joints: Provide elastomeric gasket joints in accordance with ASTM F 477.

C. Rubber Gasket Joints: Provide mechanical joints meeting the requirements of ANSI A21.11.

D. Harnessing: Series 1600 , Series 2800 and Series 2000 PV as manufactured by EBAA Iron Sales, Inc., or equal.

E. Color: Provide pipe made of 100 percent of the color specified. Provide green sewer pipe. Provide blue force main pipe.

F. Pressure Pipe Outside Diameter: Provide pressure pipe of the outside diameter consistent with ductile-iron pipe.

G. Pipe Marking: Provide mark on each pipe at internals of 5 feet or less to designate compliance with applicable ASTM or AWWA specification.

H. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed and are not ready to connect.

1. Remove all temporary bulkheads when they are no longer needed.

I. Date of Manufacturer: Provide pipe and fittings manufactured no earlier than 12 month period proceeding the date of the Agreement.

J. Wall Thickness for PVC Pressure Pipe: Provide Class 150 with a Dimension Ratio of DR-18 conforming to AWWA C900.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all buried PVC pipe in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1 and Section 33 05 50. Where PVC pipe is buried, include a No. 10, solid insulated copper tracer wire located over the crown of each PVC pipe.

3.2 LEAKAGE TESTING

A. Cleaning: Flush clean and test all pipes after installation.

B. Testing: Test pipes for leaks and repair or tighten as required.

C. Procedures: Conduct tests in accordance with Specification Section 01 45 50.

3.3 SCHEDULES:

A. Refer to the Schedules contained in Section 33 05 50 Laying and Jointing Buried Pipelines for information on the piping that is to be constructed using the pipe materials and methods specified herein.

END OF SECTION

SECTION 33 05 61

FIBERGLASS PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing centrifugally cast glass fiber reinforced thermosetting resin pipe, fittings and appurtenances. Provide fabricated pipe, fittings and appurtenances with sizes, joint types and thicknesses as shown or specified.

B. Related work specified in other sections includes:

1. Section 01 45 50 - Leakage Tests
2. Section 31 23 16 - Excavation - Earth and Rock
3. Section 31 23 23 - Backfilling
4. Section 33 05 50 - Laying and Jointing Buried Pipelines

1.2 REFERENCES

A. ASTM D3262 - Standard Specification for Fiberglass Sewer Pipe.

B. ASTM D4161 - Standard Specification for Fiberglass Sewer Pipe Joints Using Flexible Elastomeric Seals.

C. ASTM D2412 - Standard test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

1.3 SYSTEM DESCRIPTION

A. Design Standards: Provide centrifugally cast fiberglass pipe and fittings meeting the requirements of ASTM D3262-06, designed for direct burial, except as otherwise specified. Manufacture pipe with a controlled outside diameter in accordance with ASTM D3262 for nominal diameters 18-inches to 48-inches. Provide a minimum pipe wall thickness of 1.08 inches and a minimum stiffness of 72 psi. Base the pipe stiffness on a 5% deflection per ASTM D-2412. Supply pipe in nominal lengths of 20 feet. Furnish at least 90% of the total footage in nominal length sections. Square pipe ends to the pipe axis with a maximum tolerance of 1/8 inch. Provide pipe joints and wall fittings of the sleeve overwrapped type mechanically locked to an internal full-face elastomeric seal gaskets, capable to withstand 0.4 psi of negative internal pressure. Manufacturer the liner so that sand will not be present in the liner.

1.4 SUBMITTAL

A. General: Provide all submittal as specified in Division 1, and including the following shop drawings:

1. Pipe joints and fittings, and couplings. Where special designs or fittings are required, show the Work in large detail and completely describe and dimension all items.

2. Fully dimensioned drawings of layout of special designs, fittings, couplings, and all appurtenances. Label pipe size, materials, type, and class on drawings.

3. Cross sections showing elevations of pipes, fittings, couplings, and all appurtenances.

4. Catalog data for pipe, fittings, and couplings.

5. Certification from the resin manufacturer stating that the liner resin meets minimum 50% elongation when tested in accordance with ASTM D638. Resin manufacturer test report should be included with submittals.

B. Quality Controls: Submit certificates of compliance for pipe, fittings, gaskets, specials, couplings, and appurtenances in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all pipe, fittings and couplings as specified in Division 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below.

1. Hobas Pipe USA, Inc.

2.2 MATERIALS

A. Resin System: Provide only polyester resin systems with a proven history of performance from a composite material of similar construction and composition as proposed for this product for this particular application.

B. Glass Reinforcements: Provide quality commercial E-glass filaments with binder and sizing compatible with impregnation resins.

C. Silica Sand: Use minimum 98% silica with a maximum moisture content of 0.2%.

D. Additives: Use resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., that do not detrimentally effect the performance of the product.

E. Elastomeric Gaskets: Provide gaskets supplied by approved gasket manufacturers and suitable for the service intended.

2.3 MANUFACTURE AND CONSTRUCTION

A. Pipes: Manufacture pipe by a centrifugal casting process that results in a dense, non-porous, corrosion-resistant, consistent composite structure.

B. Joints: Utilize elastomeric sealing gaskets made of EPDM rubber compound as the sole means to maintain water tightness. Provide joints meeting the requirements of ASTM D4161. For connection of pipes with wall thimbles, provide a FWC coupling at the plain end of the F thimble, at a distance recommended by the FRP manufacturer, from the wall. Provide a second FWC coupling at 6 feet away from the first FWC coupling.

C. Fittings: Provide flanges, elbows, reducers, tees, wyes, laterals and other fittings capable of withstanding all operating conditions when installed. They may contact molded or manufacturer from mitered sections of pipe joined by glass-fiber-reinforced overlays.

D. Thrust Blocks: Provide thrust blocks to restrain all fittings, if determined that they are required.

2.4 QUALITY CONTROL

A. General: Test pipe in accordance with ASTM D3262.

B. Shop Testing: Provide shop test prior to shipping pipe to the site.

C. Customer Inspection: the Owner or other designated representative is entitled to inspect pipes or witness the pipe manufacturing. The manufacturer must provide the Owner with adequate advance notice of when and where the production of the pipe will take place.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation: Install all pipe, fittings and appurtenances in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Burial (or encasement): Provide bedding and burial (or encasement) of pipe, fittings and appurtenances in accordance with the project plans and specifications and the manufacturer's requirements.

C. Jointing

1. Clean ends of pipe and coupling components.

2. Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricant approved by the pipe manufacturer.

3. Use suitable equipment and end protection to push or pull the pipe together. Do not push on the FWC end of the pipes when joining them in the field.

4. Do not exceed forces recommended by the manufacturer for coupling pipe.

5. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed the deflection permitted by the manufacturer.

3.2 LEAKAGE AND DEFLECTION TESTS

A. Low Pressure Air Test: All Leak Testing shall be in accordance with Specification Section 01 45 50.

B. Deflection Test: Maximum allowable long-term deflection is 5% of the initial diameter. Testing for deflection can be required upon the OWNERS request.

END OF SECTION

SECTION 40 05 01

SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing all hanging and supporting devices of construction shown, specified, or required for pipelines, apparatus, and equipment other than electrical equipment.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 05 05 13 - Galvanizing
2. Section 05 12 00 - Structural Steel
3. Section 09 96 00 - High Performance Coatings
4. Section 40 05 10 - Erecting and Jointing Interior Piping
5. Section 40 05 16 - Ductile Iron Pipe and Fittings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, 800
2. ASME B31.1 - Power Piping (Includes Revision Service)
3. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
4. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture
5. MSS SP-69 - Pipe Hangers and Supports - Selection and Application
6. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices
7. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit shop drawings to show the quantity, type, design and location of all supports, hangers and anchors required.

C. Submit a CERTIFICATE (ONLY), signed and sealed by a Licensed Professional Engineer experienced in structural Engineering and registered in the State where the construction will be performed, that certifies that the Licensed Professional Engineer has evaluated and approved the CONTRACTOR's supports and anchors as detailed on the submittal drawings and has prepared complete design calculations confirming the adequacy of all supports, hangers, anchors and expansion compensating devices used. Provide a separate CERTIFICATE for each piping system before starting the installation.

1.4 SYSTEM DESCRIPTION

A. General: System includes supporting devices adequate to maintain the pipelines, apparatus, and equipment in proper position and alignment under all operating and testing conditions with due allowance for expansion and contraction.

B. Design Requirements: Design supporting devices in accordance with the best practice and provide supporting devices that are not unnecessarily heavy. Design supporting devices to accommodate loads imposed during leakage tests for the test pressures specified. Base the required strength of supporting devices on the combined weight of the piping and connected equipment, the weight of the denser of the fluids used in operations or testing and the weight of insulation where applicable. Install supports with a working safety factor of not less than 5, and conform installation to requirements of Section 05 12 00.

C. Provide springs where necessary. Make hangers and supports of standard design where possible and best suited for the service required. Include proper pipe protection saddles for hangers and supports on pipes which are covered with insulation. Where required, make supports screw adjustable after installation unless approved otherwise.

D. Interference: Design all supporting devices so as to minimize interference with access and movement. Eliminate the potential for injuries due to protruding supporting devices.

E. Sizing: Provide base piping support, hanger rod size, brackets and spacing meeting the requirements of ASME B31.1, MSS SP-58, SP-69, SP-89 and SP-90 except as modified herein.

1. Modify hangers for plastic pipes to increase the bearing area by inserting a protective sleeve of medium-gauge aluminum sheet metal between the pipe and the hanger.

    a. Align hangers such that no sharp edges come in contact with the pipe.

    b. Provide a wooden or thermoplastic pad between the plastic pipe and any concrete or masonry surface.

    c. Use supports for vertical lines of a type which do not exert a compressive strain on the pipe. Riser-type clamps that squeeze the pipe will not be permitted.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Pipe hangers and supports

    a. Grinnell Corporation, Cranston, RI
    b. Globe Pipe Hanger Products, Inc., Cleveland, OH

2. Sheet metal shield

    a. "Thermal-Hanger Shields" by Pipe Shields Incorporated, Vacaville, CA

2.2 MATERIALS

A. Use structural and miscellaneous steel, metal castings, ductile iron pipe and fittings, steel pipe and fittings, and supports meeting the requirements of Sections 05 12 00.

B. Support overhead hangers using threaded rods properly fastened in place by suitable screws, clamps, inserts, or bolts, or by welding. Subject hangers to tensile loading only. Where lateral or axial movement may occur, provide suitable linkage to permit sway.

C. Suspended Piping: Support suspended piping by adjustable ring or clevis hangers and threaded rods from heavy duty concrete inserts or other fastening devices, except as otherwise specified or noted.

D. Brackets: Make brackets of welded steel and designed for the following load classifications.

Load Classification	Maximum Load per Bracket
Light	750 pounds
Medium	1,500 pounds
Heavy	3,000 pounds

1. When medium or heavy brackets are bolted to vertical surfaces, furnish and install backplates of adequate size and thickness to distribute the load against the vertical surfaces.

2. When the use of backplates is not practicable, fasten the brackets to the vertical surfaces in such a manner that the safe bearing strength of the vertical surfaces will not be exceeded.

E. Chairs and Pipe Rolls: Use cast-iron pipe rolls or chairs. Provide pipe rolls with threaded nuts or with sockets to take threaded rods.

F. Saddle Stands: Use adjustable saddle stands.

1. Provide each stand with a length of steel pipe fitted at the base with standard threaded cast-iron flange or steel base plate and at the top with an adjustable saddle or roll. Bolt the base flange or plate to the floor, foundation or concrete base.

2. Use stanchions of construction similar to the saddle stand, except fit them at the top with cast-iron pipe saddle supports or with pipe stanchion saddles with yokes and nuts.

G. Insulation Support Requirements: At support points, protect insulated pipes by a 360 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 360 degree sheet metal shield.

1. Make inserts of the same thickness as the adjoining pipe insulation.

2. Provide the shield length, minimum galvanized sheet metal gauge and installation procedure in accordance with the manufacturer's recommendations.

3. Extend insulation inserts one inch beyond the sheet metal shields on cold water lines, and jacket and vapor seal as required when the abutting insulation is installed.

H. Expansion: Connect, support and guide piping to permit and control pipe expansion and contraction and to accommodate building expansion, contraction and settling without damage to the piping or support system.

1. Furnish and install anchors when specified, shown, or required for holding the pipelines and equipment in position or alignment. Design anchors for rigid fastening to the structures, either directly or through brackets.

2. Provide cast-iron chair type anchors for piping with steel straps, except where anchors form an integral part of pipe fittings or where an anchor of special design is required.

3. Inserts: Provide galvanized concrete inserts.

a. Design inserts to permit the rods to be adjusted horizontally in one plane and to lock the rod nut or head automatically.

b. Recess inserts near the upper flange to receive reinforcing rods.

c. Design inserts so that they may be held in position during concrete placing operations. Design inserts to carry safely the maximum load that can be imposed by the rod which they engage.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install hanger and supports in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 01 and Section 40 05 10.

3.2 GALVANIZING AND PAINTING

A. Galvanizing: When specified, galvanize hangers and supports as specified in Section 05 05 13.

B. Painting: Paint hangers, supports, anchors, and similar devices as specified in Section 09 96 00.

C. Touch-Up Painting: Clean and touch-up painting of field welds, bolted connections and abraded areas as specified in Section 09 96 00.

END OF SECTION

SECTION 40 05 03

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for furnishing and installing identification materials and devices for the mechanical systems and indoor building signage for non-potable water.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Product Data: Submit the manufacturer's technical product data and installation instructions for each identification material and device required.

C. Schedules: Submit a typewritten valve schedule for each piping system, reproduced on 8-1/2-inch by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in the schedule margin.

D. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system. Provide a mock-up type sample installation.

E. Maintenance Data: Include product data and schedules in the appropriate operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide the specified items from firms regularly engaged in the manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than (5) five years.

1.5 SPARE PARTS

A. Spares: Furnish a minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain the stencils after completion of stenciling and include used stencils in the extra stock, along with the required stock of stenciling paints and applicators.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Identification Materials

a. Allen Systems, Inc.
b. Brady (W.H.) Co.; Signmark Div.
c. Industrial Safety Supply Co., Inc.
d. Seton Name Plate Corp.

2.2 MATERIALS

A. Provide the manufacturer's standard products of categories and types required for each application as referenced in other Division 40 sections. Where more than a single type is specified for an application, selection is at the CONTRACTOR's option, but provide a single selection for each product category. Comply with ASME A13.1 for lettering size, length of color fields, colors and viewing angles of identification devices.

2.3 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Provide metal stencils, prepared for the required applications with a letter sizes generally complying with the recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4 inches high letters for ductwork

and not less than 3/4-inch high letters for access door signs and similar operational instructions.

B. Stencil Paint: Provide a standard exterior type stenciling enamel, black, except as otherwise indicated, for either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Provide a standard identification enamel of the colors indicated or, if not otherwise indicated for piping systems, comply with ASME A13.1 for colors.

Piping System or Services	Color
Pant Air	Green
Sludge	Brown
Potable Water	Light Blue
Non-Potable Water	Dark Blue with Orange Stripes
Plant Service Water (Effluent)	Light Blue with Red Stripes
Drains	Grey
Gas Lines	Red

2.4 PLASTIC PIPE MARKERS (APPLIES TO PRODUCT SERVICE PIPING, CONCEALED PIPING AND PIPING NOT CONTINUOUSLY COLOR CODE PAINTED)

A. Pressure-Sensitive Type: Provide the manufacturer's standard pre- printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ASME A13.1.

B. Insulation: Furnish 1-inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Cut the insulation length to extend 2 inches beyond each end of the plastic pipe markers.

C. Small Pipes: For external diameters less than 6 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around the pipe at each location, fastened by one of the following methods:

1. Adhesive lap joint in pipe marker overlap.

2. Laminated or bonded application of pipe marker to pipe (or insulation).

3. Taped to the pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inches wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

D. Large Pipes: For external diameters of 6 inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3

times the letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).

2. Taped to the pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide; full circle at both ends of pipe marker, tape lapped 3 inches.

3. Strapped-to-pipe (or insulation) application of semi-rigid type, with the manufacturer's standard stainless steel bands.

E. Lettering: Comply with the piping system lettering nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

1. Arrows: Print each pipe marker with arrows indicating the direction of flow, either integrally with the piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

2.5 PLASTIC DUCT MARKERS

A. General: Provide the manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code:

1. Green: Cold air

2. Yellow: Hot air

3. Yellow/Green: Supply air

4. Blue: Exhaust, outside, return, and mixed air

5. For hazardous exhausts, use colors and designs as recommended by ASME A13.1

B. Nomenclature: Include the following:

1. Direction of air flow
2. Duct service (supply, return, exhaust, etc.)
3. Duct origin (from)
4. Duct destination (to)
5. Design cfm

2.6 PLASTIC TAPE

A. General: Provide the manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2 inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inches wide tape for larger pipes.

C. Color: Except where another color selection is indicated comply with ASME A13.1.

2.7 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. Provide the manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of the buried pipe.

1. Provide multi-ply tape consisting of a solid aluminum foil core between 2-layers of plastic tape.

2.8 VALVE TAGS

A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviations in 1/4-inch high letters and sequenced valve numbers 1/2-inch high. Provide a 5/32-inch hole for the fastener.

1. Provide 1-1/2-inch diameter tags, except as otherwise indicated.

2. Fill tag engraving with black enamel.

B. Valve Tag Fasteners: Provide the manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of the tags to valves, and manufactured specifically for that purpose.

C. Access Panel Markers: Provide the manufacturer's standard 1/16 inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to the concealed valve. Include a 1/8-inch center hole to allow for attachment.

D. Other Descriptions: Provide manual and automatic balancing valve tags with the valve model number, rated flow in GPM, differential pressure range and zone or unit identification for each valve.

2.9 VALVE SCHEDULE FRAMES

A. For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.10 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses required, engraved with the engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of the substrate.

B. Thickness: Provide tags 1/8 inch thick, except as otherwise indicated.

C. Fasteners: Provide self-tapping stainless steel screws, or contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.11 PLASTIC EQUIPMENT MARKERS

A. General: Provide the manufacturer's standard laminated plastic, color coded equipment markers conforming to the following color code:

1. Green: Cooling equipment and components.

2. Yellow: Heating equipment and components.

3. Yellow/Green: Combination cooling and heating equipment and components.

4. Blue: Equipment and components that do not meet any of the above criteria.

5. For hazardous equipment, use colors and designs recommended by ASME A13.1.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and drawing number

2. Equipment service

3. Design capacity

4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

C. Size: Provide approximate 2-1/2-inch x 4-inch markers for control devices, dampers, and valves; and 4-1/2-inch x 6-inch for equipment.

2.12 PLASTICIZED TAGS

A. Provide the manufacturer's standard pre-printed or partially preprinted accident-prevention tags, of plasticized card stock with a matte finish suitable for writing, which are approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.13 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification Work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by the manufacturers or as required for proper identification, operation and maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of the same generic name are shown and specified, provide identification which indicates the individual system number as well as the service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation: Degrease and clean surfaces to receive adhesive for identification materials.

1. Prepare surfaces in accordance with Section 09 96 00 for stencil painting.

3.2 INSTALLATION

A. General: Install identification system materials in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install the identification after completion of the covering and painting. Install the identification prior to installation of acoustical ceilings and similar removable concealment.

3.3 DUCTWORK IDENTIFICATION

A. General: Identify air supply, return, exhaust, intake and relief ductwork with duct markers, or provide stenciled signs and arrows, showing ductwork service and direction of flow, in black or white (whichever provides the most contrast with the ductwork color).

B. Location: In each space where ductwork is exposed, or concealed only by a removable ceiling system, locate signs near points where the ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacings along exposed runs. Paint all exposed ductwork per color selection as approved.

C. Access Doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

3.4 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system and include arrows to show normal direction of flow:

1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend the color band or rectangle 2 inches beyond ends of lettering.

2. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot noninsulated pipes.

3. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

B. Color Coding: Continuously paint and color code all exposed piping to allow for quick identification. Paint each piping system a different color as selected and approved.

C. Identifier Location: Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior nonconcealed locations.

1. Near each valve and control device

2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be a question of the flow pattern

3. Near locations where pipes pass through walls or floors/ceilings, or enter nonaccessible enclosures

4. At access doors, manholes and similar access points which permit view of the concealed piping

5. Near major equipment items and other points of origin and termination

6. Spaced intermediately at a maximum spacing of 50 feet along each piping run, except reduce spacing to 25 feet in congested areas of piping and equipment

7. On piping above removable acoustical ceilings, except omit intermediately spaced markers

3.5 UNDERGROUND PIPING IDENTIFICATION

A. During back-filling and placing of top-soil over each exterior underground piping system, install a continuous underground-type plastic line marker, located directly over the buried line at 6 to 8 inches below the finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16 inches, install a single line marker. For tile fields and similar installations, mark only the edge pipe lines within the field.

3.6 VALVE IDENTIFICATION

A. General: Provide a valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in the valve schedule for each piping system.

B. Valve Designations: Identify valves with 13-digit alpha-numeric Antero designations of the form XXXX-XXXX-XXXXX as shown, specified or provided by the ENGINEER. The “Antero Equipment Tagging” requirement is attached at the end of this section.

C. Location: Mount the valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed. Where more than one major machine room is shown for the Project, install a mounted valve schedule in each major machine room, and repeat on the schedule only main valves which are to be operated in conjunction with operations of more than single machine room.

3.7 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device, as specified if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets

2. Meters, gauges, thermometers and similar units

3. Fuel-burning units including boilers

4. Pumps, compressors, chillers, condensers and similar motor-driven units

5. Fans, blowers, primary balancing dampers and mixing boxes

6. Packaged HVAC central-station or zone-type units

7. Tanks and pressure vessels

8. Strainers, filters, humidifiers, water treatment systems and similar equipment

B. Lettering Size: Use a minimum 1/4 inch high lettering for name of unit where viewing distance is less than 2 feet 0 inches, 1/2-inch high for distances up to 6 feet 0 inches, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of the size of the principal lettering.

C. Text of Signs: Identify equipment with 13-digit alpha-numeric Antero designations of the form XXXX-XXXX-XXXXX as shown, specified or provided by the ENGINEER. In addition to the equipment designation, inform the operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. The “Antero Equipment Tagging” requirement is attached at the end of this section.

3.8 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by the Work of this division or other divisions.

B. Cleaning: Clean the face of identification devices, and glass frames of valve charts.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 40 05 10

ERECTING AND JOINTING INTERIOR AND EXPOSED EXTERIOR PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing of supports and hangers and installation of all interior and exposed exterior piping and supports.

1. Furnish, support, hang and install piping of the materials, coatings and linings shown or specified at locations as specified or where shown.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 00 - Leakage Tests
2. Section 05 05 13 - Galvanizing
3. Section 07 90 00 - Joint Sealers
4. Section 09 96 00 – High Performance Coatings
5. Section 40 05 01 - Supports and Anchors

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASME B1.20.1 - Pipe Threads, General Purpose, Inch

2. ASME B31.1 - Power Piping with Addenda

3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

1.3 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 and as follows:

1. Take extreme care in loading and unloading the pipe and fittings. Do the work slowly using skids or suitable power equipment, and keep the pipe under control at all times.

2. Handling Procedures: Under no condition is the pipe to be dropped, bumped, dragged, pushed or moved in any way which will cause damage to the pipe, lining or coating.

3. Use of Slings: When handling the pipe with a crane, use a suitable pipe hook or sling around the pipe. Under no condition is the sling to be allowed to pass through the pipe unless adequate measures are taken to prevent damage to the pipe ends, lining and coating.

4. Damage: If any piping or fittings are damaged in the process of delivery, storing, handling, or laying, replace or repair such piping or fittings as approved.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Pipe Dope for Threaded Joints

a. Masters Metallic Compound by Harbinseal Corporation

2.2 MATERIALS

A. Provide hangers and supports and all necessary appurtenances as specified in Section 15060.

2.3 FABRICATION

A. Coating: Provide all threads coated with a suitable pipe dope, Masters Metallic Compound, graphite and engine oil, or equal, before jointing.

PART 3 EXECUTION

3.1 PREPARATION

A. Galvanizing and Painting: Galvanize as specified, in accordance with Section 05 05 13.

1. Paint hangers, supports, anchors, and similar devices as specified in Section 09 96 00.

3.2 INSTALLATION

A. General: Install all piping in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

2. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications, with 1-inch clearance outside the insulation.

3. Place pipe runs to minimize obstruction to other work.

4. Install piping to allow for expansion and contraction without stressing pipe, joints or connected equipment.

5. Slope piping as shown and arrange systems to drain at low points.

6. Do not penetrate building structural members unless shown.

7. Locate groups of piping parallel to each other and at common elevations whenever practical, spaced to permit applying insulation and servicing of valves.

8. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Section 07 90 00 for special sealers and materials.

9. Arrange miscellaneous pipelines, which are shown in diagram form on the Plans, clear of other pipelines and equipment.

10. Fit and install pipelines in a neat and workmanlike manner in accordance with approved shop drawings.

11. Provide an adequate number of unions in main pipe and branch pipe runs to facilitate dismantling or removal of pipeline sections without disturbing adjacent branch or connecting lines.

12. Install suitable sleeves at all points where pipes pass through walls or floors of structures and where wall castings are not provided.

13. Include proper pipe protection saddles on pipes which are covered with insulation.

B. Flanged Joints: Make flanged joints with bolts or bolt studs with a nut on each end.

1. Field Flanges: Shop screw threaded flanges to pipe unless threading in the field is permitted with prior approval.

2. Flange to Pipe Assembly: Assemble pipe to be fitted with threaded flanges as follows:

   a. Accurately thread pipe and flanges to the appropriate gauge, screw flanges on by heavy machinery until the end of the pipe projects beyond the face of the flange and a tight metal-to-metal joint is produced without evidence of heat in the threaded portion.

   b. Cut the projecting end of the pipe off flush with the face of the flange.

   c. Make a light refacing cut across both the end of the pipe and the face of the flange at right angles to the center line of the pipe and then ream the pipe.

   d. Flanged to Flange Assembly: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by bolt manufacturer.

C. Threaded Joints: Conform threaded joints to ASME B1.20.1, tapered pipe threads for field cut threads unless otherwise specified. Join pipe, fittings, and valves as follows:

1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. Assemble joint to produce a tight joint without evidence of heat in the threaded portion. When using a pipe wrench on valves, place wrench on valve end into which pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If weld opens during cutting or threading operations, do not use that portion of pipe.

6. Retightening: Once a threaded joint has been assembled, it is not to be backed off unless the threads are recleaned and new compound or tape applied before rejointing.

D. Mechanical Joints: In making up mechanical joints, center the spigot in the bell.

1. Thoroughly brush the surfaces with which the rubber gasket comes in contact, with a wire brush just prior to assembly of the joint.

2. Brush pipe manufacturers recommended lubricant over the gasket just prior to installation.

3. Place the gasket and gland in position, insert bolts, and fingertighten nuts.

4. Tighten the nuts with a torque wrench to bring the gland up toward the pipe evenly.

5. Torques: Apply bolt torques complying with AWWA C600.

6. Effective Sealing: If effective sealing is not obtained at the maximum torque listed, disassemble and reassemble the joint after thorough cleaning.

E. Sleeve Type Couplings: For sleeve type couplings, equally tighten diametrically opposite bolts on the coupling to bring the gaskets up evenly all around the pipe.

1. Torque Wrenches: Do final tightening with torque wrenches set for the torque recommended by the coupling manufacturer.

F. Welding: Comply welding of pipe joints with the requirements of ASME B31.1 unless otherwise specified. Do all off site welding of steel pipe conforming to the appropriate requirements.

1. Procedures: Confirm that pipe and fittings with wall thickness of 3/16-inch and larger have ends beveled for welding, and that the parts to be welded are securely held in place and are in proper alignment during welding.

a. Separate the abutting pipe ends before welding to permit complete fusion to the inside wall of the pipe without overlapping.

b. Provide welding continuous around the joint and completed without interruption.

c. Provide welds of the single vee butt type, of sound weld metal thoroughly fused into the ends of the pipe and into the bottom of the vee.

d. Provide welds free from cold shuts, pinholes, oxide inclusions or other defects.

G. Anchors and Stands: Furnish and install anchors and stands when specified, shown, or required for holding the pipelines and equipment in position or alignment.

1. Small Piping Supports: Where adjustable supporting devices are not required, support pipelines 3 inches in diameter and smaller on cast-iron, malleable iron, or steel hooks, hook plates, rings or ring plates.

H. Hangers and Supports

1. Direction Changes: Provide pipe hangers at each change in pipe direction, on both sides of pipe mounted valves and equipment and on both sides of pipe loops and expansion absorbing devices.

2. Brackets: Use brackets for the support of piping from vertical surfaces.

3. Anchors: Furnish and install anchors when specified, shown, or required for holding the pipelines and equipment in position or alignment.

4. Inserts: Install galvanized inserts in concrete structures where required for fastening supporting devices.

5. Fire Protection System Piping: Support fire protection system piping independently from other piping systems.

6. Controlled Movements: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

7. Load Distribution: Adjust hangers to distribute loads equally on the attachment and to achieve any indicated slope of the pipe.

I. Cast Iron Soil Pipe and Fittings

1. Joints: Provide joints of neoprene gasket compression type or lead and oakum.

a. Thoroughly caulk leaded joints with picked oakum and molten lead.

b. Use twelve ounces of soft pig or bar lead in each joint for each 1-inch of pipe diameter.

c. Pour all lead in at one time.

d. Finish the face of lead joints with the face of the hub and leave without putty, paint or cement.

e. Extend gasket on rubber gasket joints the full depth of the bell and overlap the face of the bell

2. Connection: Provide all joints to be leakproof and gastight.

3.3 FIELD QUALITY CONTROL

A. Tests: After installation of the interior and exposed exterior piping and supports, control equipment and all appurtenances, subject the units to a field running test, as specified in Division 1, under actual operating conditions. Where field welding of pipe joints shown, specified, permitted, or required meet the requirements of ASME B31.1 -Power Piping, Chapter VI (Section 136.4.2 Visual Examination) (Section 137.4 Hydrostatic Testing) or (Section 137.5 Pneumatic Testing).

1. Perform testing of pipelines in accordance with the requirements of Section 01 45 00.

3.4 CLEANING

A. General: Clean the interior of pipelines of all dirt and superfluous material of every description in an approved manner.

B. Thoroughly clean threads for threaded joints after reaming.

3.5 SCHEDULE

A. Definitions: Abbreviations used in the schedule are as follows:

1. Pipe Materials:

a. DI Ductile Iron
b. PVC Polyvinyl Chloride

2. Joints:

a. F Flanged
b. SW Solvent Welded

3. Coatings and Linings:

a. CE Ceramic Epoxy (Protecto 401)
b. P Painted

B. Schedule: Provide products as listed, but not limited to, in the following schedule.

END OF SECTION

INTERIOR AND EXPOSED EXTERIOR PIPING SCHEDULE								
Service	Size (Inches)	Pipe Material	Protective Coatings		Joints	Test Pressure (psig)(2)	Pipe Class or Thickness	Remarks
			Int.	Ext.				
Sump Pump Discharge	2	PVC	--	--	SW	20	Schedule 80	--
Sanitary Sewer	36	DI	CE	P	F	150	Class 53	--

Notes:

(1) Provide restrained joints at all joints, including those at fittings, valves and between pipe segments.

(2) Measure the test pressures shown in the schedule at the centerline of the pipeline's low point. Adjust test pressures measured at other locations accordingly.

SECTION 40 05 16

DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing ductile-iron pipe, fittings and appurtenances, except soil pipe.

1. Provide ductile-iron pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation in and completion of the pipelines to be constructed.

2. Provide flanged, plain end, rubber gasket, push-on or mechanical joint, or grooved-type pipe joints of the types, sizes and classes shown or specified.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 00 - Leakage Test
2. Section 09 96 00 – High Performance Coatings
3. Section 40 05 10 - Erecting and Jointing Interior Piping

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water AWWA C104/A21.4

2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids AWWA C105/A21.5

3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3 inches through 48 inches, for Water and Other Liquids AWWA C110/A21.10

4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings AWWA C111/A21.11

5. AWWA C115/A21.15 - Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges AWWA C115/A21.15

6. AWWA C151/A 21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids AWWA C151/A21.51

7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings, 3 inches through 12 inches, for Water and Other Liquids AWWA C153/A21.53

8. AWWA C606 - Grooved and Shouldered Type Joints AWWA C606

9. ASTM A 307 - Specification for Carbon Steel bolts and Studs

1.3 SYSTEM DESCRIPTION

A. Design Standards: Provide ductile-iron pipe meeting the requirements of AWWA C 151/A21.51.

1. Provide pipe of the various sizes as specified in the pipe schedule, except provide Thickness Class 53 for pipe with threaded flanges or grooved-type joints.

2. Construct concrete encasement where shown.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Submit the following shop drawings:

1. Pipe joints and fittings, sleeves, cleanouts and couplings. Where special designs or fittings are required, show the Work in large detail and completely describe and dimension all items.

2. Fully dimensioned layout of pipes, fittings, couplings, sleeves, cleanouts, expansion joints, harnessing, valves, supports, anchors and equipment. Label pipe size, materials, type, and class on drawings and include schedule.

3. Cross sections showing elevations of cleanouts, pipes, fittings, couplings, sleeves, valves, supports, anchors and equipment.

4. Catalog data for pipe, fittings, couplings, sleeves, harnessing and cleanouts.

C. Quality Controls: Submit certificates of compliance for pipe, fittings, gaskets, lining, polyethylene encasement, coatings, specials, couplings, sleeves and cleanouts in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all pipe, fittings and couplings as specified in Division 1 and Section 40 05 10.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Manufacturers of equivalent product may be submitted.

1. Ductile-iron pipe and fittings.

   a. American Cast Iron Pipe Company
   b. McWane Incorporated
   c. United States Pipe and Foundry

2. Ductile-iron retainer glands.

   a. 3-inch through 24-inch diameter
      (1) Nappco, Inc. Series 1246
      (2) Ebba Iron, Inc., Series 100

   b. larger than 24-inch diameter
      (1) Ebba Iron, Inc., Megalug

3. Sleeve-type couplings.

   a. 12-inches in diameter and smaller
      (1) Dresser Industries, Style 153
      (2) Smith-Blair, Type 441 Omni Coupling System

   b. larger than 12-inches in diameter
      (1) Dresser Industries, Style 38
      (2) Smith-Blair, Type 411

   c. Gaskets.
      (1) Dresser Plain Grade 27
      (2) Smith-Blair 003

4. Gaskets.

    a. John Crane, Inc.
    b. Garlock Packing Company
    c. U.S. Rubber Company
    d. American Cast Iron Pipe Company
    e. United States Pipe and Foundry
    f. McWane Incorporated

5. Interior Pipe Lining.

    a. Protecto 401 Ceramic Epoxy

6. Approved Pipe Lining Applicators.

    a. Baumann Coatings, Inc., Bessemer, AL
    b. Vulcan Materials, Birmingham, AL
    c. Bredero Shaw Company, Houston, TX

2.2 MATERIALS

A. Fittings:

1. General: Provide all fittings meeting the requirements of ANSI A21.10, unless shown or specified otherwise. Fittings 14 inches and larger require a pressure rating of 150 psi, or as specified, whichever is greater.

2. Flanged: Where long radius flanged fittings and other flanged fittings not covered in ANSI A21.10 are shown or indicated, provide items meeting the requirements of ANSI A21.10 and having laying lengths conforming to ANSI B16.1 for 125 pound American Standard fittings.

3. Nonflange: Where compact mechanical joint or rubber gasket joint fittings are shown or indicated, provide items meeting the requirements of AWWA C153/A21.53.

B. Grooved-Type Coupling Joints

1. General: Groove-type coupling joints consist of elements that remain jointed under pressure with no restraint from buttresses when the pipe is subjected to axial tension.

2. Requirements: Provide groove dimensions, couplings, gaskets, and bolts for grooved-type joints meeting the requirements of AWWA C606.

3. Dimensional Characteristics: Provide pipe for grooved-type coupling joints which has radius cut grooves in accordance with Table 5(5a) of AWWA C606.

    a. Provide the outside surface of the pipe between the groove and the pipe free from deep pits or swells.

4. Working Pressure: Provide joints where the maximum joint working pressure of the coupling as specified by the manufacturer is not more than the test pressure of the pipeline and is not more than one-third of the ultimate strength of the coupling joint.

5. Unacceptable Joints: Do not accept the following:

    a. Accept no grooved-type coupling joint unless it can be readily disassembled after it is made up.

    b. Accept no joints depending on stud bearing or friction to remain tight under tension.

C. Flanged Joints

1. Threaded Flanges: Provide threaded, ductile-iron, long hub flanges meeting the requirements of AWWA C115/A21.15.

    a. Screw flanges pipe on the threaded end of the pipe in the shop.

    b. Reface the face of the flange and the end of the pipe together.

    c. Design the flanges to prevent corrosion of the threads from the outside and to prevent leakage through the pipe threads.

2. Facing and Drilling: Provide flanges faced and drilled to the requirements of AWWA C115/A21.15, unless special drilling is called for or required. Face flange accurately at right angles to the pipe axis. Drill flanges smooth and true, and cover machined faces with zinc dust and tallow or equivalent material.

3. Taps: Tap flanges where tap or stud bolts are required.

4. Fasteners: Provide bolts, stud bolts, and nuts meeting the requirements of ASTM A 307, Grade B.

5. Gaskets: Provide full-face gaskets for flanged joints on 12-inch diameter and smaller pipe and gaskets of the ring type for flanged joints on larger pipe. Provide flange gaskets meeting the requirements of AWWA C115/A21.15 except make gaskets for gas lines with neoprene and aramid.

D. Rubber Gasket Joints

1. Provide mechanical joints and push-on type joints meeting the requirements of AWWA C111/A21.11.

E. Harnessing

1. General: For ductile-iron pipe and fittings with mechanical joints that require harnessing, provide ductile-iron mechanical joint retainer glands.

2. Joint Assemblies: Design the joint assemblies to resist pullout of the joints at the test pressures specified.

F. Wall Pipes and Sleeves

1. Wall Pipes

a. Where wall pipes are shown or specified, provide ductile iron wall pipes that meet the requirements of AWWA C110/A21.10 with end connections that are 1) of the types shown and 2) flush with the surfaces of the walls or floors. Unless otherwise shown or specified, provide wall pipes with intermediate collars located at the centers of the walls or floors.

2. Sleeves

a. Where pipes pass through exterior walls or floors or wetted interior walls or floors of structures and where wall pipes are not to be provided, provide ductile-iron sleeves meeting the requirements of AWWA C110/A21.10, with ends that are flush with the wall or floor surfaces and with intermediate collars located at the centers of the walls or floors.

b. Where pipes pass through non-wetted interior walls or floors and where wall pipes are not to be provided, provide ductile-iron sleeves meeting the requirements of AWWA C110/A21.10; steel pipe sleeves meeting the requirements of Section 40 05 17 or as shown or specified otherwise. Provide sleeves with ends that are flush with the wall or floor surfaces. Where shown or specified, provide intermediate collars located at the centers of the walls or floors.

c. Provide sleeves having large enough diameters to accommodate the passage of pipe joints, if required.

d. Where shown or specified, provide modular, mechanical sleeve seals, meeting the requirements in Section 40 05 18, in the annular spaces between pipes and sleeves. In all other locations, caulk the annular

spaces between pipes and sleeves with caulk meeting the requirements in Section 07 90 00.

G. Sleeve-Type Couplings

1. General: Manufacture middle rings to the following sizes.

a. At least 1/4 inch thick and 5 inches wide for 8-inch diameter and smaller pipe.

b. 3/8 inch thick and 7 inches wide for 10- through 30-inch diameter pipe.

c. 1/2 inch thick and 10 inches wide for 36-inch diameter and larger pipe.

2. Design: Manufacture middle rings without a pipe stop. Provide follower rings of proper thickness. Provide molded rubber gaskets.

H. Cleanouts

1. General: Provide cleanouts where shown or specified.

2. Size: Provide not less than 6 inch diameter cleanout openings for pipe 8 inches in diameter or larger. Provide cleanout openings for pipe 6 inches in diameter or smaller of the same diameter as the pipe.

3. Cleanout Covers: Provide cleanout covers which are blind flanges meeting the requirements of AWWA C110/A21.10, except where conformation is required with the inside curvature of the pipeline, in which case the covers are flanged plugs of proper shape with American Standard flange drilling.

a. Fasten covers by means of steel studs and bronze nuts. Drill and tap covers for a 1-1/2-inch diameter pipe connection.

4. Plugs: Equip the flange of conformed plugs with a dowel or other suitable means to provide proper setting.

I. Connecting Pieces, and Special Fittings

1. Connecting Pieces: Provide connecting pieces, such as bell and bell, bell and spigot, bell and flange, flange and flange, flange and spigot, and flange and flare, meeting the requirements of AWWA C110/A21.10.

2. Special Fittings : Provide special fittings, where required, of an approved design that have the same diameters and thicknesses as standard fittings, unless otherwise required, but their laying lengths and other functional

dimensions are determined by their positions in the pipeline and by the particular piping materials to which they connect.

J. Temporary Bulkheads: Provide temporary bulkheads at the ends of pipeline sections where adjoining pipelines have not been completed and are not ready to connect.

1. Removal: Remove all temporary bulkheads when they are no longer needed.

K. Coatings and Linings

1. Ceramic Epoxy Interior Lining: Line all 36" sanitary sewer pipe with a ceramic epoxy not less than 40 mils nominal dry film thickness. Line exterior of spigot ends and interior of socket with ceramic epoxy 8 to 10 mils nominal dry film thickness. Pipe lining material shall be applied in accordance with the lining manufacturer recommendations.

2. Exterior Primer: Shop coat ductile-iron pipe and fittings on the outside with one coat of Kop-Coat 340 Gold Primer, 2.0 mils minimum dry thickness, for use in exposed locations, such as inside buildings, where finish painting or insulating is required.

3. Asphaltic Coating: Coat pipe for use not exposed to view with the standard asphaltic outside coating specified in AWWA C151/A21.51.

4. Encased Pipe: Do not coat or paint the outside of fittings and pipe which are to be encased in concrete where watertightness is to be obtained.

5. Labels: Paint the weight and class designation conspicuously in white on the outside of each pipe, fitting, and special casting after the shop coat has hardened.

6. Grooved-type Couplings: Shop coat couplings with Kop-Coat 340 Gold Primer, 2.0 mils minimum dry thickness.

7. Flange Joints: Immediately after facing and drilling, coat the back of the flanges and bolt holes with asphaltic coating meeting the requirements of AWWA C151/A21.51, Section 51-8.1.

8. Sleeve-type Couplings:

a. Shop coat couplings with Dresser Industries Red D or Smith-Blair Standard Blue shop coat.

b. Provide an additional shop coat of Kop-Coat Hi-Guard epoxy or Tnemec Pota-pox on the interior of the middle ring.

c. Finish coat exterior of sleeve-type coupling after installation with the same coating specified in Section 09 96 00 for the pipeline of which it is a part.

d. Ensure shop coats and finish coats are compatible.

L. Drip Pans: Provide drip pans constructed of 16-gauge Type 304 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all ductile-iron pipe and fittings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1 and Section 40 05 10.

B. Drip Pans: Provide drip pans under all ductile-iron pipelines installed over electrical equipment and motors and properly connect to the drainage system with 3/4-inch red brass pipe. Make leak tight connection between the drip pan and the drain pipe. Pitch pans uniformly toward the drain pipe not less than 1/8-inch per lineal foot.

3.2 LEAKAGE TESTING

A. Cleaning: Flush clean and test all pipes after installation.

B. Testing: Test pipes for leaks and repair or tighten as required.

C. Procedures: Conduct tests in accordance with Section 01 45 50.

3.3 SCHEDULES

A. Refer to the Schedule contained in Section 40 05 10 Erecting and Jointing Interior Pipe for information on the piping that is to be constructed using the pipe materials and methods specified herein.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 40 05 18

MISCELLANEOUS PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing miscellaneous pipe and fittings as indicated. Miscellaneous pipe and fittings include all aluminum, copper, brass, plastic, cast-iron soil and lined steel pipe and fittings.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Tests
2. Section 09 96 00 - High Performance Coatings
3. Section 22 10 00 - Plumbing Piping and Fittings
4. Section 23 21 00 - Hydronic Piping Valves and Specialties
5. Section 23 23 00 - Refrigeration Piping and Specialties
6. Section 33 05 50 - Laying and Jointing Buried Pipelines
7. Section 40 05 10 - Erecting and Jointing Interior Piping
8. Section 40 05 17 - Steel Pipe and Fittings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ASTM A 74	-	Specification for Cast Iron Soil Pipe and Fittings
2.	ASTM B 26/B26M	-	Aluminum Alloy Sand Castings
3.	ASTM B 32	-	Specification for Solder Metal
4.	ASTM B 42	-	Specification for Seamless Copper Pipe, Standard Sizes
5.	ASTM B 43	-	Specification for Seamless Red Brass Pipe, Standard Sizes
6.	ASTM B 108	-	Specification for Aluminum Alloy Permanent Mold Castings
7.	ASTM B 241	-	Specification for Aluminum and Aluminum Alloy Seamless Pipe and Seamless Extruded Tube

8.	ASTM C 564	-	Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
9.	ASTM D 1784	-	Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
10.	ASTM D 1785	-	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
11.	ASTM D 2464	-	Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
12.	ASTM D 2564	-	Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
13.	ASTM D 2855	-	Recommended Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
14.	ASTM F 491	-	Specification for Poly (Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings
15.	ASTM F 492	-	Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings
16.	ASTM F 599	-	Specification for Poly (Vinylidene Chloride) (PVDC) Plastic-Lined Ferrous Metal Pipe and Fittings
17.	ASME B1.20.1	-	Screw Threads - Pipe Threads, General Purpose (Inch)
18.	ASME B16.15	-	Cast Bronze Threaded Fittings, Classes 125 and 250 (Includes Revisions Service)
19.	ASME B16.18	-	Cast Copper Alloy Solder Joint Pressure Fittings (Includes Revision Service)
20.	ASME B16.22	-	Wrought Copper and Copper Alloy Solder-Joint Pressure Fitting (Includes Revision Service)

21. ASME - Boiler and Pressure Vessel Codes, Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

22. AWWA C151/A21.51 - Ductile-Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

23. CISPI 301 - Hubless Cast Iron Sanitary System

24. CISPI 310 - Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

25. AWS A5.8 - Brazing Filler Metal

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit the following Shop Drawings.

1. Submit complete detailed shop drawings in conformance with the specified requirements.

2. Include drawings that show the piping layouts and schedules of all pipe, fittings, valves, expansion joints, flexible couplings, hangers, supports and other appurtenances.

3. When any work is of special design show in large detail and completely describe and dimension.

4. Welders Certificate: Include welders' certification with ASME/Section IX.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 and as follows:

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Pipe and Fittings:

a. Aluminum Pipe and Fittings

(1) ALCOA, Pittsburgh, PA
(2) ALCAN Aluminum Corp., Cleveland, OH

b. Brass Pipe and Fittings

(1) Metalloy Industries, Inc., Ft. Lauderdale, FL
(2) Nibco, Elkhart, IN

c. Cast-Iron Soil Pipe and Fittings

(1) U.S. Pipe and Foundry Co., Birmingham, AL
(2) Tyler Pipe Industries, Tyler, TX
(3) Charlotte Pipe and Foundry, Charlotte, NC

d. Copper pipe and Fittings

(1) Mueller Industries, Inc., Wichita, KS
(2) Nibco, Elkhart, IN

e. PVC and CPVC Pipe and Fittings

(1) United States Plastic Corp., Lima, Ohio
(2) Harvel Plastics Inc., Easton, Pennsylvania

f. Lined Steel Pipe and Fittings

(1) Polyvinylidene Chloride (PVDC) lined pipe and fittings

(a) Ameriform Manufacturing, Inc., Milton, KY

(2) Polypropylene-lined pipe and fittings

(a) Performance Plastics Products, Houston, TX
(b) Crane Resistoflex Co., Bay City, MI

(3) Polyvinylidene fluoride (PVDF or Kynar®) lined pipe and fittings

(a) Performance Plastics Products, Houston, TX
(b) Crane Resistoflex Co., Bay City, MI

g. Wall Sleeve Annular Seals

(1) Thunderline Corp. (Link-Seal), Belleville, MI

2. Dielectric Insulating Fittings:

a. Walter Vallett Co., Detroit, MI
b. EPCO, Inc., Cleveland, OH

2.2 MATERIALS

A. Aluminum Pipe and Fittings

1. Pipe: Provide aluminum pipe of Alloy 6061 and T6 temper conforming to ASTM B 241.

2. Welding and Threaded Fittings: Provide aluminum forged welding fittings or cast threaded fittings conforming to ASTM B 26/B26M or B 108.

3. Flanged and Coupling Connections: Provide joints that are made with aluminum mechanical couplings in combination with grooved, flared or plain end pipe or that are flanged.

a. When grooved couplings are used, roll the grooves into the pipe in conformance with the coupling manufacturers specifications.

b. Do not use cut grooves.

4. Lubricating Compound: Carefully assemble fittings and couplings with an approved lubricating compound to prevent seizing of the connection and overstressing of the pipe.

a. Provide a lubrication compound which both lubricates and seals, for pipelines subject to internal pressure.

5. Supports: Use aluminum, hot-dipped galvanized steel or other approved type.

B. Brass Pipe and Fittings

1. Pipe: Provide red brass pipe that meets the requirements of ASTM B 43.

a. Provide pipe sizes, wall thicknesses and dimensions that meet the ASTM B 43 Table 2 requirements for regular pipe.

2. Fittings: Provide brass pipe fittings that meet the ASME B16.15 requirements.

a. Provide fittings rated for steam working pressures up to 125 psig.

b. Provide unions made entirely of brass or bronze.

c. Provide screwed type joints with clean cut, tapered and smooth threads that meet ASME B1.20.1 requirements.

3. Finish: Provide piping with a rough finish, unless otherwise specified.

C. Cast-Iron Soil Pipe and Fittings

1. Pipe and Fittings: Provide service weight, hub and spigot, cast-iron soil pipe and fittings meeting the requirements of ASTM A 74 or hubless cast iron soil pipe and fittings meeting the requirements of CISPI 301. Do not use hubless pipe and joints for buried pipe.

2. Protective Coatings: Provide interior protective coatings (linings) and exterior protective coatings for pipe and fittings in the finished work as follows and as indicated in the piping schedules:

a. For pipe and fittings not exposed in the finished work, provide an interior bituminous lining and an exterior bituminous coating that meet AWWA C151/A21.51 requirements.

b. For pipe and fittings exposed in the finished work, provide an interior bituminous lining that meets AWWA C151/A21.51 requirements.

(1) If the pipe schedules indicate that the pipe exterior is to be painted, paint in accordance with the requirements in Section 09 96 00.

(2) If the pipe schedules indicate that the pipe exterior is to have a bituminous coating, coat the pipe in accordance with the requirements in AWWA C151/A21.51.

3. Joints: Provide lead and oakum joints or neoprene gasket, compression type joints in accordance with ASTM C 564 for hub and spigot pipe. Consult the piping schedules. Provide hubless couplings for hubless pipe. Compose hubless couplings of a stainless steel shield, clamp assembly and an elastomeric sealing sleeve conforming to CISPI 310.

4. Cleanouts: Provide cleanouts where shown or specified, and meeting the requirements of Section 22 10 00, unless otherwise specified.

D. Copper Pipe and Fittings

1. Small Copper Piping: For copper pipe 3 inches in diameter and smaller, provide Type K hard drawn copper tubing that meets ASTM B 88 requirements.

a. Fittings: Provide ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and copper alloy fittings.

b. Joints: Threaded or ASTM B 32 lead-free soldered joints.

c. Joints: Brazed joints, AWS A5.8 BCUP silver/phosphorus/copper alloy with melting range 1190-1480 degrees F.

2. Large Copper Piping: For copper pipe larger than 3 inches in diameter, provide regular seamless copper pipe that meets the ASTM B 42 requirements.

a. Fittings: Provide solder type fittings of the same material as the pipe.

b. Joints: Use threaded or brazed joints.

3. Potable Water Piping: Use ASTM B 32 alloy Grade 95TA (95 percent tin and 5 percent antimony) solder for piping carrying potable water.

4. Unacceptable Uses: Do not use copper pipe with soldered joints for transporting fuel oil or other flammable or toxic liquids inside buildings.

E. Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings

1. Pipe and Fittings: Provide PVC pipe and fittings that are Schedule 80 and meet the requirements of ASTM D 1784 Class 12454-B and ASTM D 1785 unless otherwise shown or specified. Provide CPVC pipe and fittings that are Schedule 80 and meet the requirements of ASTM D 1784 Class 23447-B and ASTM D 1785, unless otherwise shown.

2. Joints: Provide ASTM D 2855 solvent welded joints utilizing ASTM D 2564 solvent cement or ASTM D 2464 threaded joints, as indicated in the piping schedules.

F. Lined Steel Piping

1. Polyvinylidene Chloride (PVDC) Lined: Provide PVDC lined steel pipe and fittings meeting the requirements of ASTM F 599, except provide PVDC liner that has a minimum elongation at yield of 5 percent.

2. Polypropylene Lined: Provide Type I polypropylene lined steel pipe and fittings meeting the requirements of ASTM F 492.

3. Polyvinylidene Fluoride (PVDF) Lined: Provide PVDF lined steel pipe and fittings meeting the requirements of ASTM F 491.

G. Wall Pipes and Sleeves for Miscellaneous Pipe and Fittings

1. Wall Pipes

a. Where wall pipes are shown or specified, provide ductile iron wall pipes that meet the requirements of AWWA C110/A21.10 with end connections that are 1) of the types shown and 2) flush with the surfaces of the walls or floors. Unless otherwise shown or specified, provide wall pipes with intermediate collars located at the centers of the walls or floors.

2. Sleeves

a. Where pipes pass through exterior walls or floors or wetted interior walls or floors of structures and where wall pipes are not to be provided, provide ductile-iron sleeves meeting the requirements of AWWA C110/A21.10 with ends that are flush with the wall or floor surfaces and with intermediate collars located at the centers of the walls or floors.

b. Where pipes pass through non-wetted interior walls or floors and where wall pipes are not to be provided, provide ductile-iron sleeves meeting the requirements of AWWA C110/A21.10; steel pipe sleeves meeting the requirements of Section 40 05 17 or as shown or specified otherwise. Provide sleeves with ends flush with the wall or floor surfaces. Where shown or specified, provide intermediate collars located at the centers of the walls or floors.

c. Provide sleeves having large enough diameters to accommodate the passage of pipe joints, if required.

d. HDPE Sleeves: Where shown or specified, provide molded HDPE sleeves as manufactured by the Thunderline Corporation, or approved equal, with integrally formed intermediate collars or waterstops.

e. Where shown or specified, provide modular, mechanical sleeve seals, meeting the requirements of this Section, in the annular spaces between pipes and sleeves. In all other locations, caulk the annular spaces between pipes and sleeves with caulk meeting the requirements in Section 07 90 00.

H. Modular, Mechanical Sleeve Seals: Provide modular, mechanical type seals consisting of interlocking, synthetic-rubber links shaped to continuously fill the annular space between the pipe and the sleeve. Provide an elastomeric sealing element that is of the size, quantity, type and material that the manufacturer recommends for the intended service and that will provide an effective hydraulic seal. Provide stainless steel bolts and nuts.

I. Supports and Anchors: Provide all pipelines with supporting and anchoring devices as specified in Section 40 05 01. Provide drip pan hangers and supports as specified for sheet metal ductwork in Section 23 31 00.

J. Drip Pans: Provide drip pans constructed of 16-gauge Type 304 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all miscellaneous pipe and fittings in accordance with the specifications contained herein and in Sections 33 05 50 and 40 05 10 and in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Connections between Dissimilar Metals: Where connections are to be made between pipelines or equipment of corrosion causing dissimilar metals make the connections using dielectric insulating couplings, unions or other approved dielectric insulating devices.

C. Couplings: Only use couplings to join standard lengths of pipe and as required to complete a straight run of pipe. Do not use couplings to join random lengths of pipe and cuttings from standard lengths.

D. Reducing Fittings: Use reducing fittings for all changes in pipe size. Do not use bushings.

E. Pipe Flexibility: Make ample provisions for flexibility in all pipelines in accordance with Section 33 05 50 for buried pipelines and Section 40 05 10 for interior pipelines.

F. Drip Pans: Provide drip pans under all metallic pipelines installed over electrical equipment and motors and properly connect to the drainage system with 3/4-inch red brass pipe. Make leaktight connection between the drip pan and the drain pipe. Pitch pans uniformly toward the drain pipe not less than 1/8-inch per lineal foot.

3.2 CLEANING AND PAINTING

A. Cleaning: Flush all process and potable water pipelines with clean water.

B. Leakage: Test pipes at the pressures specified in the piping schedules located in Section 33 05 50 and Section 40 05 10.

C. Paint in accordance with Section 09 96 00, unless otherwise specified.

3.3 DISINFECTION

A. Disinfect all potable water pipelines in accordance with Section 33 13 00.

3.4 SCHEDULES

A. Refer to the schedules contained in Section 33 05 50 Laying and Jointing Buried Pipelines and Section 40 05 10 Erecting and Jointing Interior Piping for information on the piping that is to be constructed using the pipe materials and methods specified herein. Provide type of pipes not scheduled similar in type and quality to that provided for scheduled pipes that are to be used for similar purposes. Schedule is provided for convenience and accuracy is not guaranteed.

END OF SECTION

SECTION 40 05 20

VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for furnishing and installing all valves and operators.

1. Provide valves and operators complete, including a suitable enclosure, with all appurtenances necessary for the operator to perform its intended function. Such appurtenances include, but are not limited to, anchor bolts and other mounting hardware, extension stems, local and remote indicators, operating nuts, floor boxes, direct burial valve boxes and other such items.

2. For each valve, provide the type of operator specified for the valve in the Valve Schedule.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 05 05 13 - Galvanizing
2. Section 09 96 00 - High Performance Coatings
3. Section 26 05 60 - Electrical Requirements for Shop-Assembled Equipment
4. Section 26 05 19 - Wires and Cables – 600 Volts and Below
5. Section 26 05 80 - Electric Motors
6. Section 26 28 16 - Disconnect Switches
7. Section 40 90 50 – Process Control System Description

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASME B1.20.1 - Pipe Threads, General Purpose

2. ASME B1.20.7 - Hose Coupling Screw Treads

3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

4. ASTM A 27/A27M - Specification for Steel Castings, Carbon, for General Application

5.	ASTM A 29/A29M	- Specification for Steel Bars, Carbon and Alloy, Hot Wrought and Cold-Finished, General Requirements
6.	ASTM A 48	- Specifications for Gray Cast Iron Castings
7.	ASTM A 126	- Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
8.	ASTM A 197	- Specification for Cupola Malleable Iron
9.	ASTM A 276	- Specification for Stainless and Heat-Resisting Steel Bars and Shapes
10.	ASTM A 278	- Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 F
11.	ASTM A 395	- Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
12.	ASTM A 436	- Specification for Austenitic Gray Iron Castings
13.	ASTM A 536	- Specification for Ductile Iron Castings
14.	ASTM A 564/A564M	- Hot Rolled and Cold Finished Age Hardening Stainless and Heat Resisting Steel Bars and Shapes
15.	ASTM A 572/A572M	- Specification for High Strength Low Alloy Columbium Vanadium Steels of Structural Quality
16.	ASTM A 743/A743M	- Specifications for Castings, Iron-Chromium, Iron-Chromium - Nickel, and Nickel-Base Corrosion-Resistant for General Application
17.	ASTM A 744/A744M	- Specification for Castings, Iron-Chromium-Nickel, Corrosion-Resistant, for Severe Service
18.	ASTM B 30	- Specification for Copper Base Alloys in Ingot Form
19.	ASTM B 62	- Specification for Composition Bronze or Ounce Metal Castings
20.	ASTM B 148	- Specification for Aluminum-Bronze Castings

21. ASTM B 584 - Specification for Copper Alloy Sand Castings for General Applications

22. AWWA C502 - Dry-Barrel Fire Hydrants

23. MSS SP-81 - Specification for Stainless Steel, Bonnetless, Flanged Knife Gate Valves, Metal Seated

24. SAE J356 - Welded Flash Controlled Low-Carbon Steel Tubing Normalized for Bending, Double Flaring, and Beading

25. SAE J524 - Seamless Low-Carbon Steel Tubing Annealed for Bending and Flaring

26. SAE J525 - Welded and Cold-Drawn Low-Carbon Steel Tubing Annealed for Bending and Flaring

27. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit the following:

1. Complete detailed drawings of all valves

2. Working drawings, including arrangement and erection drawings of the operators and control equipment; schematic control diagrams, electrical connection diagrams, and complete description of the control system; and operating characteristics

C. Quality Control Submittals: Submit the following:

1. If requested, manufacturer's certified performance and material records.

2. If requested, complete calculations for each size of motor operator indicating the force required to operate the valve, the operator force provided, full load and locked rotor current, and horsepower.

D. Operation and Maintenance: Submit operation and maintenance manuals for the valve operators.

1.4 QUALITY ASSURANCE

A. Furnish all valves of the same type from the same manufacturer. Provide parts that are interchangeable for all valves of the same type and size.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products as specified in Division 1 and as follows.

B. Historical Performance: Furnish and install eccentric plug valves of a type that has shown successful performance for a minimum of ten years. If requested, submit documentation of successful installations in which eccentric plug valves of the proposed type have been in operation for at least ten years.

C. Tests: Furnish a letter confirming that all plug valves have been satisfactorily tested as specified, prior to shipment.

D. Storage and Erection: Pack and store all valves in satisfactory operating condition. Carefully erect all valves in their respective positions, free from all distortion and strain.

1.6 SPARE PARTS

A. For electric motor operators:

1. One motor of each size
2. One torque switch of each size
3. One limit switch assembly of each size
4. Six push buttons
5. Six color caps of each color
6. Twenty indicating lamps
7. One reversing starter of each size
8. One overload relay of each size

PART 2 PRODUCT

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Eccentric Plug Valves:

a. DeZurik
b. Clow

2. Electric Motor Operators – Modulating:
   a. Rotork, Inc.
   b. Flowserve Limitorque
   c. E-I-M Company

2.2 MATERIALS

A. General:

1. Fabricate valves of materials resistant to corrosion for the required service.

2. Unless other materials are needed for corrosion resistance or are specified elsewhere, fabricate valves that are to be installed in metal pipelines and that are 2 inches in diameter and smaller of all brass or bronze, except fabricate the handwheel of ASTM A 197 malleable iron. Fabricate valves that are to be installed in metal pipelines and that are 2-1/2 inches in diameter and larger of the materials specified herein.

3. Fabricate operators of materials resistant to corrosion for the required services. Provide operator materials as specified.

4. Operator housings and pedestal handwheels:

a.	Cast iron	ASTM A 126, Class B ASTM A 48, Class 30 or 35
b.	Ductile iron	ASTM A 395 ASTM A 536, Grade 65-45-12
c.	Cast steel	ASTM A 27/A27M

5.	Operator worms, steel	ASTM A 29/A29M Grade Designation 8620
6.	Operator gears, steel (spur & helical)	ASTM A 572/A572M
7.	Worm gears, bronze	ASTM B 148, Alloy C95400 or C95500 ASTM B 584, Alloy C86300

B. Valve Joints

1. Fabricate valves 2 inches in diameter and smaller of the threaded or solder end type for valves to be installed in copper pipelines, and of the threaded end type for valves to be installed in metal pipelines.

2. Fabricate all valves 2-1/2 inches in diameter and larger, except bronze valves 2-1/2 and 3 inches in diameter, with flanged ends, unless otherwise specified.

3. Fabricate bronze valves 2-1/2 and 3 inches in diameter with solder or threaded type ends for valves installed in copper pipelines and threaded type ends for all other pipelines.

4. For metallic flanged joints, provide flanges that are faced accurately at right angles to the axis of the casting. Face and drill flanges and shop coat with a rust-preventive compound before shipment.

5. For flanged joints, provide flanges whose dimensions and drillings meet the requirements of ASME B16.1, 125 pounds as a minimum. For valves installed in pipelines with test pressure requirements higher than 125 psi, provide flanges whose pressure ratings equal or exceed the specified test pressure of the pipeline. Furnish special drillings where required. For valves having flanges that do not conform with the thickness requirements of ASME B16.1, test each valve in accordance with the hydrostatic shell test pressure requirements of ASME B16.1.

C. Operating Force: Fabricate valves to limit the maximum force required to operate all manual valves, including but not limited to valves with wrench operated nuts, levers, handwheels and chainwheels, to 40 pounds. Limit the overall length of each wrench or single-arm lever to 18 inches. Limit the overall length of each dual-arm lever to 36 inches.

D. Handwheel: Mark each valve handwheel with an arrow and the word OPEN. Mark each nut with an arrow.

E. Manually Operated Valves: Equip all manually operated valves that have operating nuts, levers or handwheels and that are more than 7 feet above the floor with chain operated levers or chainwheels. Extend chains to 7 feet above the floor.

2.3 ECCENTRIC PLUG VALVES

A. General: Provide quarter turn valves having an eccentric action that causes the plug to rise off the seat contact during the opening movement rather than sliding from its seat.

B. Plugs: Provide plug valves with Neoprene or Buna-N faced plugs.

C. Materials: Construct plug valves of cast iron or semi-steel at least equal to ASTM A 126, Class B. For valve sizes 3-inch and larger, construct the body seats with a welded-in overlay, of not less than 90 percent pure nickel, on all surfaces contacting the plug face. For valve sizes under 3-inch provide uncoated or epoxy coated body seats. Make the overlay a minimum of 1/16-inch thick for valve sizes

20-inch and smaller and a minimum of 1/8-inch thick for valve sizes 24-inch and larger. Provide zinc plated bonnet bolts, studs and nuts.

D. Seat Adjustment: Make the water-tightness or gas-tightness of the valve seating adjustable. Provide a seating adjustment device that is external to the valve and that can be used without the need to remove the valve from the piping and with the valve under pressure.

E. Lubrication: Furnish plug valves with oil impregnated, permanently lubricated, Type 316 stainless steel bearings in the upper and lower journals.

F. Stem Seal: Provide a stem seal consisting of multiple, self-adjusting and replaceable chevron type packing rings and a packing gland or provide two replaceable, self-adjusting, U-cup seals. Make the stem seal adjustable and replaceable without removing the valve from the piping and without the need to disassemble the valve and operator. For buried or submerged service, provide a sealed enclosure to keep the stem seal clean.

G. Valve Port: Unless otherwise specified, construct the valve with a full port opening equal to the full diameter of the pipe in which the valve is installed.

H. Position Indicator: Equip plug valves, except for buried or submerged service, with external visible indication of the plug position.

I. Operators: Unless otherwise shown or specified, equip 6-inch and smaller valves with wrench or lever operators and 8-inch and larger valves with gear operators. Equip all valves in low pressure gas service with gear operators. Furnish one wrench for each size valve in each individual room or space in which valves are located. House gear operators for submerged or buried service in a watertight enclosure. For buried or submerged service, equip valve operators with stainless steel external bolting.

2.4 EXTENSION STEMS, VALVE BOXES AND FLOOR BOXES

A. Equip all direct burial valves and valves in vaults or manholes with operating nuts and extended shafts to grade, unless otherwise shown or specified. Equip all direct burial valves with adjustable type, cast-iron, valve boxes and extended shafts to grade. Equip all valve boxes and floor boxes with ground level valve position indicators, unless otherwise shown or specified. Provide two tee wrenches for each size and type of operating nut.

2.5 FLOOR AND BENCH STANDS

A. General: Provide floor and bench stands for valves smaller than 12 inches of the wheel operated type without gears. Provide stands for 12- to 20-inch valves of single crank, single speed operated. Provide stands for 24-inch and larger valves of single crank, single speed or 2-speed operated as specified.

B. Materials: Use materials in floor and bench stands meeting the applicable requirements of the "General" specifications subsection. Provide frames of cast iron or fabricated steel of heavy and substantial design with smooth exterior and neat appearance. Make adequate provision for lubrication and protect all operating parts.

C. Nameplate and OPEN Indication Marking: Equip each stand with a nameplate stating the valve controlled by the stand and also stamp the operator with an arrow and the word OPEN to indicate the direction of rotation.

D. Rising Stems: Fit rising stem floor and bench stands with ball or roller bearings designed to take the thrust. Equip rising stem stands with a transparent plastic cover to protect the stem. Provide the cover with labels and other attachments that will facilitate its use as an indicator of valve position.

E. Nonrising Stems: Fit nonrising stem floor and bench stands with thrust ball or roller bearings. Provide an indicator to show the position of the valve.

F. Operating and Lift Nuts: Provide operating nuts or lift nuts of bronze meeting the requirements of ASTM B 62, finished all over, suitably splined to connect with the handwheel or gear and with threads which will engage smoothly with those of the lifting shaft.

G. Crank-Operated Stands: Provide crank-operated stands with a crank that will open the valve when the crank is turned counterclockwise. Locate the center of the crank approximately 36 inches above the operating floor. Provide gears which are bevel or worm, of hardened steel or manganese bronze, with machine cut teeth and enclosed in a cast-iron body. Equip the crank with a brass or bronze sleeve-type handgrip rotating freely on the handle. Utilize a gear ratio that will enable the stand to operate the valve with a maximum force of 40 pounds on the crank at single or low speed.

H. Handwheel-Operated Stands: Provide handwheel-operated stands with handwheels that open the valve when the wheel is turned counterclockwise. Locate the center of the handwheel approximately 36 inches above the operating floor. Provide a handwheel of sufficient diameter so that the stand will operate the valve with a maximum pull on the handwheel of 40 pounds.

I. Manually Operated Bench Stands: Equip manually operated bench stands located more than 7 feet above the floor with chains and chainwheels that meet the requirements of the subsection headed "Chainwheel Operators".

2.6 ELECTRIC MOTOR OPERATORS – NON-MODULATING

A. General: Provide non-modulating electric motor operators of the close-coupled, electric motor-driven, worm gear type, complete with motor, gearing, limit

switches and auxiliary contacts, torque switches, position indicator, handwheel, integral controller, and all required appurtenances. Design the operators to (rotate valve discs through 90 degrees from the fully open to the fully closed position and back, as in butterfly, ball or plug valves,) (lift gate discs from the fully closed to the fully open position and back, as in gate valves). Provide operators that complete each operation in the time specified. Provide operators that hold the discs in any position from fully open to fully closed without vibration.

B. Operator Mounting: Design the operator to be mounted in the position shown or specified.

C. Standard: Except as otherwise specified, provide operators meeting AWWA C540.

D. Open and Close Time Periods: Provide valve operators that fully open the valve from the closed position in approximately not less than 2 minutes and fully close it in approximately not less than 2 minutes when the differential pressure and flow are at what was specified for the valve and the voltage at the terminals is within 15 percent of the nominal voltage. Design the operator to operate the valve through three consecutive opening and closing cycles or for a period of 15 minutes, whichever is longer, during every 60-minute period, at specified ambient temperature conditions under full differential pressure.

E. Temperature Range: Design the operator for outdoor operation and for an ambient temperature range of -20 to 140 degrees F.

F. Torque: Design the operator to exert an unseating torque of at least 50 percent in excess of the required disc seating torque at the specified voltage, neglecting hammer-blow effect.

G. Power Gearing: Provide power gearing consisting of helical or spur gears and worming gearing. Fabricate helical and spur gears of accurately machined hardened alloy steel. Provide a hardened alloy steel worm with threads ground and polished after heat treating. Provide a nickel or manganese bronze worm gear. Use antifriction bearings throughout. Grease pack or oil bath lubricate the operator. Provide lubricants suitable for the ambient temperatures specified.

H. Lost-Motion Device: Design operators for gate valves to include a lost-motion device that will permit the motor to attain full speed, and then impart a hammer blow to the stem nut to start movement of the disc in both the opening and closing directions. Do not include this feature if the valve is for modulating service.

I. Handwheel - Manual Operation: Provide a handwheel for manual operation with a maximum rim pull of 40 pounds. Design the handwheel so that it does not rotate during electrical operation and the motor does not rotate during manual handwheel operation. Provide an operator that is arranged so that motor or motor gearing failure does not prevent manual operation. Arrange the operator to automatically

change from manual operation to electrical operation when its motor is energized and to continue electric operation until the operator is reset to manual operation. Provide a means for locking the drive in either manual or motor operation. Provide removable handwheels. Provide an adaptor key or drive nut to permit operation by a portable operator.

J. Declutching Mechanism: Provide a declutching mechanism to disengage the motor mechanically but not electrically from motor to handwheel operation. If the clutch is of the external lever type, arrange it such that the lever does not move when the motor is energized.

K. Position Indication: Provide an operator-mounted disc position indicator of the mechanical or indicating light type. For OPEN-CLOSED service, indicate the fully open, fully closed and intermediate disc position either mechanically or by lights. For modulating or throttling service, provide continuous disc position indication between the fully open and fully closed positions. Provide electrical contacts as required for remote indication of disc position.

L. Electric Motor Design: Provide an operator motor of the high torque, ball or roller bearing, squirrel-cage type designed for continuous valve duty. Provide motor rated for 15 minute duty cycle or four complete opening and closing valve strokes, whichever is longer, during a 60 minute period under full differential pressure at 50 degrees C ambient. Design the motor for use on a nominal 480 volts, 3-phase, 60-hertz electrical service. Provide motor windings and leads with Class F or better insulation with built-in thermal overload protection. In other respects, provide motors meeting the requirements of Section 26 05 80.

M. Housing: Provide housings for controls, gears, and motors with integrally cast flanges. Fully machine and template drill the flanges and their mating surfaces. Provide joints which are metal-to-metal or gasket or O-ring sealed as required.

N. Control and Motor Enclosures: Provide NEMA 4 control and motor enclosures, except as otherwise specified. Provide the controller with mechanical interlocks and mount as an integral part of the operator.

O. Electrical Compartment Heater: Provide electrical compartment heaters, unless other means can be proven effective for moisture elimination.

P. Electrical Requirements: Provide electrical controls for the operator as shown or specified. Design operators for 480-volt, 3-phase, 60-hertz service. Design all control circuits for 120- volt, single-phase, 60-hertz ac. Provide an integral 480/120-volt control transformer with fused secondary.

Q. Reversing Controller, Overload Protection and Internal Wiring: Provide a NEMA rated reversing controller, or an approved special duty rated reversing controller, complete with mechanical interlocks and controls as an integral part of the operator. Provide adequate overload protection in the controller or embedded in

the motor windings. Install an overload device in each phase. If overload devices are installed in the motor windings, provide devices of the bimetallic automatic reset type with the contacts in the control circuit. Arrange the internal wiring in the operator so that the opening and closing coils cannot be energized simultaneously at any time, regardless of external wiring conditions.

R. Push Buttons and Selector Switches: Where operators are 7 feet or closer to the floor and in an accessible location, mount OPEN- STOP-CLOSE push buttons or a selector switch as shown on the operator housing, integral to the housing. Also mount red and green position indicator lights and, where shown or required, an amber ready light or MANUAL-AUTO mode selector on the operator housing. Where the operators are located over 7 feet from the floor or in an inaccessible location, connect all internal control and indication wiring to a terminal block within the operator enclosure and provide a separate control station for remote mounting. Provide the remote control station with the same NEMA rating as the operator.

S. Limit and Torque Switches: Provide the operator with limit and torque switches, either direct or gear driven. Provide adjustable limit and torque switches with auxiliary contacts that are operative in either direction of travel. Provide limit switches that are "in step" with torque switches at all times, whether in motor or manual operation. Equip the operator with limit switches to stop movement in each direction and torque switches for protection against mechanical overload and to stop movement in either direction if an obstruction is encountered. Provide the number, function and arrangement of limit switches as shown, specified or required.

T. Additional Accessories: Provide additional limit switches, indicating lights, position transmitters and remote position indicators, remote operating controls and other accessories and controls as shown, specified or required.

U. Control Components, Operator Housing and Operator Wiring: Provide control components and operator housing that meets the requirements of Section 26 05 60. Provide operator wiring that meets the requirements of Section 26 05 19.

2.7 ELECTRIC MOTOR OPERATORS - MODULATING

A. General: Provide modulating motor operators that meet the requirements for nonmodulating operators, except as specified herein. In addition to the other equipment specified for nonmodulating operators, provide an electronic control module and a solid state reversing starter.

B. Control Module: Provide a solid state type control module with a comparator circuit which senses the error between the input command signal and the position feedback signal. Mount the control module within the operator switch compartment.

Accept a 4-20 mAdc input command signal. Provide zero and span adjustments to align minimum and maximum gate position with zero and 100 percent values of the input command signal. Provide deadband adjustment from 0.16 to 1.0 percent to eliminate excessive motor movement due to minor variation in the process variable signal.

Activate the solid state reversing starter to drive the actuator in the proper direction necessary to reduce the error to zero. Provide proportional band adjustment from 5-40 percent. When the error is outside the proportional band, run the actuator motor continuously toward set point. When the error is within the proportional band, pulse the actuator motor toward set point to prevent overshoot.

Provide actuator to open the valve when command input signal increases.

On loss of command input signal, have valve fail in last position. On loss of feedback signal, have valve fail in last position.

C. Selector Switch and Push Buttons: When the operator is 7 feet or less from the floor and in an accessible location, integrally mount a 3-position AUTO-OFF-MANUAL selector switch plus two push buttons marked OPEN and CLOSED on the operator housing. Where the operator is located more than 7 feet from the floor or in an inaccessible location, connect all internal control and indication wiring to a terminal block and provide a separate control station for remote mounting. Provide valve position indicator on separate remove control station.

D. Auto and Manual Operations: Provide operators that, when in the AUTO position, will respond to the automatic signal as described above. Provide operators that, when in the MANUAL position, will be operable by either the push buttons, or handwheel.

E. Motor Design: Design the motor specifically for the gate operator service and to be continuous rated for continuous modulating duty. Provide motor insulation of at least Class H.

2.8 SOURCE QUALITY CONTROL

A. Eccentric Plug Valve Leakage Test: Perform a plug leakage shop test on each eccentric plug valve with the plug in the closed position. Unless otherwise specified, perform the leakage test with a minimum pressure of 150 pounds per square inch (gauge) applied sequentially to both the upstream and downstream faces of the plug. Perform the test for a minimum duration of 15 seconds. Demonstrate that there is no leakage past the plug.

B. Eccentric Plug Valve Hydrostatic Test: Give each eccentric plug valve hydrostatic shop pressure tests with the plug open and with the plug closed. Perform the hydrostatic tests with a minimum pressure that is at least equal to the test pressure specified for the pipeline in which the valve is installed. Perform the test for a

minimum duration of 30 seconds. Demonstrate with the hydrostatic tests that the valve is structurally sound and that there are no leaks through the external surfaces of the valve.

C. Hydraulic Power Unit Shop Test: Prior to shipping the fluid power unit, conduct a shop test that demonstrates that the unit fulfills the operating requirements of the Specifications.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install valves in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Eccentric Plug Valves: Unless otherwise shown or specified for eccentric plug valves installed in horizontal piping, orient the valve such that the shaft is in the horizontal position, the seat is in the downstream position and when the valve is in the open position the plug is up. Unless otherwise shown or specified, for eccentric plug valves installed in vertical piping, orient the valve with the plug up when the valve is in the closed position.

3.2 PAINTING AND COATING

A. General: Unless otherwise specified, coat the inside iron or steel surfaces of all valves and exterior surfaces of valves and operators that are to be buried in the ground or immersed in sewage or water with two coats of asphalt varnish. Paint exterior surfaces of other valves and operators as specified in Section 09900.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Furnish the services of a qualified representative of each of the various manufacturers to provide instruction on the proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment and place the equipment in trouble-free operation, as specified in Division 1.

B. Tests: After installation of the valves, control equipment and all appurtenances, subject the units to a field running test, as specified in Division 1, under actual operating conditions. Operate each valve through one complete open-close cycle under the maximum pressure differential practical.

3.4 OPERATION DEMONSTRATION

A. Manufacturer's Field Services: Furnish the services of a qualified representative of each of various manufacturer's electrically powered valves to demonstrate the proper operation and instruct plant personnel in the equipment's operation and maintenance, as specified in Division 1.

3.5 PAINTING

A. Paint the equipment in accordance with the requirements in Section 09900.

3.6 SCHEDULE

A. Abbreviations used in the schedule are as follows:

Joints

F	Flanged

Operators

H	Handwheel
TE	Throttling Electric Motor (modulating)

END OF SECTION

VALVE SCHEDULE					
Facility/Service	Valve Type	Size Inches	Joint Type	Operator Type	Remarks
Diversion Facilities – Valve Vault	Plug	36	F	H & TE	Throttling, Floor Stand, Stem Extension, Orient plug upward when open

(NO TEXT FOR THIS PAGE)

SECTION 40 05 32

STOP LOGS AND APPURTENANCES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for furnishing and installing all stop logs and appurtenances.

1. Furnish all labor, materials, equipment and incidentals required and install complete prefabricated stop logs and appurtenances as specified herein.

B. Related Work Specified in Other Sections Includes, But is not Limited to, the Following:

1. Section 09900 - Painting

1.2 REFERENCE STANDARDS

A. Codes and standards referred to in this section are:

1. ASTM A 36 - Specification for Carbon Structural Steel
2. ASTM A 276 - Specifications for Stainless and Heat-Resisting Steel Bars and Shapes
3. ASTM A 9923 - Specifications for Structural Steel Shapes
4. ASTM B 148 - Specification for Aluminum Bronze Sand Castings
5. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
6. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications
7. ASTM D 4020 - Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
8. ASTM F 593 - Specification for Stainless Steel Bolts, Hex Cap Screws
9. ASTM F 594 - Specifications for Stainless Steel Nuts

1.3 SYSTEM DESCRIPTION

A. Stop log sizes and operating data are indicated in the Stop Log Schedule in the end of the specification. Provide all stop logs of the same type from one manufacturer.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit shop drawings, including arrangement and erection drawings of the stop logs and appurtenances; structural design data.

C. Quality Control:

1. Submit manufacturer's certified performance and material specifications, as specified.

D. Operation and Maintenance Manuals: Submit operation and maintenance manuals as specified in Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1.

PART 2 PRODUCT

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below:

1. Rodney Hunt Company
2. Whipps Inc.
3. Fontaine
4. Hydro Gate

2.2 STOP LOGS AND APPURTENANCES

A. Stop Logs

1. Provide stop logs that have the characteristics and dimensions as tabulated in the Stop Log Schedule.

2. Fabricate stop logs of alloy 6061-T6 Aluminum plate and structural shapes specifically designed for use as stop logs, and structurally reinforced to limit maximum bending stress.

    a. Minimum Thickness: 1/4 inch

    b. Maximum Bending Stress: 8,400 psi

3. Provide drainage such that neither air nor water can become trapped in a log.

4. Joints: Mitered and all shop welds ground smooth.

5. Provide all contact surfaces between stop log seals, grooves and log with a smooth mill.

6. Protect all stop log parts from dissimilar metal corrosion.

7. Provide recesses on each stop log to accept the hooks from the stop log lifter.

8. Maximum allowable deflection: L(width)/360 or ¼-in, whichever is less.

9. Seals:

    a. Provide each log with three separate seals: two side seals and an invert seal that form a continuous seal surface.

    b. Provide neoprene invert attached by means of an ultra-high-molecular-weight polyethylene (UHMWPE) retainer gland to mate with neoprene side seals.

    c. Frame mounted seals are not acceptable

    d. UV stabilized.

    e. Maximum compression set at 25 percent

    f. Low temperature brittleness in accordance with ASTM D-2000 for -40 deg. F.

    g. Removable and replaceable

10. All contact surfaces between stop log seals and the grooves and the logs to be smooth finish.

11. Provide stop logs with UHMWPE guide bars to prevent metal-to-metal contact between stop logs and grooves.

12. Hardware: Type 316 stainless steel.

13. Leakage:

    a. Manufacture the stop logs to withstand the differential heads required with a leakage no greater than 0.05 GPM per linear foot of seal length regardless of the order in which the logs are installed.

14. Provide all stop logs for a particular location of identical construction and capable of being installed in random order.

B. Stop log grooves:

1. Stop log grooves: Cast Iron, minimum ¼ inch thickness.

2. Provide stop log grooves with a flush invert.

3. Provide grooves for embedment into the channels walls and floor, surface mounting or in-channel mounting as specified and indicated with Type 316 stainless steel hardware.

C. Stop log lifter:

1. Provide a stop log lifter for each stop log sized and furnished by the stop log manufacturer.

    a. Lifter: Galvanized steel

    b. Lifting hardware: Type 316 stainless steel

2. Lifters to be portable and match the channel width of the stop logs provided. Provide lifters for each width of stop logs in accordance with the Stop Log Schedule.

3. Provide lifter with a latch, and unlatching lines operated from above, to engage or disengage one stop log at a time.

4. Lifting device to grab the log automatically when lowered into the stop log groove.

5. Lifting devices to be rated to handle five times stop log weight.

PART 3 EXECUTION

3.1 INSTALLATION

A. Prior to installation, protect stored stop logs, grooves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, vandalism.

1. Store stop logs, grooves and appurtenances in accordance with the manufacturer's written instructions.

B. Clean debris, dirt, and gravel from grooves and channels before placing stop logs in place.

C. Handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's drawings and recommendations. Install frames and guides in a true vertical plane and with 90 degree corners.

D. Install stop logs with embedded guides and inverts in accordance with the recommendations of the manufacturer.

E. Install all stop logs grooves under the supervision of a representative of the manufacturer furnishing the stop logs.

F. Ensure that grooves are straight and true so stop logs move easily and seat tight without binding.

3.2 FIELD TESTING

A. Furnish the services of a factory representative, as provided under PART 1, who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test of the equipment. These services may be combined with those provided under PART 1.

B. After installation, all stop logs shall be field tested at maximum differential head to ensure that all items of equipment are in compliance with this Section, including the leakage requirements.

1. Maximum allowable leakage for stop logs shall be 0.05 gpm/ft of seal length under the design seating head.

C. In the event that any unit fails to meet the above requirements, the necessary changes shall be made and the unit retested. If the unit remains unable to meet the test requirements to the satisfaction of the ENGINEER, it shall be removed and replaced with a satisfactory unit at no additional cost to the CITY.

3.3 SCHEDULE

A. Abbreviations used in the Stop Log Schedule are as follows:

Types

SL	Stop Log

Direction of Head

S	Seating
U	Unseating

END OF SECTION

STOP LOG SCHEDULE											
Equipment Name	Service	Stop Log Size [1] (Inches)					Frame Type	Head (Feet)[1]	Direction	Maximum Section Size (ft)	Number of Sections[2,3]
		A	B	C	D (min)	F					
SL1	East Bank Junction Structure	36	42	312	8	2.5	Embedded	28	S	3	9
SL2	East Bank Junction Structure	36	42	312	8	2.5	Embedded	28	S	3	9
SL3	East Bank Junction Structure	32	38	312	8	2.5	Embedded	28	S	3	9
SL4	East Bank Junction Structure	72	78	312	8	2.5	Wall Mounted	28	S	3	12
SL5	West Bank Junction Structure	46	52	108	8	2.5	Wall Mounted	15	S	3	3

Notes:
1. Sizes shown are approximate.
2. Provide all Stop Log Sections 3 feet in height accept where shorter is required to reach Size “C”.
3. For SL4 at least 5 of the Sections must be 1 foot in height.

(NO TEXT FOR THIS PAGE)

SECTION 40 80 50

PROCESS CONTROL SYSTEM COMMISSIONING

PART 1 GENERAL

1.1 SUMMARY

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all equipment and coordinate all activities necessary to perform check-out and start-up of the equipment installed as part of the SSWWTP Flow Optimization Project, Third River Crossing.

B. CONTRACTOR: retain the services of a SYSTEM INTEGRATOR, with substantial documented experience, to supervise and perform check-out and start-up of all Process Control System components. Provide the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the equipment.

C. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 33 00 - Submittals
2. Section 40 90 00 - Process Control System General Requirements
3. Section 40 90 50 - Process Control System Descriptions
4. Section 40 95 13 - Process Control System Panel Enclosure and Equipment
5. Section 40 96 15 - Process Control System IO list
6. Section 40 98 00 - Process Control System Training

1.2 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Section 01 33 00 - Submittals.

B. Prior to beginning commissioning activities, submit the following for OWNER approval, meeting the sequence and schedule established by the CONTRACTOR for facilities impacted by the Contract, as well as overall commission. Submit to meet requirements per process area and for facility wide commissioning:

1. Test Plan

2. Test Forms

3. Test Schedule

4. Testing Tools

5. Test results

6. Test Logs

7. Loop Check List

8. Point to Point Wiring Diagrams

9. Preliminary Testing Results

10. Approved O&M Manual List

11. Certification that all appropriate Operator Component training has been completed

12. Certification that the Test Engineer has reviewed all data and the system and certifies that it is ready for operation

C. Forms

1. Submit sample test forms and test logs for review

1.3 SYSTEM CHECKOUT AND START-UP

A. SYSTEM INTEGRATOR: perform the following, as witnessed by the OWNER, as applicable:

1. Check and approve the installation of all Process Control System components and all cable and wiring connections between the various system components.

2. Conduct a complete system checkout and adjustment, including checking each components functions, and testing of final process control system instrument, device, computer, and network functions. Promptly correct all problems encountered to prevent any delays in start-up of the process control system.

B. SYSTEM INTEGRATOR: furnish all test equipment necessary to perform the testing during system checkout and start-up.

C. SYSTEM INTEGRATOR: assume responsibility of the initial operation of the process control system. Make any required changes, adjustments, or replacements necessary to the system to perform the intended functions.

D. SYSTEM INTEGRATOR: furnish RESIDENT PROJECT REPRESENTATIVE an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of CONTRACTOR, SYSTEM INTEGRATOR, and equipment SUPPLIER.

1.4 INTEGRATED SYSTEM FIELD TEST

A. SYSTEM INTEGRATOR: perform a complete system test, as witnessed by the OWNER, as applicable, to verify that all Process Control System (PCS) instrumentation and controls equipment, network hardware, and software is operating properly as a fully integrated system, and that the intended network functions are fully implemented and operational. Complete this integrated test after all process areas are demonstrated as operational and tested individually, and after individual facilities are tested and proven operational.

B. SYSTEM INTEGRATOR: correct any defects or problems found during the test and then retest to demonstrate proper operation.

C. Refer to Part 2 of this specification for detailed Integrated System Field Test (SAT & Start-up) requirements.

1.5 7-DAY TEST

A. The 7-Day Test is a period of time during which the control system shall be utilized by the OWNER in day-to-day operations. The purpose of the process control system 7-Day test is to test the control system stability and completeness over time. This test shall occur in conjunction with all other systems included in the project. The intent of the test is for the system to operate without modification or repairs.

B. CONTRACTOR: start the 7-Day Test upon written approval from the OWNER/RESIDENT PROJECT REPRESENTATIVE.

C. 7-Day Test shall continue until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.7 percent for 7 consecutive days and no system failures have occurred which result in starting the 7-Day Test over. During the 7-Day Test the system shall be available to facility operating personnel for use in normal operation of the facility.

D. For the purpose of the 7-Day Test, the system shall be defined as all new control system work installed under this Contract, as well as any modifications made to

the existing control system.

E. The 7-Day Test shall be terminated if one or more of the following occur. Following correction of the problem, a new 7 consecutive day 7-Day Test shall begin.

1. Failure to repair a hardware or software problem, causing one or more processes halt execution.

2. Recurrent hardware or software problems: If the same type of problem occurs more than once. Any hardware change or replacement will reset

3. Programming or configuration changes shall reset the 7-Day clock.

F. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.5.G, below:

1. Loss of communications between devices on the process control system network.

2. Failure of one or more network devices

3. Failures of any device impacting two or more process control system components simultaneously.

4. Failure of Power Supply: Where redundant power supplies are provided, failure of one power supply will not constitute a system failure provided the backup power supply operates properly and maintains power supply. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.

5. The system shall be considered down if the system cannot generate the periodic reports, alarm log, or event log. The report and logs need not appear on the printer originally selected for the report.

6. Downtime caused by primary utility power failure will not count as downtime.

7. Loss of any microprocessor shall be considered downtime.

8. Loss of more than 5 percent of the total inputs or outputs per processor or RIO shall be considered downtime.

9. The accuracy and precision of all of the analog inputs and outputs must be within the limits specified, or the system shall be considered down.

10. The time between notifying the CONTRACTOR of a system failure and the time it has been corrected and back on line shall be considered downtime.

11. Shutdown of the critical systems from a software fault shall be considered downtime.

G. The system availability shall be calculated based on the following equation:

$$A = \frac{TTO}{TTO + TTR} \times 100 \text{ percent}$$

where,

A = system availability in percent
TTO = total time in operation
TTR = total time to repair

H. Time to repair shall be the period between the time that CONTRACTOR is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.

1. Actual travel time for service personnel to get to the Site up to four hours per incident from the time CONTRACTOR is notified of a system failure.

2. Time for receipt of replacement parts to the Site once identified up to 8 hours per incident. Work done on the system while waiting for delivery of replacement parts does not stop the failure clock.

3. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the 7-Day Test extended for an amount of time equal to the total dead time. Dead time shall be totalized.

I. CONTRACTOR: furnish all parts and maintenance materials required to repair the system prior to completion of the 7-Day Test at no additional cost to OWNER. Immediately replace parts that are obtained from the Contract spare parts inventory.

1.6 SPARE PARTS

Not Used

PART 2 SITE ACCEPTANCE TESTING

2.1 GENERAL

A. The Process Control System (PCS) Site Acceptance Test (SAT) shall be focused on verifying that all instrumentation, equipment, PLC/OIT/HMI, and controller hardware and software is working properly and that all software configurations match the requirements identified in the detailed process narratives. Successful completion of the SAT shall be considered to be a critical project milestone.

B. CONTRACTOR: test the software under all possible process conditions in order to demonstrate the robustness of the software. The software test shall be witnessed by OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE.

C. The SAT shall consist of testing using the actual field inputs/outputs once all field equipment has been installed and successfully tested.

D. SAT testing shall be carried out for all PLC/OIT/HMI and controller software including packaged and vendor supplied products as a whole system.

2.2 PREREQUISITES

A. Complete equipment start-ups with manufacturer representatives including all mechanical equipment required to fully test the operation of the software. Complete process area start-ups prior to overall SAT.

B. Install, calibrate, and test all required instrumentation prior to starting SAT.

C. Install and test all required network equipment prior to starting the first facility SAT.

D. Submit the SAT & Start-Up Test plan for approval by the OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE no later than four (4) weeks in advance of the SAT.

E. Wire, test, and sign off 100% all process area and packaged system panel I/O prior to commencing SAT unless otherwise approved by OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE. Submit a request to defer I/O testing until after the SAT for review and approval at the same time when the SAT & Start Up test plan is submitted for review and I/O is not available. Identify the reason for deferring I/O testing in the request along with a proposed date when the I/O shall be tested.

2.3 START-UP TEAM

A. The Start-Up Team shall consist of individuals from the OWNER, ENGINEER,

RESIDENT PROJECT REPRESENTATIVE, CONTRACTOR, SYSTEM INTEGRATOR, and Equipment Manufacturers.

B. The Start-Up Team shall review the testing plan, SAT, & Start-Up Plan and revise, if necessary, at a pre-SAT & Start-Up meeting to be scheduled no later than six (6) weeks in advance of the proposed SAT period.

C. Furnish details for the SAT & Start-Up Plan to clearly identify the proposed test procedure for the equipment and software.

D. The SAT testing shall be witnessed by the Start-Up Team.

E. Members of the Start-Up Team shall be identified at the pre-SAT & Start-Up meeting. These team members will be involved throughout the process and shall be changed only with the approval of the RESIDENT PROJECT REPRESENTATIVE.

2.4 PURPOSE AND SCOPE

A. Goal of software testing: to verify that the system released for use by the Facility's Staffs meets the contract requirements, and is error-free, and does not adversely affect other systems. Software installed or modified under the project shall not adversely affect the operation of other systems currently in operation at existing OWNER facilities. All functionality that is currently available within the system must remain available at the completion of the testing.

B. Test all software installed as part of the project to confirm that the software developed, tested, and installed under the project conforms to the approved process control narratives.

C. All software shall meet the requirements of the project specifications including all operational control, monitoring, and alarming. Software shall integrate all vendor packaged systems as defined within the contract documents.

D. Testing shall demonstrate that all software developed works throughout OWNER SCADA workstations. Conduct all system-wide testing concurrently with the local testing to confirm operation throughout the system.

2.5 DEFINITIONS

A. Software Testing: defined as the execution of a program to find its faults, and not just a process to verify its correctness.

B. Other definitions are:

1. Verification: The process of proving the program's correctness.

2. Validation: An attempt to find errors by executing a program in the controllers, Control nodes, and Monitoring nodes.

3. Debugging: Diagnosing the precise nature of a known error then correcting it. Debugging is a "fix" activity, not strictly a testing activity.

4. Errors: Human mistakes; errors in design definition or interpretation of the design by the programmer.

5. Defects: Improper program conditions that are generally the result of an error. Not all errors produce defects (as with incorrect program comments, for example).

6. Bugs: A fault that is a program defect found when the program is being tested or is in operational use. Bugs result from defects, but all defects do not necessarily produce bugs.

2.6 OBJECTIVES

A. The following identifies the overall objectives of the PCS Site Acceptance Test:

1. Confirm and document that the PLC I/O matches the panel shop drawings in terms of input/output configuration, tagging, and function.

2. Confirm and document that the individual device logic operates all field equipment correctly and safely, as described in the detailed process control description.

3. Confirm and document that the control logic operates the facility correctly and safely, as reviewed at the FAT and also described in the detailed process control description.

2.7 APPROACH

A. As part of the testing process regression, incorporate testing into all test plans to demonstrate that any changes made to the software do not impact other areas of the logic. This approach shall ensure that corrections/modifications have not adversely affected the previously tested (and debugged) systems and system components.

B. Testing is to be both progressive and regressive.

1. Progressive testing introduces and tests new functions and uncovers problems in the newly added or modified modules and in their interfaces.

2. Regressive testing concerns the effects of newly introduced changes or system components on all previously integrated (tested) code.

2.8 TEST SUCCESS CRITERIA

A. Test success shall be based on the number of defects and the defect severity levels encountered during the testing period. The OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE at their discretion shall determine to restart a new SAT.

2.9 COMPLETION CRITERIA

A. Testing of software is deemed to be complete when all features, functions and information required in accordance with Section 40 90 00 - Process Control System General Requirements, contract drawings, and the complete functionality as described in the contract documents has been verified as present and functioning, and documented as accurate within the anticipated operating range for the process being monitored and controlled.

2.10 PARTICIPANT AND RESPONSIBILITIES

A. SAT & Start-Up Test Planner (CONTRACTOR / SYSTEM INTEGRATOR / Equipment Manufacturer):

1. Develops the complete SAT & Start-Up test plan

2. Develops the schedule

3. Coordinates all meetings identified in the contract documents to develop and implement the test plan

4. Coordinates the involvement of all team members and equipment manufacturers required to be present during testing

5. Develops/compiles the test data

6. Oversees the test planning and test plan execution of the process control system

7. Obtains approval for test plan and schedule from ENGINEER/RESIDENT PROJECT REPRESENTATIVE.

B. OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE:

1. Reviews and approves test plan

2. Documents test results and classifies defect severity

3. Identifies system "design" defects (where the design does not match the specification) and coding defects (where the system does not behave as specified)

4. Reviews test results

5. Assigns Level 1, 2, and 3 faults. Logs action required and taken in the Software Action Log

6. Assigns Level 4, 5, and 6 faults. Logs action required and taken in the Software Action Log

7. Maintains Software Action Log

8. Maintains Deficiency Log related to other trades: electrical, instrumentation, vendor packages, and others

9. Presents Correction Requests to the OWNER for prioritization

10. Schedules approved correction request work

11. Maintains Correction Request Log

12. Coordinates with City operations staff to avoid conflicts and minimize impact to operations of construction activities

13. Participates and assists in the acceptance testing

14. Responsible for signing-off on the acceptance testing that the system is fully functional as defined within the detailed process control narrative

15. Oversee the integration of the software into the existing SCADA network

C. SYSTEM INTEGRATOR

1. Responsible for defining the procedure required to complete the SAT & Start-Up tests

2. Responsible for directing the SAT and start-up testing and for providing input to the CONTRACTOR as to which trades are required to complete the tests identified within the test plan

3. Installs and tests all software for functionality as per the detailed process control description

4. Fixes all defects

5. Documents test results and forwards to CONTRACTOR

PART 3 EXECUTION

3.1 GENERAL

A. Part 3 provides an outline of the work to be carried out by the OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE/ CONTRACTOR/SYSTEM INTEGRATOR/Equipment Manufacturer as part of the PCS Site Acceptance Test(s).

3.2 TEST SUB-PHASE

A. The types of software tests are:

1. Individual instruments, equipment, and process units: these sub-phases test/verify that devices and their larger system parts (e.g. process units and duty tables) perform as specified.

2. Intra-system Integration: tests/verifies the interfaces between units and the associated process logic related to multiple units, and facility-wide operating strategies.

3. Function: tests/verifies the functions the program is to perform as set out in the detailed process control narratives.

4. Performance/Operational: tests/verifies the system's performance under a variety of conditions (normal/abnormal) and verifies these results against the detailed process control narratives. Includes testing of the system's configuration, security, backup/recovery, and reliability in the planned network architecture.

5. System Wide Integration: tests/verifies the operation of all control areas from all OITs and HMI operator workstations.

3.3 DEFECT HANDLING

A. During testing, identify the need for corrections to the system. This shall be as a result of a test failure or as a result of an incorrectly implemented requirement (test did not fail, but the requirement is incorrectly implemented).

B. For test failures, record the defect in the SAT test document. Immediately review

and resolve all defects during the SAT period.

C. The following "Fault Severity Index" is to be used for handling defects:

Defect Severity Level	Defect Description
1	Fault causes system to crash. System rendered unusable/non-functional.
2	Fault occurs in a critical function. Function is rendered unusable. A critical function is defined as a function that is required to maintain operation of the facility without manual intervention by the operations team.
3	Fault occurs in a critical function. A portion of the function is rendered unusable.
4	Fault occurs in a non-critical function. Function is rendered unusable.
5	Fault occurs in a non-critical function. A portion of the function is rendered unusable.
6	Cosmetic (e.g. typo) and would be unlikely to result in loss of confidence by users.

D. Testing cut-off points also need to be established in the test plan and reflected in the testing schedule. Level 1, Level 2, and Level 3 faults shall be corrected as a first priority and testing should not proceed to the next sub-phase until all Level 1, 2, and 3 faults are corrected.

E. The OWNER/ENGINEER/RESIDENT PROJECT REPRESENTATIVE determines the priority for correcting Level 4, 5, and 6 faults and prioritizes all Correction Requests.

F. If Correction Requests are required, they will be prepared by the RESIDENT PROJECT REPRESENTATIVE. Possible implications of not proceeding should also be identified. The OWNER will authorize the work to be done under any correction request. Prior to implementing, CONTRACTOR shall schedule correction request work based on the project priorities.

3.4 SUCCESSFUL COMPLETION

A. The SAT is deemed successful when the following items have been completed:

1. SAT Test plan has been completed and signed-off

2. All Level 1, 2, and 3 faults identified during the SAT have been corrected and verified for correct operation

3. The completed SAT plan has been reviewed and signed off by the

ENGINEER, RESIDENT PROJECT REPRESENTATIVE, CONTRACTOR, and SYSTEM INTEGRATOR.

3.5 FACILITY STARTUP PERIOD

A. Following successful completion of the SAT testing, the startup period may commence. OWNER, ENGINEER, RESIDENT PROJECT REPRESENTATIVE, CONTRACTOR, SYSTEM INTEGRATOR, and Equipment Manufacturers, are to be present during the startup period.

B. RESIDENT PROJECT REPRESENTATIVE maintains a log of faults/deficiencies encountered during the startup period. The CONTRACTOR/SYSTEM INTEGRATOR/Equipment Manufacturer is to immediately correct faults/deficiencies at the request of the OWNER, ENGINEER, or RESIDENT PROJECT REPRESENTATIVE. If any Level 1, 2, or 3 fault occurs during the startup period, the test period shall be restarted from Day 1 after completion of the software modifications and testing by the SYSTEM INTEGRATOR.

C. Following completion of the startup period, the fault/deficiency log is submitted to the RESIDENT PROJECT REPRESENTATIVE for review. Sign-off by OWNER, ENGINEER, RESIDENT PROJECT REPRESENTATIVE, CONTRACTOR, and SYSTEM INTEGRATOR is required at the completion of the facility startup period.

3.6 TRAINING

A. Provide training in accordance with the requirements contained in Section 40 98 00 - Process Control System Training.

3.7 MANUFACTURER'S FIELD SERVICES AND TRAINING

A. During the 7-Day Test, the CONTRACTOR shall include the services and training time of factory trained personal, as required, from each manufacturer listed. This time shall be utilized at the discretion of the OWNER. Field services shall be based on an eight (8) hour day, Monday through Friday, during the Facility's normal working hours. All travel and living related costs are the responsibility of the CONTRACTOR.

END OF SECTION

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SECTION 40 90 00

PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section 40 90 00 describes the general requirements for furnishing and installing process control system (PCS) including all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, and place in operation a complete system as illustrated on drawings, and as specified in the following sections.

B. Provide labor, materials, equipment, and services to store, transport, install, calibrate, and make operational the PCS work for the SSWWTP Flow Optimization Project, Third River Crossing. The work includes the design shown on the drawings and specifications including instruments, field devices, networks, programming, integration, testing, and commission for all devices provided including packaged systems and control. Work shall also include wiring, raceway, fittings, and connections to link and integrate the individual components and packaged control systems into the existing SCADA network.

C. Work Areas for This Project Include, But are Not Limited to:

1. Diversion Facilities

2. Modifications to existing PLCs and HMIs

D. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 33 00 - Submittals
2. Section 40 80 50 - Process Control System Commissioning
3. Section 40 90 50 - Process Control System Description
4. Section 40 95 13 - Process Control System Panel Enclosure and Equipment
5. Section 40 96 15 - Process Control System Input and Output List
6. Section 40 98 00 - Process Control System Training

1.2 SYSTEM SUPPLIERS

A. CONTRACTOR: provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place

in satisfactory operation the modifications required for a complete process control system. Assume responsibility for all elements specified and provided as part of this section and related sections.

B. SYSTEM INTEGRATOR: provide all programming, integration, testing, start-up, and commissioning services related to PLC control system and PCS HMI systems.

1.3 REFERENCES

A. Regulatory Requirements

1. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes, applicable to construction and installation of electrical wiring, devices, material, and equipment.

2. NECA Standards: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation".

3. UL Labels: Provide control panel components, power supplies, relays, etc., which have been listed and labeled by Underwriter's Laboratories.

B. The purpose of Contract drawings and specifications is to convey information required for complete and functioning systems.

C. SYSTEM INTEGRATOR is responsible for all details necessary to properly install, adjust, configure, and place in operation the intended systems. Instrument List and Input/Output List, if provided, are for convenience; their accuracy is not guaranteed.

D. Section 01 42 20 - References.

E. Codes and Standards referred to in this Section are:

1. NFPA 70 National Electrical Code

2. UL Underwriter's Laboratory

3. NEMA National Electrical Manufacturers Association

1.4 QUALITY ASSURANCE

A. Standard Products

1. Use standard hardware and software which is fully developed, tested, and supported as a base for the Work. Provide custom modifications as specified elsewhere. Provide a fully operational, reliable system which

meets the functional intent of the Specifications.

B. Software Testing Standards

1. Test programs to ensure that the software to be provided is consistent with the design parameters and that no errors occur when the programs are executed, either at machine level (PLC) or operator level (HMI).

2. Establish testing standards.

C. Revision Level

1. Update hardware and firmware to the manufacturer's latest revision level as currently deployed at the Southside WWTP facility. If revisions are required deploy revisions across the enterprise system. Perform updates periodically until final acceptance, as revisions are issued by the manufacturer. Hardware and firmware shall be uniform across enterprise system.

2. Exceptions will be considered on a case-by-case basis. Exceptions shall not be allowed without certification that the original equipment manufacturer will continue to support and warranty the hardware.

3. Ensure retention of compatibility with all systems before performing any hardware, software, or firmware upgrades.

1.5 ABBREVIATIONS

A. HMI – Human Machine Interface.

B. OIT – Operator Interface Terminal

C. OWS – Operator Work Station

D. PC – Personal Computer.

E. PCS – Process Control Systems.

F. PLC – Programmable Logic Controller

G. SCADA – Supervisory Control And Data Acquisition

H. SSWWTP – South Side Wastewater Treatment Plant

I. TMUA – Tulsa Metropolitan Utility Authority

1.6 DEFINITIONS

A. Process Instrumentation and Control Equipment: Instrumentation and control and monitoring components such as field elements, panels, process control systems, and associated electromechanical, electrical, and electronic accessories.

B. Process Instrumentation and Control System: Materials, equipment, and work required to implement a complete and operating system of instrumentation and control equipment.

C. PLC (Programmable Logic Controller): System includes power supply, central processing unit (CPU), communication controller, interconnect cables, and input and output interface.

D. SCADA (Supervisory Control and Data Acquisition): Computer system that operates as primary operator interface to the entire PLC network, which includes process visualization and control, data collection and storage, alarm management, and process data link to other office productivity software.

E. OIT (Operator Interface Terminal): Graphical local operator interface terminal at a PLC enclosure or control panel.

F. OWS (Operator Work Station): PC based operator system, including hardware, operating system software, and operator interface HMI system software. This is generally referred to as the SCADA or HMI workstation.

1.7 GENERAL DESCRIPTION OF WORK

A. Provide all materials and work necessary for complete and fully functional systems.

1. Provide instrumentation and controls components as well as complete system integration. Provide all mounting hardware and supports. Work shall include panel mounting and the completion of all wiring terminations within control panels.

2. Integrate new equipment and instrumentation to existing PLC systems for monitoring and control of equipment as shown in the contract drawings. Control strategies for the PLC systems are provided in Section 40 90 50 - Process Control System Description.

3. Configure all I/O points as shown on Contract Drawings and as required by Section 40 96 15 - Process Control System Input/Output List.

4. Commission PLC system per the requirements of section 40 80 50 - Process Control System Commissioning.

5. Ensure communication with existing SCADA system through existing control network allowing monitoring and control of new equipment.

6. Ensure proper interface between SCADA, PLC, and OIT, OWS, RIO systems and equipment provided in this contract.

7. Provide control panels and enclosures as shown on Contract Drawings and as specified in Section 40 95 13 - Process Control System Panel Enclosures and Equipment.

8. Provide training for OWNER to perform all functions necessary to operate equipment per Section 40 98 00 - Process Control System Training.

9. Work is generally as shown on the drawings and as specified. Programming of each PLC/OIT/HMI is required including communication and messaging with related equipment (drives, packaged systems, generators, power monitors, etc.) Configuration of network equipment, including implementation of network security consistent with TMUA is required.

10. Coordinate work with all electrical, mechanical, civil, and structural work provided in this Contract.

11. Ensure proper interface between SCADA, PLC, and OIT, OWS, RIO systems and equipment provided in this contract.

12. Install, make final connections, adjust, test, start-up systems per manufacturer's instructions and recommendations.

B. Source Code Ownership

1. Any developed ladder logic (along with source code) shall become property of the OWNER. This applies to any logic associated with package control systems as well.

2. Any developed or modified PLC, HMI, OWS, and OIT applications (along w/ source code) shall become property of the OWNER, and shall be consistent with existing for look, feel, navigation, including type of graphics and colors. This applies to any logic associated with package control systems as well.

3. All passwords shall be documented and submitted to OWNER.

1.8 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Section 01 33 00 - Submittals.

B. SYSTEM INTEGRATOR: Prior to beginning any work on this Contract, submit a plan for performing programming, site testing, commissioning, and start-up for OWNER approval.

C. Include the following information in the submittal for this section:

1. A system hardware overview that provides an overall description of the PCS equipment being added, including a detailed system configuration diagram.

2. Power and grounding interconnection diagrams. Show the grounding philosophy and implementation. Detail interconnections from the main power source. Show uninterruptible power supplies and power conditioners.

3. Interconnecting wiring and cabling diagrams. Include maximum distance limitation between panels and equipment. Include cable identification.

4. Color schedule with color and samples for panels.

D. Include the following submittal information on each hardware item:

1. General data and description.

2. Engineering specifications and data sheets, annotated as necessary to describe specific hardware.

3. Dimension drawings, including exterior dimensions and clearances required, cable ingress and egress areas, cable routing and terminations.

4. Equipment weights.

5. Power and grounding requirements, wiring diagrams, and electrical schematics.

6. Heat rejections and environmental operating requirements.

7. Spare parts list, special tools and test equipment.

8. Other submittal information as required in individual specification sections.

E. Action Submittals

1. Product Data: Submit manufacturer’s official and published product data, specifications, and installation recommendations for each item.

2. Shop Drawings: Submit shop drawings as per Section 01 33 00 - Submittals, and as required below. Include the following information in each submittal:

    a. Instrument index, including tag number, description, location, and calibrated range for each instrument.

    b. Individual instrument specification sheet, including manufacturer's name and complete catalog number.

    c. Panel construction drawings with dimensions, layout, and bill of materials.

    d. Panel wiring diagrams

    e. Loop diagrams

    f. Communication and digital networks diagrams

F. Include connections to Ethernet network. Identify cable, termination type, termination location, and drop lengths for each segment.

1. Format: Network schematic for each different type of network.

2. Input and Output drawings, containing, but not limited to, the following information:

    a. Line numbers and instrument tag numbers

    b. Individual component locations

    c. Actual equipment wiring terminal designations, point to point wiring, and cable shield terminations

    d. Wire type, size, and identification number

    e. Signal types (e.g., 120 VAC, 4-20 mA, pulse frequency, etc.)

    f. Contact orientations (e.g., normally open, normally closed, etc.)

    g. Equipment grounding requirements

    h. Signal boosters, interposing relays, optical isolators, and shunt resistors.

3. Completely developed process screens.

G. Information Submittals

1. Test Reports: Provide all loop field calibration reports.

2. Factory and Field Testing: Provide the following:

a. Test Results:

(1) Pass/fail status of all digital I/O.

(2) Results of analog I/O testing.

b. Miscellaneous:

(1) Detailed step-by-step in-factory and field test procedure at least 6-weeks in advance of scheduled test date. Include sign-off sheets and punch list forms and description of configurations to be tested.

(2) Complete inventory of equipment to be tested including make, model, and serial number. Label each piece of equipment.

(3) Preventive maintenance schedule.

(4) Repair Report Forms.

(5) Spares and Consumables Report.

3. Provide manufacturer published installation manuals and operations manuals for each instrument, device, or equipment.

H. Graphics

1. CONTRACTOR: submit static copies of each proposed or modified graphic screen including alarm screens. Submittal shall indicate navigation, pop-ups, alarms, and status information.

I. Submittals for Closeout: Furnish submittals as required below.

1. Project Record Documents: In addition to requirements described in Section 01 78 90 - Contract Close Out, provide the following:

a. Program documentation: Provide paper copies of all software development and configuration including listing of all register tables.

b. Include functional narrative description of the developed ladder logic to describe each control system. Ladder logic is to be annotated as specified in Section 40 94 43 - Programmable Logic Controller Systems to include functional alphanumeric description of logic elements to assist OWNER in understanding the ladder logic for troubleshooting and future modification.

c. Program copies: Provide two digital copies of fully configured systems. Digital copies shall be included in both CD-ROM format and USB storage drive format.

d. Operator interface program copies: Provide hard copy printouts and digital copies of new or modified OWS screens and database listings. Digital copies shall be included in both CD-ROM format and USB storage drive format.

2. Operation and Maintenance Data: Provide operation and maintenance manuals as specified in Division 1. Include the following information:

a. Recommended spare parts list.

b. Manufacturer approved repair and service centers list.

c. Replacements part sources.

d. Recommended maintenance procedures and frequencies.

3. Warranty: Provide warranty certificate as described in Section 01 78 90 - Contract Close Out.

1.9 RESPONSIBILITY

A. SYSTEM INTEGRATOR:

1. Provide application software programming as specified in Section 40 90 50 - Process Control System Description.

2. Prepare Interconnecting Wiring Diagram Drawings for the Process and Instrumentation Control System. Interconnecting wiring and terminations for the System shall be provided by the electrical CONTRACTOR under Division 26, in accordance with the Interconnecting Wiring Diagram Drawings.

3. Responsible for configuration, coordination, and addressing of Ethernet networks for the devices specified herein and as shown on the Drawings. Where additions to existing plant networks are required, request the range of available addresses from the OWNER and coordinate requirements.

4. For Process Control System control panels, components, and ancillaries specified under this section:

    a. Coordinate to ensure that: The proper size, type, and number of PCS related raceways and conductors are provided and installed.

    b. Complete panel fabrication and modification drawings.

    c. Provide the specified submittals.

    d. Provide panels, components, and ancillaries.

    e. Provide programming and configuration of PCS components.

    f. Provide instructions, details, and advice to and coordinating with the CONTRACTOR to ensure proper installation.

    g. Certify correctness of installation.

    h. Verify final power and signal connections and labeling (lugging and connecting).

    i. Adjust and calibrate components and devices.

    j. Perform Start-up

    k. Perform Testing

    l. Provide the required training.

5. For systems, components, and ancillaries not provided under this Section but that are directly connected to components provided under this Section:

    a. Obtain manufacturers' information regarding installation, interface, function, and adjustment.

    b. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacture's recommendations.

    c. Testing to demonstrate proper interface and operation with PCS.

B. CONTRACTOR: immediately correct incomplete or deficient Work discovered during application software programming, downloading, testing, troubleshooting, and System startup. Use interim modifications or patches as required to maintain 24 hr x 7 day operation.

1.10 APPLICATION SOFTWARE PROGRAMMING

A. SYSTEM INTEGRATOR:

1. Provide application software programming as required in this and related Sections.

2. Download and test application software programming after successful completion of Process Control System Factory Acceptance Testing specified in Section 40 98 50 and Process Control System Commissioning in Section 40 80 50.

B. Training Services specified in Section 40 98 00 - Process Control System Training shall not begin until SYSTEM INTEGRATOR has successfully completed application software programming, downloading, and testing. Refer to construction sequences and constraints that affect completion of application software programming, downloading, and testing.

C. All work performed by the SYSTEM INTEGRATOR shall be performed in accordance with TMUA SCADA standards.

1.11 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver, store, and handle all products and materials as specified in Section 01 60 00 - Material and Equipment.

B. Acceptance at Site: Inspect all materials and equipment against approved shop drawings at time of delivery. Immediately return for replacement or repair any equipment or materials damaged or not meeting requirements of approved shop drawings.

C. Storage and Protection: Label all equipment and materials after they have been inspected. Store all equipment and materials in dry, covered, ventilated location. Protect from harm in accordance with manufacturer's recommendations.

1.12 PROJECT/SITE CONDITIONS

A. Environmental Requirements: Protect all equipment and instruments specified herein from moisture. Site is a wastewater treatment plant with potential for hazardous, corrosive, and chemical rich vapors. Process control equipment may

be located outdoors and subject to temperatures from -20F to +120F, with rain and 100% humidity.

1.13 SEQUENCING AND SCHEDULING

A. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawing Reviews by ENGINEER:

a. Prerequisite: RESIDENT PROJECT REPRESENTATIVE's acceptance of Schedule of Values and Progress Schedule.

2. Training

a. Prerequisite: Associated training plan Submittal approved.

b. Prerequisite: Offsite Training plan submittal approved

PART 2 PRODUCTS

2.1 GENERAL

A. Provide hardware consisting of ruggedized components designed specifically for the site conditions. Refer to other sections for appropriate NEMA requirements.

B. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL), Inc., and so marked or labeled, together with manufacturer's brand or trademark.

C. Provide material and equipment in accordance with applicable codes and standards, except as modified by the specifications.

D. Coordinate instrumentation to assure proper interface and system integration. Provide signal processing equipment, to include, but not be limited to, process sensing and measurement, transducers, signal converters, conditioners, transmitters, receivers, and power supplies. Coordinate the various subcontractors, equipment suppliers, and manufacturers.

2.2 SYSTEM ARCHITECTURE

A. SYSTEM INTEGRATOR: responsible to configure and program the PCS to provide control and monitoring of all instruments, devices, and equipment connected to the PLC system as described in this Contract.

2.3 MONITORING AND CONTROL – GENERAL

A. Functional descriptions of the processes and equipment to be monitored and controlled by (or through) the Process Control System are specified in Section 40 90 50 - Process Control System Description.

2.4 SYSTEM HARDWARE

A. Provide all hardware and ancillary equipment required to provide a fully functional PCS. PCS components, including panel hardware, motor starters, etc. shall be as specified in Division 40 and other Divisions.

2.5 SYSTEM INTEGRATION

A. Provide system integration of the complete PCS. System integration may require the installation of additional pieces of equipment to make the PCS a reliable, safe, maintainable and fully functional system. Such equipment includes, but is not limited to, communication modules, terminations, wires, cables, connectors, power supplies, transceivers, transducers, signal isolators, power surge suppressers, lights, switches, circuit breakers, fuses, power receptacles, fans, and communication devices.

B. Provide all additional pieces of equipment as necessary to provide a fully integrated, fully operative PCS with fully functional signal interfaces to field instrumentation, motor controllers, and other control devices as described elsewhere.

C. System integration requires thorough testing of all system equipment and circuits under all probable system conditions to ensure a robust PCS.

2.6 GRAPHIC DISPLAY REQUIREMENTS

A. The displays shall include at a minimum all the equipment shown in the Process and Instrumentation Diagrams and described in the control description provided in Section 40 90 50 - Process Control System Description. Graphics shall follow requirements of High Performance HMI standards. All equipment shall be labeled as shown on the Contract Drawings or as listed in the I/O list.

B. All HMI & OIT displays shall have the following attributes:

1. Display window sizes:

    a. 1330 wide by 553 high with “Size to Main Window at Runtime” checked

b. 1900 wide by 790 high

2. Pop-up displays (e.g. Set Point Displays):

a. No set size, but sized appropriately for content and be smaller than display window sizes as defined above

b. Use the "On Top" Display Type

3. OIT Display Window sizes:

a. Size normal display windows to appropriately the full screen or scale properly as to avoid stretching

b. Pop-up displays

(1) Do not have to be set to fill the screen, but should use the "On Top" display type.

(2) Background color shall be Grey

(3) All Buttons will be Style: Recessed

(4) All standard text will have the following attributes:

(a) Arial Bold 10pt font

(b) Center aligned

(c) Either Black or White, dictated by whichever color provides the best contrast for easy readability

(5) All numeric displays and numeric inputs shall have the following

(a) Courier New Bold 10pt font

(b) Right-aligned

(c) Fore Color: White

(6) Any visual graphics (e.g. tanks) will endeavor to reasonably reflect their real-world counterpart in look

(7) All grouping containers will use the panel object tool and have the following attributes:

(a) Inset border style

(b) Border width: 2

(c) Back style: Solid

(d) Pattern Style: None

(e) Back color of Dark Grey

C. Color standards for all HMI & OIT displays (specified in RGB):

1. Numeric displays – centered in a small panel object with an associated background color:

a. Levels: 0, 136, 200

b. Temperatures: 140, 140, 0

c. Pressures: 0, 128, 0

d. Flows: 128, 0, 0

2. Green: 0, 255, 0

3. Red: 255, 0, 0

4. Grey: 128, 128, 128

5. Dark Grey: 63, 63, 63

6. Yellow: 255, 255, 0

7. White: 255, 255, 255

8. Black: 0, 0, 0

9. Other Colors with OWNER approval

D. HMI Tags

1. All HMI tags shall have a prefix designated by OWNER.

2.7 CABLES AND CONNECTORS

A. Provide wiring, connectors, and cables to connect the equipment.

B. Size wiring and cables to equipment such as printers, operator workstations, and similar devices to accommodate relocation within the control rooms and operator workstation areas. Add a minimum of 25 percent of the cable length or 15 feet, whichever is greater, to the laying lengths.

C. Clearly label all cables at both ends according to requirements of electrical identification.

PART 3 EXECUTION

3.1 GENERAL

A. Provide the detailed hardware configuration, integration, construction, testing, startup, installation, and demonstration of all equipment.

B. Install all equipment at the OWNER's facilities in accordance with applicable federal, state, and local codes. Supervise the installation and be responsible for the performance of the completed system.

C. Provide for the protection, insurance, and proper storage of equipment. In the event the equipment is damaged, for whatever reason, repair or replace, as required, the damaged equipment at no cost to the OWNER until Final Acceptance.

D. Provide coordination of the overall PCS for resolution of interface discrepancies between the PCS input/output hardware, panels, equipment, instrumentation, and final control devices. Where interface conflicts exist, provide resolution to the problems and document them in writing to the RESIDENT PROJECT REPRESENTATIVE. Keep Drawings current with all changes.

E. Provide operations and maintenance manuals, record drawings, documentation, and warranty as described elsewhere in the Specifications.

3.2 EXAMINATION

A. Verify equipment locations and delivery routes prior to installation to ensure the equipment will fit in the available space. Investigate and make any field modifications necessary to allocated space for new equipment.

B. Existing raceways which contain space to run wiring may be used with the approval of the RESIDENT PROJECT REPRESENTATIVE. Do not damage

existing equipment or wiring. If equipment or wiring is damaged, repair or replace it at no additional cost to the OWNER. Do not interrupt control or monitoring signals or power. Obtain approval from the OWNER before pulling wires.

3.3 PROTECTION

A. Maintain site security.

1. Check in with facility staff each day while on site.

2. Verify that all enclosures, doors, and gates which were opened during the day are locked when leaving.

3. Do not leave unlocked enclosures unattended for longer than 30 minutes.

3.4 INSTALLATION AND WIRING

A. Install wiring to interface the PCS components to field devices for all points on the I/O list. Wiring shall be in accordance with the recommended methods and practices of the manufacturers of the field devices and the manufacturer of the PCS.

B. Resolve all interface problems. Supply all additional hardware, signal isolators, media converters, signal converters, transceivers, relays, and other required components as necessary to properly interface each field I/O point to the PCS.

C. Provide and keep a neatly marked set of record wiring drawings on the job site showing the installed location and routing of all wiring, including spares, and instrumentation cable runs. These drawings shall also show all terminal connections. These drawings must show as a minimum:

1. All wiring between PCS components and field devices and/or panels, including terminal and wire numbers for all wiring.

2. All PCS communication wiring and interconnection.

3. All interconnections between any PCS components.

4. All power connections to PCS components.

D. Keep drawings current with the work as it progresses, subject to inspection by the RESIDENT PROJECT REPRESENTATIVE at any time.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspection: Provide tests as required in Section 40 80 50 - Process Control System Commissioning.

B. Inspection: Demonstrate that instruments, panels, programming equipment and network equipment:

1. Has not been damaged by transportation or installation,

2. Has been properly installed,

3. Has no mechanical defects,

4. Is in proper alignment,

5. Has been properly connected.

C. Testing Process:

1. Test digital inputs and outputs by actual starting and stopping of equipment when possible, or with jumpers at field equipment terminals.

2. Conduct all tests in presence of plant personnel ENGINEER, and RESIDENT PROJECT REPRESENTATIVE.

D. Manufacturers Field Service: Provide manufacturer field service for calibration, initial setup, programming, and commissioning of each instrument.

END OF SECTION

SECTION 40 90 50

PROCESS CONTROL SYSTEM DESCRIPTION

PART 1 GENERAL

1.1 SUMMARY

A. Section 40 90 50 includes requirements for furnishing and installing instrumentation and control systems including all work and materials necessary to perform control and monitoring functions as illustrated on drawings, and as specified in this document.

B. Related work specified in other sections includes, but is not limited to the following:

1. Section 01 33 00 - Submittals
2. Section 40 05 20 - Valves
3. Section 40 80 50 - Process Control System Commissioning
4. Section 40 90 00 - Process Control System General Requirements
5. Section 40 95 13 - Process Control System Panel Enclosure and Equipment
6. Section 40 96 15 - Process Control System Input and Output List
7. Section 40 98 00 - Process Control System Training

1.2 SYSTEM SUPPLIERS

A. The CONTRACTOR shall furnish all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a process control system as specified herein and in Contract Documents and Drawings.

1.3 SYSTEM DESCRIPTION

A. General Description of Work

1. Provide process control applications for the Southside Wastewater Treatment Plant (SSWWTP) control system as shown on drawings and as specified in this document to provide a complete control system including networking and software development.

2. The Instrumentation and Control documents are requirements to assist the CONTRACTOR with the detailed design of control system including networks and communication with existing facilities' Process Control

System (PCS).

3. The Site Acceptance Testing shall be performed for each process equipment area individually and with other equipment as a system.

B. The Control descriptions provide the functional requirements of the Control represented in the Contract Documents. Descriptions in this document will be provided as follows:

1. Equipment overview and general description.

a. Control Equipment

b. Control Operation

c. Control Philosophy

C. The Control Descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the Drawings and other Specification Sections. The Control Descriptions will be the base document for the CONTRACTOR creation of the Control Strategies. Identification of required elements, documentation, and coordination between loops are to be developed during shop drawings. Finalizing and tuning of strategies, as required by process characteristics, are to be completed during start-up.

D. The project scope includes the following facilities and areas:

1. Diversion Facilities New Valve Vault:

The purpose of the new valve vault at the diversion facilities is to provide flow diversion when the SSWWTP capacity is less than 84 MGD, by increasing the portion of the discharge diverted from the Influent Lift Station and 71st Street Lift Station to the flow equalization basin (FEB).

The new valve vault will include a new plug valve provided with local control panel, with normal operation of the valve to be accomplished through the existing SCADA system.

2. Existing SCADA PLCs:

The existing SSWWTP control network architecture shall be modified as required to incorporate the controls of new and existing equipment as specified herein, as well as in the Contract Documents and Drawings.

1.4 SUBMITTALS

A. CONTRACTOR: furnish all submittals, including the following, as specified in Division 01.

B. Action Submittals

1. Product Data: Submit manufacturer's official and published product data, specifications, and installation recommendations for each item.

2. Shop Drawings: Submit shop drawings as per Section 01 33 00 - Submittals, and as required below. Include the following information in each submittal:

a. Complete control descriptions/strategies developed from the Control Descriptions specified.

b. I/O List complete with Instrument Ranges, Alarm levels, and setpoints.

c. Each detailed control logic permissive and interlock.

d. Furnish complete control description/strategies further developed from the control descriptions provided in this Specification, with a breakdown on each control mode, based on requirements of Part 3.

(1) Include sufficient detail for a complete understanding of each Operator controllable setpoint, failure mode and alarm.

(2) Detailed control strategy shall include detailed ranges, setpoints, and operator adjustments.

(3) Provide screen layouts for OIT and HMI applications including navigation, graphic standards, alarms, popups, and animation.

e. All graphics and process screens for all PLC control strategies and PCS control strategies shall be completed and included in the submittal.

f. Ladder logic focused diagrams, functional blocks as approved by the OWNER, and messages to carry out the program. The messages shall be within the program to explain how the control program will carry out the required functions. The use of "structured text" type programing shall not be an acceptable alternative to ladder logic programing.

g. Configuration and data registers.

C. Contract Closeout Information Submittals: CONTRACTOR: furnish submittals as

required below:

1. Project Record Documents: In addition to requirements described in Division 01 78 23 - Contract Closeout, furnish the following:

    a. Program documentation: Furnish paper copies of all software development and configuration including listing of all register tables.

2. Operation and Maintenance Data: Furnish operation and maintenance manuals as specified in Division 01, including the following information:

    a. Recommended spare parts list

    b. Manufacturer approved repair and service centers list

    c. Replacements part sources

    d. Recommended maintenance procedures and frequencies

3. Warranty: Furnish warranty certificate as described in Division 01.

1.5 QUALITY ASSURANCE

A. CONTRACTOR: furnish Quality Assurance as specified in Division 01.

B. The purpose of contract drawings and specifications is to convey information required for complete and functioning systems. SYSTEM INTEGRATOR shall be responsible for all details necessary to properly install, adjust, and place in operation intended systems. Preliminary Input and Output (I/O) List will be provided to the CONTRACTOR for convenience; however, their accuracy will not be guaranteed.

C. Meetings

1. Meetings shall be scheduled as necessary at the ENGINEER'S designated office to jointly review control requirement submittals. This shall also serve to coordinate and resolve any issues or discrepancies in regard to the operator interface software programming and implementation, and detailed PLC programming. Plan to attend meetings of one-day duration to jointly review all control requirements with the OWNER's representative and ENGINEER.

2. At a minimum, meetings to review progress of control network architecture and software graphics shall include:

    a. Kick-Off Meeting

b. Controls development at 30% development

c. Controls development at 60% development

d. Controls development at 90% development

e. Controls development at 100% development

f. Testing and start-up planning

D. When requested by CONTRACTOR, OWNER, and/or ENGINEER, SYSTEM INTEGRATOR will attend Monthly Progress Meetings and Weekly Meetings as required and specified.

1.6 RESPONSIBILITY

A. SYSTEM INTEGRATOR: provide application software programming as specified herein and in Section 40 90 00 - Process Control System General Requirements.

1.7 APPLICATION SOFTWARE PROGRAMMING

A. SYSTEM INTEGRATOR: provide application software programming as specified in this and related Sections. Download and test application software programming after successful completion of the Process Control System Commissioning, as specified in Section 40 80 50.

B. Training services, as specified in Section 40 98 00 - Training, and equipment testing and start-up shall not begin until SYSTEM INTEGRATOR has successfully completed application software programming, downloading, and testing.

C. Refer to Section 01 14 00 - Construction Work Sequence Limitations and Constraints for specified construction limitations and constraints that affect completion of application software programming, downloading, and testing.

1.8 DELIVERY, STORAGE, AND HANDLING

Not Required

1.9 PROJECT/SITE CONDITIONS

A. Equipment is subject to humidity, dust, noise, and elevated and reduced temperatures.

1.10 SEQUENCING AND SCHEDULING

A. Refer to Section 01 14 00 - Construction Work Sequence Limitations and Constraints.

PART 2 PRODUCTS

NOTE USED

PART 3 EXECUTION

3.1 SITE MONITORING AND CONTROL

A. Monitoring and control functions to be programmed under this Contract are outlined in the narratives described below.

B. All settings shall be adjustable based on log-in credentials.

C. All alarms and trips shall have time delay dampening.

3.2 DIVERSION FACILITIES

A. General

The purpose of the new valve vault at the diversion facilities is to provide flow diversion when the SSWWTP capacity is less than 84 MGD, by increasing the portion of the discharge diverted from the Influent Lift Station and 71st Street Lift Station to the FEB. Refer to the contract drawings for point of connection and equipment locations.

B. New Valve Vault

The new valve vault shall include a new plug valve provided with local control panel, with normal operation of the valve to be accomplished through the existing SCADA system.

The new plug valve shall be controlled by the existing SCADA PLC-F, in either automatic or manual mode, and shall include hardwired interlocks. The plug valve shall also include a local control panel to provide control capabilities, including manual and remote control from SCADA.

The existing flow instrumentation measurement (Montana Flow Meter) shall be used to control the operation of the plug valve when operating in AUTO mode. The position of the valve shall be adjusted based on the flow measurement.

1. New Valve Vault Motor-Operated Plug Valve (Reference drawing CN1):

The normal operation of the plug valve shall be accomplished through SCADA. Local and remote operation shall be available, as well as monitoring of the open/closed status of the valve, and the valve position.

a. Control Equipment:

(1) The following controls shall be included for the plug valve:

(a) LCP located adjacent to the valve vault including the following:

1) LOCAL/OFF/REMOTE (LOR) selector switch

2) OPEN/CLOSE selector switch

3) POSITION INDICATOR for analog position indication

4) OPEN/CLOSED/FAULT status indicating lights

b. Control Operation:

(1) LOR in REMOTE Position:

When the LOR selector switch is in the REMOTE position, PLC-F shall control the operation of the plug valve, and AUTO/MANUAL selection shall be available to the Operator in SCADA.

(a) AUTO Mode:

The plug valve shall open and close automatically when in AUTO mode, and operation shall be based on flow measurement.

(b) MANUAL:

When in MANUAL mode, the Operator shall have the ability to control the plug valve manually via SCADA.

(2) LOR in LOCAL Position:

When the LOR selector switch is in the LOCAL position, the plug valve shall open and close as selected by the Operator through the LCP.

(3) OFF Position:

When the LOR selector switch is in the OFF position, the plug valve shall not operate under any condition.

(4) The SCADA system shall receive and display the following signals from the LCP of the plug valve via hardwired connection to PLC-F:

(a) POSITION FEEDBACK (analog signal for actual valve position indication)

(b) OPENED status

(c) CLOSED status

(d) IN REMOTE status indicating the LOR switch is in the REMOTE position

(e) FAULT status

(5) The SCADA system shall send the following signals to the LCP of the plug valve via hardwired connection from PLC-F:

(a) POSITION COMMAND (analog signal for valve positioning)

(6) Warning alarms shall be generated in SCADA for:

(a) VALVE FAULT based on FAULT status

c. Control Philosophy:

During normal operation, the LOR selector switch of the plug valve shall be placed in REMOTE position, and the plug valve shall be placed in AUTO mode in SCADA. Plug valve positioning shall be adjusted, within predetermined position ranges, based on the existing influent flow measurement (Montana meter) in order to provide flow diversion when the SSWWTP capacity is less than 84 MGD.

(1) Plug Valve Position Control:

When the plug valve operates to provide flow diversion to the FEB, the valve shall adjust position in order to increase or decrease the flow diversion to the FEB. The

control logic shall be configured so that the plug valve is positioned within a predetermined position range, and change positions again if the influent flow continues to increase to greater than the predetermined capacity setpoint for a predetermined amount of time.

(a) The following table summarizes the controls details for the plug valve:

Function	Plug Valve
Valve Position Range Setpoint	10 % Open
Process Variable	Montana Meter Flow Measurement
Process Setpoint	84 MGD
Process Difference Setpoint	1.0 MGD
Time Delay Setpoint	1 Minutes
Allowed Modes	Auto & Manual
Controller 0 to 100%	0 – 100% Open
4-20 mA Corresponds to	0 – 100% Open

(b) The control inputs in SCADA from the Operator for the plug valve controller shall be:

1) Auto/Manual Mode (selection)

2) Valve Position Range Setpoint (to be set as the Valve Open/Close range when in Auto Mode)

3) Process Setpoint (to be set as the SSWWTP flow capacity setpoint)

4) Process Difference Setpoint (to be set as the maximum flow difference between the Process Setpoint and the Process Variable to be maintained when in Auto Mode)

5) Time Delay Setpoint (to be set as the time delay between valve position commands)

6) Control Output (valve position adjustment for operation in Manual Mode)

(c) The following HMI indications shall be available to the Operator:

1) Control Operation in Auto or Manual

2) Process Variable (influent meter flow measurement)

3) Valve Position Feedback (% Open)

4) Control Output Value (% Open Position)

(d) Bad quality of the process variable I/O shall result in the control operation tripping to manual mode and alerting the Operator of the change with an alarm in SCADA.

(2) Plug Valve Control Logic:

(a) OPEN PERMIT signal for the plug valve shall be active when the following condition is TRUE:

None

(b) AUTO OPEN signal for the plug valve shall be active when the following condition is TRUE (valve % open position to be increased by the Valve Position Range Setpoint amount):

The Process Variable (Influent Flow) is greater than the Process Setpoint by more than the Process Difference Setpoint for greater than the Time Delay Setpoint

(c) AUTO CLOSE signal for the plug valve shall be active when the following condition is TRUE (valve % open position to be decreased by the Valve Position Range Setpoint amount):

The Process Variable (Influent Flow) is less than the Process Setpoint by more than the Process Difference Setpoint for greater than the Time Delay Setpoint

(d) PROTECTION OPEN signal for the plug valve shall be active when the following condition is TRUE:

None

(e) PROTECTION CLOSE signal for the plug valve shall be active when the following condition is TRUE:

None

END OF SECTION

SECTION 40 95 13

PROCESS CONTROL SYSTEM PANEL ENCLOSURES AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section 40 95 13 includes technical requirements for fabrication, engineering, wiring, and installation of instrument panels and enclosures, and furnishing the panel mounted instruments and equipment. These include, but are not limited to the following:

1. Panel Construction

2. Panel Wiring

3. Panel Mounted Equipment

B. Related work specified in other sections includes, but is not limited to the following:

1. Section 01 33 00 - Submittals
2. Section 40 80 50 - Process Control System Commissioning
3. Section 40 90 00 - Process Control System General Requirements
4. Section 40 90 50 - Process Control System Description
5. Section 40 96 15 - Process Control System Input and Output List

C. Panels provided by manufacturer as part of package control systems:

1. Certain control panels are provided by manufacturers of equipment specified under other Sections as part of a packaged control system. In general, those panels shall meet the requirements of this specification section.

D. Provide all new control panels specified under this contract as indicated. This section is to provide guidelines to the electrical contractor for the design and workmanship on any new and/or existing panels to which the CONTRACTOR makes changes or modifications.

1.2 SUBMITTALS

A. General: Provide submittals as specified in Section 01 33 00 - Submittals, and as required in Section 40 90 00 - Process Control System General Requirements.

B. Include the following information in the submittal for this section:

1. Scaled drawings showing the location of mounted devices on face of panel, within panel, and all sides. Include a legend listing and identifying devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions. Include a legend listing all spec items and manufacturer's part number of each item installed.

2. Panel elementary diagrams. Include switched analog signals, panel power distribution, and ancillary devices such as relays, alarms, fuses, lights, fans, heaters, etc. Show circuits and components individually. Show panel terminal and wire identification numbers. Do not submit typical diagrams for multiple circuits.

3. Power requirement and heat dissipation summary for all panels. State required voltages, currents, and phase(s). State maximum heat dissipation in Btu/hr.

C. Pre-Construction Submittals

1. Product Data: Submit manufacturer's official and published product data, specifications, and installation recommendations for each item. Product data shall include terminal wiring details, specific features such as ranges and options, and manufacturing data.

2. Shop Drawings: Include the following information:

a. Bill of materials

b. Panel construction details and dimensions (front, internal)

c. Internal wiring diagrams, including wire type, size, and identification number

d. PLC card layout and wiring

e. Terminal block layout

f. Nameplate lists

g. Color schedules

h. Elementary control diagrams

i. Equipment weights

3. Provide loop diagrams conforming to ISA-S5.4 - Instrument Loop Diagrams.

D. Submittals for Closeout: Provide submittals as required below.

1. AS Built Drawings

2. Test Reports

1.3 QUALITY ASSURANCE

A. Comply with the applicable provision of the following codes and standards:

1. Underwriters Laboratory (UL)

a. UL50 Enclosures for Electrical Equipment

b. UL508 Industrial Control Equipment

c. UL870 Wireways Auxiliary Gutters and Associated Fittings

2. Electrical Testing Laboratory (ETL)

3. National Electrical Code (NEC)

4. National Fire Protection Association (NFPA) 79, Electrical Standard for Industrial Machinery

5. International Society of Automation (ISA)

B. All electrical materials and equipment shall be new and bear the label of the Underwriters Laboratory (UL), Inc., Factory Mutual (FM) or equivalent where standards have been established and label service regularly applies.

C. All Process Control System Panels provided as part of Division 40, including PLC panels, shall comply with the requirements of UL-508A, NFPA 79, and NEC Article 409 - Industrial Control Panels.

D. Provide integrated process control systems. Assign complete responsibility for furnishing, coordination, assembly, and installation supervision of all equipment to one Systems Integrator regularly engaged in the manufacture, assembly, and production of systems of type specified. Provide complete, satisfactory, and trouble-free operating installation.

E. Provide like instruments from the same manufacturer. Minimize number of different manufacturers.

F. Provide safety and regulatory labels required by NEC, NFPA, and UL.

1.4 MAINTENANCE

A. Provide the following spare parts:

1. One power supply of each type and size provided

2. One surge suppressor for every 10 or fraction thereof

3. One installed terminal block, for every 10 or fraction thereof

4. Ten percent spare corrosion inhibitors, minimum of 1 of each size provided

5. One dozen fuses of each type used

6. One dozen relays of each type used

7. Two breakers of each size provided

8. One convertor module of each type used

9. One switch of each type used

10. One indicating light of each type used

11. One alarm buzzer of each type used

12. One signal isolator of each type used

13. One panel meter/indicator of each type used

14. One filter of each type used

15. One fan of each type used

16. One heater of each type used

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Panels and enclosures shall meet the NEMA requirements for the type specified.

B. Fabricate panels, install instruments, and wire in the factory. Test wiring prior to shipment. Use numbered terminal blocks for external connections.

C. Provide instrument loop power supplies, mounting hardware, terminal blocks, control circuit breakers, and other items required for a fully operable panel.

D. Provide termination panels, if required. Include terminal blocks, interface hardware, wiring, and cabling necessary for a complete operational system.

E. Use panel fabrication techniques that allow for removal and maintenance of all equipment after installation.

F. Sizes shown are estimates. Provide panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within.

G. Panels located inside control or electrical room areas shall be NEMA 12 rated unless specified otherwise.

H. Panels located in process areas or outdoors (except areas classified as hazardous locations) shall be NEMA 4X unless specified otherwise. All panels shall be corrosion resistant.

I. Panels located inside Class 1 Division 1, or Class 1 Division 2 hazardous areas must be NEMA 7 rated.

J. Provide lifting rings on panels in excess of 100 pounds.

K. Panels shall be sized by the integrator based on the equipment provided. Minimum panel sizes are shown on the Drawings. Panels may be increased in size only upon approval from the ENGINEER based on substantiated request.

L. Panel Mounted Equipment

1. Unless otherwise specified, provide components to operate on 120 VAC single phase 60-Hertz power.

2. Provide 24VDC two-wire transmitter power supplies as required.

3. Provide signal isolators for each analog input and output signal to protect panel mounted equipment from electrical surges induced in field wiring.

4. Provide engraved laminated nameplates to identify each panel mounted component. The nameplates shall have black lettering on white background. Lettering height shall be 3/16-inch minimum.

M. Provide enclosures with louvers, forced ventilation, or air conditioners as required to prevent temperature build-up to protect equipment with ambient temperatures of up to 105 degrees F. Except for enclosures mounted with their backs directly adjacent to a wall, place louvers in the rear of the enclosure, top and bottom. For enclosures mounted with their backs directly adjacent to a wall, place louvers on the sides.

N. Any inputs or outputs required for system diagnostics such as analog to digital converter check points, system alarms, cold junction compensation, cabinet temperature indications, and power supply voltage checks shall be provided.

O. Where enclosures are mounted outside or in unheated areas, provide them with thermostatically controlled heaters that will maintain the inside temperature above 40 degrees F.

2.2 PANEL CONSTRUCTION

A. NEMA 12 Panels

1. Fabricate enclosures using Type 316 stainless steel. Stainless steel shall be free of pitting and surface blemishes.

2. Continuously weld all exterior seams and grind smooth.

3. Provide stiffening members for strength and stiffness as required.

4. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area

5. Use pan type construction for doors. Door widths shall not exceed 36-inches.

6. Mount doors with full length heavy duty piano hinge with stainless steel pin.

7. Provide oil resistant gasket completely around each door or opening.

8. Provide handle-operated, oil-tight, key-lockable three point stainless steel latches. All project enclosures shall be keyed alike.

9. Use stainless steel fasteners throughout.

10. Provide interior mounting panels and shelves constructed of minimum 12 gage steel.

11. Provide print pocket on door interior.

12. Provide enclosure mounting supports as required for floor, frame, or wall mount.

13. Provide all holes and cutouts for installation of conduit and equipment. Provide water tight conduit hubs. (Double locknuts are not acceptable.)

14. Completely clean all interior and exterior surfaces so they are free of dirt and corrosion.

15. Stainless Steel Panels:

    a. Do not paint stainless steel enclosure exterior surface.

    b. Cover, sides, top, and bottom to have smooth #4 brushed finish.

16. Manufacturers:

    a. Hoffman Enclosures Co.

    b. Rittal Corporation

    c. Saginaw Control & Engineering

    d. Or approved equal

B. NEMA 4X Panels

1. Fabricate NEMA 4X enclosures from Type 316 stainless steel.

2. Provide non-corrodible metal hardware including hinge and cover clamps.

3. Do not paint stainless steel enclosure exterior surface.

4. Sandblast, roughen, or chemically etch stainless steel enclosures to reduce gloss, reflections, and glare.

5. Provide conduit knock-outs prior to installation of equipment inside enclosure. Provide water tight conduit hubs. (Double locknuts are not acceptable.) Top penetrations shall not be acceptable.

6. Provide handle-operated, oil-tight, key-lockable three point stainless steel latches. All project enclosures shall be keyed alike.

7. Rolled lip around three sides of door and along top of enclosure opening.

8. Hasp and staple for padlocking.

9. Provide a clear plastic, gasketed lockable hinged door to encompass all non-NEMA 4 front of panel instruments.

10. Manufacturers:

    a. Hoffman Enclosures

    b. Rittal Corporation

    c. Saginaw Control & Engineering

    d. Or approved equal

2.3 PANEL GROUNDING

A. Provide 2 ground buses in each cabinet or panel, one for shield and cabinet grounding and one for signal grounding.

B. Provide grounding lugs for connection to the external grounding system.

C. Provide ground busbars, which shall be directly wired and connected to facility grounding system.

D. Provide DC ground bus (for analog cable shield termination) bonded to chassis ground.

E. Provide nickel-plated copper busbars, with current rating of 100 amperes.

F. Provide each busbar with at least twenty (20) screw clamp terminal blocks, each capable of accepting #10 AWG conductors.

G. Provide ground lug on each door and connect lug to the ground bus within panel.

2.4 PANEL WIRING

A. Terminate all wiring, to and from field devices, at panel terminal blocks, not on equipment terminals.

B. Do not terminate more than two wires at the same terminal. Wiring splices and wire nuts shall not be permitted within the enclosure.

C. Use flexible stranded copper wiring. Run wires in continuous lengths from terminal to terminal. Do not splice wires.

D. For analog signal wiring, use uniformly twisted shielded pairs not smaller than 16 AWG with a minimum of six twists per foot. Separate analog signal wiring at least six inches from power wiring. Provide continuous foil or metalized plastic shields with 100 percent coverage. Include a drain wire in continuous contact with the shield.

E. Use type THHN/THWN power wiring with insulation rated at 600 V. Use 14 AWG or larger for power wiring.

F. Segregate signal wiring from control and power wiring. Group wiring functionally and arrange neatly to facilitate tracing of circuits.

G. Use plastic wiring wraps to bundle wires, outside of wiring ducts. Securely fasten the bundles to the steel structure at intervals not exceeding 12 inches. Use Panduit, or equal wiring ducts and size to provide a minimum of 100% spare capacity.

H. Do not intermix signals within the same bundle or duct.

I. Use twisted unshielded wire for other DC signals and segregate from wire conducting AC signals.

J. Provide wire identification at each wire end. Utilize computer-generated, heat-shrink type wire markers.

K. Install all wiring in plastic wiring ducts, provided with snap-on covers. Size ducts to include at least 100% spare capacity. Restrain all wiring outside of ducts with plastic ties.

L. Group and wrap all wires passing a door hinge in protective wire harness. Provide abrasion protection for wire bundles passing through holes or across sheet metal edges.

M. Provide panel wiring of stranded copper with 600-volt rated thermoplastic insulation.

1. Power wiring: No. 14 AWG minimum

2. Control wiring: No. 16 AWG minimum

3. Electronic signal wiring: No. 16 twisted shielded pair minimum

4. Ethernet network wiring: Category 6 minimum

5. Other serial communication cables: As recommended by equipment manufacturer.

N. Wire color convention shall comply with the requirements and color codes of NFPA 79 (2015), part 13:

1. Line, load, and control conductors: black.

2. Neutral: white.

3. Equipment safety ground: green.

4. AC control circuit: red

5. DC control circuit: blue

6. Foreign voltage control wire: yellow

7. Energized when main disconnect it off: orange

O. Physically separate AC wiring from DC wiring.

1. Where AC and DC wiring runs in parallel, provide at least 2-inch separation.

2. Where AC and DC wiring cross, they shall cross at 90°.

P. Do not daisy-chain neutral wiring and grounding conductors at equipment terminals. Provide terminal blocks that accept jumper bridges.

Q. Protect network cables and fiber using cable management supports.

2.5 TERMINAL BLOCKS

A. Wire and terminate equipment in accordance with the latest standards of the National Electrical Code as well as state and local electrical codes.

B. Provide terminal blocks for field wiring and equipment wiring terminations. Provide unique identification at each terminal block.

1. Arrange terminal blocks in consecutively, based on standard alphanumeric order.

2. Group terminal blocks based on voltage level and function.

3. Color code foreign voltage terminal block identification to match wire insulation.

C. Provide at least 25% spare terminal blocks for each type used in each enclosure.

D. Provide high-density modular type terminal blocks suitable for mounting on standard DIN rails.

1. Material: Nylon

2. Termination type: tubular screw with serrated pressure plate

3. Current carrying parts (metal bodies): nickel or tin-plated copper

4. Ground terminal blocks shall be dual color type: Green and Yellow

5. Maximum conductor size: No. 8 AWG stranded

6. Current rating: Up to 15 amperes at 250 VAC

7. Provide manufacturer jumper bridges, designed to fit on terminal blocks. Do not daisy-chain wiring.

E. Provide fused terminal blocks or DIN rail mounted circuit breakers for panel power distribution.

1. Provide disconnect lever and fuse-puller mechanism

2. Provide illuminated indication of blown fuse

3. Fuses shall be standard 1/4" by 1-1/4", and sized to protect load

4. Provide DIN Rail breakers with trip indication and mechanical reset

F. Provide two-level type terminal blocks for PLC discrete input and outputs. Both levels shall be of the feed through types.

G. Provide three-level type terminal blocks for analog signal wiring. Top and center terminations shall be feed-through types. Bottom termination shall be grounded to isolated mounting railing, connected to the DC ground bus.

1. Provide factory assembled terminal blocks on a mounting channel and bolt the channel to the inside of the panel. Space terminal block strips no closer than 6 inches center to center.

2. Provide screw type 600 V terminals with pressure plate to accept wire size #14 AWG and smaller. Do not use miniature terminal blocks.

3. Provide a continuous marking strip with the terminals. Provide a separate terminal for terminating each shield wire.

4. Reserve one side of each terminal strip for field incoming conductors. Do not make common connections and jumpers required for internal wiring on the field side of the terminal. Terminate no more than two wires at any one terminal.

5. Provide a minimum of 25 percent spare terminals per terminal type, per panel.

H. Manufacturers:

1. Phoenix Contact

2. Allen Bradley

3. Weidmuller

4. Or approved equal

2.6 PANEL MOUNTED EQUIPMENT

A. Provide panel heaters, vapor type corrosion inhibitors and breather drains for condensation and corrosion control inside panel. Provide panel heaters of the forced air types, complete with thermostatic control.

1. Manufacturers:

a. Cortec

b. Hoffman

c. Or approved equal

B. Provide one (1) “service receptacle”, 120 VAC, 20A duplex, GFCI grounding type receptacle.

C. Provide one (1) 120 VAC 24” LED light fixture and protective plastic shield.

D. Provide one (1) 120 VAC, 20A, snap switch, to turn on the light, mounted in an outlet box with a cover and located so that it is easily accessible from access door.

E. Interposing Relays

1. Provide interposing relays to interface all PLC discrete outputs with field-mounted equipment.

2. Provide high density, DIN rail mounted type relays, with coils, contacts, and voltage ratings as required. Contacts shall be rated 10 Amperes at 120 volts minimum. Relays shall have LED indicator to indicate coil status.

3. Relays for control of motor starters larger than NEMA size 1 shall be DPDT, rated 15 Amperes at 250 VAC.

F. Regulated Power Supplies

1. Provide regulated DC power supply as required for 2-wire analog loops. Size power supplies to include 100% spare capacity. Do not power more than three transmitter loops from the same power supply.

2. Power supplies shall be as follows:

a. Input power: 120 VAC, 60 Hz.

b. Output power: 24 VDC at 200 mA or 500 mA, as required

c. Output regulation: <1%

d. Operating temperature: 0 to 50° C

e. DIN Rail mountable.

3. Manufacturers:

a. Phoenix Contact

b. Action Instruments

c. Sola

d. Puls

e. Or approved equal

G. Control Devices and Pilot Lights

1. General: Pushbuttons, selector switches, and indicating lights shall be heavy-duty type, 30.5MM, oil-tight, watertight, and corrosion resistant. Provide a legend plate at each device.

2. Contact block current rating: 10 amperes at 240 VAC.

3. Pilot lights shall be LEDs. LED color shall match the lens cover color. Provide flashing lights where indicated.

4. Pilot light colors shall be as follows:

   a. Red: Running

   b. Green: Off

   c. Amber: Fault Condition

   d. Blue: Indicator

   e. White: Power On/Available

5. Manufacturers:

   a. Allen Bradley

   b. Eaton

   c. Schneider Square D

   d. Or approved equal

H. Signal Isolators

1. Provide 4-wire type for use as a signal isolator, converter and/or repeater.

2. Input Signal: 4-20 mA DC, field configurable for other signal ranges.

3. Input Impedance: No greater than 50 ohms.

4. Isolation: 1000-volt RMS output from input, power and ground; fully floating

5. Output Signal: 4-20 mA DC into 800 ohms minimum.

6. Accuracy: +/- 0.1% of span

7. Power Supply: 120 VAC, 60 hertz or 24 VDC from UPS at DTC

8. Enclosure: designed for high density DIN rail mount

9. Isolators are not scheduled.

    a. Provide isolators on all analog inputs to the PLC (unless the PLC is provided with isolated analog input modules).

    b. Provide as shown and as necessary to eliminate ground loop problems when connecting instruments to other instrument loops.

10. Manufacturers:

    a. Phoenix Contact

    b. Action Instruments

    c. Moore Industries

    d. Or approved equal

I. Digital Panel Indicators

1. Type: Electronic, 3-1/2 Digit LED, 0.60-inch high display

2. Input Impedance: no greater than 250 ohms.

3. Power Source: 110 VAC, 60 hertz

4. Input Signal: 4-20 mA DC

5. Input Dampening: Adjustable

6. Enclosure: 1/8 DIN, general purpose for indoor flush panel mount. Indicators for outdoor panels shall have a NEMA 4X bezel rating or be mounted behind a weatherproof gasketed door assembly.

7. Accuracy: +/- 0.05 percent of span +/- 1 count

8. Decimal Point: Selectable via DIP switches or keypad.

9. Input Connections: Compression type screw terminals

10. Range Selection: DIP switches, multi-turn potentiometers, or keypad.

11. Manufacturers:

a. Precision Digital

b. Red Lion

c. Or approved equal

2.7 ENCLOSURE OPTIONS

A. Louvers

1. Include washable aluminum air filters with louvers used for ventilation

2. Provide 1 can of filter spray adhesive for every enclosure.

B. Heaters for Condensation Control

1. Provide thermostatically controlled, fan driven heaters for all outdoor enclosures for condensation control unless otherwise specified

2. Meet the following requirements:

a. Power: 115 VAC, 60 Hz

b. Rating: 100 Watts for panels smaller than 24 in by 48 in

3. Provide thermostats that sense air temperature in the panel and are adjustable from 40 to 80 degrees F.

4. Mount heaters near the bottom center of the enclosure. Do not mount electronic components closer than 6 inches to the heater.

5. Manufacturers:

a. Hoffman Design Aire Electric Heater

b. Hammond

c. Or approved equal.

C. Corrosion Inhibitors.

1. Provide enclosures with vapor phase protective corrosion inhibitors

2. Provide adequate corrosion inhibiting devices, tape, or emitters for the

individual panel volume

3. Activate the inhibitor upon delivery to the site. Do not store panels with inhibitors inactive. If necessary, cover panels to reduce ventilation and prolong inhibitor life.

4. Manufacturers:

   a. Hoffman A-HCI-5E or -10E

   b. Or approved equal

D. Air Conditioning Unit

1. For panels located outdoors or in non-conditioned space, provide panel mounted air conditioning unit. Air conditioning unit to be supplied for operation on 120 VAC, single phase, 60 Hz, powered from a circuit breaker within the control panel.

2. Provide an adjustable internal panel thermostat for control of Air Conditioner to activate on high temperatures inside panel.

3. Air conditioning unit shall have the following features:

   a. Maximum current draw: 6A at 120 VAC

   b. Corrosion resistant

   c. Stainless steel enclosure

   d. Maintain NEMA rating on installed panel

4. Manufacturers:

   a. Hoffman/Pentair

   b. Or approved equal.

2.8 SOURCE QUALITY CONTROL

A. Tests and Inspection

1. Test each panel in conjunction with factory acceptance test as described in Section 40 90 00 - Process Control System General Requirements.

2.9 PANEL IDENTIFICATION

A. Labels

1. Furnish and install safety and informational labels on the outside and inside of the control panels meeting the requirements of the following:
   a. Contract drawings - Names
   b. UL 508 -certification
   c. NPFA 70 –
   d. NFPA 70E
   e. NFPA 79 –
   f. ,

PART 3 EXECUTION

3.1 PREPARATION

A. Sequence enclosure installation as follows:

1. Prior to installation, remove enclosure door, internal panels, and equipment from enclosures.

2. Install enclosures and conduits, and pull field wiring into enclosures.

3. Seal all wire entries with non-setting silicon compound to prevent moisture from entering enclosure.

4. Cover enclosure installation thoroughly with heavy-duty plastic sheet to protect against moisture, paint splatter, and dirt. Cover until 120-volt power is available, and enclosure is ready to receive internal panel.

5. Terminate field wiring on terminal blocks.

6. Energize panel heater and keep enclosure door closed when no work is being performed in enclosure. (Do not energize any other equipment prior to field wiring termination check.)

7. Check accuracy of field wiring termination. Thoroughly test for continuity.

8. Energize panel mounted equipment only after all wiring has been thoroughly checked and tested.

9. Energize panel heater to prevent condensation inside the panel.

3.2 ERECTION, INSTALLATION, AND APPLICATION

A. Do not install control panels or enclosures directly against concrete walls. Provide stainless steel channels between wall and enclosure. Mount enclosure to stainless steel channels.

B. Install enclosures and panels level and plumb. Touch up all nicks, scratches, etc. with materials recommended by enclosure manufacturer.

C. Vacuum and clean all panel interior surfaces prior to system commissioning.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspection

1. Demonstrate that each enclosure and each panel mounted equipment:

   a. Has not been damaged during transportation or installation

   b. Has been properly installed

   c. Has no mechanical defects

   d. Is in proper alignment

   e. Has been properly wired and connected

3.4 DEMONSTRATION

A. Test all control function as described in Division 1 and Section 40 90 00 - Process Control System General Requirements. In addition, perform the following:

1. Calibrate all process variable indications

2. Adjust all alarm setpoints

3. Tune all control function to achieve optimum and stable control

3.5 SCHEDULES

A. Reference Contract Drawings and the following table for list of control panels. Data presented on the following table is for the convenience of the CONTRACTOR. Provide all control panels of size and type required by the contract documents and including all components required for the operation of the equipment as described.

CONTROL PANEL SCHEDULE

Panel	Qty	Location	Panel Type	Rating	Comments
Diversion Facility Valve Vault PGV-01 Local Control Panel	1	Diversion Facility New Valve Vault	Free-Standing	NEMA 4X	Provided by CONTRACTOR

B. Provide other control panels for packaged equipment control systems which meet the general requirements of this Section.

END OF SECTION

SECTION 40 96 15

PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 GENERAL

1.1 DESCRIPTION

A. Section 40 96 15 specifies the input/output (I/O) point list, which follows this Section and requirements for configuring the control system database.

B. Related Work Specified in Other Sections Includes, But is Not Limited to the Following:

1. Section 01 33 00 - Submittals
2. Section 40 80 50 - Process Control System Commissioning
3. Section 40 90 00 - Process Control System General Requirements
4. Section 40 90 50 - Process Control System Description
5. Section 40 98 50 - Process Control System Factory Acceptance Testing

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Section 01 33 00 - Submittals, and as specified below:

1. For each I/O attribute listed in the I/O list that cannot be used exactly as listed, submit an explanation of the reason for the deviation and propose a method to modify the I/O list information. Do not proceed with any configuration until a method of resolving deviations is accepted by the ENGINEER.

2. Include the control system I/O database information in the PLC specific submittals for Programmable Logic Controller Systems Hardware.

3. CONTRACTOR shall supplement and complete the information provided in the drawings and attached tables, including identification of all soft I/O for digital communication networks including Ethernet I/P. The Listing shall include the node address and addresses within the device. The addresses shall be coordinated by the CONTRACTOR so that node and segment addresses are unique within the Process Control System.

B. Submittals for Closeout: Provide submittals as required below.

1. Section 01 78 90 - Contract Closeout.

2. Complete I/O List

1.3 I/O POINT LIST DESCRIPTION

A. The I/O point list shall contain the information necessary to configure the PLC I/O interface hardware and to indicate range conversion or signal functions.

B. INDEX: Indicates a sequential number used to reference the I/O (0001 through 9999)

C. I/O TAGNAME: An alphanumeric character string. The format of the I/O Tagname is defined as follows:

AAA####ABCCCD

1. AAA####ABCCCD: Indicates the Tagname associated with the equipment (instrument, pump, etc):

Example:

Pressure Indicating Transmitter PIT-3600A = PIT3600A

2. AAA####ABCCCD: Indicates the type of I/O defined as follows:

I - Analog Input
O - Analog Output
S - Discrete Input
C - Discrete Output

Example:

Analog Input signal from Pressure Indicating Transmitter PIT-3600A: PIT3600AI

3. AAA####ABCCCD: Suffix indicating the I/O description, and it is defined as follows:

I/O Description	I/O Suffix
ALARM	ALM
AUTO	AUT
CLOSE	CLS
CLOSED	CLD
FAULT	FLT
FLOW	FL

I/O Description	I/O Suffix
GENERAL	GEN
HAND	HND
LEVEL	LV
LOCAL	LOC
OPEN/OPENED	OPN
POSITION	POS
PRESSURE	PR
REMOTE	REM
SPEED	SPD
START/RUNNING	STR
STOP	STO
STOPPED	STD
TEMPERATURE	TM
VIBRATION	VIB

Example:

Analog Input signal from Pressure Indicating Transmitter PIT-3600A: PIT3600AIPR

Discrete Input signal for running status from pump PMP-3830: PMP3830SSTR

4. AAA####ABCCCD: Indicates the determinant for the suffix, and applies to discrete statuses as follows:

   H: High
   HH: High-High
   L: Low
   LL: Low-Low
   1-9: Sequential

   Example:

   PMP3830SVIBH - Pump PMP-3830 Vibration High

   PMP3830STMHH - Pump PMP-3830 Temperature High-High

D. SERVICE DESCRIPTION: an alphanumeric character string up to 40 positions in length. Points described as SPARE denote pre-wired I/O.

E. I/O TYPE:

1. AI: Analog Input
2. AO: Analog Output

3. DI: Discrete Input

4. DO: Discrete Output

5. RTD: RTD Temperature Input

6. TC: Thermocouple Input

F. P&ID: Piping/Process and Instrumentation diagram where the I/O point can be referenced to.

G. SIGNAL TYPE: Indicates signal input/output type (4-20mA, SOFT I/O, 120VAC, N/A, etc.)

H. POWER SUPPLY: Indicates signal power supply (24 VDC, 120 VAC, 480 VAC, N/A, etc.)

I. SOURCE: Indicates signal power source (Loop, Field)

J. SCALE: Indicates lower and higher values of signal range (4-20mA or 0-10V for analog signals, N/A for discrete signals)

K. ENG RANGE: Indicates lower and higher values of the process variable input/output range in engineering units (0 - 100 psi, 0% - 100%, 3 - 15 MGD, etc.; N/A for discrete signals)

L. SP LL: Indicates the Low-Low Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks.

M. SP L: Indicates the Low Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks.

N. SP H: Indicates the High Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks.

O. SP HH: Indicates the High-High Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks

P. ZERO STATE: Indicates the condition that exists when contact is de-energized (NOT RUNNING, NO START, NOT LOCAL, OFF, FAULT, TRIP, etc.). State depends on the normal state of the contact (normally closed or normally open).

Q. ONE STATE: Indicates the condition that exists when contact is energized (RUNNING, START COMMAND, REMOTE, etc.). State depends on the normal state of the contact (normally closed or normally open).

R. LOCATION: Indicates the location (facility) associated with the I/O point.

S. PLC: Indicates the controller associated with the I/O point.

T. EQUIPMENT DESCRIPTION: Indicates the description of the type of equipment associated with the I/O point (Variable Frequency Drive, Vertical Turbine Pump, Motor-Operated Valve, Level Indicator, etc.).

U. FROM: Indicates origination of the I/O point (VFD, Pump, MOV, PIT, PLC, etc.).

V. TO: Indicates destination of the I/O point (VFD, Pump, MOV, PIT, PLC, etc.).

W. CONNECTION:

1. "SOFT (ETHERNET I/P)" is used to designate those I/O points that are transferred via ethernet connection between equipment and PLC.

2. "HARDWIRE" is used to designate those I/O points that are transferred via hardwired connection between equipment and PLC.

X. COMMENTS: Comments or notes, if required.

Y. HMI/PLC TAGNAME: Indicates the designated programming tag for the I/O point. By Integrator.

Z. ETHERNET/IP ADDRESS: Indicates the IP address associated with the I/O point (for soft I/Os). By Integrator.

AA. RACK: Indicates the PLC Rack number associated with the I/O point (for hardwired I/Os). By Integrator.

BB. SLOT: Indicates the PLC I/O card slot number associated with the I/O point (for hardwired I/Os). By Integrator.

CC. POINT: Indicates the PLC I/O card channel number associated with the I/O point (for hardwired I/Os). By Integrator.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide a complete single I/O point list that includes all analog, digital, and control output signals in a single list. Start a new page for each associated PLC. Sort list according to the following criteria in descending priority: P&ID, PLC, I/O TAGNAME. After final sorting, generate INDEX number column starting from

0001 through as needed. The I/O lists included in this document shall not be considered complete lists, and shall only be used for reference.

B. Provide a list that includes all information not included in the I/O list described above, but that is developed internal to the PLCs, including diagnostic alarms for communications failure, I/O signal failure, and all internal PLC alarms.

C. Submit for review preliminary copies of the I/O point list during the shop drawing review phase. For final O&M documentation, provide five printed copies and two electronic copies in Microsoft Excel spreadsheet format for each list required.

PART 3 EXECUTION

3.1 GENERAL

A. Provide I/O address information to the RESIDENT PROJECT REPRESENTATIVE for each I/O point. Use slot and point designations.

1. Slot refers to the location of a field control module on a DIN mounting rail or chassis.

2. Point refers to the point location or address for the I/O point on the designated field control module/card.

B. Provide prewired I/O for points identified as SPARE in the description.

3.2 I/O CONFIGURATION

A. Implement the control system database fields in a consistent manner by using the following procedures:

1. Use abbreviations and acronyms already established in the Contract Documents. In particular, use the information in the I/O Point List.

2. Use only abbreviation or acronym for a word or group of words, respectively.

3. Use the same subject and word order within data fields.

4. Use the same term (either phrase, description, word or acronym) to denote the same meaning. Do not use multiple terms for a single meaning.

5. Use the I/O tagnames, service descriptions, logic state descriptions, ranges, and units of measurement exactly the same wherever the point is referenced.

6. Show I/O tagnames and service descriptions for all point references on documentation.

7. Maintain lists of acronyms and abbreviations used.

3.3 I/O HARDWARE CONFIGURATION

A. Partition the I/O among cards within an I/O enclosure to provide control loop integrity.

1. Place all inputs of the same I/O type associated with a device (e.g. pump, blower, clarifier, or other piece of equipment) on the same card.

2. Place all inputs of the same I/O type for devices arranged in process trains (e.g. a pump, its inlet valve and its outlet valve) on the same card or adjacent cards if more than one card is required to accommodate the points.

3. Place all outputs of the same I/O type associated with a device or group of devices in a process train on the same card or adjacent cards if more than one card is required to accommodate the points.

4. Where the preceding requirements specified in this paragraph would cause more than 20 percent spare points on a card, points for a device or process train may be split between two consecutive cards.

5. Make unused terminals resulting from partitioning the I/O into pre-wired spares. Provide pre-wired spare points with all cabling and termination internal to the PLC as done for other I/O points.

3.4 POINT DATA FIELDS

A. I/O point data fields may be subject to review and modification by the ENGINEER during the Shop Drawing review phase. Incorporate changes directed by the ENGINEER completely into the entire system, at no increase in contract price, subject to the following limitations:

1. Limit the total number of modifications to 35 percent of the total number of I/O points.

2. Each unique change will count as one modification. For example, modifying the description, range, and engineering unit on an analog input counts as three modifications.

3. Analog input alarm limit definition shall not be counted as a modification.

3.5 INPUT/OUTPUT LIST

A. The project Input/Output list included herein indicates all minimum required I/O for the project, including all hardwired I/O as well as soft I/O to be communicated between processors and Ethernet protocols, and shall not be considered a complete list, and shall be used as reference material. All I/O shall be available at the OWNER's SCADA system.

B. The I/O list does not include all details that must be coordinated during project implementation, such as final node addresses and registers for all I/O. However, columns have been provided in the I/O list attached to facilitate inclusion of this information as the project installation progresses. The SYSTEM INTEGRATOR shall be responsible for including additional hardwired or soft I/O as required for the PLC and PCS to function as described in Section 40 90 50 - Process Control System Description.

C. All Analog Points are required to have Trends and Records created on the existing Historian.

D. The CONTRACTOR shall follow the OWNER-approved format included herein. The attached I/O list can be provided to the CONTRACTOR in electronic form (Microsoft Excel) upon request.

E. For each PLC, the CONTRACTOR shall submit the required tag database submittals in the format attached, in both hardcopy and electronic form (Microsoft Excel).

F. Each submittal shall include all information coordinated with equipment vendors and suppliers for the systems integration work including, but not limited to:

1. Alarm settings and class
2. Terminal block information
3. Power source
4. PLC term no.
5. Final PLC register location

G. Additionally, for soft I/O communicated over Ethernet, the submittal shall include similar information coordinated with all equipment vendors and suppliers. For soft I/O include, but not be limited to:

1. Alarm settings and class

2. Communication segment tag

3. Node address on segment coordinated with all vendors and suppliers with equipment on that segment.

4. Final PLC register location.

3.6 SCHEDULES

A. See attached schedules for I/O list format.

END OF SECTION

(NO TEXT FOR THIS PAGE)

INDEX	I/O TAGNAME	SERVICE DESCRIPTION	I/O TYPE	P&ID	SIGNAL TYPE	POWER SUPPLY	SOURCE	SCALE	ENG RANGE	SP LL	SP L	SP H	SP HH	ZERO STATE	ONE STATE	LOCATION	PLC	EQUIPMENT DESCRIPTION	FROM	TO
0001	PGV###SCLD	DIVERSION FACILITIES NEW VALVE VAULT PGV-### CLOSED	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	NCLOSED	CLOSED	DF Valve Vault	PLC-F	Plug Valve	PGV-01 LCP	PLC-F
0002	PGV###SFLT	DIVERSION FACILITIES NEW VALVE VAULT PGV-### FAULT	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	FAULT	NORMAL	DF Valve Vault	PLC-F	Plug Valve	PGV-01 LCP	PLC-F
0003	PGV###SREM	DIVERSION FACILITIES NEW VALVE VAULT PGV-### IN REMOTE	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	NREM	REM	DF Valve Vault	PLC-F	Plug Valve	PGV-01 LCP	PLC-F
0004	PGV###SOPN	DIVERSION FACILITIES NEW VALVE VAULT PGV-### OPENED	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	NOPND	OPND	DF Valve Vault	PLC-F	Plug Valve	PGV-01 LCP	PLC-F
0005	PGV###OPOS	DIVERSION FACILITIES NEW VALVE VAULT PGV-### POSITION COMMAND	AO	CN1	4-20 mA	24 VDC	LOOP	4 - 20 mA	TBD - TBD %	N/A	N/A	N/A	N/A	N/A	N/A	DF Valve Vault	PLC-F	Plug Valve	PLC-F	PGV-01 LCP
0006	PGV###IPOS	DIVERSION FACILITIES NEW VALVE VAULT PGV-### POSITION FEEDBACK	AI	CN1	4-20 mA	24 VDC	LOOP	4 - 20 mA	TBD - TBD %	N/A	N/A	N/A	N/A	N/A	N/A	DF Valve Vault	PLC-F	Plug Valve	PGV-01 LCP	PLC-F
0002	LSH###SLVH	DIVERSION FACILITIES NEW VALVE VAULT SUMP LEVEL HIGH	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	HIGH	NHIGH	DF Valve Vault	PLC-F	Level Switch	SUP LCP	PLC-F
0002	SUP###SFLT	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 1 FAULT	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	FAULT	NORMAL	DF Valve Vault	PLC-F	Sump Pump	SUP LCP	PLC-F
0002	SUP###SSTR	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 1 RUNNING	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	NRUNNING	RUNNING	DF Valve Vault	PLC-F	Sump Pump	SUP LCP	PLC-F
0002	SUP###SFLT	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 2 FAULT	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	FAULT	NORMAL	DF Valve Vault	PLC-F	Sump Pump	SUP LCP	PLC-F
0002	SUP###SSTR	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 2 RUNNING	DI	CN1	120 VAC	480 VAC	FIELD	N/A	N/A	N/A	N/A	N/A	N/A	NRUNNING	RUNNING	DF Valve Vault	PLC-F	Sump Pump	SUP LCP	PLC-F

DATA IN THE BLUE COLUMNS TO BE PROVIDED BY SYSTEM INTEGRATOR

INDEX	I/O TAGNAME	SERVICE DESCRIPTION	I/O TYPE	P&ID	CONNECTION	COMMENTS	HMI/PLC TAGNAME	ETHERNET/IP ADDRESS	RACK	SLOT	POINT
0001	PGV###SCLD	DIVERSION FACILITIES NEW VALVE VAULT PGV-### CLOSED	DI	CN1	HARDWIRED	N/A					
0002	PGV###SFLT	DIVERSION FACILITIES NEW VALVE VAULT PGV-### FAULT	DI	CN1	HARDWIRED	N/A					
0003	PGV###SREM	DIVERSION FACILITIES NEW VALVE VAULT PGV-### IN REMOTE	DI	CN1	HARDWIRED	N/A					
0004	PGV###SOPN	DIVERSION FACILITIES NEW VALVE VAULT PGV-### OPENED	DI	CN1	HARDWIRED	N/A					
0005	PGV###OPOS	DIVERSION FACILITIES NEW VALVE VAULT PGV-### POSITION COMMAND	AO	CN1	HARDWIRED	N/A					
0006	PGV###IPOS	DIVERSION FACILITIES NEW VALVE VAULT PGV-### POSITION FEEDBACK	AI	CN1	HARDWIRED	N/A					
0002	LSH###SLVH	DIVERSION FACILITIES NEW VALVE VAULT SUMP LEVEL HIGH	DI	CN1	HARDWIRED	N/A					
0002	SUP###SFLT	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 1 FAULT	DI	CN1	HARDWIRED	N/A					
0002	SUP###SSTR	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 1 RUNNING	DI	CN1	HARDWIRED	N/A					
0002	SUP###SFLT	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 2 FAULT	DI	CN1	HARDWIRED	N/A					
0002	SUP###SSTR	DIVERSION FACILITIES NEW VALVE VAULT SUMP PUMP 2 RUNNING	DI	CN1	HARDWIRED	N/A					

DATA IN THE BLUE COLUMNS TO BE PROVIDED BY SYSTEM INTEGRATOR

SECTION 40 98 00

PROCESS CONTROL SYSTEM TRAINING

PART 1 GENERAL

1.1 REQUIREMENTS AND RESPONSIBILITIES

A. Section 40 98 00 specifies training requirements for the Process Control System (PCS), including operation, hardware, software, instrumentation, and any equipment affected by the modifications performed as part of the SSWWTP Flow Optimization Project, Third River Crossing.

B. CONTRACTOR: provide all labor, materials, equipment, and incidentals as shown, specified, and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER.

C. CONTRACTOR: retain the services of the SYSTEM INTEGRATOR to provide operation and maintenance training for all Control System components and systems, including instrumentation as specified herein, and identified in other sections.

D. CONTRACTOR: provide on-site training by an authorized representative of the equipment manufacturer for equipment not manufactured by the CONTRACTOR. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment and certified by the manufacturer as a trainer of that specific equipment.

E. CONTRACTOR: conduct all training in the normal eight-hour working shift (day, evenings, or midnights) until conclusion of the training course. Assign a full time instructor for training. Instructor shall not perform other duties throughout the period of each scheduled course. Schedule the training courses to meet the working requirements for each shift. Schedule training classes during day, evening, and midnight shifts to allow three shift training, if applicable.

F. The requirements of this specification supplement the requirements of Section 01 79 00 - Training.

G. Related Work Specified in Other Sections Includes, But is Not Limited to the Following:

1. Section 01 33 00 - Submittals
2. Section 01 79 00 - Training
3. Section 40 80 50 - Process Control System Commissioning

4. Section 40 90 00 - Process Control System General Requirements

5. Section 40 90 50 - Process Control System Description

6. Section 40 95 13 - Process Control System Panel Enclosure and Equipment

7. Section 40 96 15 - Process Control System IO List

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Section 01 33 00, and as specified below.

B. CONTRACTOR:

1. Provide training plan, with a minimum of 30 days of prior notice, for training conforming to the requirements of Division 01. Include in the plan course outlines for each control system, equipment, instrumentation, and coordinated schedules for training to be provided at the SYSTEM INTEGRATOR's or VENDOR's facilities. Schedule training to allow OWNER personnel to receive the training in a timely manner in accordance with the project and equipment startup schedule.

2. Identify which systems are covered by each of the training courses, and identify common topics and specialty topics unique to a system or a course.

3. Provide Lesson Plans, including course outline, for each class for review by OWNER/ ENGINEER.

4. Provide copies of training materials for each class for OWNER/ ENGINEER's review a minimum of eight weeks before the scheduled class, and provide the final training materials two weeks before the scheduled class.

5. Provide instructor/trainer qualifications and experience records.

1.3 ON-SITE TRAINING

A. Provide training for all aspects of the process control system. Training shall not be limited to instruments, software, computers, and hardware. The generic requirements for training are provided below. Prepare and replicate training specifically for all elements of the process control system.

B. The OWNER may record and/or videotape on-site training sessions at its option.

C. The ENGINEER may monitor any training course.

D. Generic Training Requirements:

1. Provide on-site operation and maintenance training by SYSTEM INTEGRATOR or VENDOR and the equipment manufacturer representatives prior to placing the equipment in continuous operation, conforming to the requirements of Section 01 79 00 - Training. Provide the services of equipment manufacturer's representatives for a minimum of eight hours for each type of instrument provided.

2. Training shall accomplish the following:

a. Provide instruction covering use and operation of the equipment to perform the intended functions.

b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.

c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall facility monitoring and control system.

d. Provide all instructions necessary to operate and utilize all system components.

e. Provide all instruction necessary to monitor and control the system processes from the designated control panel.

f. Explain procedures for control of the system during scheduled or unscheduled shutdown and the subsequent start-up.

g. Provide instructions for regular maintenance and administration operations.

h. Different phases of the training may be grouped for presentation by different personnel. Submit schedule and instructors for approval.

E. Training subjects shall include, but not be limited to the following:

1. An overview of each new major piece of equipment in the system (e.g., new controller, new input/output (I/O) module, new communication module, new instrument, etc.), and how each interacts with the process.

2. An overview of the control system with a discussion showing how the hardware and software react and influence the operation of the controlled processes.

3. A unit block diagram showing how and what information flows within the system and what is done by each of the functional units.

4. Specific calibration and tuning requirements for each type of new instrument being supplied.

5. Troubleshooting instructions and techniques particular to each new instrument application.

6. Instruction in the use of any special tools necessary for maintenance and calibration.

F. The instructor shall be highly experienced in practical system applications similar to the specified installation, as well as in teaching the selected curriculum. The resumes of those on the training staff, who will be instructing the plant operating personnel, shall be available for review and approval by OWNER/ENGINEER.

G. For training conducted on-site, include the costs for the instructor's travel, meals, and lodging. For any additional time required for travel, include the cost for instructor per diem expenses. Include all course fees and course material costs.

H. Procedures:

1. The training procedures are the complete responsibility of the CONTRACTOR. There shall be formal classroom instruction in small classes (15 students maximum). Encourage trainees to freely ask questions during the instruction periods.

2. Hold classes at the facility designated by the OWNER/ ENGINEER using the actual equipment installed.

3. Hold classes as many times per day as necessary to accommodate the different shifts at the facilities.

I. Materials:

1. Provide comprehensive text material to supplement classroom lectures and to provide material for self-study. Permit the personnel who have attended training courses to retain text materials for future reference.

J. Training following two months of regular system operations:

1. The SYSTEM INTEGRATOR and/or VENDOR: provide operation and maintenance covering all system equipment provided.

2. The training shall be of the same format, content, and duration as the

training described above. Provide additional emphasis or retraining for areas of weakness.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TRAINING

A. Provide the specified minimum instructor hours/number of sessions of training in accordance with Section 01 79 00 - Training.

B. SYSTEM INTEGRATOR: supplement the table below to schedule the timing and duration of the training to verify completion of training prior to Facility Startup, testing, and commissioning.

Content	**Duration (hours per course)**	**Operator (seats)**	**Instrument Maintenance (seats)**	**System Admin. (seats)**	**Responsibility**
Onsite Process Control System	20	TBD	TBD	TBD	SYSTEM INTEGRATOR
Onsite Field Instruments	20	TBD	TBD	TBD	SYSTEM INTEGRATOR
Network Communications	2	TBD	TBD	TBD	SYSTEM INTEGRATOR
SCADA/HMI/OIT	20	TBD	TBD	TBD	SYSTEM INTEGRATOR
Vendor Training (Maintenance & Programming)	50	TBD	TBD	TBD	SYSTEM INTEGRATOR
Total instruction hours	**112**	**TBD**	**TBD**	**TBD**	

END OF SECTION

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ADDITIONAL ENGINEERING REPORTS

Geotechnical Engineering Report

Southside WWTP Sewer Crossing
Tulsa, Oklahoma
February 28, 2020
Terracon Project No. 04195009

Prepared for:
Greeley and Hansen, LLC
Chicago, Illinois

Prepared by:
Terracon Consultants, Inc.
Tulsa, Oklahoma

February 28, 2020

Terracon GeoReport

Greeley and Hansen, LLC
100 S. Wacker Drive, Suite 1400
Chicago, Illinois 60606

Attn: Mr. Timothy Gualandri, P.E.
P: (312) 578-2308
E: tgualandri@greeley-hansen.com

Re: Geotechnical Engineering Report
Southside WWTP Sewer Crossing
5300 S. Elwood Avenue
Tulsa, Oklahoma
Terracon Project No. 04195009

Dear Mr. Gualandri:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P04195009.R1 dated January 22, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning the design and construction of slab foundations for the junction boxes, design and construction of drilled pier foundations for the east junction box only, design parameters for lateral capacity of drilled pier foundations, and lateral earth pressure values for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.
Cert. of Auth. #CA-4531 exp. 6/30/21

Alec N. Strassburg, P.E. (KS)
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
MICHAEL H. HOMAN
15777
OKLAHOMA

Michael H. Homan, P.E.
Senior Principal
Oklahoma No. 15777

2/28/2020

REPORT TOPICS

INTRODUCTION 1
SITE CONDITIONS 1
PROJECT DESCRIPTION 2
GEOTECHNICAL CHARACTERIZATION 3
GEOTECHNICAL OVERVIEW 5
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DRILLED PIERS 8
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LATERAL EARTH PRESSURES 10
GENERAL COMMENTS 12

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report

Southside WWTP Sewer Crossing
5300 S. Elwood Avenue
Tulsa, Oklahoma

Terracon Project No. 04195009
February 28, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed sewer crossing under the Arkansas River from the Southside wastewater treatment plant (WWTP) located at 5300 S. Elwood Avenue in Tulsa, Oklahoma. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface conditions
- Site preparation and earthwork
- Foundation design and construction for junction boxes
- Lateral earth pressures
- Seismic site classification per IBC
- Design parameters for lateral capacity of drilled pier foundations

The geotechnical engineering Scope of Services for this project included the advancement of four test borings (designated B-1 to B-4) to depths ranging from approximately 18.5 to 69 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration.

Item	Description
Project Location	The proposed project includes a sewer crossing under the Arkansas River in Tulsa, Oklahoma. The sewer alignment is planned to extend west from an existing junction box located along Riverside Drive to the existing Southside Wastewater Treatment Plant located on the west side of the river at 5300 S. Elwood Avenue. See **Site Location** Approximate Latitude and Longitude: West side: 36.0847°N, 95.9909°W East side: 36.0853°N, 95.9849°W
Existing Improvements	Existing junction boxes and manholes, an influent lift station, and two 36-inch diameter pipes currently run along the planned sewer alignment.
Current Ground Cover	A water treatment plant exists on the west end of the project alignment. The east side of the project alignment is located in an area developed as a park with walking/biking trails along with a few structures associated with the existing sewer lines, junction boxes, and manholes.
Existing Topography	From the provided plans the riverbed grade elevation appears to vary between about 600 feet to 595 feet. Existing ground surface elevations at the east site range from about 624 to 628 feet. Existing ground surface elevations at the west side range from about 630 to 634 feet.

PROJECT DESCRIPTION

Our final understanding of the project conditions is as follows:

Item	Description
Project Description	We understand that the project will consist of the construction of a new 42-inch diameter sewer line crossing under the Arkansas River along with new, concrete junction structures on both the east and west sides of the river. We understand that the sewer line will be encased as it crosses under the river.
Proposed Structures	The new east junction box will connect to the west face of existing junction box 782 (JB-782). This box is planned to have a 2-foot thick bottom slab with a bottom of concrete elevation of approximately 592.5 feet. Based on information provided by the structural engineer, we understand that drilled piers are planned along the west face of the east box to help resist anticipated lateral forces placed on the box. The west junction box will be constructed over top of the two, existing 36-inch diameter sewer lines. This box will have a 2-foot thick bottom slab with a bottom of concrete elevation of approximately 589 feet.

Item	Description
Grading/Slopes	The new sewer line is planned to have a 0.20% slope to the west with flow line elevations of 596.0 and 592.5 feet at the east and west junction boxes, respectively.

GEOTECHNICAL CHARACTERIZATION

Site Geology

Based on information published in the Oklahoma Department of Transportation (ODOT) manuals, "Engineering Classification of Geologic Materials: Division 8", the project alignment is mapped as underlain by a combination of alluvium, the Seminole Unit, and the Holdenville Unit. Alluvium is deposits of sand, silt, clay, gravel, and/or combinations of these materials which have been deposited by streams, creeks, or rivers. Alluvium is found along the flood plains of streams and is normally present at places along all streams. The Seminole Unit is likely present west of the Arkansas River and consists mainly of shale and sandy shale and contains zones of sandstone. The Holdenville Unit is likely present east of the Arkansas River and consists mainly of fissile to blocky shale, but contains minor amounts of sandstone, siltstone, and limestone.

We encountered shale and sandstone bedrock in all borings at depths ranging from 26.5 to 39 feet below ground surface.

Subsurface Profile

We have developed a general characterization of the subsurface conditions based upon our review of the project data. The following table provides a summary of our geotechnical characterization. The characterization is based upon widely spaced exploration points across the site, and variations are likely.

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency/Density
Surface 1	3 inches (borings B-1 and B-2)	Topsoil	N/A
1	8 to 24 feet in borings B-1 to B-3 Undetermined [1] in boring B-4	Existing fill consisting of silty sand, sandy silty clay, silty clayey gravel, lean clay, sandy lean clay, silty clayey sand, clayey sand, silty clay, and boulders and cobbles	N/A
2	26.5 to 36.5 feet in borings B-1 to B-3	Native sand soils with varying amounts of silt	Loose to medium dense

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency/Density
3	Undetermined [1]	Shale and Sandstone	Shale: Soft to moderately hard Sandstone: Cemented

1. Boring B-4 terminated at a depth of about 18.5 feet upon encountering auger refusal in apparent boulders and cobbles.
2. Borings B-1 to B-3 terminated in stratum 3 at depths ranging from 13.2 to 23.8 feet. Borings B-3 and B-5 terminated upon encountering auger refusal in the sandstone at depths of about 13 and 16 feet, respectively.

Conditions encountered at each exploration point are indicated on the individual logs found in the **Exploration Results** section of this report. Stratification boundaries on the boring logs represent the approximate location of changes in material types; in situ, the transition between materials may be gradual.

Select rock samples from the borings were tested for slake durability and CERCHAR abrasiveness. In addition, thin sections were developed from select rock samples to determine the presence and estimate the quantity of abrasive minerals in the rock samples. The results of these tests and examination are included in the **Exploration Results** section of this report

Groundwater Conditions

The boreholes were observed while drilling, and immediately after completion of drilling for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results** and are summarized in the following table. The borings were advanced with hollow-stem augers until bedrock was encountered. After encountering bedrock, the borings were advanced by using rock coring techniques. Rock coring utilizes water as a drilling fluid; therefore, groundwater measurements were only recorded when drilling with augers. Groundwater measurements were not taken after the introduction of water into the borehole.

Boring	Approximate Depth to Groundwater While Drilling (feet) [1]	Approximate Depth to Groundwater After Drilling (feet) [1]
B-1	20	Not measured
B-2	22	Not measured
B-3	29	Not measured
B-4	Not encountered	Not encountered

1. Below existing ground surface.

The absence of observed water in some of the borings during or after drilling does not necessarily mean the boring terminated above groundwater. Due to the low permeability of the soils and rock

encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, water in the river, and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

Plans provided to Terracon show the bottom elevations of the new junction boxes to be at 589 to 592.5 feet for the west and east junction structures, respectively. We anticipate the junction box structures will be supported on slab or footing foundations. Based on the results from our borings, we anticipate that both junction structures will bear in moderately hard shale or cemented sandstone bedrock. Recommendations for slab or footing foundations can be found in the **Slab and Footing Foundations** section of this report.

We also understand that drilled piers are planned along the west wall of the new east junction box. Drilled piers will be utilized to resist the anticipated unbalanced lateral loads placed on the junction box. We anticipate that the drilled piers will be socketed into the moderately hard shale or cemented sandstone bedrock encountered in the borings. Recommendations for drilled piers can be found in the **Drilled Piers** section of this report.

Groundwater was encountered in the all the borings except B-4. Based on the results of the borings and due to the proximity of project to the Arkansas River, the contractor should be prepared to perform dewatering during construction to perform construction “in the dry.”

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork will include clearing and grubbing and excavations. The following sections provide recommendations and considerations for earthwork operations.

Site Preparation

We understand the junction boxes and proposed sewer crossing will be installed below-grade. Therefore, we anticipate that preparation of the subgrade may not be necessary. Where site

preparation and grading are necessary, surface vegetation, topsoil, pavements and any other surface and subsurface structures should be removed from the construction areas. Unstable subgrade conditions will likely develop during site clearing operations, particularly near the river and if the soils are wet and/or subjected to repetitive construction traffic. Using low ground pressure (tracked or balloon tired) construction equipment would aid in reducing subgrade disturbance. Even with using low ground pressure equipment, difficult conditions should be expected if the ground surface is disturbed and wetted.

After stripping, completing grading operations, and prior to placing fill, the subgrade should be proofrolled to aid in locating loose or soft areas. Proofrolling can be performed with a loaded tandem axle dump truck. Areas too small to proofroll should be evaluated by the Geotechnical Engineer. Where unstable soils are identified by proofrolling or subgrade evaluation, stabilization could include scarification, moisture-conditioning and compaction; or removal and replacement of unstable materials with suitable engineered fill. The appropriate method of improvement, if required, would depend on factors such as schedule, weather, the size of the ares to be treated, and the nature of the instability. More detailed recommendations can be provided during construction. Construction during warm, dry periods would help reduce the amount of subgrade stabilization required.

Excavations

Based on the anticipated excavation depths, the excavations will extend into the existing fill soils, native overburden, and then into bedrock. We anticipate that the existing fill soils, native overburden, and possibly the upper portions of the shale bedrock will be excavatable using conventional construction equipment. Shale and sandstone in the lower elevations especially near areas where rock coring procedures were utilized, can be difficult to penetrate with conventional equipment and may require heavy-duty excavation equipment with rock attachments.

Groundwater was observed in Borings B-1 through B-3 at depths ranging from 20 to 29 feet below existing grades (approximate elevation 605 to 603). Those groundwater levels correspond to elevations well above the anticipated excavation depths at the junction boxes and along most of the sewer alignment. However, groundwater levels are expected to fluctuate over time at this site due to fluctuations in the water level in the Arkansas River and other hydrological factors. Groundwater levels will probably rise and fall with the water level in the river. It should be expected that temporary dewatering will be required during construction to perform construction “in the dry.” Well points will be required to perform dewatering.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

SLAB OR FOOTING FOUNDATIONS

This section provides design recommendations and construction considerations for slab or footing foundations to support the junction boxes.

Slab and Footing Foundation Design Recommendations

Item	Description
Maximum net allowable bearing pressure [1]	8,000 psf
Required bearing stratum	Moderately hard shale or cemented sandstone bedrock
Minimum embedment (below lowest finished exterior grade) for frost protection	24 inches
Minimum footing width	24 inches
Estimated total settlement	About 3/4 inch or less
Estimated differential settlement	Less than 3/4 inch
Coefficient of sliding friction [2]	0.45

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended allowable bearing pressure is based on foundations bearing on moderately hard shale or cemented sandstone bedrock.
2. Coefficient of friction value is an ultimate value without a factor of safety, and considers the foundations bear on moderately hard shale or cemented sandstone bedrock.

Construction Adjacent to Existing Structure

Care should be taken during excavation for the new east junction box adjacent to existing foundations, to avoid disturbing existing foundation bearing materials.

New slab or footing foundations should bear at or near the bearing elevation of immediately adjacent existing foundations. Depending upon their locations and current loads on the existing footings, footings for the new east junction could cause settlement of the adjacent structure.

Design Parameters - Uplift Loads

It should be anticipated that the structures will be situated below the groundwater level, especially during time of higher groundwater levels. Structures situated below the groundwater level will be subject to hydrostatic uplift pressures.

To compute the design uplift pressures, it will be necessary to choose a design groundwater level. The design groundwter level should represent the highest groundwater level expected at the site. Perhaps the historical high water level in the Arkansas River or the Arkansas River 100-year flood elevation near the site should be considered when determining a design groundwater level.

Slab or Footing Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose soil or rock prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing material disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the foundation excavations should be removed before foundation concrete is placed.

To evaluate that suitable bearing materials are encountered, we recommend the base of all footing foundation excavations be observed and evaluated by the Geotechnical Engineer prior to placing reinforcing steel and concrete.

DRILLED PIERS

We understand that drilled piers will be used to support the west wall of the east junction box only to resist lateral loading. We recommend that drilled piers bear in the moderately hard shale or cemented sandstone. Design recommendations for drilled piers are presented below.

Drilled Pier Design Recommendations

Item	Description
Drilled pier type	Straight shaft drilled piers
Bearing material	Moderately hard shale or cemented sandstone bedrock
Depth bearing material encountered [1]	28.5 feet (Approx. el. 597.5 to 596.5 feet)
Net allowable end bearing pressure [2]	30,000 psf
Allowable skin friction [3]	3,000 psf
Minimum pier diameter	18 inches

Item	Description
Minimum pier spacing [4]	3 pier diameters center-to-center
Estimated total settlement	1/2 inch or less

1. Depth to recommended bearing material below the existing ground surface at the boring locations.
2. Piers should extend at least 3 feet into the moderately hard shale or cemented sandstone to use the recommended net allowable end bearing pressure. The net allowable bearing pressure is the pressure at the base of the piers in excess of the minimum surrounding overburden pressure.
3. The recommended skin friction is for that length of drilled pier extending more than 3 feet into the recommended shale or sandstone bearing material. Skin friction can be used to provide additional capacity in compression and resistance to uplift loads.
4. Minimum pier spacing is to reduce overlapping bearing stresses and for constructability. Closer spacing may require a reduction in axial capacity.

Drilled Pier Lateral Capacity Design Parameters

The following table lists input values for use in a lateral capacity analysis of drilled piers using the computer program LPile by Ensoft, Inc. The design parameters were based on the results of borings B-1 and B-2 near the location of the east junction box. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Elevation [1] (feet)	LPile Material Model	Effective Unit Weight, γ (pcf) [2]	Uniaxial Compressive Strength for Rock, q_u (psi)	Initial Modulus of Rock Mass, E_{ir} (psi)	RQD (%) [2]	Strain Factor, k_{rm}
597 to 587	Weak Rock	135	750	75,000	70	0.0005
587 to 572	Weak Rock	135	900	90,000	85	0.0005
572 to 562	Weak Rock	135	750	75,000	70	0.0005

1. The elevations provided are based on the subsurface conditions encountered in borings B-1 and B-2 only. The parameters in the above table should not be used for the west junction box.
2. Buoyant (effective) unit weight values should be used below water table. A design elevation of 605 feet was used for groundwater depth.
3. The value given for RQD is estimated from field data and sample examination.

Drilled Pier Construction Considerations

A heavy-duty drill rig equipped with a core barrel and possibly other special drilling tools will be required to penetrate the competent shale and sandstone bedrock and complete pier excavations. The rock encountered in the borings will be difficult to penetrate with pier drilling equipment.

Based on the results of the borings and the proximity of the site to the Arkansas River, casing will be required to maintain open drilled pier excavations and control water inflow. To facilitate drilled pier construction, concrete should be on-site and ready for placement as pier excavations are completed. Following drilling, loose or disturbed materials and any accumulated water should be removed from the bottom of the drilled piers prior to concrete placement. A sufficient head of concrete should be maintained in the casing as it is being pulled to prevent an influx of soft soil or water into the excavations. Also, concrete having a slump of at least 5 inches should be used to prevent the concrete from arching in the casing.

We recommend that a representative of Terracon observed the pier installation to evaluate that the intended bearing material is encountered and sufficiently penetrated, and to provide recommendations should conditions vary from those observed in our borings.

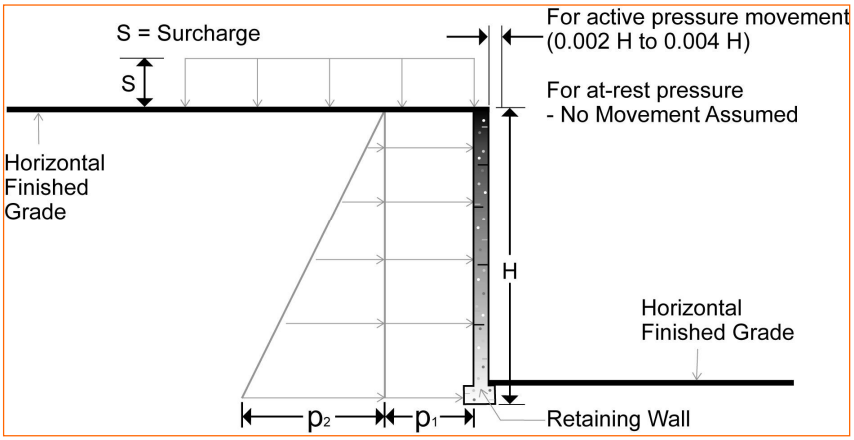
SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil/bedrock properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 69 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The “at-rest” condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Coefficients				
Earth Pressure Condition	**Coefficient for Backfill Type**	**Equivalent Fluid Density (pcf)**	**Surcharge Pressure, p_1 (psf)**	**Earth Pressure, p_2 (psf)**
Active (Ka)	Granular - 0.33	40	(0.33)S	(40)H
	Clay - 0.42	50	(0.42)S	(50)H
At-Rest (Ko)	Granular - 0.50	60	(0.50)S	(60)H
	Clay - 0.60	70	(0.60)S	(70)H
Passive (Kp)	Granular - 3.00	360	---	---
	Clay - 2.37	285	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 H to 0.004 H, where H is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- Backfill unit weight = 120 pcf
- Horizontal backfill, compacted as recommended in this report
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No loading from nearby footings or slabs
- No dynamic loading
- No safety factor included in soil parameters
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of

the wall at an angle of at least 45 from vertical for the active and at-rest cases, and at an angle of 60 degrees from vertical for the passive case. To calculate the resistance to sliding, a value of 0.45 should be used as the ultimate coefficient of friction between the footing and the shale or sandstone bedrock.

If drainage is not possible, as is likely the case for structures that will extend below the water level, then the below-grade walls should be designed to resist the combined hydrostatic and lateral earth pressures. In our opinion, walls backfilled using clay soils should be designed using an equivalent fluid weighing 100 pcf for at-rest conditions. For granular backfill, an equivalent fluid weighing 90 pcf should be used for at-rest conditions. These pressures do not include the influence of surcharge or equipment loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there

may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Boring Locations
2 (borings B-1 and B-2)	64	East junction box
2 (borings B-3 and B-4)	18.5 to 69	West junction box

Boring Layout and Elevations: The boring locations were established in the field by a Terracon representative, in conjunction with input from representatives of Greeley and Hansen during a site visit. Ground surface elevations indicated on the boring logs were interpolated from project plans provided by Greeley and Hansen. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

Subsurface Exploration Procedures: We advanced the borings with an ATV-mounted rotary drill rig using continuous flight augers and rock coring techniques. At borings B-3 and B-4, a hydrovac was used to depths of 14 and 10 feet, respectively. Samples of the soils encountered in the borings were obtained using thin-walled tube sampling and split-barrel sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. These values are used to estimate the in-situ relative density of granular soils and, to a lesser degree of accuracy, the consistency of cohesive soils and the hardness of weathered bedrock. The samples were tagged for identification, sealed to reduce moisture loss, and transported to our laboratory for examination, testing and classification. In addition, we observed and recorded groundwater levels during drilling and sampling, and immediately after completion of drilling. For safety purposes, all borings were backfilled with auger cuttings and cement-bentonite grout after their completion.

Core samples of shale and sandstone were obtained at borings B-1, B-2, and B-3 using a NX-size diamond-bit core barrel. The percentages of rock core recovered (%REC) and Rock Quality Designation (RQD) per length of core run are shown on the boring log. The RQD is an index obtained by summing the lengths of rock core pieces that are 4 inches in length or longer divided by the total length of core run.

The sampling depths, penetration distances, and other sampling information was recorded on the field logs. Our exploration team prepared field logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and the driller's interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the subsurface conditions encountered at the boring locations based on field and laboratory data and observation of the samples.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil and rock strata, as necessary, for this project. Samples obtained from the site were tested for the following engineering properties:

- Water (moisture) content
- Atterberg limits
- Particle-size analysis
- Unconfined compressive strength of rock cores
- Slake durability
- CERCHAR abrasiveness
- Thin-section examination

The laboratory testing program included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System (USCS) described in the **Supporting Information** section.

Rock classification was conducted using locally accepted practices for engineering purposes and the General Notes for Sedimentary Rock Classification described in the **Supporting Information** section; complete petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan
Exploration Plan (3 pages)

Note: All attachments are one page unless noted above.

SITE LOCATION

Southside WWTP Sewer Crossing ■ Tulsa, Oklahoma
February 28, 2020 ■ Terracon Project No. 04195009



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Southside WWTP Sewer Crossing ■ Tulsa, Oklahoma

February 28, 2020 ■ Terracon Project No. 04195009



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs with Rock Core Photographs (B-1 through B-4)
Grain Size Distribution (5 pages)

Slake Durability (3 pages)
Results of Thin-Section Examination and CERCHAR Abrasivity Testing of Rock Core Samples (20 pages)

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0852° Longitude: -95.9849°

Approximate Surface Elev.: 625 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
		3" Topsoil
2.0	623+/-	**FILL - SILTY SAND**, trace clay, brown to reddish brown
4.0	621+/-	**FILL - SANDY SILTY CLAY**, brown
7.5	617.5+/-	**FILL - SANDY SILTY CLAY**, with highly weathered sandstone fragments, brown to yellowish brown
10.0	615+/-	**FILL - SILTY CLAYEY GRAVEL**, with sand, brown to reddish brown
20.0	605+/-	**POORLY GRADED SAND (SP-SM)**, with silt, fine to medium grained, brown to reddish brown, loose
		POORLY GRADED SAND (SP-SM), with silt, fine to medium grained, brown, medium dense

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
			18	3-3-5 N=8		12		NP	32
			10			7	96	23-17-6	53
5			12	19-16-20 N=36		11			
			15	15-11-7 N=18		10		21-16-5	31
10			18	4-5-4 N=9		4			
			14	3-3-4 N=7		2		NP	7
15									
	▽		16	12-4-4 N=8		3			
20									
			12	7-5-5 N=10		12		NP	11
25									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hollow Stem Auger to 29 feet, Diamond Core Bit below 29 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *20 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-05-2019 | Boring Completed: 03-06-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

BORING LOG NO. B-1

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0852° Longitude: -95.9849°

Approximate Surface Elev.: 625 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
		POORLY GRADED SAND (SP-SM), with silt, fine to medium grained, brown, medium dense *(continued)*
26.5	598.5+/-	
		SHALE+, gray, soft to moderately hard
29.0	596+/-	
		SHALE+, with interbedded sandstone seams, gray and light gray, moderately hard
31.0	594+/-	
		SANDSTONE+, with thin shale seams, gray, cemented
37.0	588+/-	
		SHALE+, with interbedded sandstone seams, gray and light gray, moderately hard

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)
30		4	50/4"	3320	11
			REC = 97% RQD = 92%		
			REC = 100% RQD = 100%		
35			REC = 93% RQD = 90%		
40			REC = 100% RQD = 92%		
45			REC = 100% RQD = 90%	1010	
50					

DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hollow Stem Auger to 29 feet, Diamond Core Bit below 29 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

20 Feet While Drilling

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-05-2019 | Boring Completed: 03-06-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

BORING LOG NO. B-1

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0852° Longitude: -95.9849°

Approximate Surface Elev.: 625 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SHALE+, with interbedded sandstone seams, gray and light gray, moderately hard *(continued)*					REC = 100% RQD = 98%					
			55				REC = 100% RQD = 85%	950				
			60				REC = 100% RQD = 90%					
	64.0	561+/-										
		Boring Terminated at 64 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hollow Stem Auger to 29 feet, Diamond Core Bit below 29 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *20 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-05-2019 | Boring Completed: 03-06-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20



Boring B-1
Depth: 29.0’ to 39.0’



Boring B-1
Depth: 39.0’ to 49.0’

Project Manager: ANS	Project No. 04195009	Terracon Consulting Engineers & Scientists	ROCK CORE PHOTOGRAPHS
Drawn by: ANS	Scale: N/A		SOUTHSIDE WWTP SEWER CROSSING
Checked by: MHH	File Name: N/A		5300 S. ELWOOD AVENUE
Approved by: MHH	Date: FEB 2020	9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145 PH. (918) 250-0461 FAX. (918) 250-4570	TULSA, OKLAHOMA



Boring B-1
Depth: 49.0’ to 59.0’



Boring B-1
Depth: 59.0’ to 64.0’

Project Manager: ANS	Project No. 04195009	Terracon Consulting Engineers & Scientists 9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145 PH. (918) 250-0461 FAX. (918) 250-4570	ROCK CORE PHOTOGRAPHS SOUTHSIDE WWTP SEWER CROSSING 5300 S. ELWOOD AVENUE TULSA, OKLAHOMA
Drawn by: ANS	Scale: N/A		
Checked by: MHH	File Name: N/A		
Approved by: MHH	Date: FEB 2020		

BORING LOG NO. B-2

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0854° Longitude: -95.985°

Approximate Surface Elev.: 626 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
		3" Topsoil
		FILL - LEAN CLAY, brown to dark brown
5.0	621+/-	
		FILL - SANDY LEAN CLAY, dark brown and reddish brown
8.0	618+/-	
		WELL GRADED SAND (SW), fine to medium grained, brown to tan, loose to medium dense
22.0	604+/-	
		POORLY GRADED SAND (SP), fine to medium grained, brown, medium dense

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
			18	3-3-4 N=7		17		33-18-15	87
			8			16	107		
5			18	3-5-5 N=10		10			
			18	2-2-2 N=4		4		NP	5
10									
			18	3-5-7 N=12		6			
15									
			18	5-10-11 N=21		2		NP	4
20	▽								
			18	5-6-7 N=13		19		NP	4
25									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hollow Stem Auger to 29 feet, Diamond Core Bit below 29 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *22 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-06-2019 | Boring Completed: 03-07-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

BORING LOG NO. B-2

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0854° Longitude: -95.985°

Approximate Surface Elev.: 626 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
28.0	598+/-											
POORLY GRADED SAND (SP), fine to medium grained, brown, medium dense *(continued)*												
						3	50/3"		10			
SHALE+, with interbedded sandstone seams, gray and light gray, moderately hard			30				REC = 93% RQD = 65%					
			35				REC = 100% RQD = 71%					
- 12" sandstone seam at about 38 feet												
39.0	587+/-											
SHALE+, with interbedded thin sandstone seams, dark gray and light gray, moderately hard			40				REC = 100% RQD = 100%	1810				
			45				REC = 100% RQD = 88%					
			50									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hollow Stem Auger to 29 feet, Diamond Core Bit below 29 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

22 Feet While Drilling

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-06-2019 | Boring Completed: 03-07-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

BORING LOG NO. B-2

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0854° Longitude: -95.985°

Approximate Surface Elev.: 626 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SHALE+, with interbedded thin sandstone seams, dark gray and light gray, moderately hard *(continued)*						REC = 100% RQD = 94%	920				
			55				REC = 100% RQD = 73%					
			60				REC = 100% RQD = 95%	740				
64.0	562+/-											
	Boring Terminated at 64 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hollow Stem Auger to 29 feet, Diamond Core Bit below 29 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *22 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-06-2019 | Boring Completed: 03-07-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20



Boring B-2
Depth: 29.0’ to 39.0’



Boring B-2
Depth: 39.0’ to 49.0’

Project Manager: ANS	Project No. 04195009	Terracon Consulting Engineers & Scientists 9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145 PH. (918) 250-0461 FAX. (918) 250-4570	ROCK CORE PHOTOGRAPHS
Drawn by: ANS	Scale: N/A		SOUTHSIDE WWTP SEWER CROSSING 5300 S. ELWOOD AVENUE TULSA, OKLAHOMA
Checked by: MHH	File Name: N/A		
Approved by: MHH	Date: FEB 2020		



Boring B-2
Depth: 49.0’ to 59.0’



Boring B-2
Depth: 59.0’ to 64.0’

Project Manager: ANS	Project No. 04195009	Terracon Consulting Engineers & Scientists 9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145 PH. (918) 250-0461 FAX. (918) 250-4570	ROCK CORE PHOTOGRAPHS SOUTHSIDE WWTP SEWER CROSSING 5300 S. ELWOOD AVENUE TULSA, OKLAHOMA
Drawn by: ANS	Scale: N/A		
Checked by: MHH	File Name: N/A		
Approved by: MHH	Date: FEB 2020		

BORING LOG NO. B-3

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.085° Longitude: -95.991°

Approximate Surface Elev.: 632 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
			5									
			10									
14.0	618+/-		15									
18.5	613.5+/-		20									
24.0	608+/-		25									

HYDROVAC FROM 0 TO 14 FEET

FILL - SILTY CLAYEY SAND, brown

SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	14	3-10-15 N=25	12	18-12-6	34

FILL - CLAYEY SAND, brown

SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	18	9-11-8 N=19	13	22-14-8

POORLY GRADED SAND (SP), tan, fine grained, medium dense

SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)
	18	9-10-11 N=21	11

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hydrovac to 14 feet, Hollow Stem Auger from 14 to 38 feet, Diamond Core Bit below 38 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *29 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-08-2019 | Boring Completed: 03-08-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

BORING LOG NO. B-3

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.085° Longitude: -95.991°

Approximate Surface Elev.: 632 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		POORLY GRADED SAND (SP), tan, fine grained, medium dense *(continued)*										
28.5	603.5+/-											
		POORLY GRADED SAND (SP-SM), with silt, fine to medium grained, brown, medium dense		▽		18	8-10-9 N=19		9		NP	11
33.5	598.5+/-		30									
		WELL GRADED SAND (SW), brown, medium dense				12	7-6-5 N=11		15			4
36.5	595.5+/-		35									
		HIGHLY WEATHERED SHALE+, gray, soft to moderately hard				10	17-24-37 N=61		16			
							REC = 50% RQD = 17%					
41.0	591+/-		40									
		SHALE+, black, moderately hard					REC = 95% RQD = 78%	3410				
44.0	588+/-											
		SHALE+, with interbedded thin sandstone seams, gray and light gray, moderately hard	45				REC = 83% RQD = NP*					
			50									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hydrovac to 14 feet, Hollow Stem Auger from 14 to 38 feet, Diamond Core Bit below 38 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

*Note: Rock core got stuck in the core barrel during drilling. Rock core could not be recovered from the core barrel without breaking up the core. Therefore, determining an RQD value was not possible.

WATER LEVEL OBSERVATIONS

▽ *29 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-08-2019 | Boring Completed: 03-08-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

BORING LOG NO. B-3

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.085° Longitude: -95.991°

Approximate Surface Elev.: 632 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)
		SHALE+, with interbedded thin sandstone seams, gray and light gray, moderately hard *(continued)*	REC = 99% RQD = 80%	
54.0	578+/-			
		COAL, trace iron pyrite, black	REC = 100% RQD = 50%	1070
56.5	575.5+/-			
		SHALE+, with interbedded thin sandstone seams, gray and light gray, moderately hard	REC = 100% RQD = 82%	770
64.5	567.5+/-			
		SANDSTONE+, with shale seams, gray and dark gray, cemented	REC = 98% RQD = 85%	
69.0	563+/-			
		Boring Terminated at 69 Feet		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hydrovac to 14 feet, Hollow Stem Auger from 14 to 38 feet, Diamond Core Bit below 38 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *29 Feet While Drilling*

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-08-2019 | Boring Completed: 03-08-2019

Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20



Boring B-3
Depth: 37.0’ to 44.0’ *

* Rock core from 44’ to 49’ is not shown. This section of rock core was lodged in the core barrel during drilling and could not be recovered intact.



Boring B-3
Depth: 49.0’ to 59.0’

Project Manager: ANS	Project No. 04195009	Terracon Consulting Engineers & Scientists 9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145 PH. (918) 250-0461 FAX. (918) 250-4570	ROCK CORE PHOTOGRAPHS SOUTHSIDE WWTP SEWER CROSSING 5300 S. ELWOOD AVENUE TULSA, OKLAHOMA
Drawn by: ANS	Scale: N/A		
Checked by: MHH	File Name: N/A		
Approved by: MHH	Date: FEB 2020		



Boring B-3
Depth: 59.0’ to 69.0’

Project Manager: ANS	Project No. 04195009	Terracon Consulting Engineers & Scientists 9522 EAST 47TH PLACE, UNIT D TULSA, OKLAHOMA 74145 PH. (918) 250-0461 FAX. (918) 250-4570	ROCK CORE PHOTOGRAPHS
Drawn by: ANS	Scale: N/A		SOUTHSIDE WWTP SEWER CROSSING 5300 S. ELWOOD AVENUE TULSA, OKLAHOMA
Checked by: MHH	File Name: N/A		
Approved by: MHH	Date: FEB 2020		

BORING LOG NO. B-4

PROJECT: Southside WWTP Sewer Crossing

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

LOCATION See Exploration Plan

Latitude: 36.0853° Longitude: -95.9911°

Approximate Surface Elev.: 631 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psi)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		HYDROVAC FROM 0 TO 10 FEET										
	10.0	621+/-	5									
		FILL - SILTY CLAY, with gravel, brown	10									
	13.5	617.5+/-										
		FILL - SILTY SAND, brown to reddish brown				18	5-2-3 N=5		15		NP	29
	16.5	614.5+/-	15									
		FILL - BOULDERS AND COBBLES, with silty clay, gray with brown										
	18.5	612.5+/-				4	50/4"		5			
		Auger Refusal on Boulder at 18.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Advancement Method:
Hydrovac to 10 feet, Hollow Stem Auger from 10 to 18.5 feet

Abandonment Method:
Boring backfilled with auger cuttings and cement-bentonite grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

Not Encountered While Drilling

Not Encountered After Boring

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

Boring Started: 03-07-2019 | Boring Completed: 03-08-2019

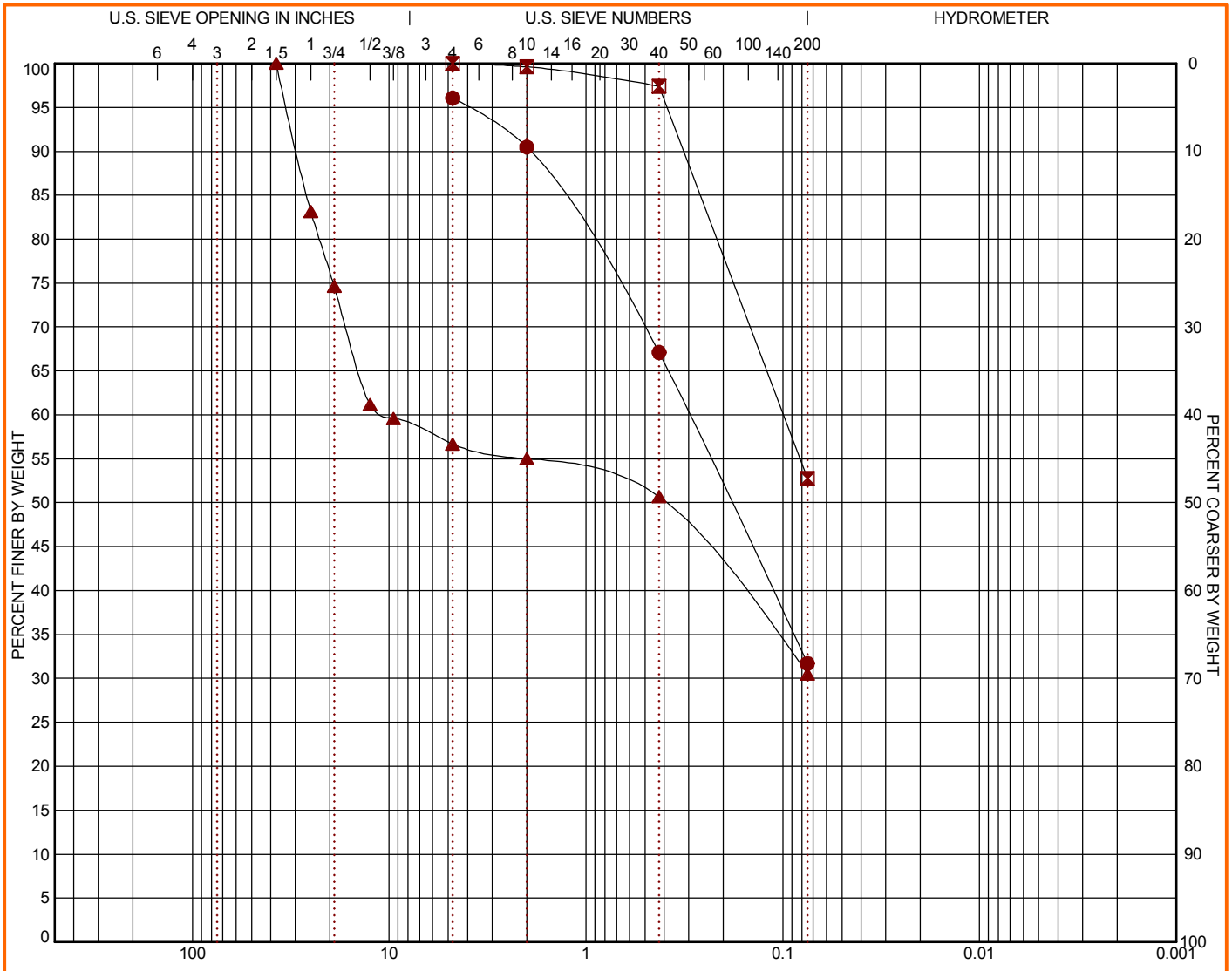
Drill Rig: ATV 8401 | Driller: CC

Project No.: 04195009

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/27/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-1	0.5 - 2			64.4		31.7		SM
⊠	B-1	2 - 3.5	0.0	0.0	47.2		52.8		CL-ML
▲	B-1	8 - 9.5	0.0	43.3	26.2		30.5		GC-GM

GRAIN SIZE	●	⊠	▲
D_{60}	0.3	0.099	10.172
D_{30}			
D_{10}			

COEFFICIENTS	●	⊠	▲
C_C			
C_U			

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	96.06	#4	100.0	1 1/2"	100.0
#10	90.48	#10	99.61	1"	83.13
#40	67.1	#40	97.4	3/4"	74.62
#200	31.69	#200	52.76	1/2"	61.17
				3/8"	59.61
				#4	56.69
				#10	55.01
				#40	50.7
				#200	30.52

SOIL DESCRIPTION	
●	SILTY SAND (SM)
⊠	SANDY SILTY CLAY (CL-ML)
▲	SILTY, CLAYEY GRAVEL with SAND

(GC-GM)	REMARKS
●	
⊠	
▲	

PROJECT: Southside WWTP Sewer Crossing

PROJECT NUMBER: 04195009

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

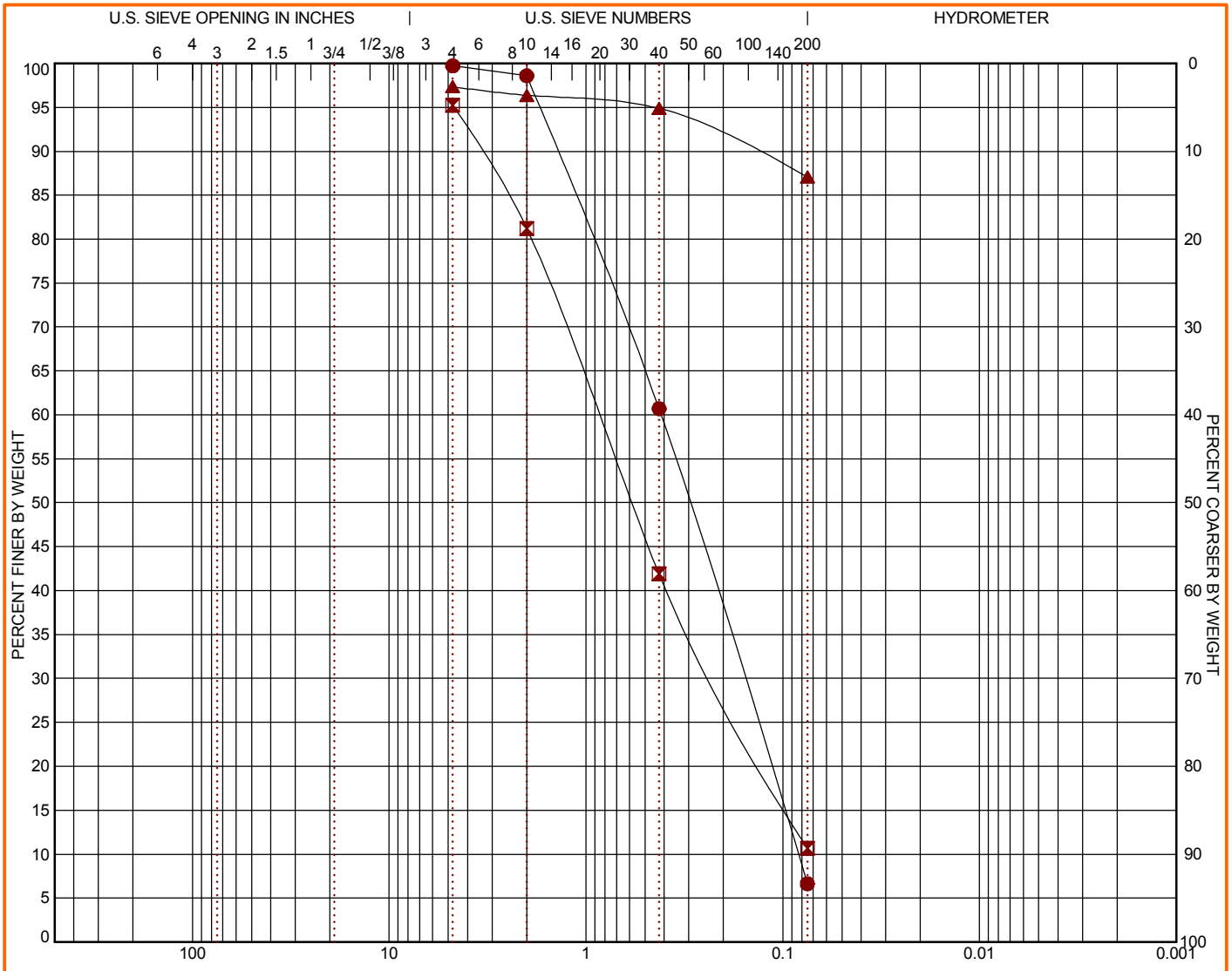
Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/28/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-1	13 - 14.5			93.1		6.6		SP-SM
⊠	B-1	23.5 - 25			84.6		10.6		SP-SM
▲	B-2	0.5 - 2			10.3		87.1		CL

GRAIN SIZE	●	⊠	▲
D_{60}	0.415	0.867	
D_{30}	0.159	0.22	
D_{10}	0.084		

COEFFICIENTS	●	⊠	▲
C_C	0.73	0.77	
C_U	4.97	11.98	

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	99.72	#4	95.25	#4	97.35
#10	98.59	#10	81.23	#10	96.37
#40	60.71	#40	41.89	#40	94.89
#200	6.63	#200	10.65	#200	87.07

SOIL DESCRIPTION	
●	POORLY GRADED SAND with SILT (SP-SM)
⊠	POORLY GRADED SAND with SILT (SP-SM)
▲	LEAN CLAY (CL)

REMARKS	
●	
⊠	
▲	

PROJECT: Southside WWTP Sewer Crossing

PROJECT NUMBER: 04195009

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

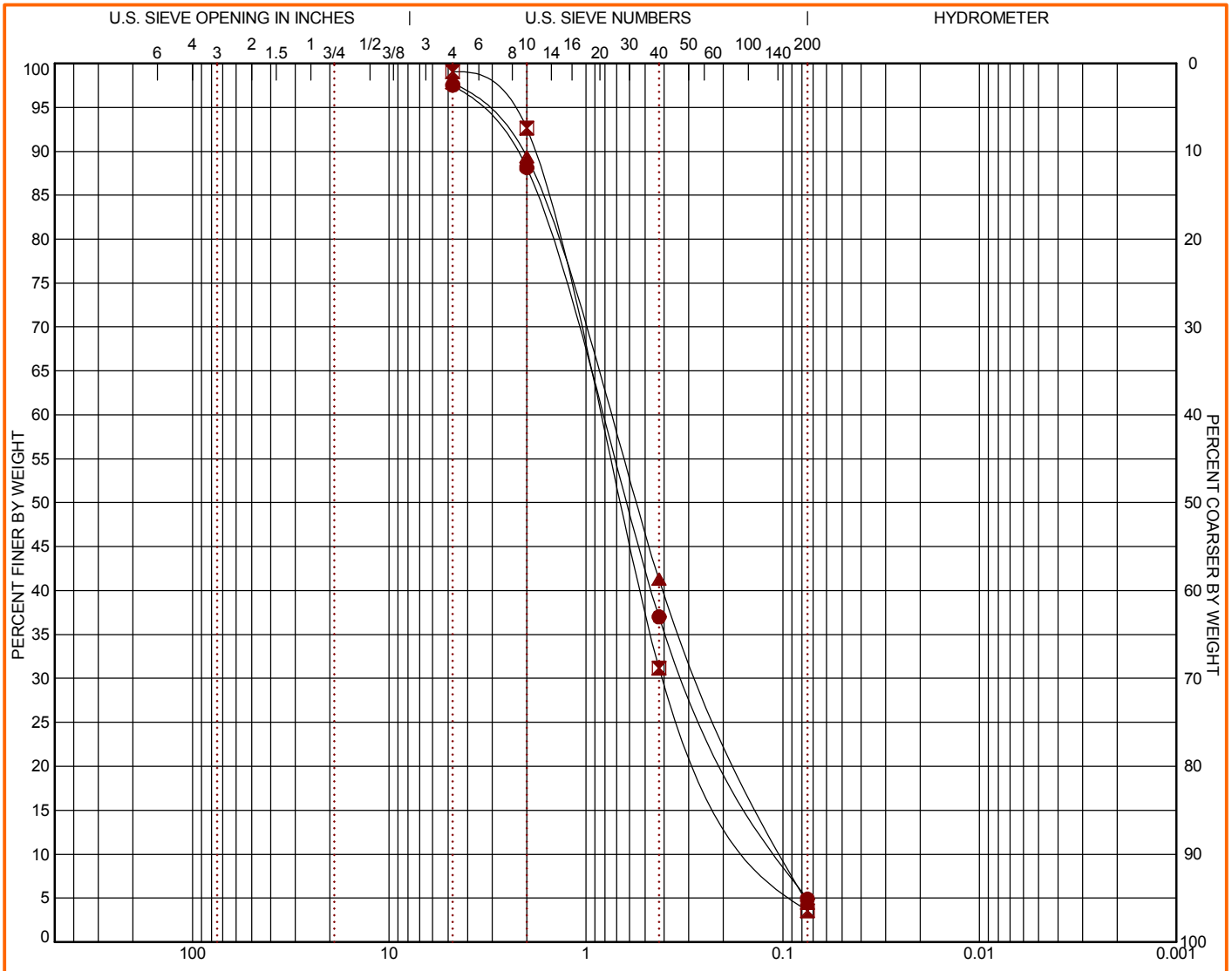
Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/28/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-2	8.5 - 10			92.6		4.9		SW
⊠	B-2	18.5 - 20			95.5		3.6		SW
▲	B-2	23.5 - 25			93.4		4.4		SP

GRAIN SIZE	●	⊠	▲
D_{60}	0.853	0.879	0.777
D_{30}	0.291	0.394	0.25
D_{10}	0.099	0.112	0.098

COEFFICIENTS	●	⊠	▲
C_C	1.01	1.58	0.82
C_U	8.63	7.83	7.95

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	97.51	#4	99.07	#4	97.81
#10	88.14	#10	92.61	#10	89.38
#40	37.0	#40	31.19	#40	41.28
#200	4.88	#200	3.58	#200	4.39

SOIL DESCRIPTION	
●	WELL-GRADED SAND (SW)
⊠	WELL-GRADED SAND (SW)
▲	POORLY GRADED SAND (SP)

REMARKS	
●	
⊠	
▲	

PROJECT: Southside WWTP Sewer Crossing

PROJECT NUMBER: 04195009

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

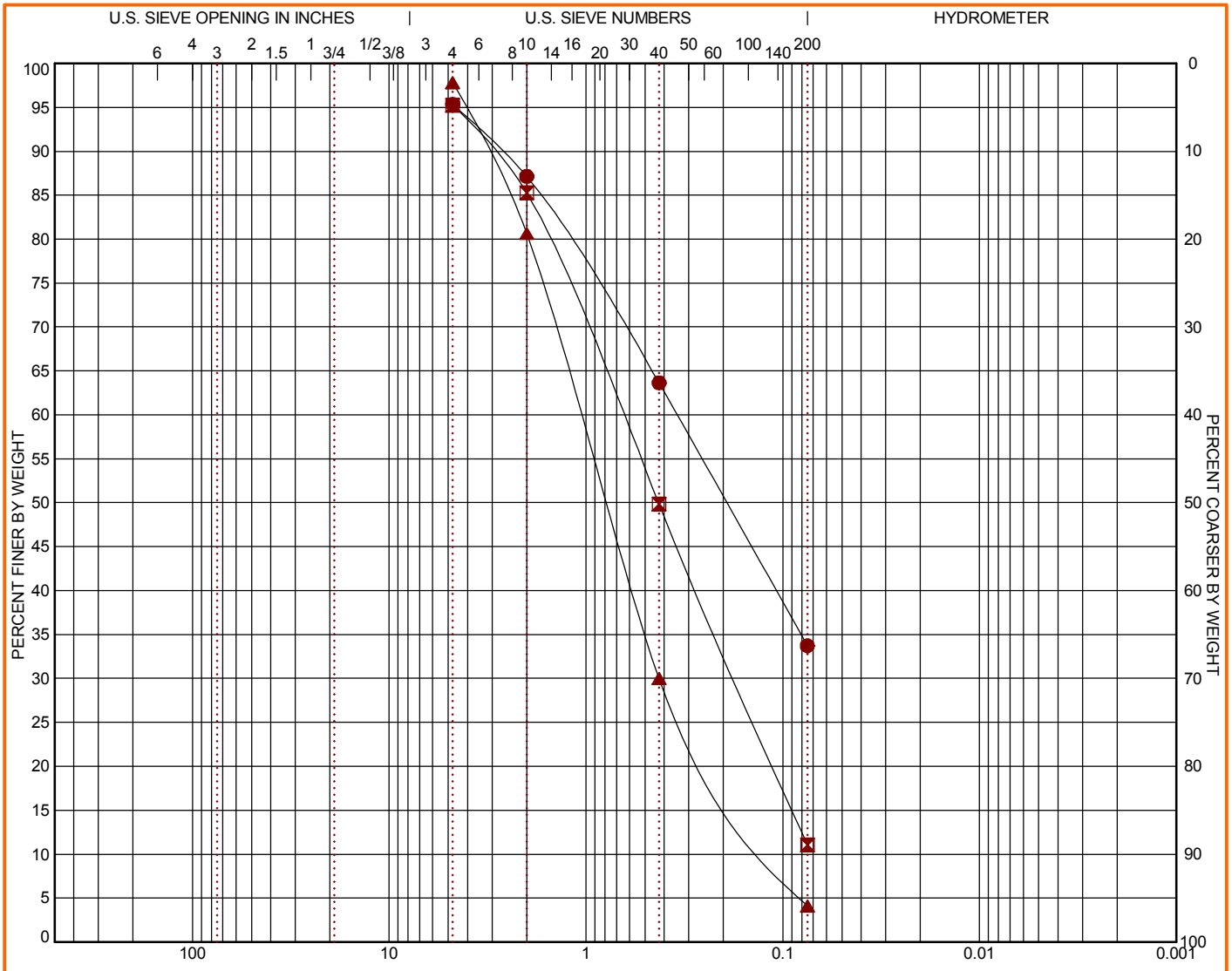
Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/28/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-3	14 - 15.5			61.6		33.7		SC-SM
⊠	B-3	28.5 - 30			84.2		11.1		SP-SM
▲	B-3	33.5 - 35			93.7		4.1		SW

GRAIN SIZE	●	⊠	▲
D_{60}	0.344	0.663	1.064
D_{30}		0.175	0.425
D_{10}			0.111

COEFFICIENTS	●	⊠	▲
C_C		0.65	1.53
C_U		9.27	9.56

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	95.34	#4	95.24	#4	97.82
#10	87.14	#10	85.25	#10	80.63
#40	63.65	#40	49.84	#40	29.99
#200	33.71	#200	11.07	#200	4.12

SOIL DESCRIPTION	
●	SILTY, CLAYEY SAND (SC-SM)
⊠	POORLY GRADED SAND with SILT (SP-SM)
▲	WELL-GRADED SAND (SW)

REMARKS	
●	
⊠	
▲	

PROJECT: Southside WWTP Sewer Crossing

PROJECT NUMBER: 04195009

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

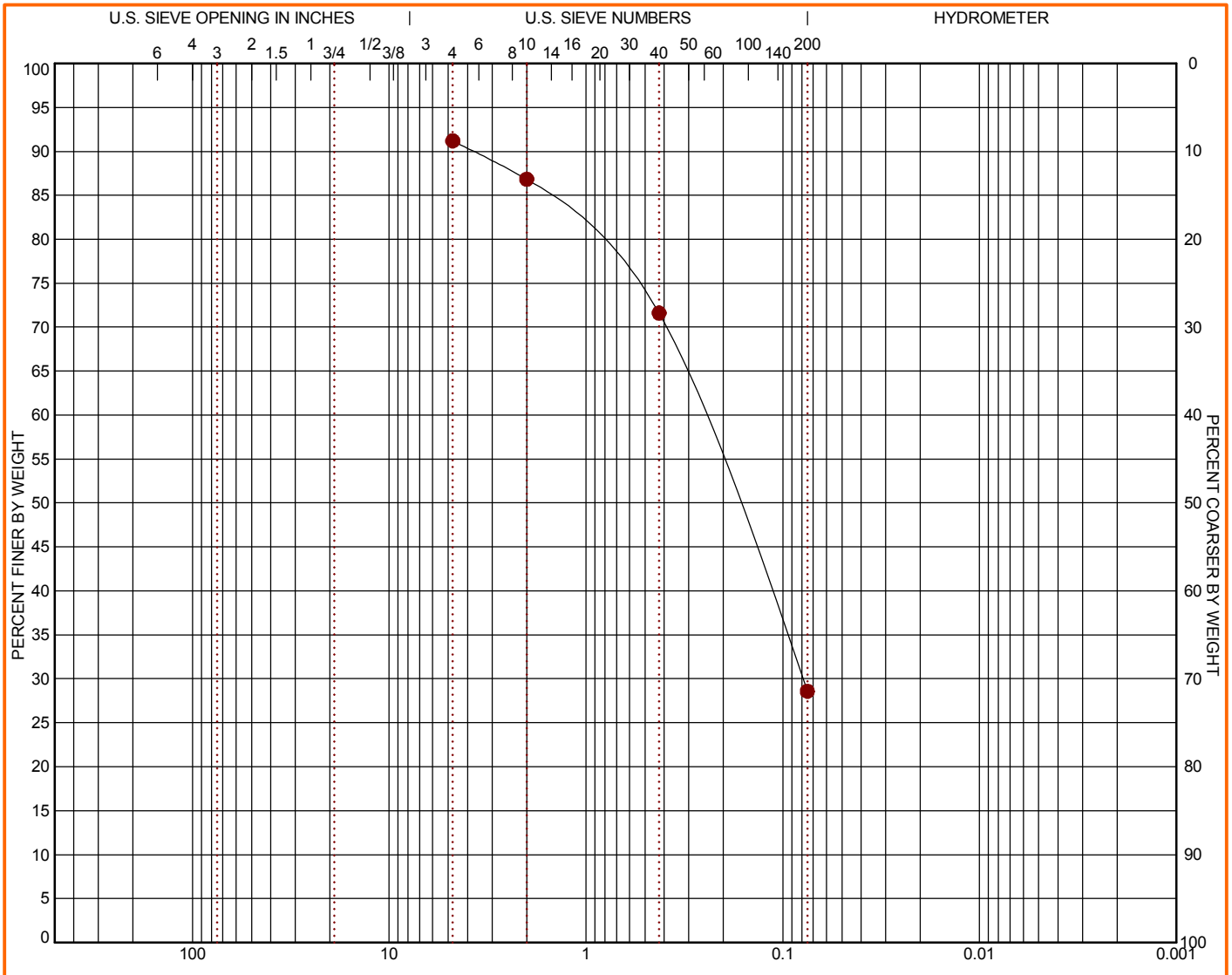
Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/28/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-4	13.5 - 15			62.6		28.6		SM

GRAIN SIZE			
	●		
D_{60}	0.266		
D_{30}	0.079		
D_{10}			

COEFFICIENTS			
	●		
C_C			
C_U			

●					
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	91.19				
#10	86.83				
#40	71.6				
#200	28.58				

SOIL DESCRIPTION
● SILTY SAND (SM)

REMARKS
●

PROJECT: Southside WWTP Sewer Crossing

PROJECT NUMBER: 04195009

SITE: 5300 S Elwood Avenue
Tulsa, Oklahoma

Terracon
9522 E 47th Pl, Ste D
Tulsa, OK

CLIENT: Greeley and Hansen, LLC
Chicago, Illinois

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 04195009 SOUTHSIDE WWTP AR.GPJ TERRACON_DATATEMPLATE.GDT 02/28/20

SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS
ASTM D4644

SOUTHSIDE WWTP ARKANSAS RIVER CROSSING
04195009

B-1
R3
36.4' - 37.4'
SHALE, GRAY

4.0	NATURAL MOISTURE CONTENT, %
1214.0	MASS OF DRUM, grams
1734.6	MASS OF DRUM PLUS OVEN-DRIED SPECIMEN BEFORE THE FIRST CYCLE, grams
1709.9	MASS OF DRUM PLUS OVEN-DRIED SPECIMEN RETAINED AFTER THE SECOND CYCLE, grams
70 Before / 70 After	WATER TEMPERATURE OF FIRST CYCLE, deg F
70 / 70	WATER TEMPERATURE OF SECOND CYCLE, deg F
70	AVERAGE WATER TEMPERATURE, deg F
TYPE 2	DESCRIPTION OF THE APPEARANCE OF THE FRAGMENTS RETAINED IN THE DRUM TYPE 1 - UNCHANGED; TYPE 2 - LARGE AND SMALL FRAGMENTS; TYPE 3 - ALL SMALL FRAGMENTS
95.3	**SLAKE DURABILTY INDEX**



OVEN-DRIED BEFORE FIRST CYCLE



OVEN-DRIED AFTER SECOND CYCLE

Terracon

SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS
ASTM D4644

SOUTHSIDE WWTP ARKANSAS RIVER CROSSING
04195009

B-2
R3
36.0' - 36.9'
SHALE, DARK GRAY

6.1	NATURAL MOISTURE CONTENT, %
1214.5	MASS OF DRUM, grams
1709.3	MASS OF DRUM PLUS OVEN-DRIED SPECIMEN BEFORE THE FIRST CYCLE, grams
1692.3	MASS OF DRUM PLUS OVEN-DRIED SPECIMEN RETAINED AFTER THE SECOND CYCLE, grams
70 Before / 69 After	WATER TEMPERATURE OF FIRST CYCLE, deg F
70 / 70	WATER TEMPERATURE OF SECOND CYCLE, deg F
70	AVERAGE WATER TEMPERATURE, deg F
TYPE 2	DESCRIPTION OF THE APPEARANCE OF THE FRAGMENTS RETAINED IN THE DRUM TYPE 1 - UNCHANGED; TYPE 2 - LARGE AND SMALL FRAGMENTS; TYPE 3 - ALL SMALL FRAGMENTS
96.6	**SLAKE DURABILTY INDEX**



OVEN-DRIED BEFORE FIRST CYCLE



OVEN-DRIED AFTER SECOND CYCLE

Terracon

SLAKE DURABILITY OF SHALES AND SIMILAR WEAK ROCKS
ASTM D4644

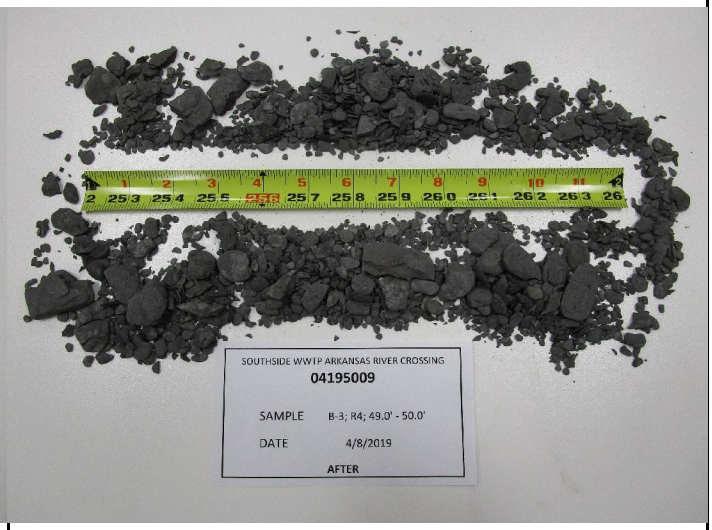
SOUTHSIDE WWTP ARKANSAS RIVER CROSSING
04195009

B-3
R4
49.0' - 50.0'
SHALE, VERY DARK GRAY

8.7	NATURAL MOISTURE CONTENT, %
1214.0	MASS OF DRUM, grams
1719.8	MASS OF DRUM PLUS OVEN-DRIED SPECIMEN BEFORE THE FIRST CYCLE, grams
1413.8	MASS OF DRUM PLUS OVEN-DRIED SPECIMEN RETAINED AFTER THE SECOND CYCLE, grams
71 Before / 71 After	WATER TEMPERATURE OF FIRST CYCLE, deg F
69 / 69	WATER TEMPERATURE OF SECOND CYCLE, deg F
70	AVERAGE WATER TEMPERATURE, deg F
TYPE 3	DESCRIPTION OF THE APPEARANCE OF THE FRAGMENTS RETAINED IN THE DRUM TYPE 1 - UNCHANGED; TYPE 2 - LARGE AND SMALL FRAGMENTS; TYPE 3 - ALL SMALL FRAGMENTS
39.5	**SLAKE DURABILTY INDEX**



OVEN-DRIED BEFORE FIRST CYCLE



OVEN-DRIED AFTER SECOND CYCLE

Terracon

Results of Thin-section Examination and CERCHAR Abrasivity Testing of Rock Core Samples

Southside WWTP Sewer Crossing
Tulsa, Oklahoma

April 18, 2019
Lab No's. 2120-2122
Terracon Project Number 04195009

Prepared for:
Greeley and Hansen, LLC
Tulsa, Oklahoma

Prepared by:
Terracon Consultants, Inc.
Cincinnati, Ohio

terracon.com

Terracon

Environmental ■ Facilities ■ Geotechnical ■ Materials

Results of Thin-Section Examination and CERCHAR Abrasivity Testing Of Rock Cores Southside WWTP Sewer Crossing Tulsa, Oklahoma

1.0 Introduction

Three rock cores samples from the referenced project were obtained by Terracon, Tulsa, Oklahoma personnel and were received at the Terracon, Cincinnati, Ohio materials laboratory on April 1, 2019. The samples were submitted for thin-section examination to determine the presence and estimated quantity of abrasive minerals in each core interval. In addition, portions of each sample were sent to Advanced Terra Testing (ATT), Denver, Colorado for the determination of the CERCHAR Abrasivity Index, a more direct indication of the potential for drill bit abrasion during drilling operations.

The received core samples were identified as B-1 (sample R3, 37.4' to 38.3'), B-2 (sample R3, 37.6' to 38.3') and B-3 (sample R2, 42.4' to 43.2'). These samples were assigned Terracon Lab No's. 2120 through 2122, respectively.

Photographs of the as-received samples and thin-section photomicrographs are presented in Appendix A. CERCHAR Abrasivity Index test results are presented in Appendix B.

2.0 Procedure

The samples were visually examined and photographed as received. Complete petrographic examinations of the rock cores in accordance with ASTM C 295 were not performed. Portions of each core (3-inch length normal to observed bedding) were selected for preparation and examination of 30-micron thick thin-sections by polarized light microscopy. Additional portions of each sample (a minimum of 2-inch length) were selected for CERCHAR Abrasivity Index testing.

3.1 Texture and Mineralogy

Abrasive minerals are typically those which exhibit a Moh's hardness of 5 or above, and commonly include quartz, feldspar and metallic minerals.

Thin-section examination by polarized light microscopy showed the presence of abundant quartz sand in sample B-1. The quartz occurred primarily as discrete layers of hard angular particles. The quartz also occurred as discrete mineral grains within the organic-rich clay layers shown in the photomicrographs. Total quartz content was estimated at 40%.

Sample B-2 also contained significant quartz, but the quartz grains tended to be much finer (silt-sized) finer and more uniformly distributed. Quartz content was estimated at 60%. Core B-3 was comprised primarily of clay and mica, with approximately 5% quartz, which occurred as discrete grains rather than as layers. Occasional discontinuous lenses of quartz were observed.

3.0 CERCHAR Abrasivity Index

The CERCHAR Abrasiveness Index was determined by ATT in accordance with ASTM D 7625. ATT's report is presented in Appendix B. Results indicated abrasivity values of approximately 1.0 to put this in perspective, values for well-cemented quartzite would typically range from about 5.0 to 5.5. The current obtained values indicate rocks of relatively low abrasivity

4.0 Findings / Conclusions

Each of the samples contained variable amounts of abrasive materials in the form of quartz. However, the quartz occurred predominantly as fine quartz sand to quartz silt, and none of the samples were well cemented. This is consistent with the relatively low CERCHAR Abrasivity Index values

Based on the low permeability of the rock, the observed lack of sulfide minerals, clays or organic materials, the lack of visual fractures or microfracturing, and the isolated porosity, Terracon concludes that material conditions conducive to the occurrence of rusting or staining are not present in the sample.

We trust this information meets your current needs. Please feel free to contact the undersigned should you have any questions.

Sincerely,
Terracon Consultants, Inc.

Terry E. Stransky, P.G.
Senior Geologist / Manager Petrographic Services
(513) 612-9081

George Sanders.
Laboratory Supervisor
513-612-9071

APPENDIX A

PHOTOGRAPHS
AND
PHOTOMICROGRAPHS



Photo 1: Core B-1, 37.4' to 38.3' (Lab No. 2120), as received.



Photo 2: Core B-2, 37.6' to 38.3' (Lab No. 2121), as received.



Photo 3: Core B-3, 42.4' to 43.2' (Lab No. 2122), as received.

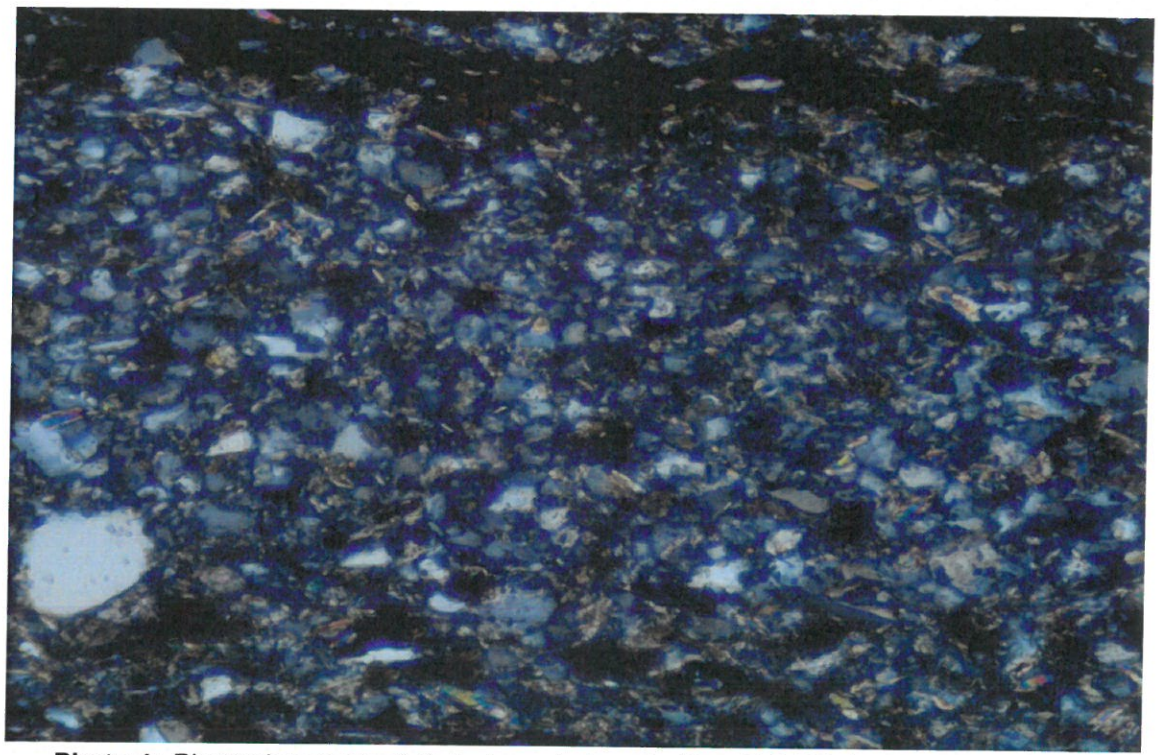


Photo 4: Photomicrograph of distinct quartz layer in Core B-1. Bright particles are mica.

100 x magnification, crossed polars.

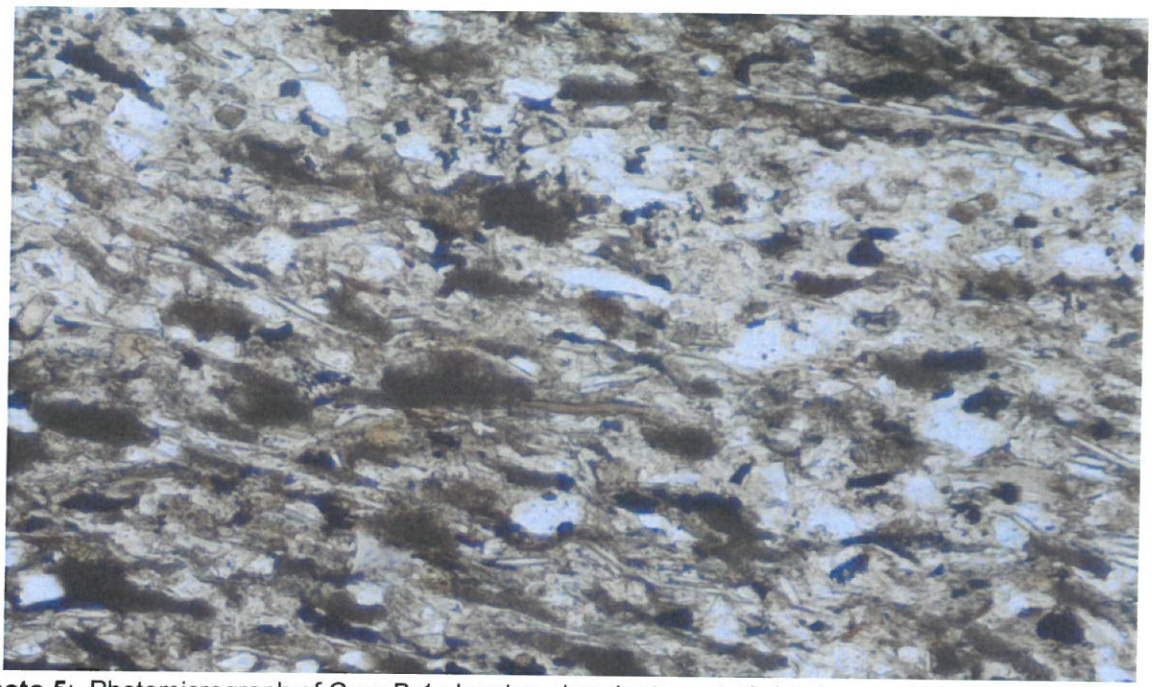


Photo 5: Photomicrograph of Core B-1 showing abundant quartz (white), organic matter (dark brown) and oriented (brown to colorless elongated particles) mica flakes. 100 x magnification, plane polarized light.

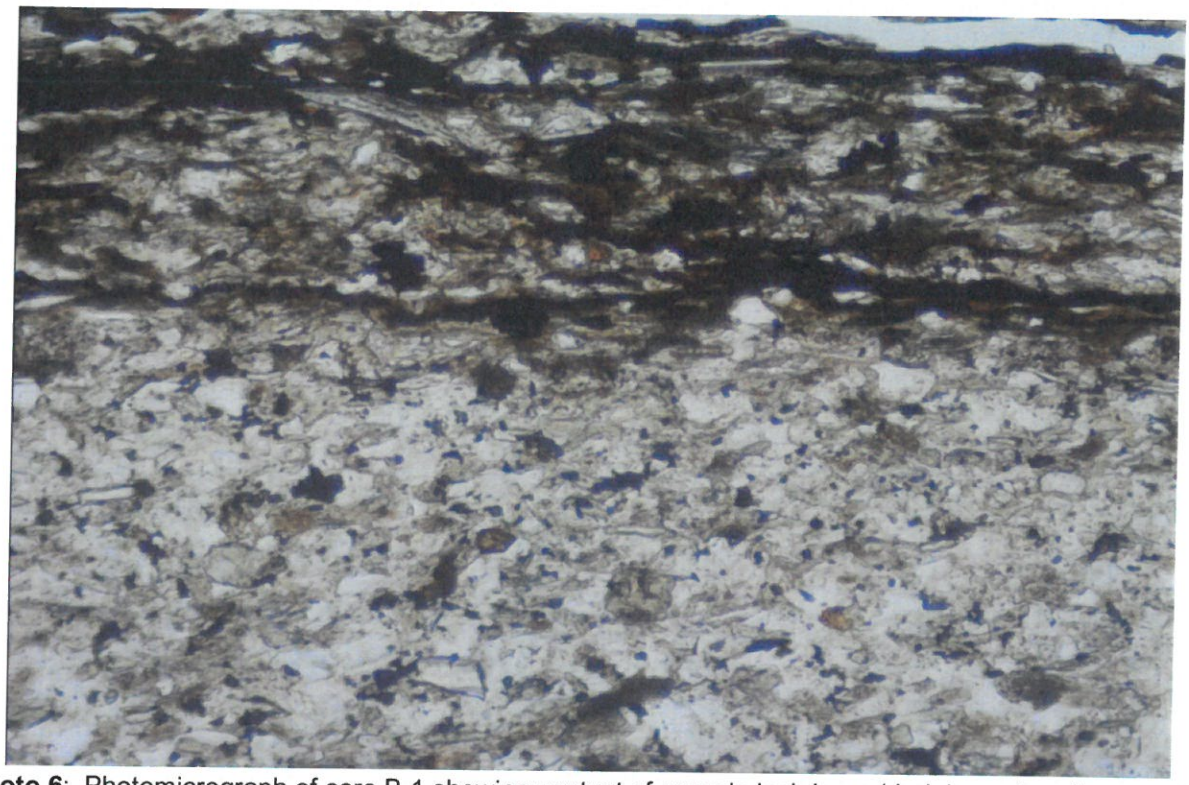


Photo 6: Photomicrograph of core B-1 showing contact of organic-inch layer (dark brown) and quartz rich layer. 100 x magnification, plane polarized light.

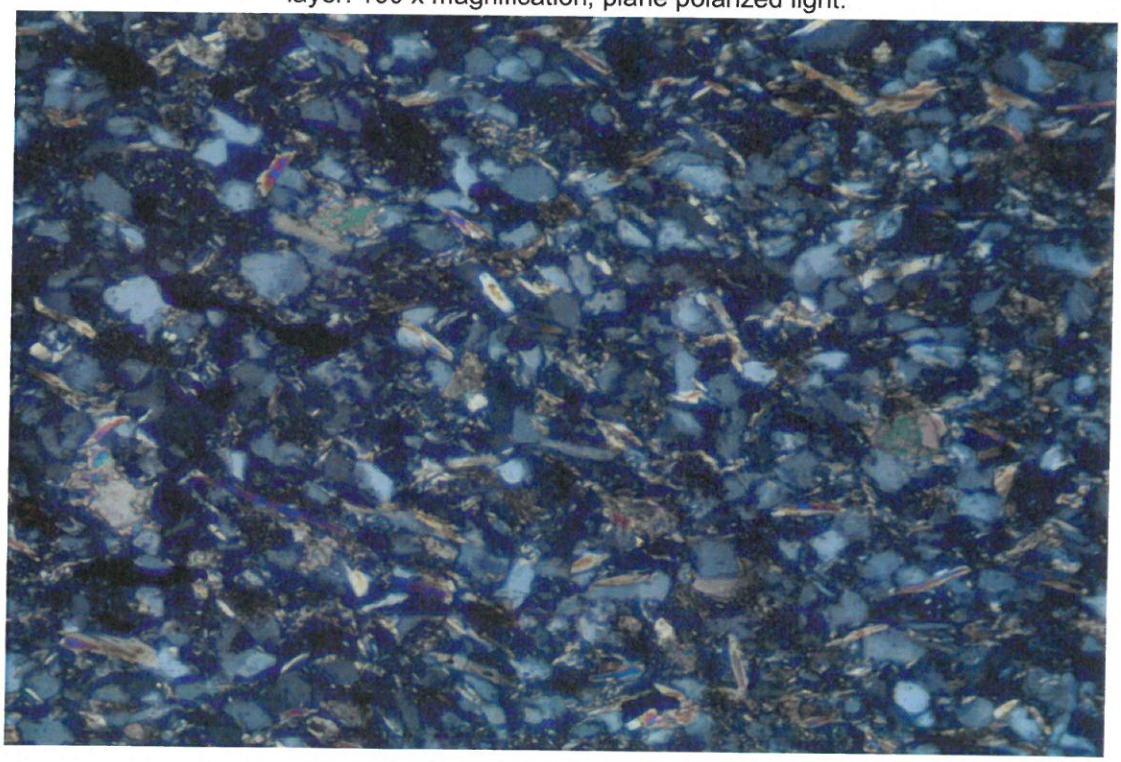


Photo 7: Photomicrograph of Core B-2 showing typical matrix of predominant quartz and mica (bright colored particles). 200 x magnification, crossed polars.

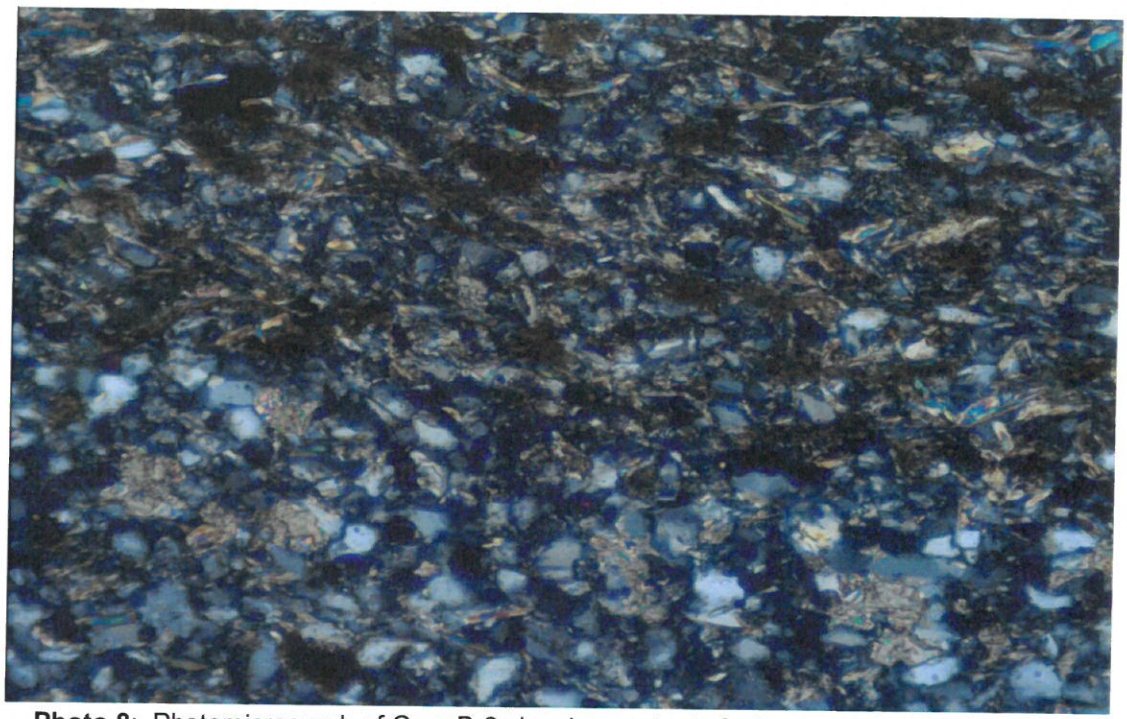


Photo 8: Photomicrograph of Core B-2 showing contact of micaceous, organic-rich layer (dark brown "clots") layer and quartzose layer. 200 x magnification, crossed polars.

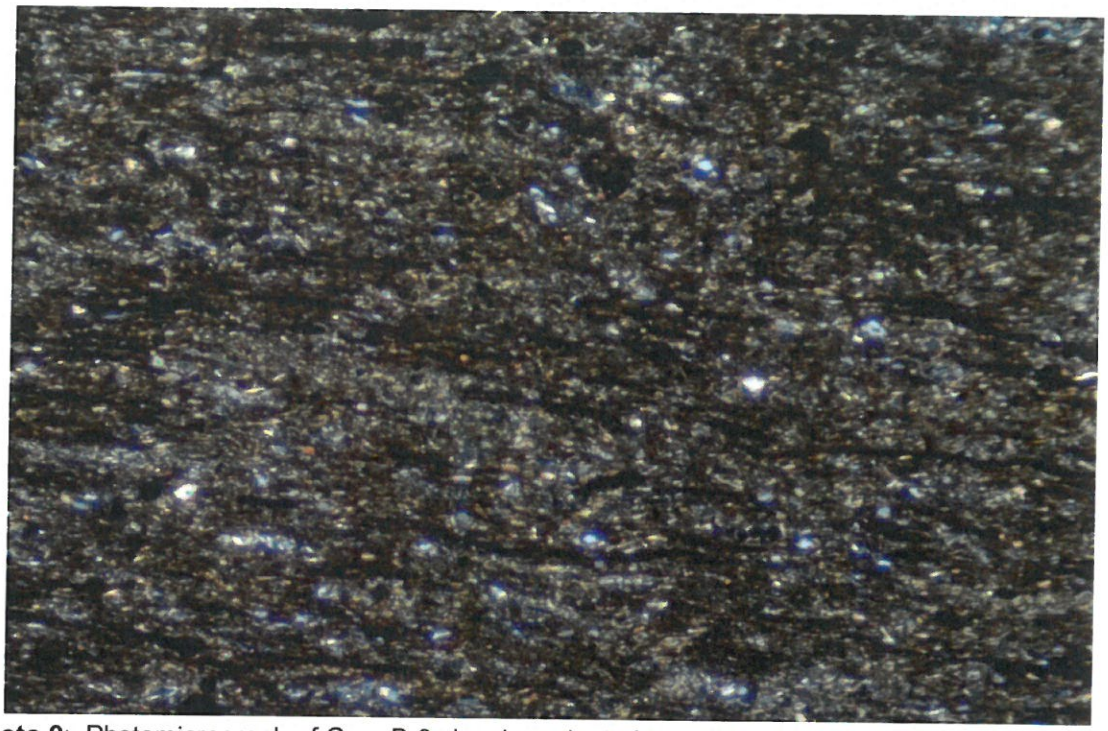


Photo 9: Photomicrograph of Core B-3 showing oriented organic material (dark brown), and minor quartz. 200 x magnification, crossed polars.

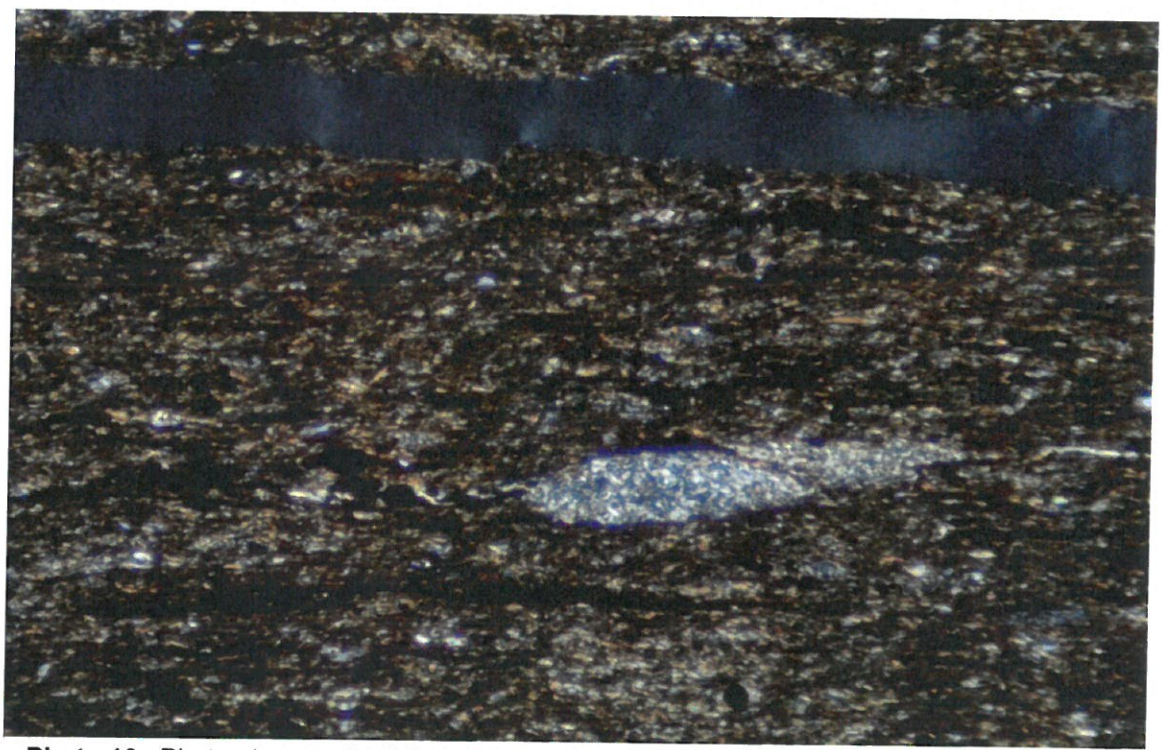


Photo 10: Photomicrograph of Core B-3 showing quartz lenses in typical organic-rich matrix.

Terracon

APPENDIX B

CERCHAR Abrasivity Index

Date: 4/17/2019

Southside Sewer Crossing, CERCHAR Abrasivity Index test

ASTM D7625

Introduction

The choice of an economic rock crushing methodology or oil drilling machinery, it is a challenging task for any project. The major factors for any excavations in any rock formations, are determination of different type of strengths (Uniaxial, Triaxial, Shear...) and also very important index of abrasivity. The CERCHAR Abrasiveness Index (CAI) has reported as one of the most common methods for laboratory measurement of hard rock abrasivity worldwide. The CERCHAR test and associated CAI were developed at a time of more demand for application of mechanical excavation machines at the Laboratoire du Center d' Études et Recherches des Charbonnages de France (CERCHAR). The test method covers the determination of the abrasiveness of rock by the CERCHAR Abrasiveness Index (CAI) method. It consist of measuring the wear on the tip of a steel stylus with a sharpened profile at one end to a conical angle of 90E, and 1 mm in length and known Rockwell Hardness (HRC 54-56), caused by scratching against a freshly broken or saw cut specimen parallel to its surface for a prescribed distance of 10 mm using CERCHAR test apparatus, presented at Fig 1.

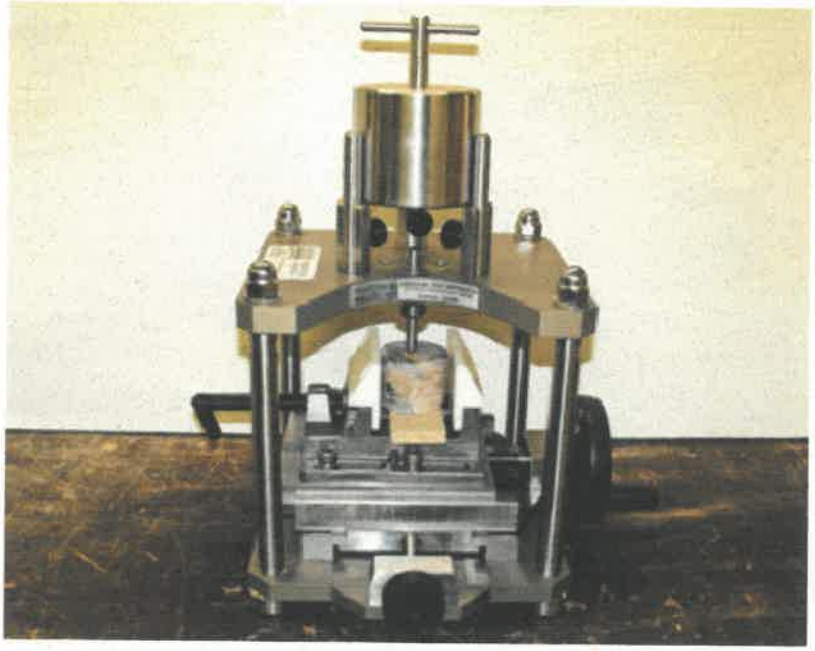


Fig. 1.- Advanced Terra Testing, Inc. CERCHAR Machine

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

Test Procedures

For Southside Sewer Crossing project three received samples were tested one by one under ASTM D 7625 recommended procedures. The rock specimen's Saw cut surface was fixed in a special vise. The hand crank is turned at a rate consistent with the number of threads on the screw-feed for moving the specimen surface under the stylus with a scratching speed of approximately 1 mm/s under total constant load of 70 Newton. Scratching of pin on surface of each sample were repeated for a total of five pins, three pins in one direction, and two more in perpendicular direction (if there were not any preferences, e.g. different color, bedding, foliation, …).

For each specimen, pictures of all pins tip were taken by special camera, reviewed by appropriate software and two perpendicular diameters of the resulting wear flat of each pin's tip were recorded. Prior to testing coating of each pin tip with machinist's blue dye makes the wear flat more visible.

As per attached summary sheet test results, which were normalized for rough surface, the highest CERCHAR index was measured **1.04** for specimen **B-2**. Advanced Terra Testing, Inc. is pleased having opportunity working with Terracon on this project and look forward to a continued partnership with them on future projects.

Sincerely,

Hamid Nazeri

Dr. Hamid Nazeri, RME
Rock Mechanics Division Manager
Advanced Terra Testing, Inc.
Suite A, 833 Parfet St., Lakewood
Colorado 80215 USA

ADVANCED TERRA TESTING

CERCHAR Abrasiveness
ASTM D7625

CLIENT	Terracon	JOB NO.	2261-202
PROJECT	Southside Sewer Crossing	LOCATION	Cincinnati, OH
PROJECT NO.	4195009		

BORING NO.	B-1	B-2	B-3
DEPTH			
SAMPLE NO.			
DATE SAMPLED			
DATE TESTED	04/14/19	04/14/19	04/14/19
TECHNICIAN	HN	HN	HN
ROCK TYPE			
Surface Type:	Saw Cut	Saw Cut	Saw Cut
Moisture Condition	As Received	As Received	As Received
Reading A.1 (in):	0.00273	0.00312	0.00221
Reading A.2 (in):	0.00195	0.00247	0.00169
Reading A.3 (in):	0.00129	0.00208	0.00247
Reading A.4 (in):	0.00299	0.00156	0.00182
Reading A.5 (in):	0.00143	0.00182	0.00273
Reading B.1 (in):	0.00169	0.00208	0.00169
Reading B.2 (in):	0.00286	0.00247	0.00182
Reading B.3 (in):	0.00169	0.00208	0.00169
Reading B.4 (in):	0.00364	0.00190	0.00221
Reading B.5 (in):	0.00157	0.00260	0.00221
Average Reading (in):	0.00218	0.00222	0.00205
Average Reading (mm):	0.0555	0.0563	0.0522
Uncorrected CAI or CAI_s:	**0.55**	**0.56**	**0.52**
Corrected CAI:	**1.03**	**1.04**	**1.00**

NOTES

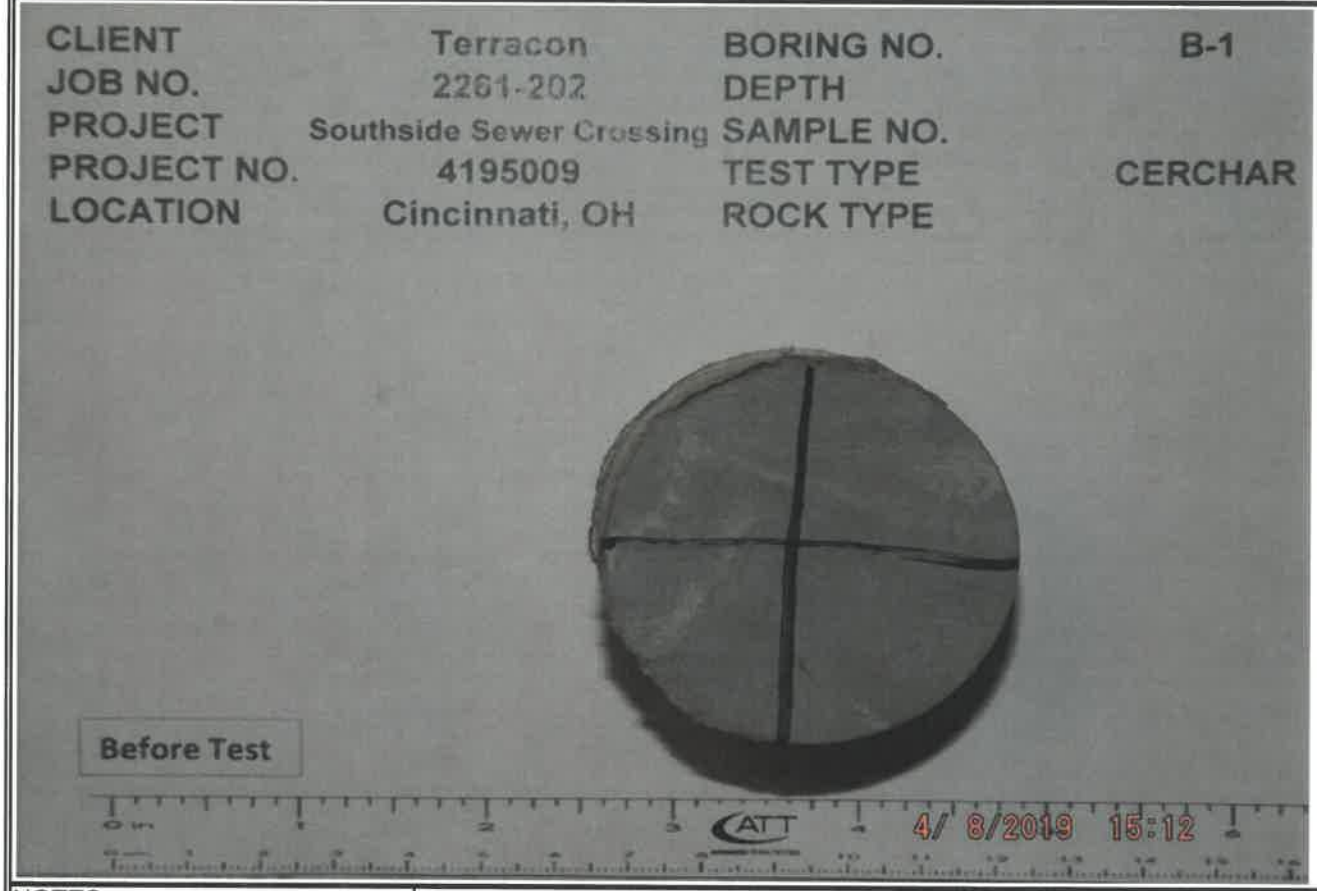
CAI_s is the CAI calculated on saw cut specimens.
Corrected CAI for saw cut specimens based on R. Plinger and H. Kasling
Suggested formula CAI = 0.99*CAIs + 0.48.
Applied pins had a Rockwell Hardness of 54-56.
Pins were grooving in B-1

Data entry by:	HN	Date:	4/16/2019
Checked by:		Date:	4/17/19
File name:	2261202__CHERCHAR ASTM D7625_0.xlsm		

ADVANCED TERRA TESTING

Image Attachment

CLIENT	Terracon	BORING NO.	B-1
JOB NO.	2261-202	DEPTH	
PROJECT	Southside Sewer Crossing	SAMPLE NO.	
PROJECT NO.	4195009	DATE SAMPLED	
LOCATION	Cincinnati, OH	DESCRIPTION	CERCHAR



NOTES

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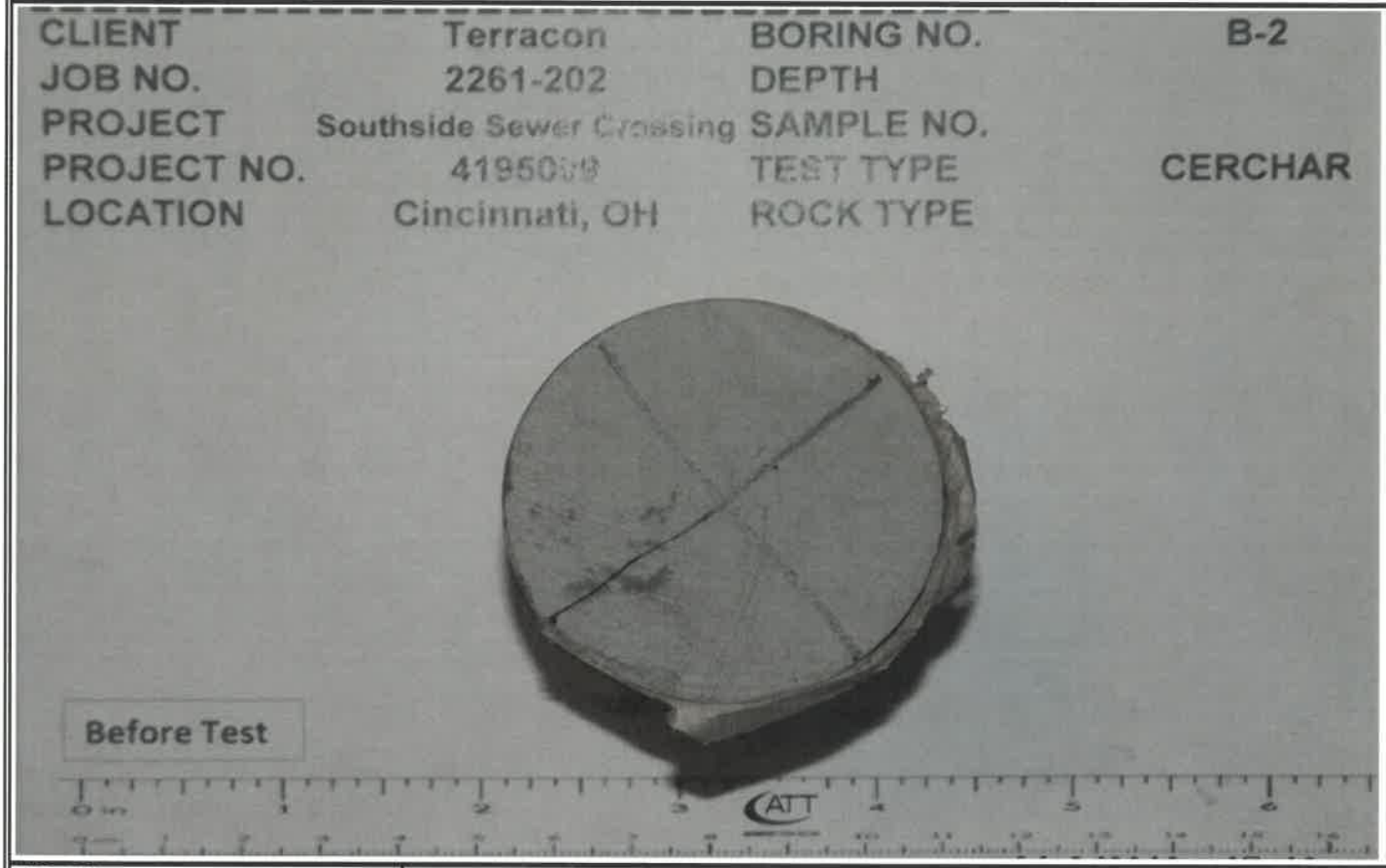
ADVANCED TERRA TESTING

Image Attachment

CLIENT	Terracon	BORING NO.	B-2
JOB NO.	2261-202	DEPTH	
PROJECT	Southside Sewer Crossing	SAMPLE NO.	
PROJECT NO.	4195009	DATE SAMPLED	
LOCATION	Cincinnati, OH	DESCRIPTION	CERCHAR



NOTES

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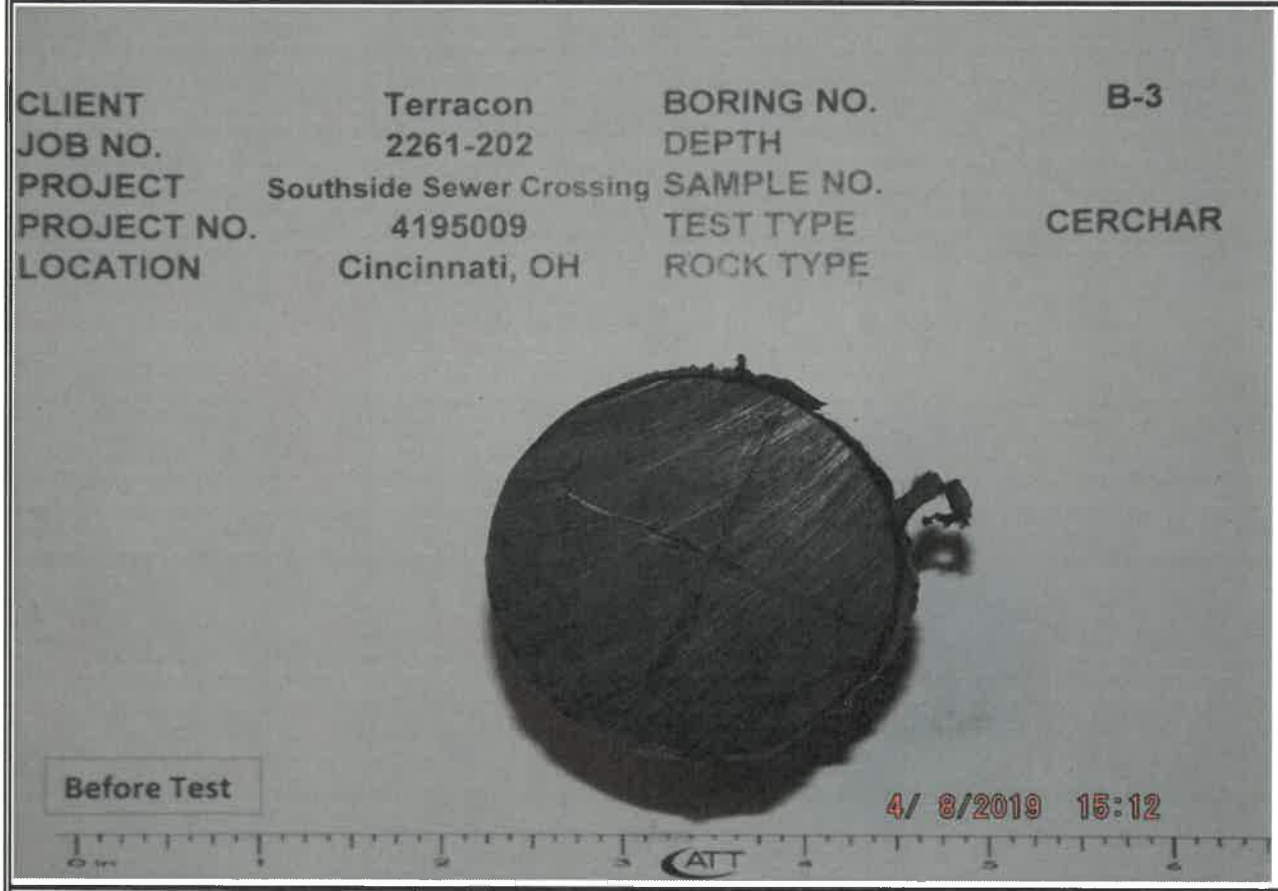
Image Attachment

ADVANCED TERRA TESTING

CLIENT	Terracon	BORING NO.	B-3
JOB NO.	2261-202	DEPTH	
PROJECT	Southside Sewer Crossing	SAMPLE NO.	
PROJECT NO.	4195009	DATE SAMPLED	
LOCATION	Cincinnati, OH	DESCRIPTION	CERCHAR



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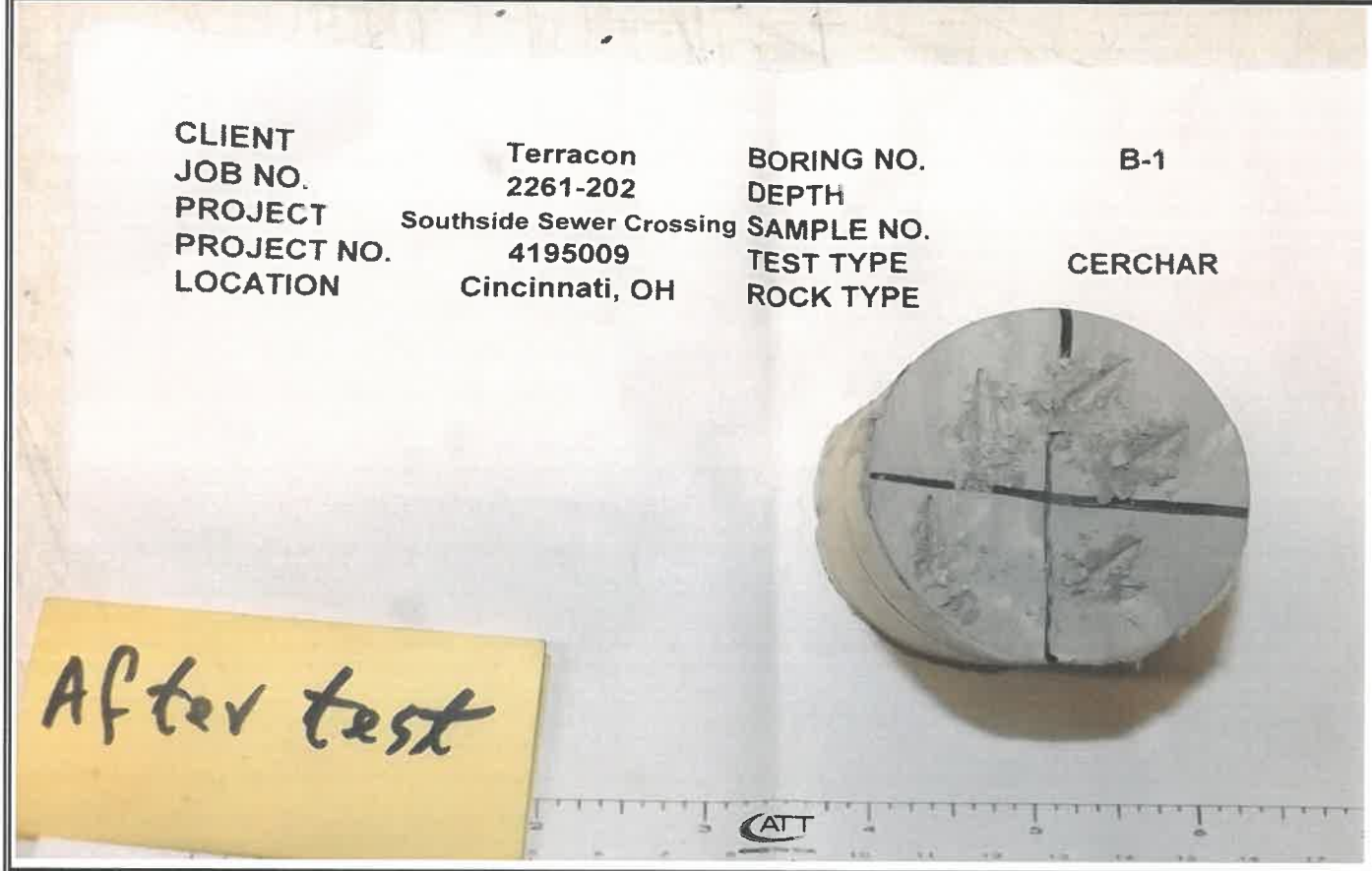
ADVANCED TERRA TESTING

Image Attachment

CLIENT	Terracon	BORING NO.	B-1
JOB NO.	2261-202	DEPTH	
PROJECT	Southside Sewer Crossing	SAMPLE NO.	
PROJECT NO.	4195009	DATE SAMPLED	
LOCATION	Cincinnati, OH	DESCRIPTION	CERCHAR



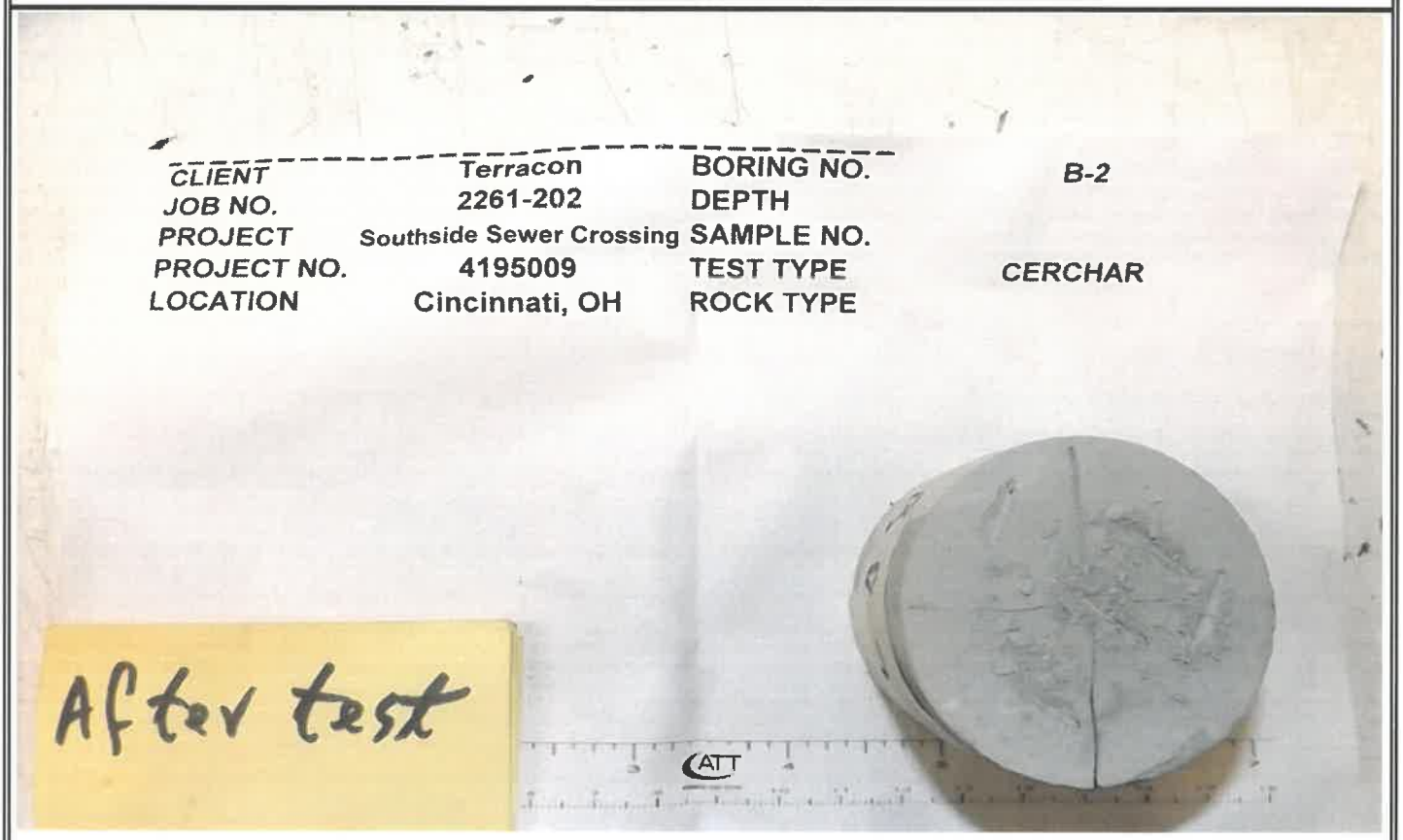
NOTES

File name: 2261202__Image_19_04_16_10_08_42

Image Attachment

ADVANCED TERRA TESTING

CLIENT	Terracon	BORING NO.	B-2
JOB NO.	2261-202	DEPTH	
PROJECT	Southside Sewer Crossing	SAMPLE NO.	
PROJECT NO.	4195009	DATE SAMPLED	
LOCATION	Cincinnati, OH	DESCRIPTION	CERCHAR



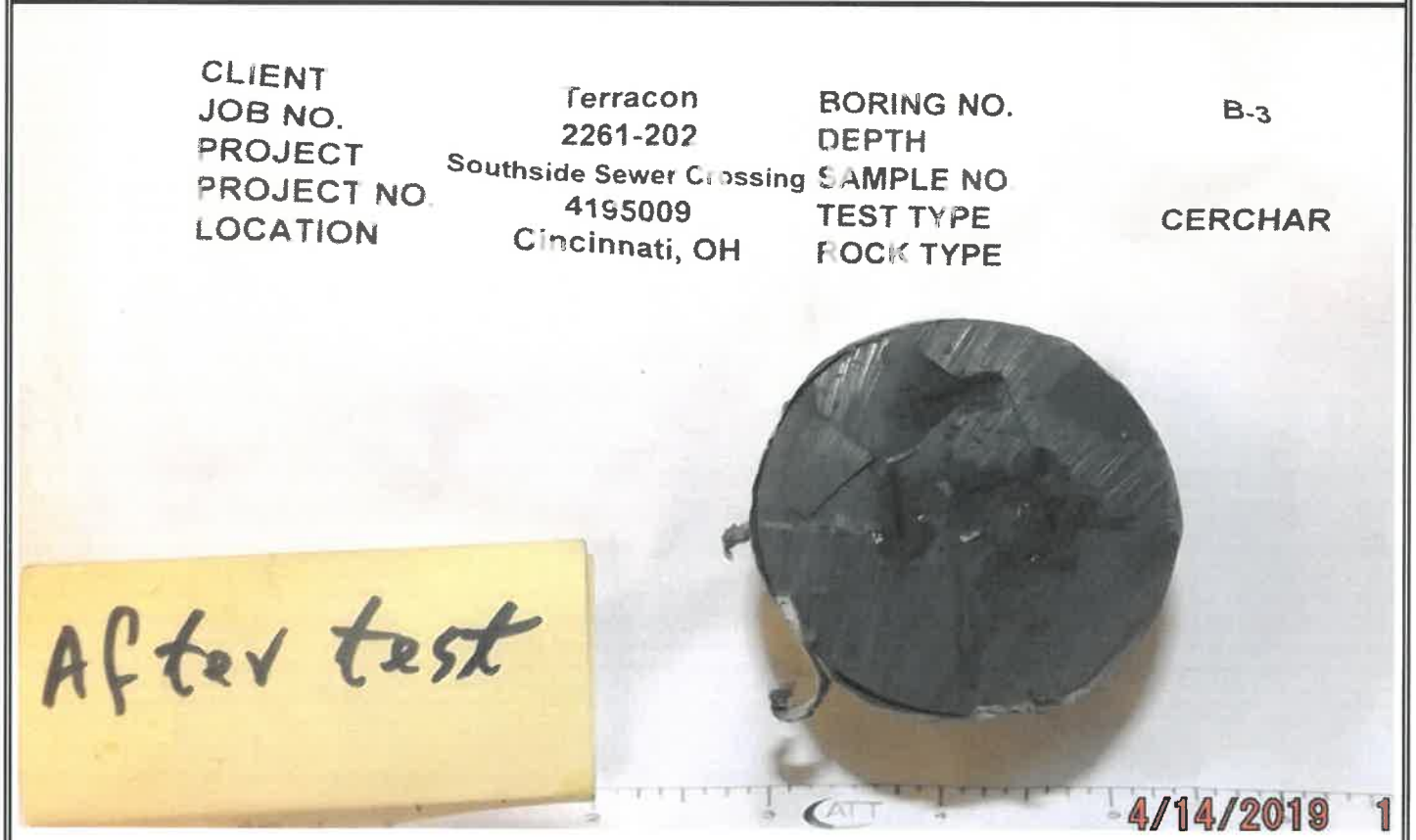
NOTES

File name: 2261202__Image_19_04_16_10_09_19

ADVANCED TERRA TESTING

Image Attachment

CLIENT	Terracon	BORING NO.	B-3
JOB NO.	2261-202	DEPTH	
PROJECT	Southside Sewer Crossing	SAMPLE NO.	
PROJECT NO.	4195009	DATE SAMPLED	
LOCATION	Cincinnati, OH	DESCRIPTION	CERCHAR



NOTES

File name: 2261202__Image_19_04_16_10_10_00

SUPPORTING INFORMATION

Contents:

General Notes
Unified Soil Classification System
General Notes – Sedimentary Rock Classification

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Southside WWTP Sewer Crossing ■ Tulsa, Oklahoma

Terracon Project No. 04195009

Terracon GeoReport

SAMPLING

Rock Core

Shelby Tube

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
UC	**Unconfined Compressive Strength**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psi)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 3.50	0 - 1
Loose	4 - 9	Soft	3.5 to 7.0	2 - 4
Medium Dense	10 - 29	Medium Stiff	7.0 to 14.0	4 - 8
Dense	30 - 50	Stiff	14.0 to 28.0	8 - 15
Very Dense	> 50	Very Stiff	28.0 to 55.5	15 - 30
		Hard	> 55.5	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ³ 4 and 1 £ Cc £ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ³ 6 and 1 £ Cc £ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above “A”		CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above “A” line		CH	Fat clay [K, L, M]
			PI plots below “A” line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ³ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ³ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ³ 30% plus No. 200 predominantly sand, add “sandy” to group name.

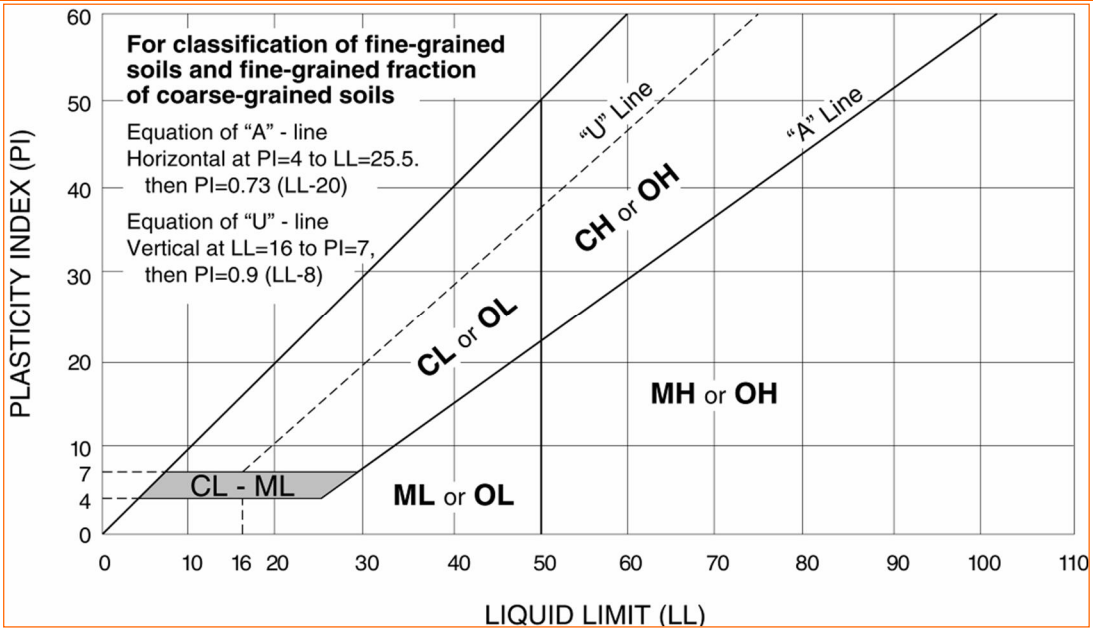
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ³ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.



GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

LIMESTONE	Light to dark colored, crystalline to fine-grained texture, composed of $CaCo_3$, reacts readily with HCl.
DOLOMITE	Light to dark colored, crystalline to fine-grained texture, composed of $CaMg(CO_3)_2$, harder than limestone, reacts with HCl when powdered.
CHERT	Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz ($Si0_2$), brittle, breaks into angular fragments, will scratch glass.
SHALE	Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone.
SANDSTONE	Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.
CONGLOMERATE	Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (½ inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

PHYSICAL PROPERTIES:

DEGREE OF WEATHERING

Slight	Slight decomposition of parent material on joints. May be color change.
Moderate	Some decomposition and color change throughout.
High	Rock highly decomposed, may be extremely broken.

HARDNESS AND DEGREE OF CEMENTATION

Limestone and Dolomite:

Hard	Difficult to scratch with knife.
Moderately Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Soft	Can be scratched with fingernail.

Shale, Siltstone and Claystone

Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be easily dented but not molded with fingers.

Sandstone and Conglomerate

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING AND JOINT CHARACTERISTICS

Bed Thickness	Joint Spacing	Dimensions
Very Thick	Very Wide	>10′
Thick	Wide	3′ - 10′
Medium	Moderately Close	1′ - 3′
Thin	Close	2″ - 1′
Very Thin	Very Close	.4″ - 2″
Laminated	—	.1″ - .4″

Bedding Plane	A plane dividing sedimentary rocks of the same or different lithology.
Joint	Fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.
Seam	Generally applies to bedding plane with an unspecified degree of weathering.

SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy (Pitted)	Rock having small solution pits or cavities up to ½ inch diameter, frequently with a mineral lining.
Porous	Containing numerous voids, pores, or other openings, which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large.

Terracon

SSWWTP Flow Optimization

Third River Crossing and
Influent Lift Station Diversion

Geotechnical Baseline Report
Tunnel Crossing of Arkansas River

Date: April 10, 2020

Prepared by:

McMillen Jacobs Associates
200 South Wacker, Suite 3100
Chicago, IL 60606

For:

Distribution

To:	Mr. Tim Gualandri, PE Greeley and Hansen
From:	Sam Swartz, PE McMillen Jacobs Associates
Prepared By:	Norman Joyal, PE GE McMillen Jacobs Associates
QA/QC By:	Sam Swartz, PE McMillen Jacobs Associates

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1 Introduction

1.1 Background

The Flow Optimization Project has two basic components: 1) various improvements at the Southside Wastewater Treatment Plant (SSWWTP) and 2) a third river crossing of the Arkansas River and associated junction structures on both sides of the river. This Geotechnical Baseline Report (GBR) was prepared specifically for an allowed microtunnel alternative for the third river crossing. The SSWWTP improvements will be contracted separately from the river crossing to expedite the plant improvements for when the river crossing is in place. The following project elements are associated with the third river crossing and diversion facilities:

- River Crossing Between Junction Box 782 and the Influent Lift Station
- East Bank Junction Structure
- West Bank Junction Structure
- Interconnection from the West Bank Junction Structure to the Influent Lift Station
- Diversion Facilities

1.2 Purpose of the Geotechnical Baseline Report

The purpose of this GBR is to:

1. Set geotechnical baselines for ground conditions that contractors are to assume in the preparation of their construction bids.
2. Provide a common basis for bidding.
3. Provide a basis for evaluation and resolution of possible differing site conditions during construction.

This GBR provides baseline ground conditions and interpreted ground behavior. Ground behavior described in the GBR is based on assumptions regarding construction means and methods. If different methods are employed, ground behavior may differ from that described. The Contractor must complete their own independent review and evaluation of the Contract Documents, the GBR and the Geotechnical Engineering Report (GER). The contractor must then consider how their selected means and methods and designs will affect ground behavior and construction of the underground facilities. As provided in the Contract Documents, the Construction team should consult with a qualified geotechnical engineer or engineering geologist to review and evaluate the GBR and its baselines, the GER and other geotechnical information, to inspect boring samples, and to consider the application of the geotechnical information to the Contractor's construction plans.

This GBR is contractually binding and must be read in conjunction with the GER and other Contract Documents. While the GBR is not the exclusive source of geotechnical information, it takes precedence over the GER, as well as and any other geotechnical information, references or interpretations, and it serves as the sole source for interpretation of differing ground conditions. The GBR has been prepared

with input and acceptance from the City of Tulsa, and baselines have been written to meet the City's tolerance of risk.

1.3 Sources of Geotechnical/Geologic Information

Geotechnical information that provides the basis for this GBR project includes the Geotechnical Engineering Report (GER), prepared by Terracon dated February 28, 2020. That report contains Terracon's project specific geotechnical investigations completed for this project. In addition, reference borings and related documents for previous improvements at the SSWWTP have been reviewed and included herein as reference information.

2 Project Description

The project consists of one trenchless drive originating from a jacking shaft in the east bank of the Arkansas River and ending at a receiving shaft in the west bank of the river at the SSWWTP. Existing odor control facilities will be demolished to make room for the new receiving shaft/junction structure excavation. The horizontal alignment is about 1,778 feet from shaft to shaft and the vertical alignment will be set in the underlying shale to provide a minimum of five feet of separation between the rock contact and the crown of the excavated tunnel placing the tunnel between 5 and 9 feet into the shale rock. To accommodate this minimum cover, the jacking shaft on the east riverbank will need to be just over 40 feet deep and the receiving shaft on the west riverbank will need to be about 50 feet deep. The tunnel alignment will be on average about 12 feet below the river bottom sediments, with some slight variation in cover along the alignment.

Table 2-3 – Trenchless Reach

Reach No.	Location	Tunnel Depth (bgs)	Approximate Tunnel Cover	Approx. Length (feet)	Design Slope
1	Arkansas River Crossing – 42" FRP Pipe	Approx. 40 to 50 feet at shafts, approx. 12 feet below river	Min. 5' of shale above crown	1,778	-0.002

Shafts are needed for construction of the new junction structures to be constructed at the same elevation as the existing twin 36-inch lines. The junction structure shaft excavations need to extend deeper at the microtunnel alignment to accommodate the deeper alignment in shale rock. The contractor has the option to construct separate microtunnel shafts that are eventually 'consumed by or incorporated into' the excavation needed for construction of the junction structure. The contractor can elect to construct circular or rectangular shafts or a combination of the two within the limits shown in the contract drawings. Site constraints and existing structures limit a circular microtunnel jacking shaft to 20 feet nominal diameter and a circular receiving shaft to 15 feet nominal diameter. The same hinderances and constraints could accommodate an approximate rectangular 20 foot by 30 foot jacking shaft and an approximate 18 foot by 25 foot receiving shaft.

Table 2-4 – Shaft Identification, Slab Depth, and Size

Shaft Locations	Shaft	Approx. Shaft Slab Depth (ft)[(1)]	Size (ft)
East Bank	Jacking	42	Rectangular – 20' x 30' Diameter – 20'
West Bank	Receiving	50	Rectangular – 18' x 25' Diameter – 15'

[(1)] Top of slab depth is assumed to be 2 feet below invert depth of pipe.

3 Sources of Geologic/Geotechnical Information

Information contained in this GBR is an interpretation of data presented in the site-specific geotechnical investigation prepared by Terracon (2019), from reference borings completed on the SSWWTP property by Terracon (2004 and 2009), and for the I-44 bridge about 1,500 feet north of the crossing. The GBR draws information from various sources, including:

1. Data compiled from a subsurface geotechnical exploration program conducted by Terracon (2019). The exploration program included two borings (B-1 and B-2) south and north of Junction Box 782, as shown in Figure 1, and borings B-3 and B-4 located about 40 and 80 feet north of the new junction structure on the plant property as shown in Figure 1a. The boring depths ranged from 64 to 69 feet below ground surface in borings B-1, B-2 and B-3. Boring B-4 was terminated on a surmised boulder at 18.5 feet. Shale bedrock was denoted as being encountered at Elevations 598.5 and 597 in borings B-1 and B-2, respectively, and at El 593.5 in boring B-3. The following summarizes the groundwater conditions reported during drilling:

Table 3-2 – Groundwater Depth at Time of Drilling

Groundwater	B-1	B-2	B-3	B-4[3]
DD[1]	El. 605/ 20 feet bgs	El. 603/ 22 feet bgs	El. 601/ 29 feet bgs	-
AD[2]	Not Measured	Not Measured	Not Measured	-

[1] – DD – During Drilling
[2] – AD - After Drilling
[3] - Boring never reached bedrock. Advance impeded by surmised boulder around 18 feet bgs.
Bgs – Below Ground Surface

2. Reference geotechnical borings completed by Terracon for prior investigations at the plant for miscellaneous improvements (2004) and for a rehabilitation project (2009). The 2004 explorations consisted of 5 borings (B-1 through B-5) three of which were drilled to depths between 30 and 44 feet and terminated in shale and two of which were terminated at about 5 and 17 feet on inferred obstructions. The 2009 explorations consisted of 3 borings (B-1 through B-3) which were drilled to depths between 15 feet and about 44 feet. Shale was denoted as being encountered at Elevations 598 and 596 in B-1 and B-2, respectively, whereas boring B-3 was terminated in the upper soils. Geotechnical boring logs for the 2004 and 2009 Terracon investigations are presented in Appendix A. Table 3-2 below summarizes groundwater levels during and after drilling for those investigations.

Table 3-2 – Reference Boring Groundwater Depth

Drilled Jan 2004	Below Ground Surface
B-1	None DD, 27 feet 8 days later
B-2	24 feet DD, 13.5 feet 8 days later
B-3, 3a	Borings terminated at 5 and 17 feet on obstruction DD
B-4	29.5 DD, none 5 days later
B-5	27.5 DD, 18.5 feet 5 days later
Drilled Jan 2009	**Below Ground Surface**
B-1	29 feet DD, 25 feet 3 days later
B-2	24 feet, 26 feet 3 days later
B-3	None DD, 12 feet 3 days later

[1] – DD – During Drilling

3. The Oklahoma Department of Transportation (ODOT) provided drawing sheets for the I-44 bridge upgrade which is about 1,500 feet north of the SSWWTP crossing. A total of 17 borings were denoted on the plan sheets. The top of shale bedrock was reportedly encountered between Elevations 597 and 602 with an average top of rock Elevation of 598 feet.

4 Geologic Setting and Site Conditions

4.1 Geologic Setting

Geology of the general area is described in the Geologic Map of Oklahoma (2012) as being within the floodplain of the Arkansas River with the immediate area underlain by geologically recent alluvial deposits consisting of mixtures of sand, silt, clay and gravel with a wide variability in the percentages of constituent materials. The surface alluvial materials are underlain by bedrock of the Pennsylvanian Age consisting primarily of shale with some thin-bedded sandstone and limestone. The sandstones are generally described as hard to soft, thin-bedded, and brown in color. The shale is primarily clayey except that it is silty to sandy in the upper portions of the unit. More detailed descriptions of the bedrock are provided in the GER.

4.2 Site Surface Conditions

4.2.1 East Side River

The river crossing will be constructed from the east river bank towards the west river bank immediately adjacent to the existing twin 36-inch lines. Except for the existing facilities just beyond the bank crest, the east river bank is in its natural condition with a relatively steep and eroded embankment down to the river's edge.

4.2.2 West Side of River

The west side of the river is the SSWWTP and it was developed on land reclaimed from the west side of the river. The recent investigations coupled with information from historical borings at the site (Terracon 2004 and 2009) reveal that the east side of the treatment plant property was developed by placing fill some of which contained rubble as revealed in prior foundation excavation project reports for some of the existing structures and geotechnical borings reporting encounters with cobbles and boulders which are thought to have impeded borings. Unlike the undeveloped bank on the east side, the bank on the west side has an evenly graded approximate 2:1 (H:V) slope down to river's edge armored with a rock revetment along the plant property fronting the river.

4.3 Geologic Units

4.3.1 Artificial Fill

Artificial fill was identified in all four borings. The artificial fill on the east side of the river is described as silty clay, sandy clay, and clayey gravel. On the west side, the fill is described as clayey sand, silty sand and silty clay. Boring B-4 identifies cobbles and boulders in the last two feet of the 18.5-foot-deep borehole at which point advance was impeded. Past construction on the plant property has reportedly encountered construction debris that impeded pier drilling for some structures.

4.3.2 Alluvial Sand

Alluvial sand deposits are found on both sides of the river below the surface fill. The alluvial material is described as poorly- to well-graded fine to medium sand with variable percentages of the different sized constituent materials. The Terracon investigations (2019) indicate these materials vary from loose to sense with SPT N-Values ranging from 4 to 21 blows per foot (bpf) with an average of 11 bpf. There is a distinct and abrupt change to shale bedrock.

4.3.3 Bedrock

Shale bedrock was encountered in three of the four borings drilled at the crossing. On the east side of the river, the rock was encountered at approximate Elevations 598.5 and 598 in borings B-1 and B-2, respectively. On the west side of the river, the rock was encountered at approximate Elevation 595.5 feet in boring B-3. The shale is described as gray to black with thin interbedded sandstone seams.

Thin section analyses of the rock estimate quartz content at 5 to 60% occurring as discrete layers of hard angular particles or as discrete mineral grains within organic-rich clay layers, with higher quartz contents for shale on the east side of the river (Borings B-1 and B-2). The 60% quartz content estimate corresponds to much finer quartz grains (silt-sized or smaller) in the rock matrix. Abrasivity of the rock is reported on later.

4.4 Groundwater

The site-specific geotechnical borings for the crossing indicate groundwater was encountered at about Elevation 604 to 605 feet on the east side of the river and at about Elevation 603 feet on the west side of the river. Note though that the groundwater level is heavily tied to the water level in the river, and is anticipated to fluctuate considerably with river level.

Permeability of the soil and rock were evaluated separately. For alluvial soils, permeability was estimated from grain size curves retrieved from Borings B-1 to B-3 using correlations proposed by Chapuis (2004).

These correlations rely primarily on D_{10} and void ratio of the soil. Permeabilities of between 5×10^{-3} and 1×10^{-2} cm/s were estimated.

For the shale bedrock, no site specific data was obtained, but permeability is generally low in similar shales. Permeabilities of less than 1×10^{-5} cm/s are anticipated.

Permeabilities for fill, alluvium, and shale bedrock are baselined below.

5 Shaft Considerations

The shafts on this project will provide excavation support for the required tie-ins at the junction structures and for the deeper microtunnel alignment. Tie-ins into the new junction structures occurs at the same elevation as the existing twin 36-inch lines that are set about 3 feet into the shale rock. To maintain five feet of separation between the top of rock and the tunnel crown, that portion of the shaft for the microtunnel alignment needs to be deeper. As discussed above, the contractor has the option to construct microtunnel shafts separately from the shafts required for the tie-in work or he can construct the larger shaft needed for the tie-in work with a deeper extension for the microtunnel alignment.

5.1 Shaft Support System

Selecting a support of excavation system must take into consideration the groundwater conditions at the shaft locations. As discussed above, the static groundwater was found to be around Elevation 603 to 605 feet at the time of drilling. However, water levels in the shafts are anticipated to fluctuate with the level of the river, which can be as high as approximately Elevation 624 feet. Because of the risk of higher water levels and the generally high permeability of the alluvial soil, the support of excavation in the alluvium (east side) and the fill/alluvium (west side) will require a watertight support of excavation method such as interlocking sheetpiles or interlocking secant piles.

Ground conditions will also require a continuous support system of the alluvial materials above the rock with the system socketed into the rock. The watertight support of excavation system will need to resist groundwater pressures. See below for baselines on groundwater levels.

The shale bedrock is deemed to be self-supporting with the anticipation that very little groundwater will drain out of the rock. The shale rock can be supported with a system that reinforces the rock mass such as rock dowels, rock bolts, steel straps, welded wire fabric, or shotcrete, and a system to prevent slaking of the shaft sidewalls, such as shotcrete or other surface membrane that prevents drying out of the shaft sidewalls.

5.2 Buoyancy and Shaft Bottom Stability

5.2.1 Buoyancy

The geotechnical borings drilled near the shaft locations encountered groundwater as discussed above. Embedding the support of excavation system in the shale could adequately cut off groundwater flow at the shale interface. The shale is relatively impermeable and hydrostatic pressures take a long time to equilibrate and buoyant forces never materialize as water is continually sumped from the bottom.

The support of excavation system for the shaft extension into rock for the microtunnel alignment is likely to be a separate system that is different and disconnected from that required for the tie-in structure support of excavation. The support of excavation system in rock is not expected to be watertight. However, the volume of water that will drain through the rock is anticipated to be low and can be managed through sumping. Consequently, the shafts in rock are not expected to be buoyant.

5.2.2 Bottom Stability

The tie-in level and the microtunnel shaft bottom both occur in the shale bedrock so bottom stability will not be a concern. However, bottom excavations in the shale rock could end up being rough so placement of a concrete or slab on a gravel sumping bed in the deeper microtunnel shafts would be prudent. Also, the bedrock may have the tendency to deteriorate when exposed to water and air, so a protection layer will also minimize the potential for deterioration.

5.3 Groundwater Treatment and Disposal

For watertight support of excavation systems, sumping of nuisance water from within the shaft will be required on a continual basis until the work rises above the groundwater level. Sumped water from within the shaft is not considered groundwater as it may be contaminated with other drilling materials so it may require special handling and testing before disposal.

The contractor is to assume that pumping nuisance water originating through watertight shoring, a storm event, or the contractor's means and methods will be required. Nuisance water encountered during construction may require permitting, special monitoring, handling, and/or disposal as outlined in the Contract Documents. It is anticipated that nuisance water may need to be collected in "Baker Tanks" to remove and collect sediment before disposal.

5.4 Disposal of Excavated Material

Excavated materials generated during shaft construction will be handled, disposed of, and documented in accordance with the Contract Documents. Although not delineated, the Geotechnical Engineering Report (GER) and historical construction on the treatment plant property has encountered debris, cobbles, and boulder constituents in the fine grain matrix of fill placed for development of the plant. Geotechnical boring B-4 drilled on the plant side did encounter an obstruction in the fill that prevented advance of the boring beyond the 18.5 depth of encounter.

5.5 Ground Modification at Shaft Penetrations

Depending on what support of excavation system the contractor selects to support the microtunnel shafts in the shale, penetrations through the shaft support system (e.g., shotcrete lining) or 'windows' within individual support elements (e.g., rock dowels) will be required to facilitate launch and retrieval of the microtunnel boring machine (MTBM). The shaft penetrations will be made in the shale bedrock that is anticipated to exhibit firm behavior and to produce very small quantities of water so a direct launch into the shale is feasible. However, lubrication will be needed to complete the drive so the MTBM will have to be launched and retrieved through a wall seal to prevent lubrication and drilling fluid from escaping the annular space and flowing into the shafts. The wall seals must be designed to prevent groundwater, lubrication or drilling fluid inflow.

Ground improvement is not anticipated at the shaft penetrations provided the contractor's support of excavation system demonstrates continuous support of the ground before and after launch and during receipt of the tunneling equipment.

The shaft support system must safely transfer ground loads around the penetrations and maintain the stability of the excavations for all phases and sequences of construction.

5.6 Existing Utilities

Buried infrastructure exists on the SSWWTP inboard of and parallel to the bank crest as shown in the contract drawings. The Contractor is required to be aware of these utilities and is required to perform additional potholing to further refine subsurface locations.

5.7 Geotechnical Instrumentation

Geotechnical instrumentation is required to monitor the shaft structures for movement, surrounding ground, and existing junction box on the east side of the crossing throughout construction. The instrumentation must be installed in advance of shaft construction. Requirements for Monitoring Points for geotechnical instrumentation and monitoring are provided in the contract documents.

6 Tunneling Considerations

The tunnel alignment has been established in the shale bedrock. The shale bedrock is expected to have a very low permeability making it somewhat impermeable at transmitting groundwater. Rock cores depict relatively intact bedrock with high RQDs and very little fracturing which suggests the rock does not store nor will it produce large quantities of water. Even though the alignment in rock is expected to yield low volumes of water, it is reasonable to assume there could be a shear zone, or zones, within the river crossing in direct communication with river water. That condition precludes the use of any open face tunneling methods which cannot counterbalance groundwater. For a pipe ID of 42 inches, the tunnel will have to be excavated with a slurry MTBM which is adept at controlling the face and counterbalancing water pressure with slurry pressure.

6.1 Ground Conditions in Tunnel Zone

6.1.1 Shale Bedrock

Ground conditions within the tunnel zone will consist of shale bedrock for the entire drive. The shale is interbedded with thin sandstone seams. Boring B-1 identifies a six-foot-thick sandstone bed sandwiched in between shale. This sandstone bed is identified as a one-foot thick seam in boring B-2. In boring B-3 on the west side, a sandstone bed is identified from about 65 feet to the boring depth at 69 feet. The following summarizes the reported rock properties.

Table 6-1 – Rock Data for Shale Bedrock

Rock Data	B-1	B-2	B-3	B-4[1]
RQD Range	85% to 100%	65% to 100%	50% to 85%	NA
RQD Average	92%	84%	75%	NA
No. of UCS	3	3	3	NA
High	3,320	1,810	3,410	NA

Low	950	740	770	NA
Average	1,760	1,160	1,750	NA

UCS – Unconfined Compressive Strength, psi
[1] – Boring never reached bedrock. Advance impeded by surmised boulder

The UCS of the rock classifies it as a weak shale.

6.1.2 CERCHAR Abrasivity Index

CERCHAR abrasivity index tests were performed on one rock sample obtained within the tunnel zone from each boring. The abrasivity index is summarized below:

Table 6-2 – CERCHAR Abrasivity Index

	B-1	B-2	B-3	B-4[1]
CERCHAR Abrasivity Index	1.03	1.04	1.0	NA

[1] – Boring never reached bedrock. Advance impeded by surmised boulder

6.1.3 Swell Behavior

The shale does contain clay and therefore it possesses a swell potential. The percent swell anticipated in the shale is baselined below.

6.1.4 Slake Potential of Shale

Slake durability tests using ASTM D4644 were performed on three shale bedrock samples, one each from Borings B-1, B-2 and B-3. For B-1 and B-2, Slake Durability Indices of 95.3 and 96.6 were measured, respectively. These results indicate High durability. For B-3, a Slake Durability Index of 39.5 was measured, which is indicative of Low durability.

6.2 Lubrication

Our independent analyses indicate jacking forces will be high for the 1,778-foot-long drive far exceeding commonly available 800 ton jacking frames. High jacking forces are mitigated through a combination of an aggressive lubrication program and the introduction of Intermediate Jacking Stations (IJSs). For this project, the microtunnel specification requires the use of an automatic lubrication system along the pipe string and the introduction of IJSs when 80% of the main jacking station capacity is reached. The number of required IJSs is a function of the contractor's means and methods, especially as it pertains to the lubrication program, and whether or not the contractor's means and methods include provisions to attain a neutrally buoyant pipe in the tunnel zone to further reduce jacking forces.

6.3 Utilities

The only utilities that will be crossed are those located parallel to and inboard of the river bank crest on the plant property. A 16-inch secondary effluent force main and the 36-inch Cherry Creek force main will be crossed in the last 30 feet of the tunnel drive. Those utilities are at least 30 feet higher than the tunnel crown and the tunnel is in bedrock, so the tunnel should have little to no impact on these facilities. Nonetheless, the pipelines that parallel the river along the bank will be instrumented for performance during tunneling.

6.4 Geotechnical Instrumentation

Geotechnical instrumentation is required to monitor performance of the existing junction structure whose west side will be exposed by the temporary support of excavation required to make the tie-in connections. The temporary excavation support system for both the east and west sides will also be monitored for movement during construction. The instrument type and their locations are shown in the Contract Documents.

7 Baseline Ground Characterization

Terminology used in describing the ground conditions is presented below.

7.1 Fill and Alluvium

7.1.1 SPT/Strength Correlations

Table 7-1 – SPT N-Values Correlated to Unconfined Compressive Soil Strength

RELATIVE DENSITY		CONSISTENCY		
Sands and Gravel	SPT, N	Silts and Clays	SPT, N	Unconfined Compressive Strength (tsf)
Very loose	0 – 4	Very soft	0 - 2	0 - 0.25
Loose	4 – 10	Soft	2 - 4	0.25 - 0.50
Medium Dense	10 - 30	Medium Stiff	4 - 8	0.50 - 1.00
Dense	30 - 50	Stiff	8 – 15	1.00 – 2.00
Very Dense	50+	Very Stiff	15 - 30	2.00 – 4.00
		Hard	30+	>4.00
Reference: Terzaghi and Peck, 1967				

7.2 Shale and Sandstone

7.2.1 Weathering, Strength, Fracture, and Abrasion Descriptors

Table 7-2 – Weathering Descriptions

Term	Description of Rock Mass	Description of Fracture Surface
Fresh	Rock shows no discoloration, loss of strength or any other effect due to weathering.	Very few or no strains or coatings along fracture surfaces.
Slightly Weathered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock.	Minor to complete staining or coatings limited to fracture surfaces.
Moderately Weathered	Less than half the rock is discolored and noticeably weakened, but core cannot usually be broken by hand across rock fabric.	Fractures extensively coated with oxides, carbonates, or clay. Discoloration can extend up to several inches beyond fracture surfaces.
Highly Weathered	Greater than half the rock is discolored and weakened to such an extent that core can be broken readily by hand across the rock fabric.	All fracture surfaces are discolored or oxidized, surfaces friable. Discoloration typically extends throughout the rock mass.

Completely Weathered	The rock is discolored and entirely changed to soil, but the original rock fabric is preserved.	Not applicable

Based on International Society of Rock Mechanics (1981)

Table 7-3 – Strength Descriptions

ISRM Strength Category	Unconfined Compressive Strength (psi)	Characteristics for Field Identification
Extremely Weak	35–150	Can be indented by thumbnail.
Very Weak	150–700	Can be peeled by pocket knife, crumbles under firm blows with point of geological hammer
Weak	700–3,500	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer
Medium Strong	3,500–7,000	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer
Strong	7,000–14,500	Specimen requires more than one blow of geological hammer to fracture it
Very Strong	14,500–35,000	Specimen requires many blows of geological hammer to fracture it
Extremely Strong	>35,000	Specimen can only be chipped with geological hammer

Based on International Society of Rock Mechanics (1981)

Table 7-4 – Fracture Density Descriptions

Term	Description
Unfractured	No observed fractures
Very Slightly Fractured	Core recovered in lengths greater than 3 feet
Slightly Fractured	Core recovered mostly in lengths from 1 to 3 feet with few scattered lengths less than 1 foot or greater than 3 feet
Moderately Fractured	Core recovered mostly in lengths from 0.33 to 1 foot with most lengths about 0.67 foot
Intensely Fractured	Lengths average from 0.1 to 0.33 foot with fragmented intervals. Core recovered in lengths less than 0.33 foot.
Very Intensely Fractured	Core recovered mostly as chips and fragments with few scattered short core lengths.

Based on US Bureau of Reclamation (2001)

Table 7-5 – Abrasion Potential for Rock

CAI Value	Description
<1	None to Slightly Abrasive
1 to 2	Medium Abrasive
2 to 4	Very Abrasive
4 to 6	Extremely Abrasive

Based on Thuro, et al. 2007. CAI = CERCHAR Abrasivity Index

Table 7-6 – Slake Durability Index

Index	Description
>98	Very High
95 to 98	High
85 to 95	Medium High
60 to 85	Medium
30 to 60	Low
> 30	Very Low

Based on ASTM D4644.

7.3 Ground Behavior

Ground behavior terms used herein are described below in Table 7-1,

Table 7-7 – Ground Behavior Conditions

Ground Condition	Description
Firm Ground	Ground in which the excavation can be advanced safely without providing direct support to the face during the normal excavation cycle and in which the stand-up time is sufficient to install ground support before problematic ground movement occurs. Where short-term stability may be attributable to the development of negative pore pressure in the fine-grained soils, significant soil movements and/or ground loading of the ground support may occur later. Examples include stiff clays, some dewatered sands and rock.
Raveling Ground	Ground that is characterized by material in which the stability tends to deteriorate with time through a process of individual particles or blocks of ground falling form the excavation surface. Examples include glacial tills, sands and gravels, and weak blocky rock.
Running or Flowing Ground	Ground that is characterized by material such as sands, silts and gravels in the presence of water, and some highly sensitive clays, all of which tend to flow into an excavation. Above the water table running ground may occur in granular materials such as dry sands and gravels. Below the water table a fluidized mixture of soil and water may flow as a liquid. This is referred to as running or flowing ground. Such materials can sometimes pass rapidly through small openings and may completely fill a heading in a short period of time. In all running or flowing ground types there will be considerable potential for rapid over-excavation.
Squeezing Ground	Ground in which the excavation-induced stress relief leads to ductile, plastic yield of the ground into the tunnel opening.
Swelling Ground	Ground that is characterized by a tendency to increase in volume due to absorption of water. This behavior is most likely to occur either in highly over-consolidated clay or in clays containing minerals naturally prone to significant swelling.

Modified from Road Tunnel Manual (FHWA-NHI-09-010) (after British Tunneling Society, BTS, 1990); and Hoek and Marinos (2000).

8 Geotechnical Baseline Conditions

8.1 Shaft Baseline Conditions

The following baselines were mutually agreed upon by the design team with input from the Owner, G&H and McMillen Jacobs Associates. The baselines were set being mindful of the ground conditions and the risk they pose, and the Owner's tolerance for risk made known to the design team. The ground conditions were previously summarized. The behavior and physical and engineering properties of those ground conditions that pose risk to the Owner are reflected in the following baseline conditions.

The existing Junction Box 782 on the east side of the river was constructed within a sheetpile-supported excavation. The Record Plans for then Junction Box 1 indicate the support of excavation is no more than three feet from the west wall of the structure and was to be abandoned in place. Consequently, the abandoned support of excavation will conflict with the support of excavation for the current work and needs to be removed. On the west side of the river, the new junction structure is located within the existing footprint of the odor control structures that will be demolished.

8.1.1 General Shaft Baselines

Some general shaft baselines are as follows:

- The shaft excavation on the east side will not encounter any debris or boulders.
- The shaft excavation on the west side will not be encumbered by remnant foundations or other abandoned facility obstructions.
- Watertight shoring systems are considered watertight if they leak no more than 25 gpm through all entry points.
- For baseline purposes, permeability of the alluvial and fill materials is baselined at 1 x 10^{-2} cm/s.
- For baseline purposes, permeability of the bedrock with RQD greater than 60% is baselined at 1 x 10^{-5} cm/s, and where fractured with RQD of less than 30%, permeability is baselined at 1 x 10^{-3} cm/s.

The elevations of the geologic units are baselined in the following table.

Table 8.1 – Baseline Subsurface Conditions at Shafts [3]

Crossing Location	Shaft	Ground Surface Elevation (feet)[2]	Tunnel Shaft Slab Elevation[1] (feet)	Fill to Alluvium Contact (feet)	Alluvium to Shale Contact (feet)
Arkansas River	Launching	625	585	615	600
	Receiving	630	582	605	595

[1] Shaft slab elevation is assumed to be 2 feet below pipe invert.
[2] Average Elevation
[3] Baseline Elevations may vary by plus or minus one foot from elevations show in the table

8.1.2 Geologic Unit Baselines

8.1.2.1 Ground Condition Baselines – East Side

- Ten feet of silty sand, sandy silty clay, and silty clayey gravelly fill. The fill is clean of debris, oversized material and contamination, and can be disposed or repurposed in accordance with the Contract Documents.
- Fifteen feet of well and poorly graded sand alluvium. The alluvium is clean of debris, oversized material, and contamination, and it can be disposed or repurposed in accordance with the Contract Documents.
- If unsupported, fill and alluvium will run above the groundwater table, and flow below the groundwater table.
- Groundwater is typically at El. 605, but can fluctuate with river level to a maximum of El. 624. For design of watertight excavation support systems, the upper level of El. 624 is baselined.

8.1.2.2 Shale Bedrock – East side

- The upper 2 feet of shale is highly weathered.
- The remainder of the shale is fresh, weak and slightly fractured.
- Unconfined Compressive Strength (UCS) for excavation equipment is baselined at 5,000 psi.
- For overall rock characteristics, an average UCS of 2000 psi is baselined.
- The rock is characterized as Medium Abrasive.
- Slake Durability is Medium High to High
- Permeability is very low and will produce 0.5 gallons per hour per square foot of face area.
- Global behavior is firm and the rock will be self-supporting. Locally, isolated zones of raveling with an aggregate total of 5 vertical feet circling the shaft will be encountered with very short stand-up time that require immediate and localized support.

8.1.2.3 Ground Condition Baselines – West Side

- Twenty-five feet of silty clayey sand fill. The fill contains debris and oversized material, but it is not environmentally contaminated. The shaft excavation through the fill will produce 5 cubic yards of deleterious fill that may consist of wood, concrete, steel and other types of construction debris. Likewise, the shaft excavation will produce 10 cubic yards of boulder-size material that can be disposed or repurposed in accordance with the Contract Documents.
- Ten feet of well and poorly graded sand alluvium. The alluvium is clean of debris, oversized material, and contamination and it can be disposed or repurposed in accordance with the Contract Documents.
- If unsupported, fill and alluvium will run above the groundwater table, and flow below the groundwater table.
- Groundwater is typically at El. 605, but can fluctuate with river level to a maximum of El. 624. For design of watertight excavation support systems, the upper level of El. 624 is baselined.

8.1.2.4 Shale Bedrock – West side

- The upper 4 feet of shale is highly weathered.
- The remainder of the shale is slightly weathered, weak and slightly fractured.
- UCS for equipment excavation is set at 5,000 psi.
- For overall rock characteristics, an average UCS of 2000 psi is baselined.

- The rock is characterized as Medium Abrasive.
- Slake Durability is Low
- Permeability is very low and will produce 0.5 gallons per hour per square foot of face area.
- Global behavior is firm and the rock will be self-supporting. Locally, isolated zones of raveling with an aggregate total of 5 vertical feet circling the shaft will be encountered with very short stand-up time that require immediate and localized support.

8.2 Tunnel Baseline Conditions

The tunnel alignment has been set to be entirely in the shale rock whose behavior and engineering properties are surmised from geotechnical borings on each side of the river. The engineering data for the shale is generally favorable ground for tunneling and the expectation is the excavation would be self-supporting due to rock strength and tunnel geometry. A fracture zone in communication with the river water cannot be ruled out as a possible geologic anomaly. The occurrence of such ground is taken into consideration in the tunnel baselines.

8.2.1 Tunnel Baselines

- The shale is slightly weathered, weak and slightly fractured.
- Unconfined Compressive Strength for tunnel excavation equipment is set at 10,000 psi.
- For overall rock characteristics, an average UCS of 2000 psi is baselined.
- The rock is characterized as Medium Abrasive.
- Slake Durability is Medium High to High for the first 1000 feet of the tunnel, and Low for the remainder of the tunnel.
- Swell will be 2% extending 360 degrees and 24 inches beyond the tunnel excavation.
- For baseline purposes, permeability of the bedrock with RQD greater than 60% is baselined at 1 x 10^{-5} cm/s, and where fractured with RQD of less than 30% permeability is baselined at 1 x 10^{-3} cm/s.
- Global behavior is firm and the rock will be self-support. Locally, isolated fracture zones of raveling ground will be encountered with an aggregate total of 40 linear feet will be encountered resulting in advertent returns that reduces the anticipated tunnel productivity by 50%.

8.3 Hazardous or Contaminated Substances

For baseline purposes, rock, ground and groundwater in the shaft excavations and tunnel zone is not contaminated with hazardous substances that require special handling, testing, or disposal provisions. The contractor will be required to dispose of only tunnel cuttings that have been in contact with drilling fluids containing bentonite and/or additives that meet NSF 60 standards and enhance the behavior or engineering properties of the slurry.

9 References

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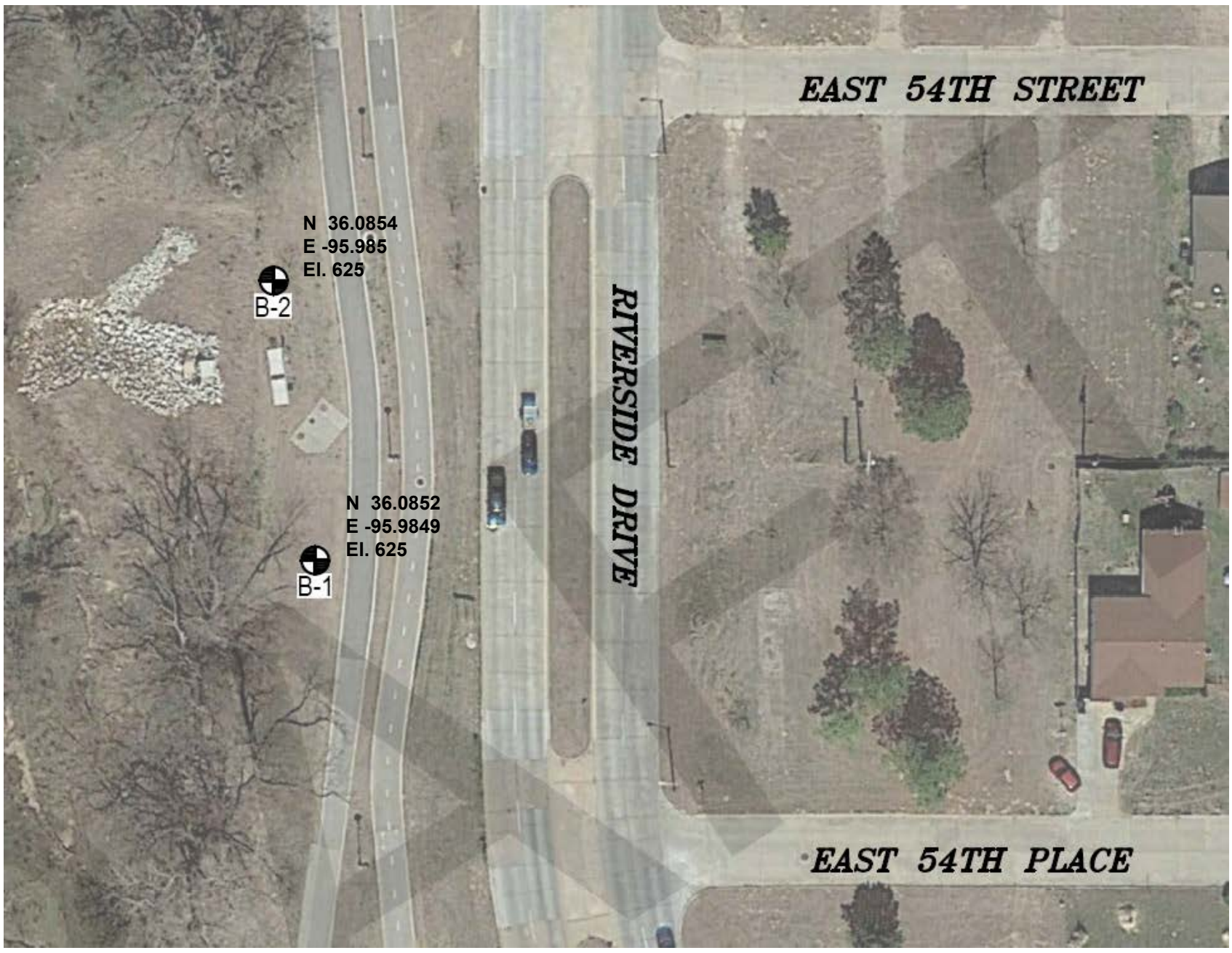
FIGURES



BORING LOCATION SOURCE:
Terracon, Geotechnical Engineering Report, dated February 28, 2020

McMILLEN JACOBS ASSOCIATES

EAST SIDE BORING LOCATION PLAN

Third River Crossing SSWWTP Flow Optimization
City of Tulsa, Oklahoma

FIGURE 1



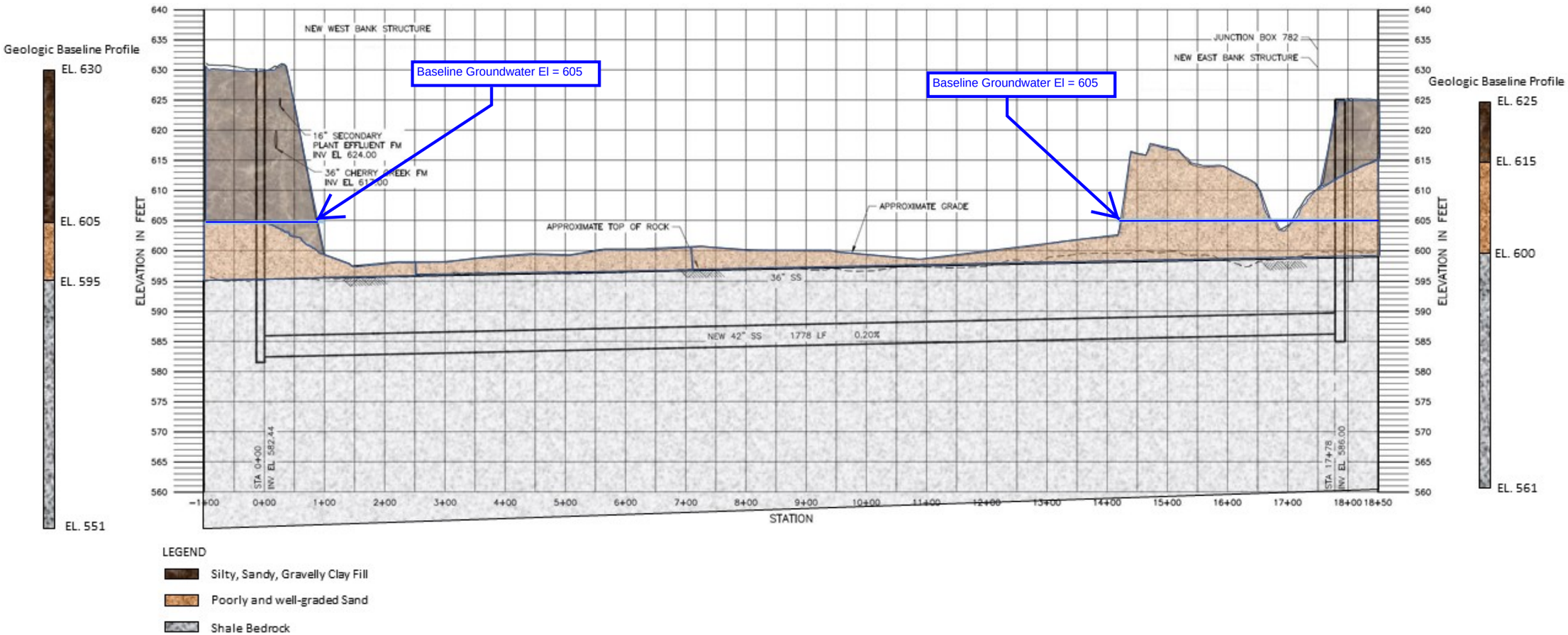
BORING LOCATION SOURCE:
Terracon, Geotechnical Engineering Report, dated February 28, 2020

McMILLEN JACOBS ASSOCIATES

WEST SIDE BORING LOCATION PLAN

Third River Crossing SSWWTP Flow Optimization
City of Tulsa, Oklahoma

FIGURE 2



BORING SOURCE:
Terracon, Geotechnical Engineering Report, dated February 28, 2020

McMILLEN JACOBS ASSOCIATES

GEOLOGIC PROFILE ACROSS RIVER

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure 3

APPENDIX A

SSWWTP REFERENCE BORINGS

Terracon 2004 and 2009



REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - LOCATION PLAN

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1

LOG OF BORING NO. B-1

Page 1 of 2

OWNER: City of Tulsa
ENGINEER: Black & Veatch
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	
	Approx. Surface Elev.: 631.2 ft				PA						
	6" Asphalt Fill: SILT WITH CLAY AND SHALE AND SANDSTONE FRAGMENTS			1	SS	18	22	13			S-1 LL=26 PL=23 PI=3
	2 — 629 dark gray and olive-brown Fill: SILTY FINE SAND light reddish-brown			2	SS	12	9	15			
					PA						
	(olive-brown clay seams with shale fragments from 4 to 5.5 feet)	5		3	SS	18	7	13			
					HS						
				4	SS	14	8	13			S-4 P200=50%
		10			HS						
	12.5 — 618.5 SANDY LEAN CLAY reddish-brown, stiff		CL	5	SS	18	7	22		3000*	
		15			HS						
	18.5 — 612.5 FINE TO MEDIUM SAND tan, loose to medium dense		SP	6	SS	16	9	3			
		20			HS						
			SP	7	SS	16	11	2			
		25			HS						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ NONE	WD	▽ AB
WL	▽		▽
WL	27 Ft on 1/28/04		

Terracon

BORING STARTED	1-20-04		
BORING COMPLETED	1-20-04		
RIG	CME-75	FOREMAN	KS
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

LOG OF BORING NO. B-1

Page 2 of 2

OWNER: City of Tulsa
ENGINEER: Black & Veatch
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	
	FINE TO MEDIUM SAND tan, loose				HS						
	28 — 603 MEDIUM TO COARSE SAND light grayish-brown		SP	8	SS	17	5/6" 50/5"	15			
	29.5 — 601.5 29.9 — 601.5 WEATHERED SANDSTONE+ greenish-gray, poorly cemented										
	BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types. Slotted PVC pipe placed in bore hole after boring completion on January 20, 2004 to enable longer-term ground water level observations. Pipe removed and boring backfilled after taking water level reading on January 28, 2004.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ NONE	WD	▽ AB
WL	▽		▽
WL	27 Ft on 1/28/04		

Terracon

BORING STARTED	1-20-04		
BORING COMPLETED	1-20-04		
RIG	CME-75	FOREMAN	KS
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2004

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1a

LOG OF BORING NO. B-2

Page 1 of 2

OWNER: City of Tulsa
ENGINEER: Black & Veatch
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	
	Approx. Surface Elev.: 631.2 ft										
	5" Asphalt 2" Gravel Fill: SILTY FINE SAND tan (trace gravel at about 3 feet)				PA						
				1	SS	18	13	4			
				2	SS	18	7	4			
					PA						
		5		3	SS	18	10	4			
					HS						
	9 622										
	SANDY LEAN CLAY reddish-brown, medium stiff to stiff		CL	4	SS	18	11	14		3000*	
		10			HS						
			CL	5	ST	18		16	116	1350	S-5 LL=26 PL=17 PI=9
		15			HS						
	18 613										
	FINE TO MEDIUM SAND tan to light gray, loose		SP	6	SS	18	8	6			S-6 P200=5%
		20			HS						
	24 ▽ 607										
	MEDIUM TO COARSE SAND, TRACE GRAVEL light grayish-brown, medium dense		SP	7	SS	18	13	2			
		25			HS						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 24 WD	▽	AB
WL	▽	▽	
WL	13.5 Ft on 1/28/04		

Terracon

BORING STARTED	1-20-04		
BORING COMPLETED	1-20-04		
RIG	CME-75	FOREMAN	KS
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

LOG OF BORING NO. B-2

Page 2 of 2

OWNER: City of Tulsa
ENGINEER: Black & Veatch
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	
	MEDIUM TO COARSE SAND, TRACE GRAVEL light grayish-brown, medium dense				HS						
	29.5 601.5		SP CL	8	SS	18	8/6" 21/6"	19			
	SHALEY LEAN CLAY, TRACE SANDSTONE SEAMS reddish-brown, light brown, and gray, very stiff	30			HS						
	34 597										
	SHALE+ dark gray, soft to moderately hard		CL	9	SS	8	17/6" 50/4"	8			
		35			HS						
				10	SS	2	50/2"	11			
		40			HS						
	▽			11	SS	3	50/3"	8			
	43.8 587.5										
	BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types. Slotted PVC pipe placed in bore hole after boring completion on January 20, 2004 to enable longer-term ground water level observations. Pipe removed and boring backfilled after taking water level reading on January 28, 2004.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 24 WD	▽	AB
WL	▽	▽	
WL	13.5 Ft on 1/28/04		

Terracon

BORING STARTED	1-20-04		
BORING COMPLETED	1-20-04		
RIG	CME-75	FOREMAN	KS
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2004

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1b

LOG OF BORING NO. B-3

Page 1 of 1

OWNER: City of Tulsa
ENGINEER: Black & Veatch
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	Approx. Surface Elev.: 629.9 ft.				PA					
	Fill: SANDY LEAN CLAY WITH LIMESTONE GRAVEL AND COBBLES, TRACE SHALE FRAGMENTS, reddish-brown			1	SS	16	7	11		
					PA					
				2	SS	18	12	11		
	5 625	5								
	BOTTOM OF BORING Terminated boring at auger refusal on obstruction (possible boulder at 5 feet.)									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ NONE WD	▽ NONE AB	
WL	▽	▽	
WL			

Terracon

BORING STARTED	1-20-04		
BORING COMPLETED	1-20-04		
RIG	CME-75	FOREMAN	KS
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

LOG OF BORING NO. B-3A

Page 1 of 1

OWNER: City of Tulsa
ENGINEER: Black & Veatch
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	Approx. Surface Elev.: 629.9 ft				PA					
	Fill: SANDY LEAN CLAY WITH LIMESTONE GRAVEL, COBBLES, AND POSSIBLE BOULDERS, reddish-brown			1	SS	6	19	10		
					PA					
				2	SS	9	52	7		
					PA					
				3	SS	8	10	7		
					PA					
	17 613	5 10 15								
	BOTTOM OF BORING Terminated boring at auger refusal on obstruction (possible boulder at 17 feet.)									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ NONE WD	▽ NONE AB	
WL	▽	▽	
WL			

Terracon

BORING STARTED	1-20-04		
BORING COMPLETED	1-20-04		
RIG	CME-75	FOREMAN	KS
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2004

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1c

LOG OF BORING NO. B-4

Page 1 of 2

OWNER: City of Tulsa

ENGINEER: Black & Veatch

SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	Approx. Surface Elev.: 630.5 ft				PA					
	4" Topsoil Fill: SANDY LEAN CLAY WITH LIMESTONE GRAVEL AND COBBLES reddish-brown (fabric and geogrid at 1 foot)	2		1	SS	8	10	5		
	Fill: LIMESTONE GRAVEL, COBBLES, AND BOULDERS WITH CLAY light gray and brown	628.5		2	SS	7	9/6" 50/4"	4		
					PA					
		5		3	SS	8	47	7		
					HS					
				4	SS	6	11	2		
		10			HS					
				5	SS	6	15	2		
		15			HS					
				6	SS	8	16	4		
		20			HS					
				7	SS	2	5/6" 50/3"			
		25			HS					

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 29.5 WD	▽	AB
WL	▽	▽	
WL	NONE on 2/2/04		

Terracon

BORING STARTED	1-29-04		
BORING COMPLETED	1-29-04		
RIG	ATV	FOREMAN	JW
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

LOG OF BORING NO. B-4

Page 2 of 2

OWNER: City of Tulsa

ENGINEER: Black & Veatch

SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	
	Fill: LIMESTONE GRAVEL, COBBLES, AND BOULDERS WITH CLAY light gray and brown				HS						
			SP	8	SS	10	30/6" 8/6"	7			
		29.5									
		▽ 601			HS						
	COARSE SAND WITH FINE GRAVEL gray, medium dense to very loose	30									
	(very loose below about 33.5 feet)		SP	9	SS	6	3	10			S-9 P200=7%
		35			HS						
		36.5		10	SS	4	50/5"	14			
		594									
	SHALE+ dark gray, soft	36.9									
		593.5									
	BOTTOM OF BORING										

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Slotted PVC pipe placed in bore hole after boring completion on January 29, 2004 to enable longer-term ground water level observations. Pipe removed and boring backfilled after taking water level reading on February 2, 2004.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 29.5 WD	▽	AB
WL	▽	▽	
WL	NONE on 2/2/04		

Terracon

BORING STARTED	1-29-04		
BORING COMPLETED	1-29-04		
RIG	ATV	FOREMAN	JW
APPROVED	BMW	JOB #	04045005

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2004

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1d

LOG OF BORING NO. B-5

Page 1 of 2

OWNER: City of Tulsa
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
ENGINEER: Black & Veatch
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	
	Approx. Surface Elev.: 630.1 ft				PA						
	4" Topsoil Fill: SANDY LEAN CLAY reddish-brown			1	SS	18	7	12			
	626.5			2	SS	15	4/6" 15/6"	15			
	3.5 Fill: SANDY LEAN CLAY WITH LIMESTONE GRAVEL				PA						
	625	5		3	SS	3	13	6			
	5 reddish-brown Fill: LEAN CLAY WITH LIMESTONE GRAVEL, COBBLES, AND POSSIBLE BOULDERS reddish-brown				HS						
				4	SS	11	7	11			
		10			HS						
				5	SS	15	25	8			S-5 LL=26 PL=15 PI=11
	(moist below about 16 feet)	15			HS						
				6	SS	16	5	12			
		20			HS						
	(boulder or boulders from 24 to 27.5 feet)			7	SS	7	37/6" 50/2"	6			
		25			HS						

Continued Next Page

*Calibrated Hand Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL ▽ 27.5	WD ▽	AB ▽	
WL ▽		▽	
WL 18.5 Ft on 2/2/04			

Terracon

BORING STARTED	1-29-04		
BORING COMPLETED	1-29-04		
RIG ATV	FOREMAN JW		
APPROVED BMW	JOB # 04045005		

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

LOG OF BORING NO. B-5

Page 2 of 2

OWNER: City of Tulsa
SITE: Southside Wastewater Treatment Plant, Tulsa, Oklahoma
ENGINEER: Black & Veatch
PROJECT: Residuals and Miscellaneous Improvements Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	Fill: LEAN CLAY WITH LIMESTONE GRAVEL, COBBLES, AND POSSIBLE BOULDERS reddish-brown				HS					
	27.5 ▽ 602.5									
	Possible Fill: MEDIUM SAND WITH LIMESTONE GRAVEL tan and gray		SP	8	SS	8	33	13		
	29.5 600.5	30			HS					
	MEDIUM TO COARSE SAND tan, dense		SP CL	9	SS	18	5/6" 12/6"	11		
	34.5 595.5									
	35 SHALEY LEAN CLAY 595 olive-brown to gray, very stiff BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types. Boring converted to temporary piezometer to enable longer-term groundwater level observations.	35								

*Calibrated Hand Penetrometer

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL ▽ 27.5	WD ▽	AB ▽	
WL ▽		▽	
WL 18.5 Ft on 2/24/04			

Terracon

BORING STARTED	1-29-04		
BORING COMPLETED	1-29-04		
RIG ATV	FOREMAN JW		
APPROVED BMW	JOB # 04045005		

BOREHOLE 04045005.GPJ TERRACON.GDT 2/12/04

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2004

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1e

LOG OF BORING NO. B-1

Page 1 of 2

CLIENT: Greeley and Hansen

SITE: Tulsa Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Wastewater Treatment Plant Rehabilitation

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT-N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED COMPRESSION, psf	
	Approx. Surface Elev.: 631 ft										
	13" Asphalt 2" Aggregate Base **SANDY LEAN CLAY** reddish-brown, stiff to very stiff				PA						
			CL	1	SS	18	15	8			
			CL	2	SS	18	19	11			S-2 #200=59%
					PA						
		5	CL	3	SS	18	4/6" 8/6"	10			
					PA						
	8.5 622.5										
	SANDY LEAN CLAY brown, stiff to very stiff		CL	4	SS	18	16	12			
		10			PA						
			CL	5	SS	18	7	21			S-5 #200=68%
		15			PA						
	18.5 612.5										
	FINE SAND tan, medium dense		SP	6	SS	12	11	4			
		20			PA						
			SP	7	SS	13	21	3			
		25			PA						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft					
WL	▽ 29	WD	▽	AB	
WL	▽ 25	1/12	▽		
WL					

Terracon

BORING STARTED	1-9-09		
BORING COMPLETED	1-9-09		
RIG	ATV	FOREMAN	PE
APPROVED	CSK	JOB #	04085298

BOREHOLE 04085298.GPJ TERRACON.GDT 2/9/09

LOG OF BORING NO. B-1

Page 2 of 2

CLIENT: Greeley and Hansen

SITE: Tulsa Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Wastewater Treatment Plant Rehabilitation

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT-N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED COMPRESSION, psf	
	FINE SAND tan, medium dense										
	28.5 602.5										
	MEDIUM SAND brown,loose ▽		SP	8	SS	8	7	17			
		30			PA						
	33.5 597.5										
	SHALE+ gray, moderately hard			9	SS	3	50/3"	13			
		35			PA						
				10	SS	2	50/2"	11			
		40			PA						
	43.8 587			11	SS	2	50/2"	11			
	BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft					
WL	▽ 29	WD	▽	AB	
WL	▽ 25	1/12	▽		
WL					

Terracon

BORING STARTED	1-9-09		
BORING COMPLETED	1-9-09		
RIG	ATV	FOREMAN	PE
APPROVED	CSK	JOB #	04085298

BOREHOLE 04085298.GPJ TERRACON.GDT 2/9/09

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2009

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1f

LOG OF BORING NO. B-2

Page 1 of 2

CLIENT: Greeley and Hansen

SITE: Tulsa Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Wastewater Treatment Plant Rehabilitation

Approx. Surface Elev.: 629 ft

DEPTH, ft.	DESCRIPTION	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT-N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED COMPRESSION, psf	
	15" Asphalt			PA						
	SANDY LEAN CLAY reddish-brown, medium stiff to very stiff	CL	1	SS	16	17	11			S-1 -#200=56%
		CL	2	SS	16	18	14			
				PA						
5		CL	3	SS	16	5	14			
				PA						
8.5 / 620.5	**CLAYEY SAND** reddish-brown and brown, loose to medium dense	SC	4	SS	13	5	8			S-4 -#200=32%
10				PA						
		SC	5	SS	17	10	11			
15				PA						
18.5 / 610.5	**FINE TO MEDIUM SAND** tan and brown, medium dense	SP	6	SS	16	22	8			
20				PA						
		SP	7	SS	14	7/6" 19/6"	10			
25				PA						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft					
WL	▽ 24	WD	▽	AB	
WL	▽ 26	1/12	▽		
WL					

Terracon

BORING STARTED	1-9-09		
BORING COMPLETED	1-9-09		
RIG	ATV	FOREMAN	PE
APPROVED	CSK	JOB #	04085298

BOREHOLE 04085298.GPJ TERRACON.GDT 2/9/09

LOG OF BORING NO. B-2

Page 2 of 2

CLIENT: Greeley and Hansen

SITE: Tulsa Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Wastewater Treatment Plant Rehabilitation

DEPTH, ft.	DESCRIPTION	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT-N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED COMPRESSION, psf
	FINE TO MEDIUM SAND tan and brown, medium dense	SP	8	SS	12	10	16		
30				PA					
33.5 / 595.5	**SHALE+** gray, soft to moderately hard		9	SS	4	50/5"	10		
35				PA					
			10	SS	2	50/2"	16		
40				PA					
43.8 / 585	BOTTOM OF BORING		11	SS	3	50/3"	13		

+Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft					
WL	▽ 24	WD	▽	AB	
WL	▽ 26	1/12	▽		
WL					

Terracon

BORING STARTED	1-9-09		
BORING COMPLETED	1-9-09		
RIG	ATV	FOREMAN	PE
APPROVED	CSK	JOB #	04085298

BOREHOLE 04085298.GPJ TERRACON.GDT 2/9/09

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2009

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1g

LOG OF BORING NO. B-3

CLIENT: Greeley and Hansen

SITE: Tulsa Southside Wastewater Treatment Plant, Tulsa, Oklahoma

PROJECT: Wastewater Treatment Plant Rehabilitation

Approx. Surface Elev.: 630 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT-N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED COMPRESSION, psf	
					PA						
	13" Asphalt **SANDY LEAN CLAY** reddish-brown, very stiff		CL	1	SS	14	21	12			
			CL	2	SS	17	23	14			
					PA						
	625	5	CL	3	SS	16	12	14			S-3 #200=52%
	SANDY LEAN CLAY brown, stiff to very stiff				PA						
			CL	4	SS	18	13	16			
		10			PA						
			CL	5	SS	17	13	16			
	615	15									
	BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None	WD	▽ AB
WL	▽ 12	1/12	▽
WL			

Terracon

BORING STARTED	1-9-09		
BORING COMPLETED	1-9-09		
RIG	ATV	FOREMAN	PE
APPROVED	CSK	JOB #	04085298

BOREHOLE 04085298.GPJ TERRACON.GDT 2/9/09

REFERENCED FROM: Terracon 2004 and 2009

McMILLEN JACOBS ASSOCIATES

HISTORICAL PLANT BORINGS - 2009

THIRD RIVER CROSSING, SSWWTP PEAK FLOW OPTIMIZATION
City of Tulsa, Tulsa, Oklahoma

Figure A-1h