SET NO. _____

PROJECT MANUAL

BID SET

CITY OF GRAND JUNCTION

KANNAH CREEK WATER STORAGE TANK

JANUARY 2024

PROJECT MANUAL

BID SET

CITY OF GRAND JUNCTION

KANNAH CREEK WATER STORAGE TANK

JVA, Inc.
817 Colorado Avenue, Suite 301
Glenwood Springs, CO

JVA Job No. 1071.17e

JANUARY 2024

PROJECT MANUAL

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CITY OF GRAND JUNCTION
KANNAH CREEK WATER STORAGE TANK

SECTION 01010

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C. Contractor use of site and premises

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1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work will include all necessary labor, supervision, equipment, tools and materials for the construction of a cast-in-place concrete or welded steel potable water storage tank. Work includes, but is not limited to, inlet and outlet piping, overflow and drain pipes, ladders, railings, hatches, conduit, earthwork, site piping and all associated site work relating to the tank project.

B. Contractor shall furnish and pay for all materials, equipment, supplies, appurtenances; provide all construction equipment and tools; and perform all necessary labor and supervision

C. Contractor shall coordinate the progress of the Work including coordination between trades, subcontractors, suppliers, public utilities, instrumentation and controls specialist, and Owner.

D. It is the intent of this contract that Work proceed in the most expeditious manner possible

E. Construct the Work under contract indicated in the Bid Form

F. The cross-referencing of specification sections under the heading "Related Sections" and elsewhere within each specification section is intended as an aid to the Contractor and shall not relieve the Contractor from his responsibility to coordinate the Work under the Contract Documents. Listings of cross-references are not intended to be comprehensive. The omission of a cross-reference to an additional or related requirement shall not relieve the Contractor of his obligation to provide a complete Project.

1.3 WORK BY OTHERS

A. Construct work to allow for work by others. Coordinate construction schedule with the Owner.

B. The Contractor is responsible for completing all work per the Contract Documents.

1.4 CONTRACTOR USE OF SITE AND PREMISES

A. Contractor shall limit use of the premises for Work and will use the designated staging area for field offices, equipment, and material storage. Areas have been designated on the Drawings for contractor’s use

B. Coordinate use of premises under direction of Engineer and/or Owner

C. Assume full responsibility for the protection and safekeeping of equipment and products stored on site under this Contract

D. Contractor may use only those areas indicated on the Drawings for storage and such additional areas as Engineer may designate

E. Contractor shall protect all existing site infrastructure. Contractor shall install orange construction fencing around all existing tanks and the control panels to protect them from damage during construction

F. Contractor should plan for normal workdays, Monday through Friday, within the hours of 7:00 am to 7:00 pm. Other work hours and days may be allowed by the City and Engineer upon 48 hours written notice

1.5 OWNER USE OF SITE AND PREMISES

A. Owner reserves the right to occupy the site as needed during the course of construction. Contractor shall coordinate their work and provide access at all times.

B. Existing infrastructure to remain operational during construction. All access shall be maintained.

1.6 WORK SEQUENCE AND WORK RESTRICTIONS

A. Construct work to allow for work by others. Coordinate construction schedule with the Owner.

B. Provide open access for Owner to property at all times during construction. Maintain minimum width clearance for City access, Contractor personnel and emergency vehicles at all times.

C. Contractor shall submit a detailed CPM format schedule outlining all steps required to assure complete and satisfactory construction, testing, and startup of work in such a manner as to result in the least possible disruption to City operations and staff. Address all work sequence and constraints described in this Section.

D. Conduct work in a manner that will not impair the operational capabilities of essential elements of the existing distribution system and the water treatment plant that feeds the tanks.

E. Indicate required shutdowns of existing infrastructure/facilities or interruptions of existing operations on Progress Schedule. Shutdowns of the distribution system will be permitted on a limited basis and cannot interfere with water treatment plant operations. All identified constraints will need to be satisfied before a shutdown can occur.

F. Shutdowns may be required to complete the scope of work. All shutdowns shall be coordinated with City operations staff and performed by the City unless otherwise agreed to. The Contractor shall submit a detailed work plan/sequence for each shutdown and receive the City's approval at least 10 days prior to the planned date of shutdown. For each approved shutdown, the Contractor shall submit a written confirmation notification 10-days in advance of the proposed shutdown to the City. Unless specifically indicated otherwise, shutdowns are to be limited to 4-hours and are to occur during low-flow periods, which may include night work, unless otherwise agreed to by the City. Where working hours conflict with hours allowed for construction activities, the Contractor shall submit a request for approval from the City for modified construction activity hours.
   1. Minimize shutdown times by thorough advanced planning. Have required equipment, materials, and labor on hand at time of shutdown.
   2. Disruptions include, but are not limited to:
      a. Removing from service, restricting, or impeding the function of utility or water systems
      b. Delaying or denying access to any infrastructure or area needed by operations staff to complete their work assignments

G. The Contractor shall protect both existing tanks, all utilities, and telemetry equipment using construction fencing. A detailed plan shall be submitted to the Owner for review and approval before the start of construction.

H. The water main tie-ins shall be completed during low demand periods. This may require tie-ins at night or early in the morning. Tie-ins shall be completed within a four-hour timeframe. Contractor shall coordinate all tie-in work with the City of Grand Junction at

least seven (7) days prior to the work and provide a tie-in plan to the City for review and approval.

I. Contractor is responsible for filling the tank for all required leak tests and for all other operations that require water in the tank prior to Final Completion. Water shall be potable meeting all CDPHE requirements and chlorinated. Owner will be responsible for filling the tank after Final Completion.

J. The Contractor shall be responsible for demoing the existing concrete tanks after the new tank is brought online. This includes the existing hatches and CMP pipe that surrounds them. See plans for additional requirements.

K. Construct work in stages to minimize water service outages. Coordinate construction schedule and water main shutdowns with Engineer and Owner. Contractor must notify affected homeowners and/or businesses of planned service outages a minimum of seven (7) days prior.

L. Water service interruptions of up to 4 hours duration will be permitted
   1. Schedule each outage with the City
      a. Number of outages to be kept to a minimum

M. Existing water storage tanks shall remain in operation through the contract period.

N. Sequences other than those specified will be considered by Engineer, provided they afford equivalent continuity of operations

1.7 EASEMENTS AND RIGHT-OF-WAY

A. Work shall be performed at the City's existing water storage tank site

B. Construction access to the site is available only via Reeder Mesa Road. Access across private property is strictly prohibited.

C. Work will be performed on Owner's property

D. Confine construction operations to the immediate vicinity of the location indicated on drawings and use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies, so as to cause the least possible damage to property
   1. Contractor shall fence off the existing storage tanks and controls to prevent damage during the duration of the contract. Access to the equipment/infrastructure shall be provided through the fencing for City staff.

E. Construction Area Limits
   1. Confine construction operations to the immediate vicinity of the location indicated on Drawings and in accordance with the Owner
   2. Areas not designated for access, parking, storage, existing facilities, and construction areas, Contractor shall not trespass in or on these areas

a. Contractor shall be responsible for keeping all their personnel out of areas not designated for Contractor use except in case of isolated Work located within these areas for which the Contractor shall coordinate with Owner and shall not proceed with such work without Owner approval

3. Contractor shall use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies, so as to cause the least possible damage to the City's property
   a. Responsibility for protection and safekeeping of materials and equipment on or near the work site shall be entirely that of the Contractor and no claim shall be made against the Owner for any reason
   b. If the Owner needs access to the sites occupied by stored materials or equipment, Contractor shall provide access

F. On Private Property
   1. Do not enter for material delivery or occupy for any purpose with personnel, tools, equipment, construction materials, or excavated materials, any private property without written permission of the owner.

G. Within Street Right-of-Way and Utility Easement
   1. Perform all work and conduct all operations of Contractor, his employees, and his subcontractors in accordance with the requirements of the City of Grand Junction and Mesa County

1.8 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

A. Protect, shore, brace, support, and maintain underground conduits, drains, and other underground construction uncovered or otherwise affected by construction operations

B. Contractor shall be responsible for all damage to streets, roads, highways, shoulders, street lighting and/or signage, embankments, culverts, location or character, which may be caused by transporting equipment, materials, or personnel to or from the Work or any part or site thereof, whether by him or his subcontractors

C. Make satisfactory and acceptable arrangements with the Owner of, or the agency or authority having jurisdiction over, any damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage

1.9 PROTECTION OF WORK AND FACILITIES

A. Contractor shall be solely responsible for the protection of Work until final acceptance

B. Contractor shall protect all and any previously performed Work, work in progress or completed by others, and existing facilities from damage during the performance of Work in the area

1.10 MAINTENANCE OF TRAFFIC

A. Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian
   1. Whenever it is necessary to cross, close, or obstruct private roads, driveways, multi use paths, and walks, provide and maintain suitable and safe detours, or other temporary expedients for accommodation of private travel
      a. Submit traffic control plans for work within right-of-ways for approval by the City prior to commencing any work
   2. Maintenance of traffic is not required if Contractor obtains written permission from the owner and tenant of private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point

1.11 BARRICADES AND LIGHTS

A. Protect streets, roads, highways, and other public thorough fares which are closed to traffic by effective barricades with acceptable warning and directional signs

B. Locate barricades at the street intersecting public thoroughfare on each side of the blocked section

C. Provide suitable barriers, signs, and lights to the extent required to adequately protect the public

D. Provide similar warning signs and lights at obstructions such as material piles and equipment

E. Illuminate barricades and obstructions with warning lights from sunset to sunrise

F. Store materials and conduct work to cause the minimum obstruction to the other contracts

G. Install and maintain barricades, signs, lights, and other protective devices in conformity with applicable statutory requirements including the Manual of Uniform Traffic Control Devices and as required by Mesa County

1.12 LINES, GRADES AND SURVEY

A. Construct all Work to the lines, grades, and elevations indicated on the Drawings
   1. The Owner may employ a separate surveyor to perform a verification survey to check final layout and grades.
   2. Contractor is responsible for correcting all incorrect grades or grades not meeting specified tolerances

B. Engineer has established basic horizontal and vertical control points in the Drawings
   1. Use these points as datum for the Work
   2. Provide such competent personnel and tool, stakes, and other materials as Engineer may require in establishing or designating control points, in establishing construction

easement boundaries, or in checking layout survey, and measurement work performed by Contractor

C. Provide all survey, layout, and measurement work required
   1. Work performed by a qualified professional engineer or registered land surveyor acceptable to Engineer
   2. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction
      a. Make no changes or relocations without prior written notice to Engineer
      b. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations
      c. Require surveyor to replace Project control points which may be lost or destroyed
      d. Establish replacements based on original survey control
   3. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means
      a. Temporary project benchmark
      b. Stakes for grading, fill and topsoil placement
      c. Utility slopes and invert elevations
   4. From time to time, verify layouts by the same methods
   5. Maintain a complete, accurate log of all control and survey work as it progresses
   6. On request of Engineer, submit documentation to verify accuracy or field engineering work

1.13 REGULATORY REQUIREMENTS

A. Comply with all federal, state, and local laws, regulations, codes, and ordinances applicable to the Work

B. References in the Contract Document to local codes shall mean the codes in effect in the City of Grand Junctions and Mesa County according to the jurisdiction in which the Work is performed

C. Other standards and codes which apply to the Work are designated in the specific technical specifications

1.14 CUTTING AND PATCHING

A. Contractor shall be responsible for all cutting, and patching, including attendant excavation and backfill, required to complete the Work or to
   1. Uncover portions of the Work to provide for installation of ill-timed work
   2. Remove and replace defective work
   3. Remove and replace work not conforming to requirements of Contract Documents
   4. Remove samples of installed work as specified for testing

B. Provide products as specified or as required to complete cutting and patching operations

C. Inspection

1. Inspect existing conditions of the Project, including elements subject to damage or to movement during cutting and patching
2. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work
3. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with the work until the Engineer has provided further instructions

D. Preparation
1. Provide devices and methods to protect other portions of the Project from damage
2. Provide protection from the elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water
3. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes
4. Restore work which has been cut or removed; install new products to provide completed Work in accord with requirements of Contract Documents

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01020

GEOTECHNICAL REPORT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Reports of explorations and tests of subsurface conditions at the project site.

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 02300 – Earthwork

1.3 INVESTIGATION

A. Soil and subsurface investigations were conducted at the site, the results of which are to be found in the report issued by RockSol Consulting Group, Inc., Proposed Juniata Structural Water Tank, April 6, 2023. An addendum letter was later prepared by RockSol Consulting Group, Inc. on September 15, 2023, that details design parameters for the steel tank alternative.

B. A reference copy of the report and memo are included herein as Supplement A (01020) and Supplement B (01020) respectively.

C. Bidders are expected to examine soils investigation data and to make their own investigation of the site on or prior to the bid date.

1.4 INTERPRETATION

A. Soil investigation data is provided only for information and the convenience of bidders. Owner and Engineer disclaim any responsibility for the accuracy, true location, and extent of the soils investigation that has been prepared by others. They further disclaim responsibility for interpretations of that data by bidders, as in projecting soil-bearing values, rock profiles, soil stability and the presence, and level and extent of underground water.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

Geotechnical Investigation Report
Proposed Juniata Structural Water Tank
City of Grand Junction, Colorado

RockSol Project No. 599.61
April 6, 2023

Prepared for:

City of Grand Junction
333 West Avenue, Building C
Grand Junction, Colorado, 81501

Attention: John Ecklund, PE, CFM

Prepared by:

RockSol Consulting Group, Inc.
566 W Crete Circle #2
Grand Junction, Colorado, 81505
(970) 822-4350

Geotechnical Investigation Report
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COLORADO REGISTERED
DONALD GORDON HUNT
7-31-23
35249
PROFESSIONAL ENGINEER

Calen Shoen, EIT
Civil Engineering Associate

Donald G. Hunt, P.E.
Senior Geotechnical Engineer

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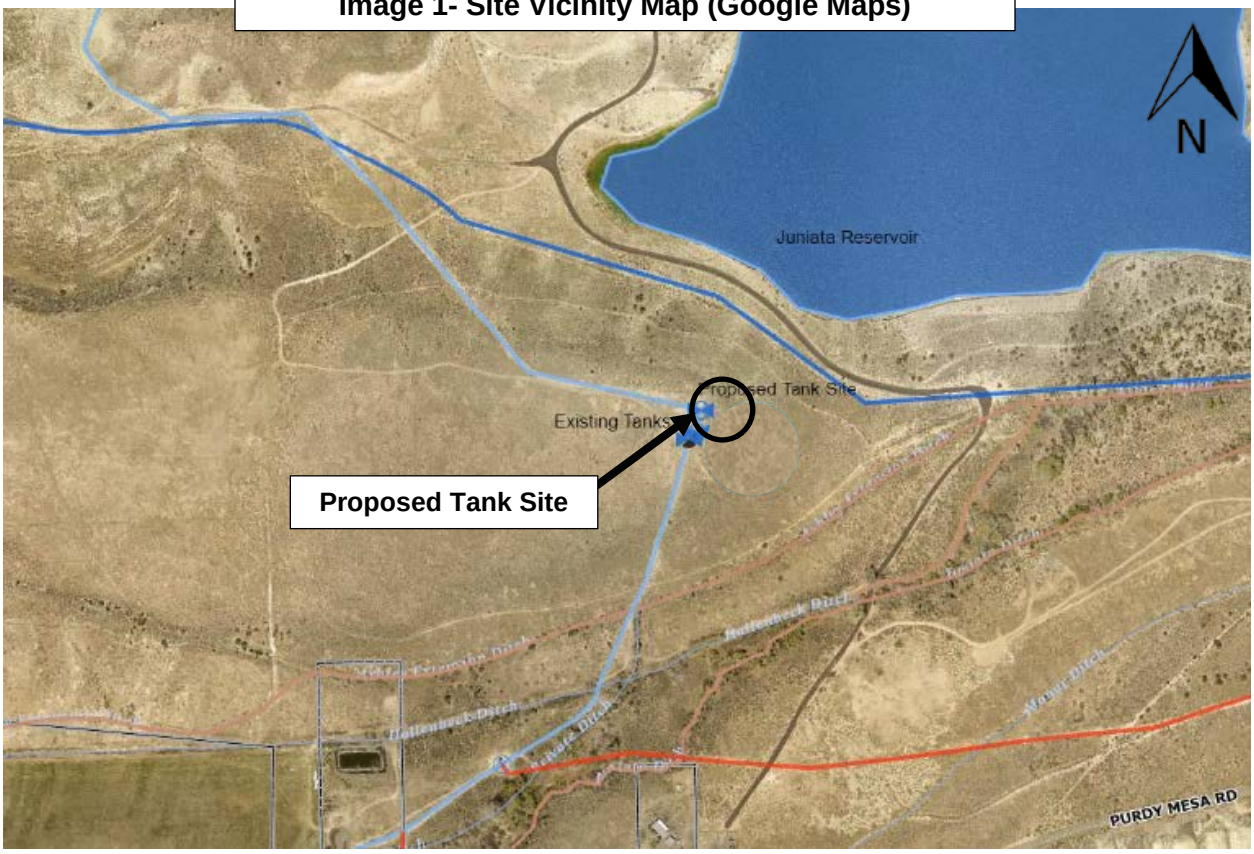
ATTACHMENTS

1.0 PROJECT PURPOSE AND DESCRIPTION

This report documents the Geotechnical Investigation performed by RockSol Consulting Group, Inc. (RockSol) to assist with the design of the proposed Juniata Structural Water Tank Project for the City of Grand Junction (See Image 1). The proposed structure is a water tank on the southwest side of the Juniata Reservoir, adjacent to several existing underground water tanks.

An initial geotechnical investigation was performed for the preliminary tank located approximately 30 feet south of the current proposed configuration. Information from the original investigation will be included in this report when relevant to the new location.

Image 1- Site Vicinity Map (Google Maps)



The scope of work for this geotechnical investigation included:

- Performing the necessary subsurface investigation including the collection of samples as required at the borehole locations were provided by JVA, Inc. (JVA).
- Performing appropriate laboratory tests and analyzing the data to determine strength, allowable bearing capacity, and corrosivity of foundation material.
- Identifying geologic conditions at the site.
- Providing recommendations for structure foundation type, bearing capacity for recommended foundations, lateral earth pressures, where needed, and recommendations for drainage, grading, and general earthwork.
- Providing seismic site class in accordance with the 2018 International Building Code (IBC)

- Preparing a Geotechnical Investigation Report summarizing the subsurface conditions encountered, the results of the laboratory testing, geological conditions, geotechnical parameters for foundation design, and earthwork recommendations.

2.0 PROJECT SITE CONDITIONS

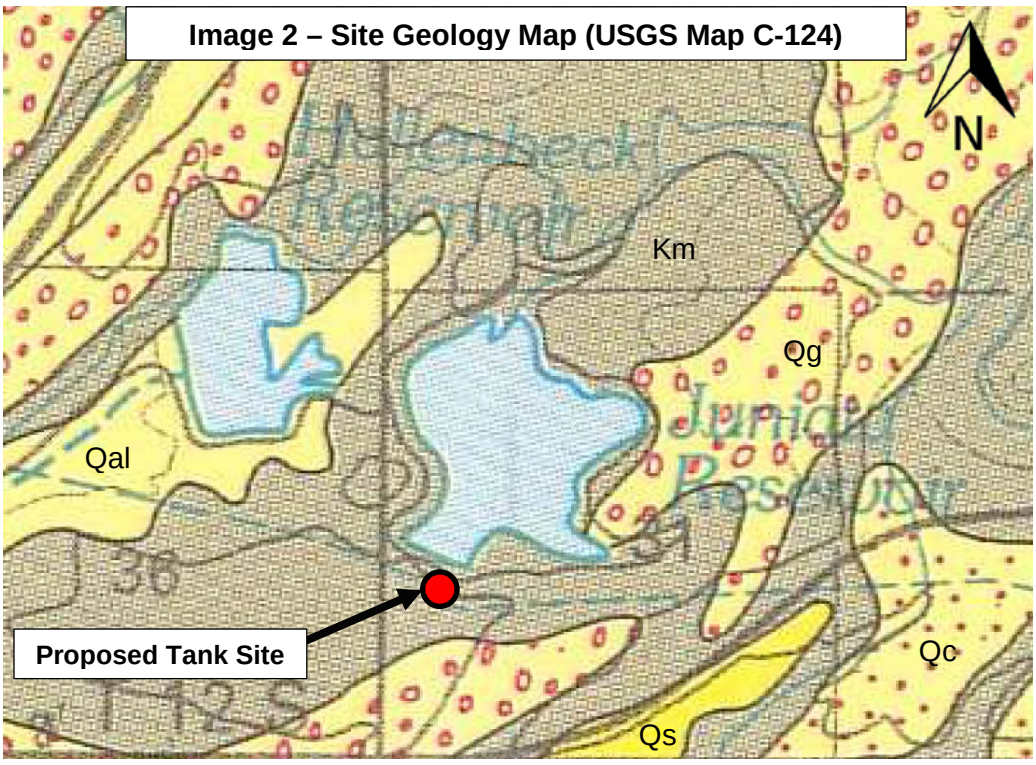
The project site is on a hill located approximately 600 feet southwest of the Juniata Reservoir, and approximately 150 feet higher in elevation than the reservoir's high-water level. The proposed improvements include a new, above ground water tank adjacent to the underground water tanks currently on the hill. The surrounding land is primarily recreational with isolated agricultural and residential properties in the vicinity. Topography at the general project area consists of mild to steep downward slopes surrounding the project area.

3.0 GEOLOGICAL CONDITIONS

Geologic information about the project site and site vicinity is presented in the United States Geological Survey (USGS) *Geologic Map and Cross Sections of Parts of the Grand Junction and Delta 30' x 60' Quadrangles, West-Central Colorado (USGS Coal Investigations Map C-124)* by Margaret S. Elis and Virginia Gabaldo, dated 1989 (See Image 2, Site Geology Map below).

Based on the USGS map, the site is underlain by a sedimentary bedrock formation of Mancos Shale (Km) which consists mostly of gray shale and minor sandstone. The Mancos Shale extends to significant depths. Surficial deposits at and near the project site include alluvial deposits (Qal) of well-rounded boulder to clay-size debris, and terrace and pediment gravel (Qg), colluvium (Qc) and undifferentiated surficial deposits (Qs).

Image 2 – Site Geology Map (USGS Map C-124)



Potential Geologic Hazards

Based on our soil borings, laboratory results and understanding of the site geologic conditions, expansive soils (Mancos Shale) encountered at this site may impact the proposed development. Further discussion of the expansive soils is presented in Section 6.1 of this report.

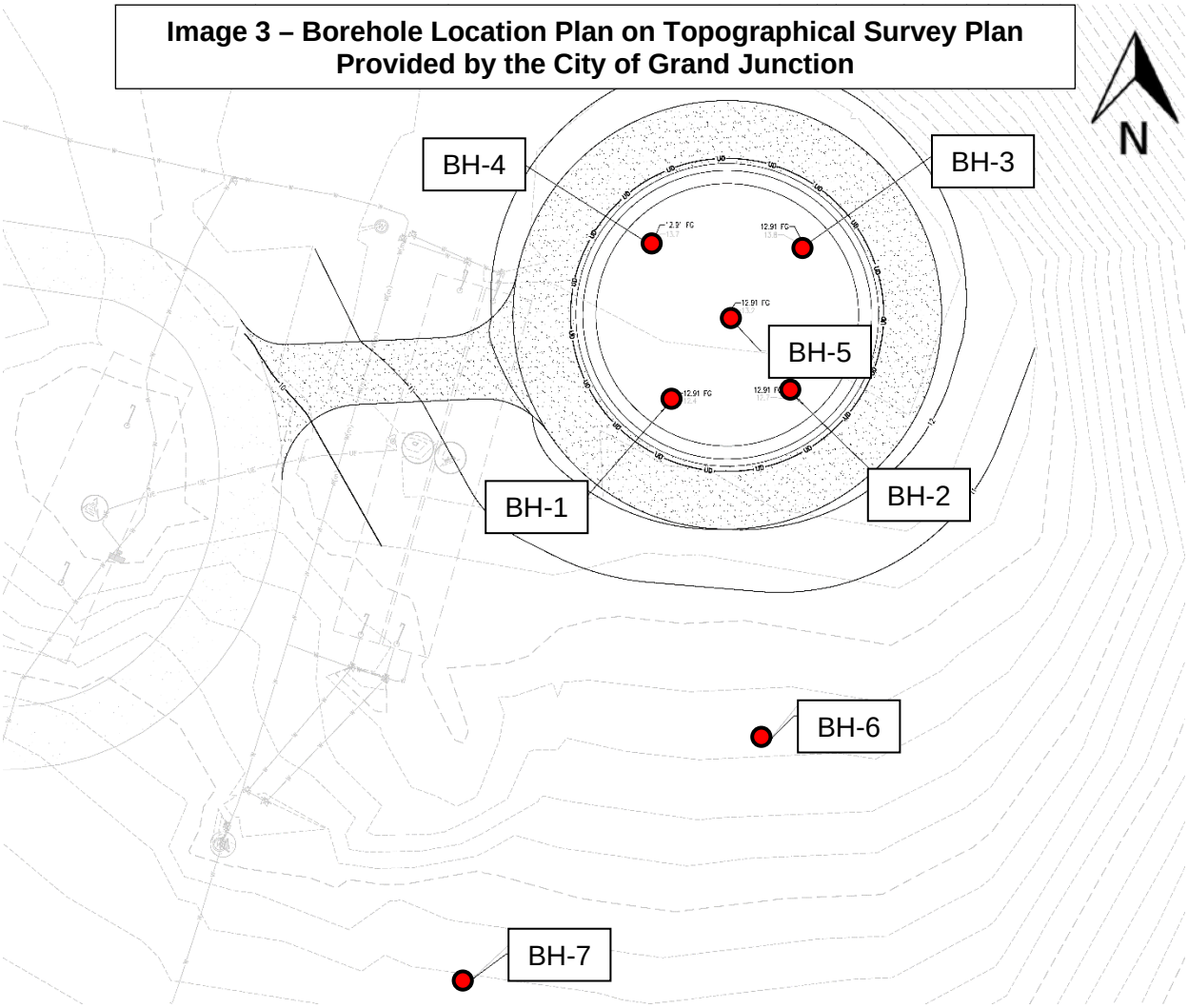
Due to the topography of the site, slope instability is considered a potential site geologic hazard depending on the final location chosen for the tank; site excavations must consider potential shoring and stabilization requirements, with special consideration for soil slopes over an underlying sloping shale bedrock surface.

4.0 SUBSURFACE EXPLORATION SUMMARY

For this investigation, RockSol completed seven total boreholes in two phases. Phase 1, performed at the original proposed tank location on August 23, 2022, included drilling and sampling of Boreholes BH-1, BH-6, and BH-7. Phase 2, performed at the new site location on March 6, 2023, included drilling and sampling of Boreholes BH-2 through BH-5 (see Image 3).

Boreholes BH-1 through BH-5 were proposed within the proposed water tank area by JVA and located in the field by the City of Grand Junction. They were advanced to total depths ranging from 5 feet to 20.0 feet below existing grade. Boreholes BH-6 and BH-7 were drilled outside of the planned water tank area to depths of 18.7 feet and 23.4 feet respectively. See Image 3 for approximate borehole locations overlayed on a topographical survey plan of the area. The full topographical plan sheet is provided in Appendix A.

Image 3 – Borehole Location Plan on Topographical Survey Plan Provided by the City of Grand Junction



Boreholes were advanced with Simco 2800 HS/HT truck mounted drill rig using 8-inch outside diameter hollow stem auger at Borehole BH-1 and 4-inch outside diameter solid stem auger at Boreholes BH-2 through BH-7. The boreholes were logged in the field by a representative of RockSol. All boreholes were backfilled after completion of drilling.

Subsurface materials were sampled and resistance of the soil to penetration of the sampler was performed using modified California barrel and standard split spoon samplers. Penetration Tests were performed using an automatic lift system and a hammer weighing 140 pounds falling 30 inches. The modified California barrel sampler has an outside diameter of approximately 2.5 inches and an inside diameter of 2 inches. The standard split spoon sampler used had an outside diameter of 2 inches and an inside diameter of 1⅜-inches. Brass tube liners were used with the modified California barrel sampler. Brass tube liners are not used with the standard split spoon sampler.

The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586. The modified California Barrel sampling method is similar to the SPT test with the difference being the sampler dimensions and the number of 6-inch intervals driven with the hammer per ASTM D-3550. It is RockSol's experience that blow counts obtained with the modified California sampler tend to be slightly greater than a standard split spoon sampler.

Subsurface materials were identified in the field by a representative of RockSol using visual-manual methods as described in ASTM D-2488. Penetration resistance values (blow counts) were recorded for each sampling event. Blow counts, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were taken, the type of sampler used, and the blow counts that were obtained are shown on the Borehole Logs (See Appendix B).

Each borehole location was surveyed by the City of Grand Junction and ground surface elevation and location (easting and northing) was provided to RockSol for inclusion on the individual borehole logs presented in Appendix B.

5.0 LABORATORY TESTING

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. The following laboratory tests were performed in accordance with the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and current local practices:

- Natural Moisture Content (ASTM D-2216)
- Percent Passing No. 200 Sieve (ASTM D-1140)
- Liquid and Plastic Limits (ASTM D-4318)
- Dry Density (ASTM D-2937)
- Gradation (ASTM D-6913)
- Water-Soluble Sulfates (CDOT CP-L 2103)
- Soil Classification (ASTM D-2487 and AASHTO M145)
- Soil Resistivity (ASTM G187 - Soil Box)
- Swell Test (Denver Swell Test, modified from ASTM D-4546)

Laboratory test results were used to characterize the engineering properties of the subsurface material encountered. For soil classification, RockSol conducted sieve analyses and Atterberg Limits tests. Swell tests were used to determine the swell or consolidation characteristics of the subsurface materials. Lab testing was also performed on selected samples to determine the water-soluble sulfate content of subsurface materials to assist with cement type recommendations.

All laboratory tests were performed by RockSol. Laboratory test results are presented in Appendix C and are also summarized on the Borehole Logs presented in Appendix B.

6.0 SUBGRADE CHARACTERIZATION

Subsurface conditions encountered in Boreholes BH-1 through BH-7 generally consisted of approximately 12 to 17 feet of native sand and gravel with rounded and angular cobbles, silt, and clay in parts. Some boulders of varying sizes were observed on the ground surface at the subject site. This is consistent with the boulder to clay-sized deposits and terrace and pediment gravel identified near the proposed site in Section 3.0. See Image 4 for surficial cobbles, gravel and small boulders found near the borehole locations. Additional images of the site conditions are presented in Appendix D.

Image 4 – Surficial Cobbles and Small Boulders near Borehole BH-6

The sedimentary bedrock encountered below the overburden soils in Boreholes BH-2 through BH-7 is Mancos Shale. Bedrock encountered in Boreholes BH-2 through BH-5 is at an approximate elevation of 5,897 feet. Bedrock was not encountered to the total depth drilled of 5 feet in Borehole BH-1, and bedrock encountered in BH-6 and BH-7 indicates the bedrock slopes downwards away from the hilltop. Groundwater was not encountered in any borehole at the time of drilling.

6.1 Swell/Consolidation Potential of Subgrade Soils

Based on plasticity index (PI) testing, the subgrade soils above the Mancos Shale exhibit low to no swell potential. Based on swell test results, the Mancos Shale bedrock exhibits moderate to very high swell potential (4.7 percent swell to 17.3 percent swell). Four swell tests were performed on samples of Mancos Shale obtained from our boreholes and are summarized in Table 1, and presented in laboratory output sheets in Appendix C and on the individual borehole logs found in Appendix B.

Table 1 – Mancos Shale Swell Test Summary

Borehole Location	Approximate Sample Depth (feet)	Approximate Sample Elevation (feet)	Swell Test Surcharge (psf)	Swell (%)
BH-4	19	5,894.7	1,000	5.9
BH-6	18	5,890.9	200	11.1
BH-7	18	5,885.0	200	4.7
BH-7	23	5,880.0	200	17.3

Based on swell/consolidation and penetration data obtained from the boreholes, RockSol recommends an underdrain system be installed to mitigate swell risk from the Mancos Shale and reduce frost heave potential for a shallow foundation. See Section 8.0 for more details.

6.2 Cement Type/Sulfate Resistance

The City of Grand Junction uses the 2018 International Building Code (IBC 2018) for development of concrete sulfate resistance. The IBC 2018 references the American Concrete Institute (ACI) for

such parameters. Cementitious material requirements for concrete in contact with site soils or groundwater are based on the percentage of water-soluble sulfate in either soil or groundwater that will be in contact with concrete constructed for this project. Mix design requirements for concrete exposed to water-soluble sulfates in soils or water is considered by the ACI as shown in Table 2 and in the Building Code Requirements for Structural Concrete (ACI 318-14) (ACI Tables 19.3.1.1 & 19.3.2.1).

Table 2 - Requirements to for Concrete by Sulfate Exposure Class

Exposure Class	Water-soluble sulfate (SO_4), in dry soil, percent	Water Cementitious Ratio, maximum	Cementitious Material Requirements (ASTM C150)	Minimum Compressive Strength (psi)
S0	0.00 to <0.10	Not Applicable	No Restriction	2500
S1	0.10 to < 0.20	0.50	Type II	4000
S2	0.20 to 2.0	0.45	Type V	4500
S3	2.01 or greater	0.45	Type V plus pozzolan	4500

The concentration of water-soluble sulfates measured in soil samples obtained from RockSol's exploratory boreholes varied from 0.04 percent to 1.52 percent (See Appendices B and C). Based on the results of the water-soluble sulfate testing, Exposure Class S2 is recommended for concrete in contact with subgrade materials for the project. For Exposure Class S2, Type V cement is recommended. A compressive concrete strength of 4,500 psi is also recommended for the S2 Exposure Class.

6.3 Corrosion Resistance

To help evaluate the potential corrosivity conditions of the in-situ soils, water-soluble sulfate test results discussed in Section 6.2 were compared to *Table 1 - Guidelines for Selection of Corrosion Resistance Levels* as presented in the *CDOT Pipe Materials Selection Guide,* dated April 30, 2015. Table 3 summarizes the data and the Corrosion Resistance (CR) Level as determined by CDOT as it relates to drainage pipes.

Table 3 – CDOT Corrosion Resistance Summary

Borehole Location	Sample Depth (ft)	Water-Soluble Sulfate (% by weight)	CDOT CR Level
BH-1	0-5	1.52	CR 5
BH-2	10-15	1.44	CR 5
BH-2	15	0.12	CR 2
BH-3	17	1.48	CR 5
BH-4	0-5	0.04	CR 0
BH-4	19	0.08	CR 1
BH-5	16	0.66	CR 4
BH-6	0-10	1.48	CR 5
BH-6	13	0.82	CR 4
BH-6	18	1.12	CR 5
BH-7	18	1.36	CR 5

The test data indicates the overburden soils and the Mancos Shale have elevated levels of water-soluble sulfates. Due to elevated sulfate content, careful consideration for water tank pipe material type should be accounted for and it should be noted that there is higher potential for metallic materials to experience corrosion in soils with elevated water-soluble sulfates.

In addition, an electrical resistivity test was performed on the bulk soil sample obtained from 0 to 5 feet at Borehole BH-1. The test was performed in the RockSol laboratory using the soil box method (ASTM G-187) and resulted in a minimum electrical resistivity of 4,200 ohm-cm at a moisture content of 10.0%. A second resistivity test on the same sample resulted in a resistivity of 13,000 ohm-cm at a moisture content of 6.2%. This indicates a significantly lower electrical resistivity will occur under higher soil moisture conditions, and an aggressive soil condition may be present at the site if a significant increase in soil moisture occurs. Cathodic protection may be considered, along with other methods of protection and further evaluation by a corrosion engineer should be considered.

7.0 SEISMICITY

The City of Grand Junction uses the 2018 International Building Code (IBC-2018) for development of seismic design parameters. The IBC-2018 references the American Society of Civil Engineers 7-16 (ASCE 7-16) seismic design code. Seismic design parameters were obtained from the United States Geological Survey (USGS) Earthquake Design Maps using the 2018 International Building Code specifications which reference ASCE 7-16. Values were obtained using the USGS site: https://seismicmaps.org.

7.1 Seismic Design Parameters

Based on the Standard Penetration Resistance encountered for the onsite subsurface conditions, it is our opinion that the Juniata structural water tank site meets the criteria for Seismic Site Class C. Shear wave velocity testing was not performed by RockSol. The IBC classifies public utility facilities as Risk Category III structures (per Table 1604.5 of the *IBC-2018)*. Interpolated values for Peak Ground Acceleration Coefficient (PGA), Spectral Acceleration Coefficient at Period 0.2 sec (S_s), and Spectral Acceleration Coefficient at Period 1.0 sec (S_1) were obtained using the latitude and longitude for the site. The seismic acceleration coefficients obtained (data based on 0.05-degree grid spacing) are presented in Table 4.

Table 4 – Seismic Acceleration Coefficients (IBC 2018)

Juniata Water Tank Location (Latitude°/Longitude°)	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)
38.9623 N/ 108.2835W	0.144	0.256	0.067

The acceleration coefficients are then used to obtain Site Factors F_a, and F_v based on the defined Site Class as shown in Tables 1613.2.3(1) and 1613.2.3(2) of the *IBC-2018*. A summary of the Site Factor values obtained are shown in Table 5.

Table 5 – Seismic Site Factor Values

Juniata Water Tank Location (Latitude°/Longitude°)	F_{pga} (at zero-period on acceleration spectrum)	F_a (for short period range of acceleration spectrum)	F_v (for long period range of acceleration spectrum)
38.9623 N/ 108.2835W	1.256	1.3	1.5

Table 6 summarizes the Seismic Zone determination and horizontal response spectral Acceleration Coefficients (S_{D1}) and (S_{DS}) obtained for the proposed structures. Seismic Performance Zone determination is based on the value of the horizontal response spectral Acceleration Coefficient at 1.0 Seconds, S_{D1}, as determined by *Eq. 16-39* of the IBC-2018 and

the horizontal response spectral Acceleration Coefficient at 0.2 Seconds, S_{DS}, as determined by *Eq. 16-38.* Values for S_1 and F_v are presented in Tables 4 and 5, shown above. The seismic performance zone was determined *IBC-2018* Tables 1613.2.5(1) and (2). Seismic Design output sheets are summarized in Appendix E.

Table 6 – Seismic Performance Zone

Juniata Water Tank Location (Latitude°/Longitude°)	Acceleration Coefficient at 1.0 seconds (S_{D1})	Acceleration Coefficient at 0.2 seconds (S_{DS})	Seismic Design Category (1)
38.9623 N/ 108.2835W	0.067	0.221	B
Note (1): Seismic Design Category B (for Risk Category III) is assigned when *0.067g ≤ S_{D1} < 0.133g and 0.167g ≤ S_{DS} < 0.330g*			

8.0 GEOTECHNICAL FOUNDATION RECOMMENDATIONS

The structural water tank is proposed to be located near the existing, underground water tanks. The proposed water tank has an approximate 60-foot diameter, with a minimum 12-foot workspace surrounding the tank. The proposed tank will be approximately 18 feet tall and be filled to a maximum water level of approximately 17 feet. A mat slab foundation and a drilled shaft foundation are feasible for this structure.

Groundwater was not encountered to the maximum depth explored of 23.4 feet (elevation 5,880 feet) at the time of drilling. Temporary lowering of the groundwater at the foundation location is not likely to be required during construction. Permanent dewatering or deep subsurface drainage system is not anticipated to control natural groundwater at this location. To manage stormwater infiltration, or potential discharges from the water tank, RockSol recommends a subsurface drainage system at the bottom of the structural fill along the perimeter of the structure. The drainage system outlet should daylight at least 25 feet from any structures or roadways.

Bearing soils are based on information obtained from Boreholes BH-1 through BH-5 which showed overburden soils of dense gravel and cobbles with clay, silt, and sand. Below the overburden material, very hard Mancos Shale bedrock was encountered in Boreholes BH-2 through BH-5 at elevations of approximately 5,897 feet.

Shallow Foundation (Mat Slab) Recommendations:

A mat slab shallow foundation is a feasible system for the 60-foot diameter structural water tank. Based on information provided by JVA, the maximum water level in the tank is approximately 17 feet. Foundation design parameters were developed based on the American Water Works Association (AWWA) Standard D110-13 (R18), which references the American Concrete Institute (ACI). Values for ultimate and allowable bearing capacities based on ACI 372R-13 are presented in Table 7 for a shallow foundation system. A safety factor of 3 is used to determine the factored bearing resistance for the strength limit state evaluation.

Based on the proposed bottom-of-tank elevation of approximately 5,912 feet, RockSol recommends over-excavation of at least one foot below the bottom of the mat and replacement with properly compacted CDOT Class 1 Structure Fill to provide a uniform bearing surface material. Doing so will eliminate frost heave potential and subgrade soil swell potential.

Service bearing resistances for the proposed foundation on CDOT Class 1 Structure Fill were correlated to estimated total settlement of less than 1 inch. Based on our settlement evaluation

and borehole data collected, differential settlement less than a half-inch is expected across the water tank building footprint, and the foundation is expected to meet the settlement requirements outlined in ACI 372R-13 Section A.3.2

Table 7 – Bearing Resistance Recommendations

Foundation Type	Bottom of Foundation Elevation (ft)	Strength Limit State		Service Limit State (LRFD)
		Ultimate Resistance (ksf)	Allowable Resistance (ksf)	Service Bearing Resistance (ksf)
Mat Slab	Approximately 5,912	23.1	7.7	2.0

Deep Foundation (Drilled Shaft) Recommendations:

A drilled shaft deep foundation is also feasible for the structural water tank. Drilled shafts will provide support by embedment into the Mancos Shale bedrock. Based on the subsurface conditions encountered, it is anticipated that hard to very hard bedrock will be encountered at an approximate elevation of 5,897 feet.

Based on our evaluation, recommended Load and Resistance Factor Design (LRFD) nominal (unfactored) base resistance and nominal (unfactored) side resistance values for the bedrock material are presented in Table 8.

Table 8 – LRFD Base and Side Resistance Values for Drilled Shafts

Bearing Stratum	Approximate Stratum Elevation (Note 1)	Ultimate (Nominal) Resistance		Service Resistance	
		Bearing (ksf)	Side (ksf)	Bearing (ksf)	Side (ksf)
Gravel/Cobbles with Clay and Sand	Above 5,887 feet	–	0.5	–	0.2
SHALE Bedrock	Below 5,887 feet	36	1.6	18	0.8

Note 1: Approximate stratum elevations may be revised after selection of a final location and size of the proposed water tank.

The side resistance is applicable to the portion of the shaft embedded in bedrock and the dense sandy, clayey, and gravelly layer. When evaluating the side resistance of the drilled shaft, the upper 5 feet of the shaft should be ignored. For LRFD strength limit state evaluation, a resistance factor of 0.50 is recommended for base/ tip resistance and a resistance factor of 0.50 is recommended for side resistance evaluation for redundant single shafts.

For axial bearing, a minimum shaft embedment into bedrock of 5 feet is recommended. Additional embedment may be necessary to satisfy axial bearing requirements and for lateral stability requirements as determined by the structural engineer.

Drilled shaft diameters shall be sufficient to satisfy axial, bending, and lateral load resistance requirements. In addition, the shaft diameters shall be sufficient to allow for use of casing, if required, and placement of reinforcement with adequate concrete cover.

Additional design and construction considerations for drilled shafts are presented below.

(a) The construction of the drilled shafts should follow the guidelines specified in the “CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 503, 2022.”

(b) During construction of drilled shafts, casing or slurry methods may be required to support the excavation where holes are unstable due to caving soil conditions above the Mancos Shale bedrock, or due to potential groundwater. RockSol anticipates that caving may occur as a result of drilling equipment entering and exiting the excavation.

(c) Prior to the placement of the concrete, the drilled shaft excavation, including the bottom, should be cleaned of all loose material. For wet conditions (more than two inches of water), concrete placement by "tremie" methods should be used.

(d) Lateral load capacity of the drilled shafts should be evaluated. Geotechnical parameters for evaluation of lateral load capacity are provided in Table 9.

(e) All piers should be reinforced as required for resistance to axial, bending, lateral and uplift stresses.

(f) Drilled shafts should be constructed with spacing at least four shaft diameters center to center. For closely spaced drilled shafts, the axial and lateral capacities should be appropriately reduced. Group action of drilled shafts should be analyzed on an individual basis to assess the appropriate reduction.

Lateral Resistance Parameters

Recommended lateral resistance parameters for drilled shafts are presented in Table 9. The parameters listed are for use with LPILE® or equivalent software. Material properties are based on SPT and PT blow counts.

Table 9 - Drilled Shaft Lateral Resistance Parameters

Borehole Material	L-Pile Soil Type	Undrained Shear Strength (psf)	Angle of Internal Friction (degrees)	Subgrade Reaction Coefficient (pci)	Strain Facto ε_{50} (%)	Unit Weight (pcf)
CDOT Class 1 Structure Backfill (CDOT Section 703.08)	Sand	0	34	60	----	125 (Total)
(Native) GRAVEL, Cobbly with Sand and Clay	Sand	0	34	125	----	130 (Total)
Claystone Bedrock (Mancos Shale)	Stiff clay w/o free water	4,000	0	1,000	0.005	135 (Total)

Total unit weight indicated in Table 9 includes soil plus moisture content. Depths at which groundwater were encountered are indicated on the attached borehole logs in Appendix B.

9.0 EARTHWORK

Materials used to construct embankment, structure backfill, and aggregate base course materials should meet the material and moisture density control requirements specified in Article IV of the Mesa County Standard Specifications for Road and Bridge Construction and City of Grand Junction Transportation Engineering Design Standards (current editions). On-site materials may be used to construct embankments if they meet these requirements.

A 12-foot workspace is proposed around the tank. Broken concrete, broken asphalt, or other solid materials more than 3 inches in greatest dimension shall not be placed within the upper 12 inches of subgrade areas supporting this workspace or other flatwork.

Material excavated for utility trenches may be used for backfilling provided it does not contain unsuitable material or particles larger than 6 inches and does not impair the integrity of the utility in the trench. Unsuitable material includes, but is limited to, topsoil, vegetation, brush, sod, trash, and other deleterious substances.

Prior to construction of new concrete flatwork or improvements to the existing vehicle pathway, the underlying subgrade should be properly prepared by removal of all organic matter (topsoil), debris, loose material, and any deleterious material followed by scarification, moisture conditioning and recompaction. The minimum depth of scarification, moisture conditioning and re-compaction in all cases shall be 6 inches. Cobbles greater than 3 inches and boulders are expected to be encountered at or near the surface and must be removed from the scarification zone as well.

Unsupported temporary excavation slopes in the existing soils and new embankment must not be steeper than 1.5H:1V. Excavations that cannot meet 1.5H:1V, or flatter, will require temporary shoring.

New unsupported embankment slopes shall not be steeper than 3H:1V and if required to support any structure, additional evaluation of slope stability will be required.

10.0 SURFACE AND SUBSURFACE DRAINAGE

Final site surface grades shall be designed to prevent water from precipitation events from collecting adjacent to the water tank structure. Surface drainage patterns may be altered during construction and must be controlled to prevent excessive moisture infiltration into the site subgrade soils during construction.

Based on the conditions encountered in our boreholes, groundwater was not noted to the depths explored. Even though groundwater was not encountered, RockSol recommends a subsurface drainage system be constructed to manage water infiltration and surface runoff, as described in Section 8.0.

11.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices, in accordance with City of Grand Junction Transportation Engineering Design Standards, should be followed during site preparation, structure and earthwork excavations for the suitable long-term performance of the proposed improvements.

Excavation support should be provided to maintain onsite safety and the stability of excavations and slopes. Excavations shall be constructed in accordance with local, state, and federal regulations including OSHA guidelines. The contractor must provide a competent person to determine compliance with OSHA excavation requirements. For preliminary planning, existing fill material and native soils may be considered as OSHA Type C soils. Unsupported temporary excavations in the existing soils must not be steeper than 1.5H:1V. Excavations that cannot meet 1.5H:1V, or flatter, will require temporary shoring.

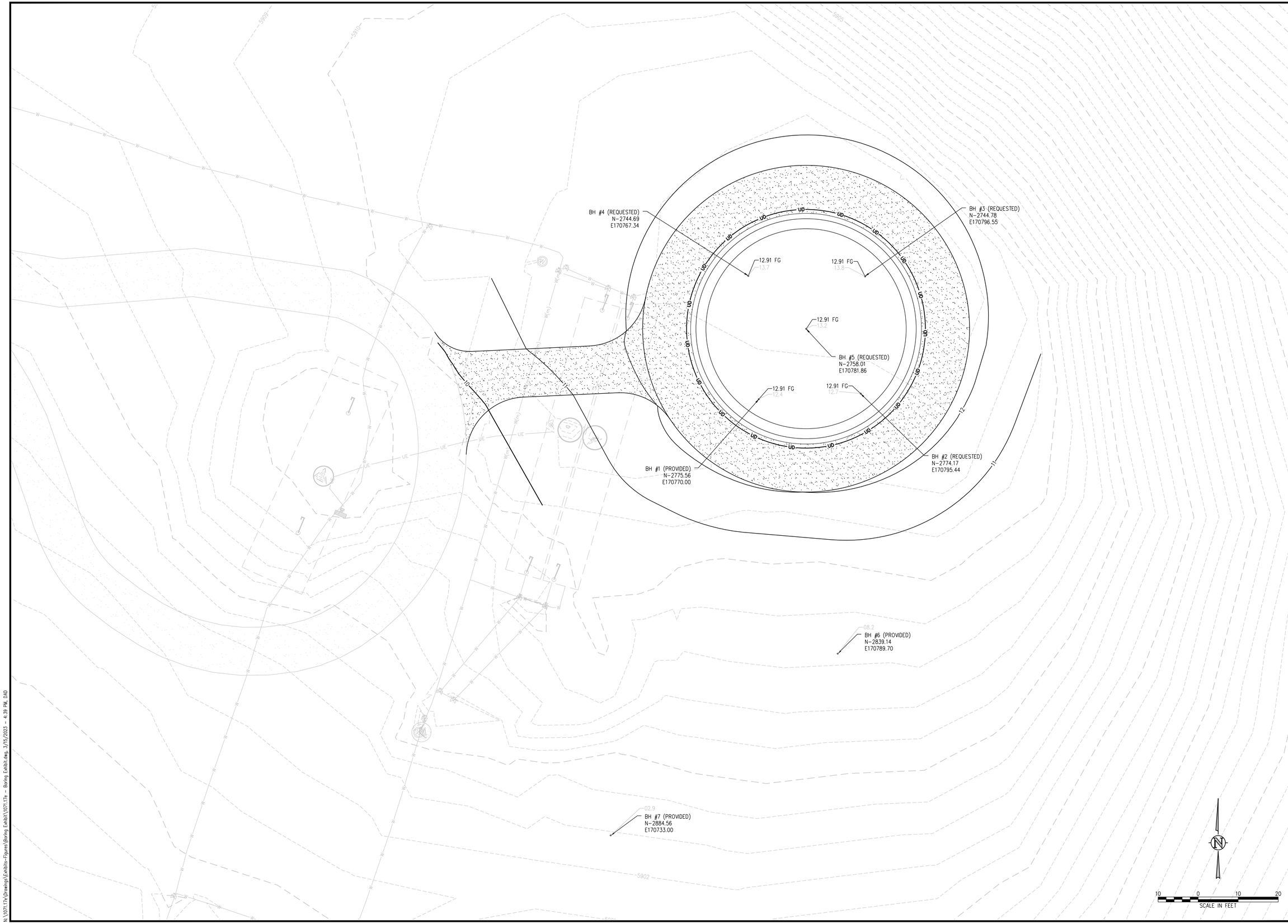
Environmentally contaminated material, if encountered, should be characterized, and removed under the direction of the project environmental consultant. Design and construction plans should be reviewed, and onsite construction should be observed by the professional engineers.

12.0 LIMITATIONS

This geotechnical investigation was conducted in general accordance with the scope of work. RockSol's geotechnical practices are similar to those used in Colorado with similar soil conditions and based on our understanding of the proposed work. This report has been prepared for use by the City of Grand Junction for the project described in this report. The report is based on our exploratory boreholes and does not consider variations in the subsurface conditions that may exist between boreholes. Additional investigation is required to address such variation. If during construction activities, materials or water conditions appear to be different from those described herein, RockSol should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. RockSol is not responsible for liability associated with interpretation of subsurface data by others.

APPENDIX A

PROJECT SITE TOPOGRAPHIC PLAN SHEET



JVA, Inc. 817 Colorado Ave., Suite 301
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Boulder • Fort Collins • Winter Park
Glenwood Springs • Denver

NO.	DATE	DES'D	DWN	REVISION DESCRIPTION

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
JOB #:	1071.17e
DATE:	JANUARY, 2023

CITY OF GRAND JUNCTION
KANNAH CREEK WTP TANK
GRAND JUNCTION, COLORADO

BORING EXHIBIT

SHEET NO.

FIG 1

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APPENDIX B

LEGEND AND BOREHOLE LOGS

RockSol Consulting Group, Inc.

LEGEND

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado

LITHOLOGY


Native - SAND, silty


Native - CLAY


Native - CLAY, sandy


Native - SILT, gravelly


Native - GRAVEL, silty


Bedrock - SHALE/CLAYSTONE

SAMPLE TYPE


BULK SAMPLE (Auger Cuttings)


GRAB SAMPLE
FROM CUTTINGS


MODIFIED CALIFORNIA SAMPLER
2.5" O.D. AND 2" I.D.
WITH BRASS LINERS INCLUDED


SPLIT SPOON SAMPLER
2" O.D. AND 1 3/8" I.D.
NO LINERS

Fines Content indicates amount of material, by weight, passing the US No 200 Sieve (%)

15/12 Indicates 15 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 12 inches.

50/11 Indicates 50 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 11 inches.

5,5,5 Indicates 5 blows, 5 blows, 5 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 18 inches.

RockSol Consulting Group, Inc.

BORING : BH-1

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 8/23/22 **COMPLETED** 8/23/22
GROUND ELEVATION 5912.4 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2775.6 **EAST** 170770.0
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: ~30' SE of the existing water tanks
LOGGED BY C. Shoen **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES 4 borings drilled within 25 feet of staked location
WATER DEPTH None Encountered on 8/23/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5912.4	0		(Native) CLAY with cobbles 3" to 1' with minimal vegetation cover										
5911.4	1		(Native) GRAVEL, with cobbles, clay, and sand, mildly moist to moist, brown, hard	GB						27	17	10	62.1
5910.4	2		**Approximate Bulk Depth 0-5** Liquid Limit= 25 Plastic Limit= 18 Plasticity Index= 7 Fines Content= 32.8 Sulfate= 1.52	BULK			1.52			25	18	7	32.8
5909.4	3			MC	39/12								
5908.4	4												
5907.4	5		Bottom of hole at 5.0 feet.										

LOG - STANDARD 599.61_JUNIATA WATER TANK.GPJ 3/22/23

RockSol Consulting Group, Inc.

BORING : BH-2

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 3/6/23 **COMPLETED** 3/6/23
GROUND ELEVATION 5912.7 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2774.2 **EAST** 170795.4
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: ~25' E of B-1
LOGGED BY A. Kachin **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 3/6/23

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5912.7	0		(Native) SAND, silty, with rock and cobbles, slightly moist, brown to light brown										
5907.7	5		**Approximate Bulk Depth 0-10** Liquid Limit= 23 Plastic Limit= 19 Plasticity Index= 4 Fines Content= 42.7	B BULK						23	19	4	42.7
5902.7	10		(Native) GRAVEL, silty with rock and cobbles, gray to light brown										
5897.7	15		**Approximate Bulk Depth 10-15** Liquid Limit= 18 Plastic Limit= 17 Plasticity Index= 1 Fines Content= 46.8 Sulfate= 1.44	B BULK			1.44			18	17	1	45.8
			(Bedrock) SHALE/CLAYSTONE, tan to brown, hard, trace iron staining and mica	MC	50/9	2.2	0.12	129.6	9.8				
			Bottom of hole at 16.0 feet.										

LOG - STANDARD 599.61 JUNIATA WATER TANK.GPJ 3/24/23

RockSol Consulting Group, Inc.

BORING : BH-3

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 3/6/23 **COMPLETED** 3/6/23
GROUND ELEVATION 5913.8 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2744.8 **EAST** 170796.6
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: ~50' NE of B-1
LOGGED BY A. Kachin **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES Refusal at 13', moved 10' SW
WATER DEPTH None Encountered on 3/6/23

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5913.8	0		(Native) SAND, silty, with gravel and cobbles in parts, slightly moist, brown to light brown										
5908.8	5												
5903.8	10		(Native) GRAVEL, with silt and cobbles, light gray **Approximate Bulk Depth 10-15** Liquid Limit= 21 Plastic Limit= 19 Plasticity Index= 2 Fines Content= 23.2	B BULK						21	19	2	23.2
5898.8	15		(Bedrock) SHALE/CLAYSTONE, brown, hard	MC	50/8		1.48	128.6	4.8				
			Bottom of hole at 18.0 feet.										

RockSol Consulting Group, Inc.

BORING : BH-4

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 3/6/23 **COMPLETED** 3/6/23
GROUND ELEVATION 5913.7 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2744.7 **EAST** 170767.3
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: ~40' N of B-1
LOGGED BY A. Kachin **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 3/6/23

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5913.7	0		(Native) SAND, silty, with cobbles and rock, slightly moist, brown, loose **Approximate Bulk Depth 0-5** Liquid Limit= 27 Plastic Limit= 24 Plasticity Index= 3 Fines Content= 37.3 Sulfate= 0.04	B) BULK			0.04			27	24	3	37.3
5908.7	5		(Native) SILT, with cobbles and gravel, light gray to gray										
5903.7	10												
5898.7	15		**Approximate Bulk Depth 15-17** Liquid Limit= 21 Plastic Limit= 17 Plasticity Index= 4 Fines Content= 40.2										
			(Native) GRAVEL, with silt, brown	B) BULK						21	17	4	40.2
			(Bedrock) SHALE/CLAYSTONE, tan to brown, hard, minor iron staining and mica										
5893.7	20			MC	50/8	5.9	0.08	123.5	12.8				
			Bottom of hole at 20.0 feet.										

LOG - STANDARD 599.61_JUNIATA WATER TANK.GPJ 3/22/23

RockSol Consulting Group, Inc.

BORING : BH-5

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 3/6/23 **COMPLETED** 3/6/23
GROUND ELEVATION 5913.2 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2758.0 **EAST** 170781.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: ~25' NE of B-1
LOGGED BY A. Kachin **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 3/6/23

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5913.2	0		(Native) SAND, silty, with gravel and cobbles, slightly moist, brown, loose										
5908.2	5												
5903.2	10												
			(Native) GRAVEL, with silt, light brown to gray **Approximate Bulk Depth 11-15** Liquid Limit= 20 Plastic Limit= 19 Plasticity Index= 1 Fines Content= 35.7	B BULK						20	19	1	35.7
5898.2	15												
			(Bedrock) SHALE/CLAYSTONE, tan to brown, hard, some mica seams	MC	15/5		0.66	126.8	9.6				
			Bottom of hole at 17.0 feet.										

LOG - STANDARD 599.61_JUNIATA WATER TANK.GPJ 3/22/23

RockSol Consulting Group, Inc.

BORING : BH-6

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 8/23/22 **COMPLETED** 8/23/22
GROUND ELEVATION 5908.2 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2839.1 **EAST** 170789.7
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: ~50' SSE of the existing water tanks
LOGGED BY C. Shoen **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 8/23/22

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5908.2	0	(Native) CLAY with cobbles 3" to 1' with minimal vegetation cover										
		(Native) GRAVEL, with cobbles, sand, and clay, mildly moist to moist, brown, hard										
5903.2	5	**Approximate Bulk Depth 0-10** Liquid Limit= 23 Plastic Limit= 16 Plasticity Index= 7 Fines Content= 41.6 Sulfate= 1.48	BULK			1.48			23	16	7	41.6
5898.2	10		GB						19	14	5	40.6
		(Bedrock) Claystone SHALE with sand in parts, moist, brown, hard to very hard, minimal iron staining and mica in parts										
			SS	23/35/37		0.82			37	17	20	92.9
5893.2	15											
			MC	86/9	11.1	1.12	127.5	9.2				
		Bottom of hole at 18.7 feet.										

LOG - STANDARD 599.61_JUNIATA WATER TANK.GPJ 3/22/23

RockSol Consulting Group, Inc.

BORING : BH-7

CLIENT City of Grand Junction
PROJECT NAME Juniata Structural Water Tank Foundation
PROJECT NUMBER 599.61
PROJECT LOCATION Mesa County, Colorado
DATE STARTED 8/23/22 **COMPLETED** 8/23/22
GROUND ELEVATION 5902.9 ft **STATION NO.**
DRILLING CONTRACTOR Colorado Drilling and Sampling
NORTH -2884.6 **EAST** 170733.0
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: ~80' S of the existing water tanks
LOGGED BY C. Shoen **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 8/23/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5902.9	0		(Native) CLAY, sandy with cobbles 3" to 1' with minimal vegetation cover										
			(Native) CLAY, sandy, dry, light gray to white **Approximate Bulk Depth 0-10** Liquid Limit= 24 Plastic Limit= 15 Plasticity Index= 9 Fines Content= 68.3										
5897.9	5		(Native) GRAVEL, with cobbles, clay, and sand, mildly moist to moist, brown, hard	B BULK						24	15	9	68.3
5892.9	10												
5887.9	15		(Bedrock) Claystone SHALE with sand in parts, moist, orange to grey, very hard, iron staining in parts	MC	90/9	4.7	1.36	-122.0	9.6				
5882.9	20												
			Bottom of hole at 23.4 feet.	MC	50/4	17.3		126.9	9.2				93.1

LOG - STANDARD 599.61_JUNIATA WATER TANK.GPJ 3/22/23

APPENDIX C

SUMMARY OF LABORATORY TESTING

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61

PROJECT LOCATION Mesa County, Colorado

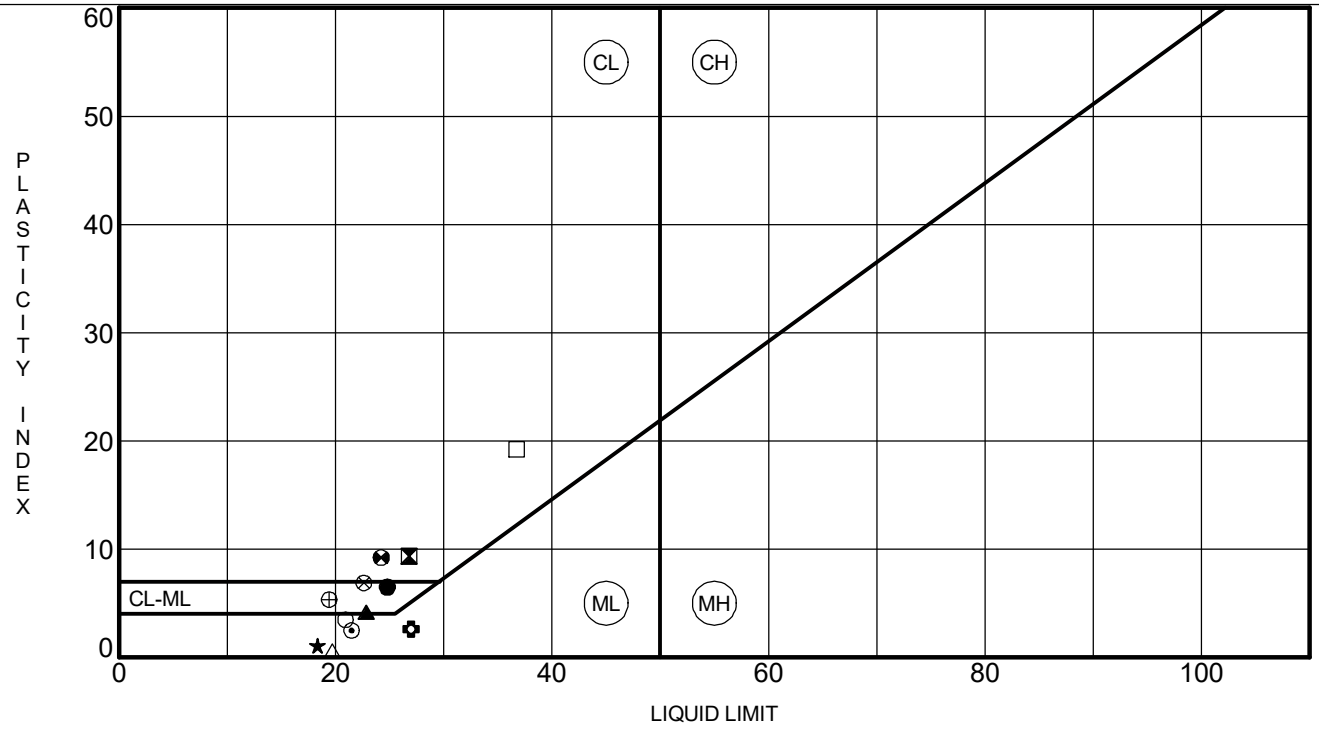
Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BH-1	0-5	25	18	7		33	SC-SM	A-2-4 (0)				1.52	4200 @ 10.0%			118.1	11.3	S
BH-1	1	27	17	10		62	CL	A-4 (4)										
BH-2	0-10	23	19	4		43	SC-SM	A-4 (0)										
BH-2	10-15	18	17	1		46	SM	A-4 (0)				1.44		7.7				
BH-2	15				2.2				9.8	129.6		0.12						
BH-3	10-15	21	19	2		23	SM	A-1-b (0)										
BH-3	17								4.8	128.6		1.48						
BH-4	0-5	27	24	3		37	SM	A-4 (0)				0.04						
BH-4	15-17	21	17	4		40	SC-SM	A-4 (0)										
BH-4	19				5.9				12.8	123.5		0.08						
BH-5	11-15	20	19	1		36	SM	A-4 (0)										
BH-5	16								9.6	126.8		0.66						
BH-6	0-10	23	16	7		42	SC-SM	A-4 (0)				1.48						
BH-6	11	19	14	5		41	SC-SM	A-4 (0)										
BH-6	13	37	17	20		93	CL	A-6 (19)				0.82						
BH-6	18				11.1				9.2	127.5		1.12						
BH-7	0-10	24	15	9		68	CL	A-4 (3)										
BH-7	18				4.7				9.6	-122.0		1.36						
BH-7	23				17.3	93			9.2	126.9								

RockSol Consulting Group, Inc.

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



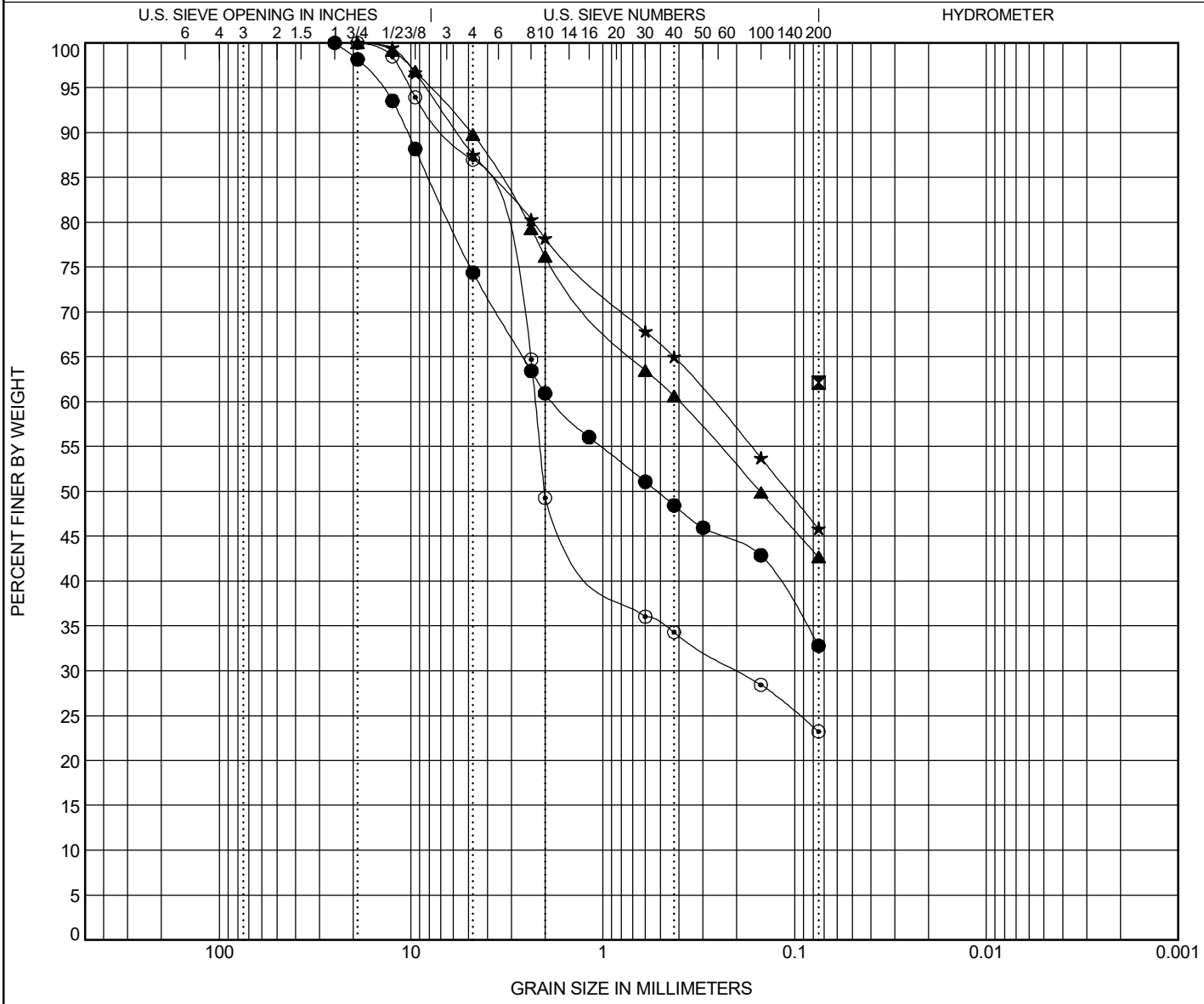
	Specimen Identification		LL	PL	PI	Fines	Classification
●	BH-1	0.0-5.0	25	18	7	32.8	SILTY, CLAYEY SAND with GRAVEL (SC-SM) (A-2-4)
⊠	BH-1	1.0	27	17	10	62.1	SANDY LEAN CLAY (CL) (A-4)
▲	BH-2	0.0-10.0	23	19	4	42.7	SILTY, CLAYEY SAND (SC-SM) (A-4)
★	BH-2	10.0-15.0	18	17	1	45.8	SILTY SAND (SM) (A-4)
⊙	BH-3	10.0-15.0	21	19	2	23.2	SILTY SAND (SM) (A-1-b)
✿	BH-4	0.0-5.0	27	24	3	37.3	SILTY SAND with GRAVEL (SM) (A-4)
○	BH-4	15.0-17.0	21	17	4	40.2	SILTY, CLAYEY SAND (SC-SM) (A-4)
△	BH-5	11.0-15.0	20	19	1	35.7	SILTY SAND with GRAVEL (SM) (A-4)
⊗	BH-6	0.0-10.0	23	16	7	41.6	SILTY, CLAYEY SAND (SC-SM) (A-4)
⊕	BH-6	11.0	19	14	5	40.6	SILTY, CLAYEY SAND (SC-SM) (A-4)
□	BH-6	13.0	37	17	20	92.9	LEAN CLAY (CL) (A-6)
⊛	BH-7	0.0-10.0	24	15	9	68.3	SANDY LEAN CLAY (CL) (A-4)

GRAIN SIZE DISTRIBUTION

RockSol

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH-1	0.0-5.0	SILTY, CLAYEY SAND with GRAVEL (SC-SM) (A-2-4)	25	18	7		
⊠	BH-1	1.0	SANDY LEAN CLAY (CL) (A-4)	27	17	10		
▲	BH-2	0.0-10.0	SILTY, CLAYEY SAND (SC-SM) (A-4)	23	19	4		
★	BH-2	10.0-15.0	SILTY SAND (SM) (A-4)	18	17	1		
⊙	BH-3	10.0-15.0	SILTY SAND (SM) (A-1-b)	21	19	2		

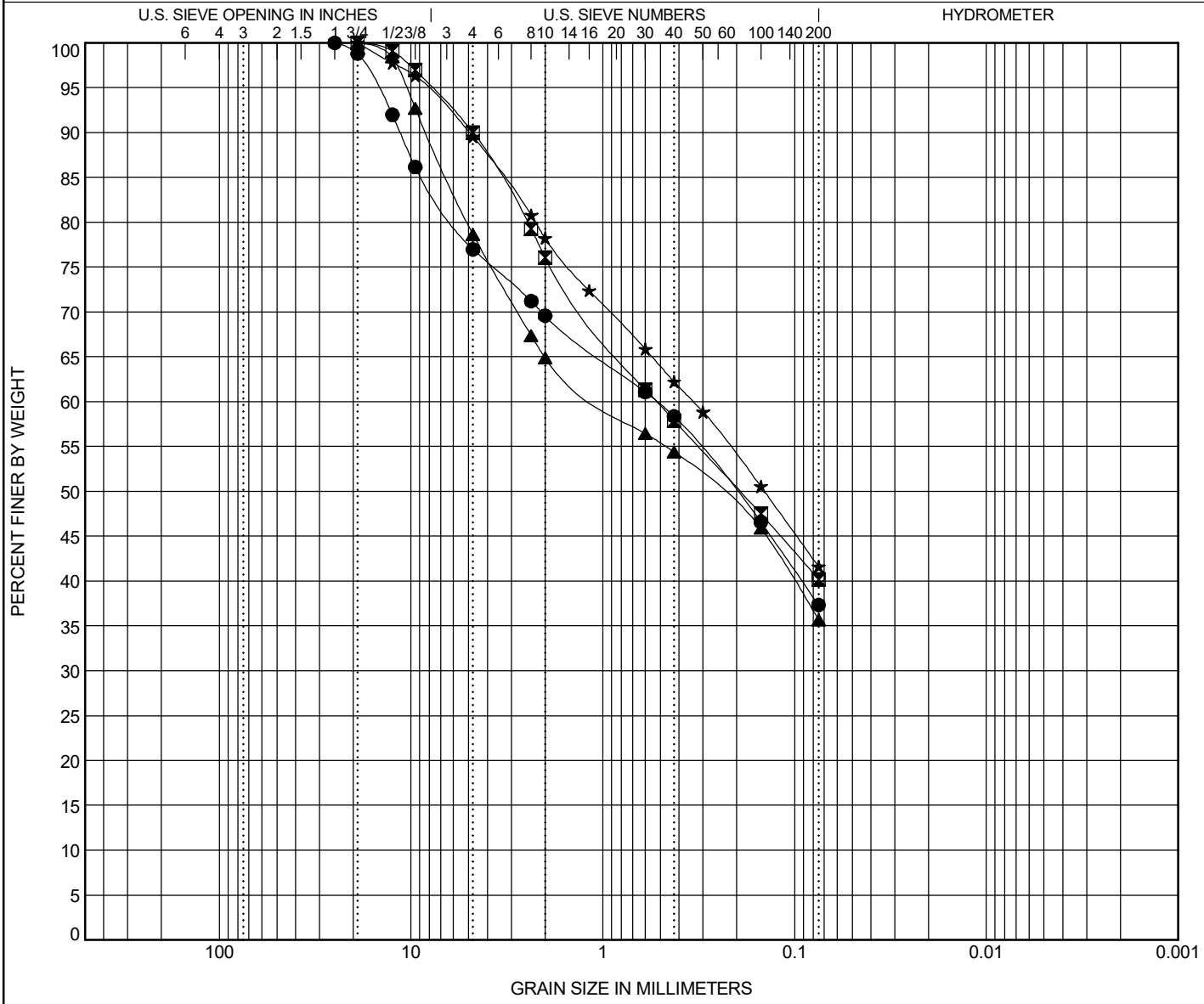
Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	BH-1	0.0-5.0	25	1.809			39.1	12.5	15.6	32.8	
⊠	BH-1	1.0	0.075							62.1	
▲	BH-2	0.0-10.0	19	0.4			23.8	15.6	18.0	42.7	
★	BH-2	10.0-15.0	19	0.268			21.8	13.2	19.2	45.8	
⊙	BH-3	10.0-15.0	19	2.244	0.198		50.7	15.0	11.1	23.2	

GRAIN SIZE DISTRIBUTION

RockSol

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH-4	0.0-5.0	SILTY SAND with GRAVEL (SM) (A-4)	27	24	3		
⊠	BH-4	15.0-17.0	SILTY, CLAYEY SAND (SC-SM) (A-4)	21	17	4		
▲	BH-5	11.0-15.0	SILTY SAND with GRAVEL (SM) (A-4)	20	19	1		
★	BH-6	0.0-10.0	SILTY, CLAYEY SAND (SC-SM) (A-4)	23	16	7		
⊙	BH-6	11.0	SILTY, CLAYEY SAND (SC-SM) (A-4)	19	14	5		

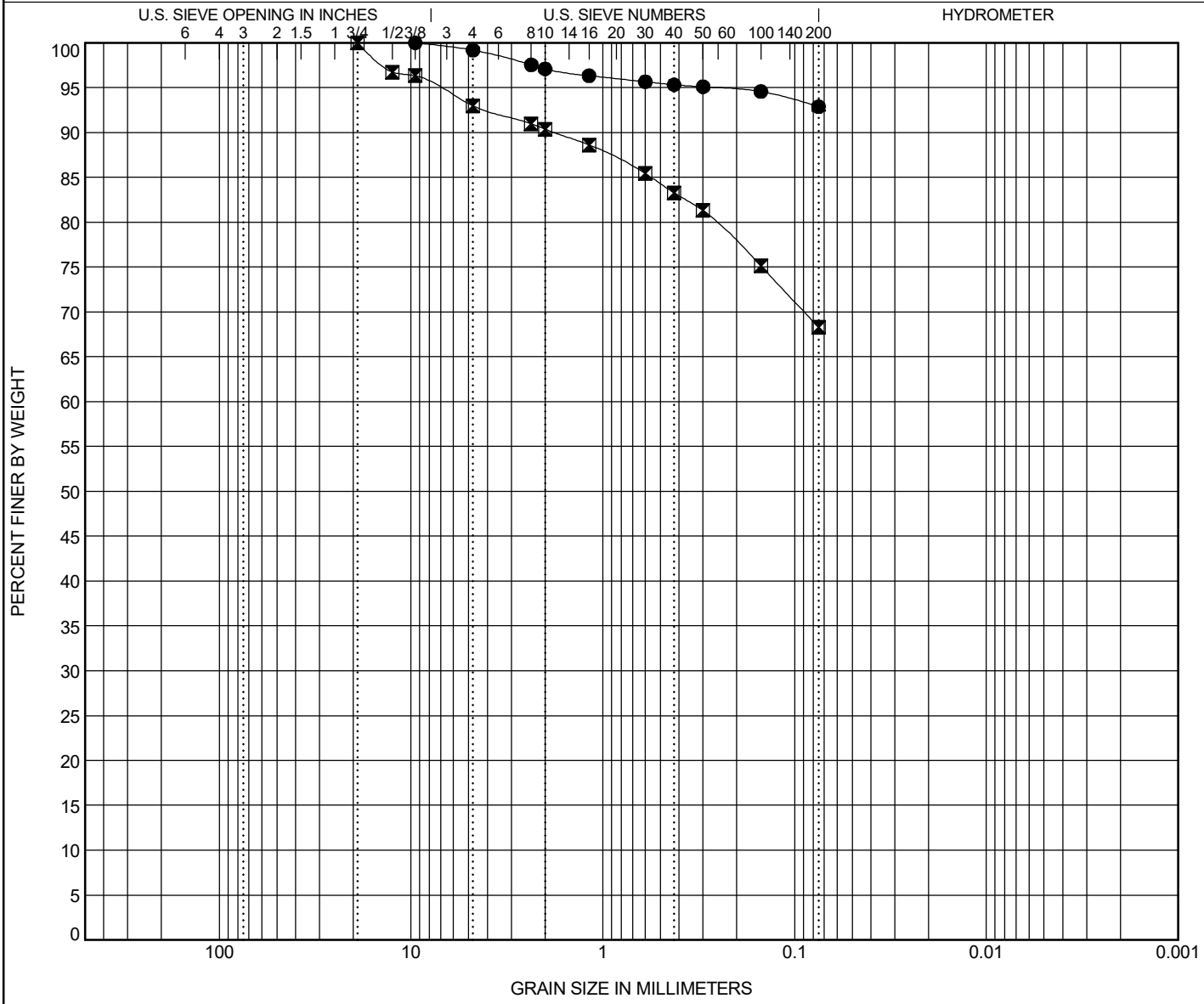
Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	BH-4	0.0-5.0	25	0.523			30.4	11.2	21.0	37.3	
⊠	BH-4	15.0-17.0	19	0.524			23.9	18.2	17.7	40.2	
▲	BH-5	11.0-15.0	19	0.996			35.1	10.5	18.7	35.7	
★	BH-6	0.0-10.0	19	0.337			21.8	16.0	20.6	41.6	
⊙	BH-6	11.0	0.075							40.6	

GRAIN SIZE DISTRIBUTION

RockSol

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH-6	13.0	LEAN CLAY (CL) (A-6)	37	17	20		
⊠	BH-7	0.0-10.0	SANDY LEAN CLAY (CL) (A-4)	24	15	9		
▲	BH-7	23.0	(Bedrock) SHALE with sand in parts					

Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	BH-6	13.0	9.5				2.9	1.8	2.4	92.9	
⊠	BH-7	0.0-10.0	19				9.6	7.1	15.0	68.3	
▲	BH-7	23.0	0.075							93.1	

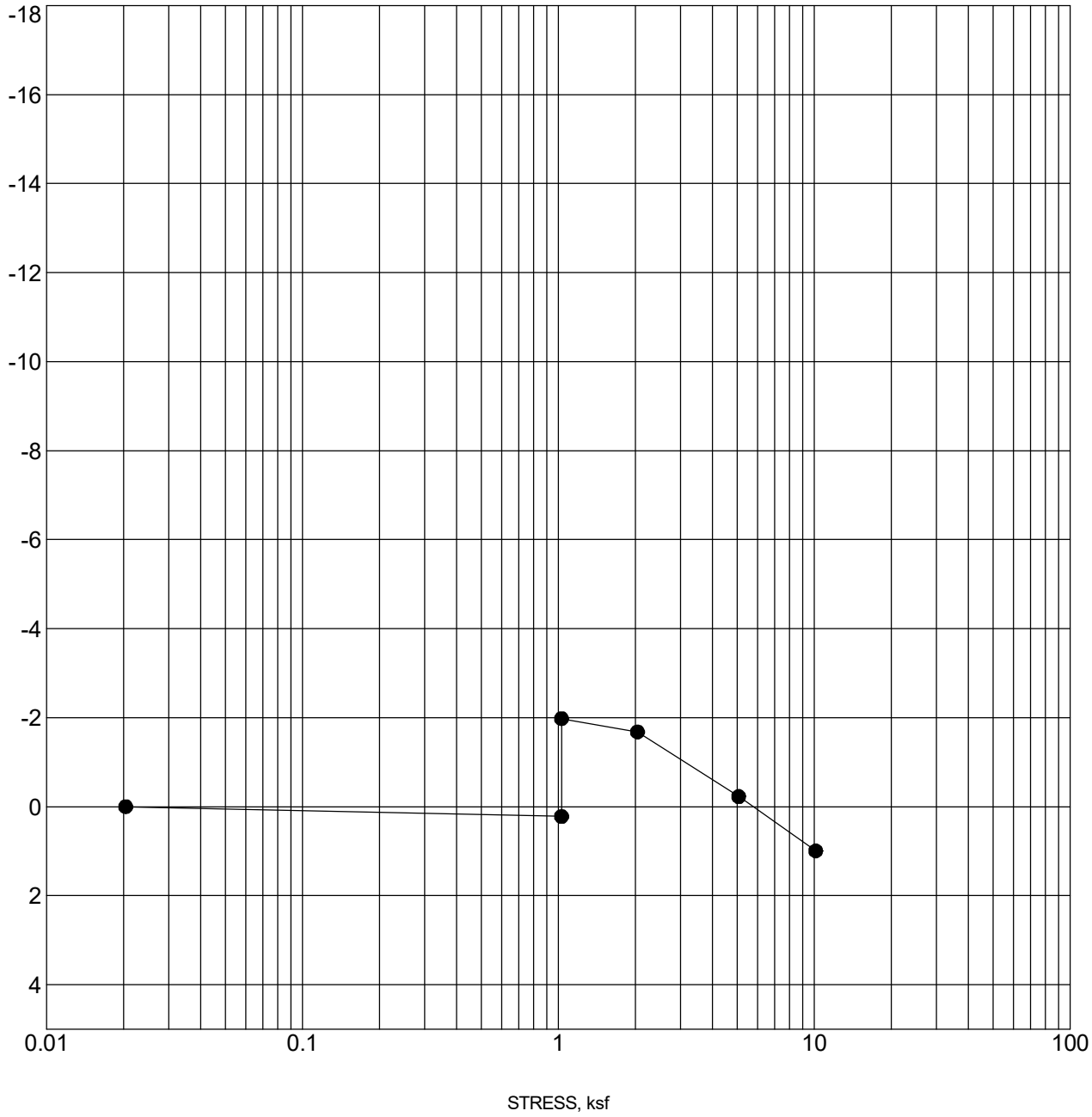
GRADATION - STANDARD 599.61_JUNIATA WATER TANK.GPJ ROCKSOL TEMPLATE.GDT 3/22/23

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BH-2**	**15**	**(Bedrock) SHALE/CLAYSTONE**	**2.2**	**129.6**	**9.8**

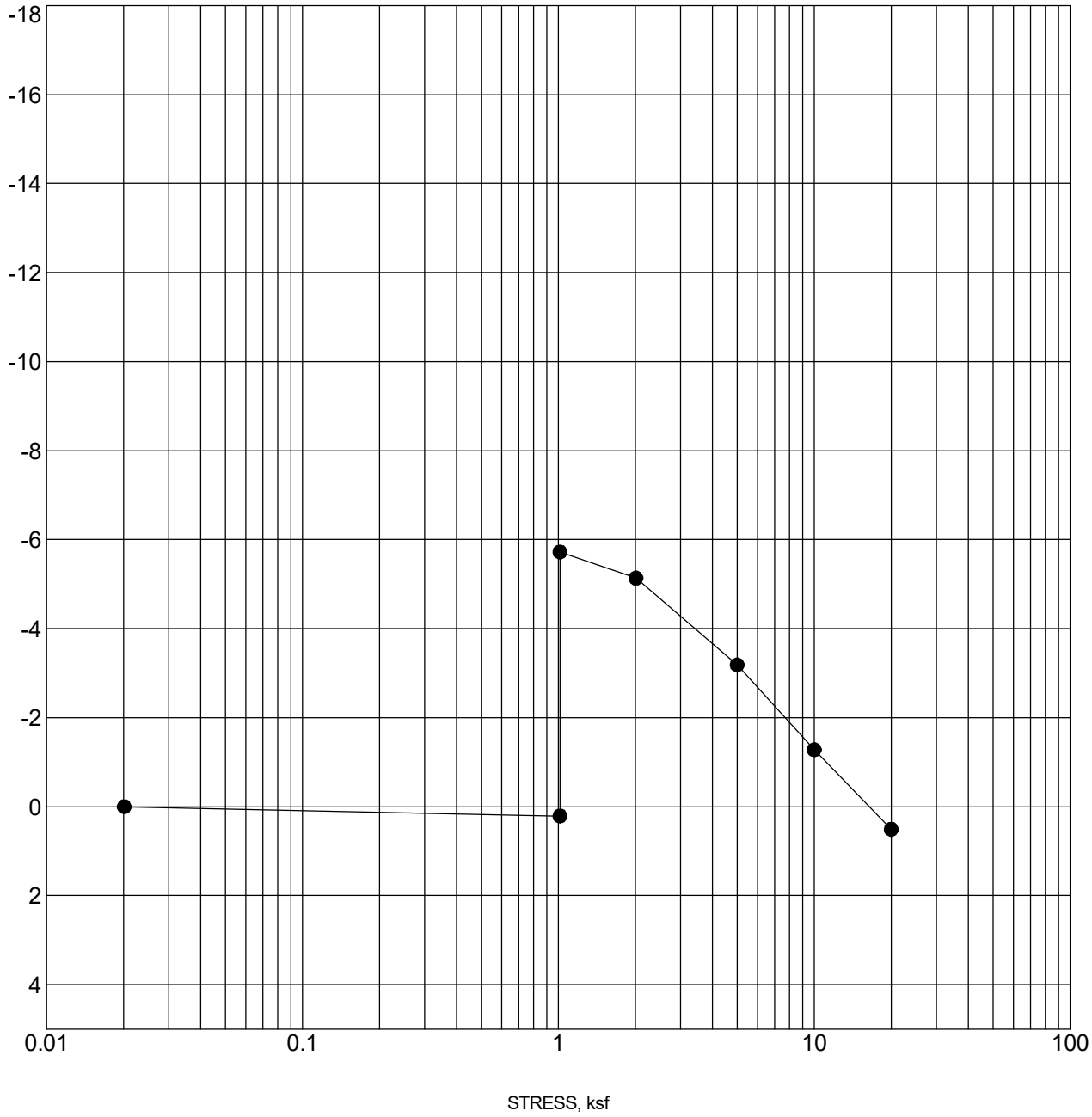
SWELL - STANDARD 599.61_JUNIATA WATER TANK.GPJ ROCKSOL TEMPLATE.GDT 3/24/23

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BH-4**	**19**	**(Bedrock) SHALE/CLAYSTONE**	**5.9**	**123.5**	**12.8**

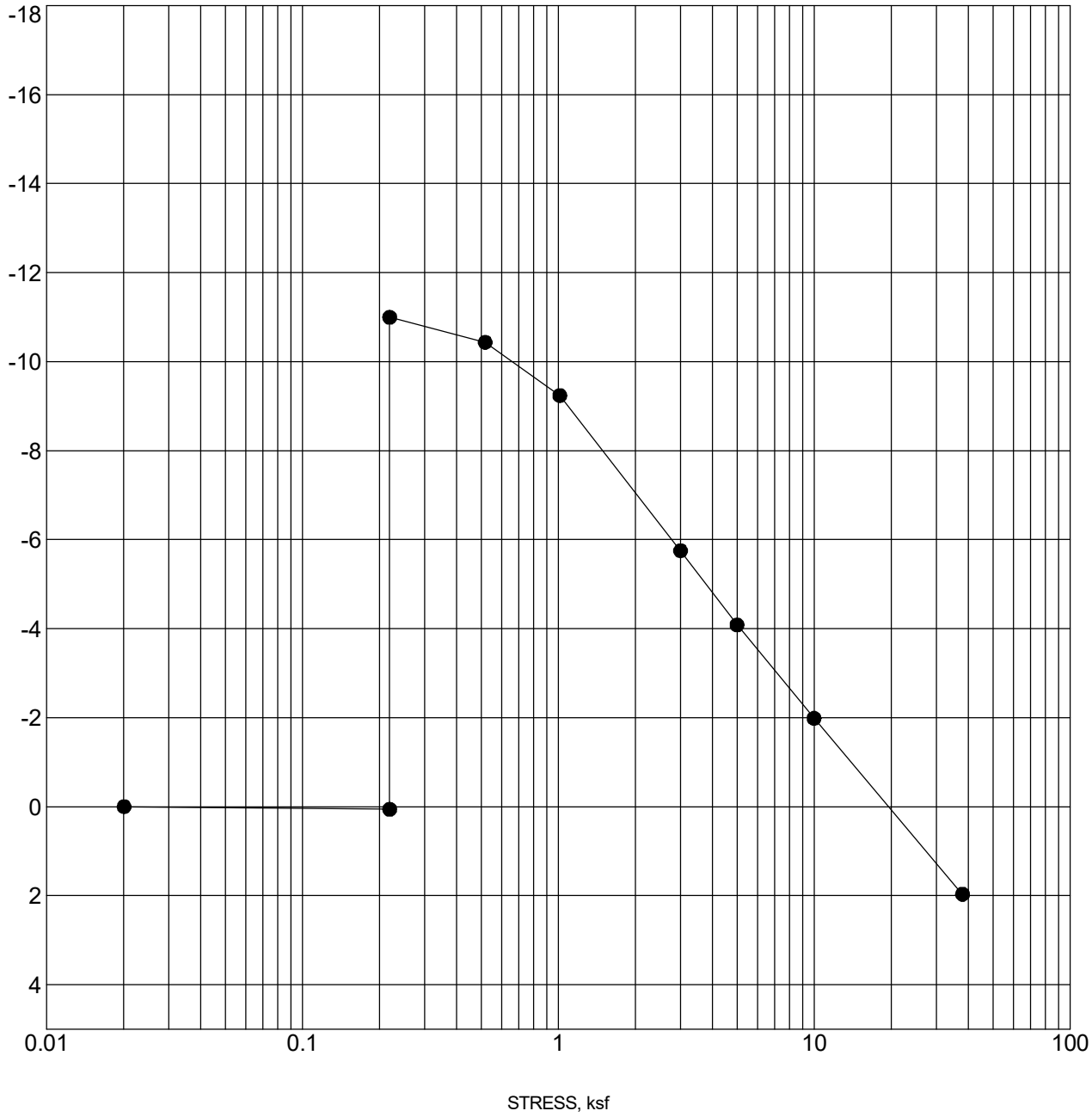
SWELL - STANDARD 599.61_JUNIATA WATER TANK.GPJ ROCKSOL TEMPLATE.GDT 3/24/23

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BH-6**	**18**	**(Bedrock) SHALE with sand in parts**	**11.1**	**127.5**	**9.2**

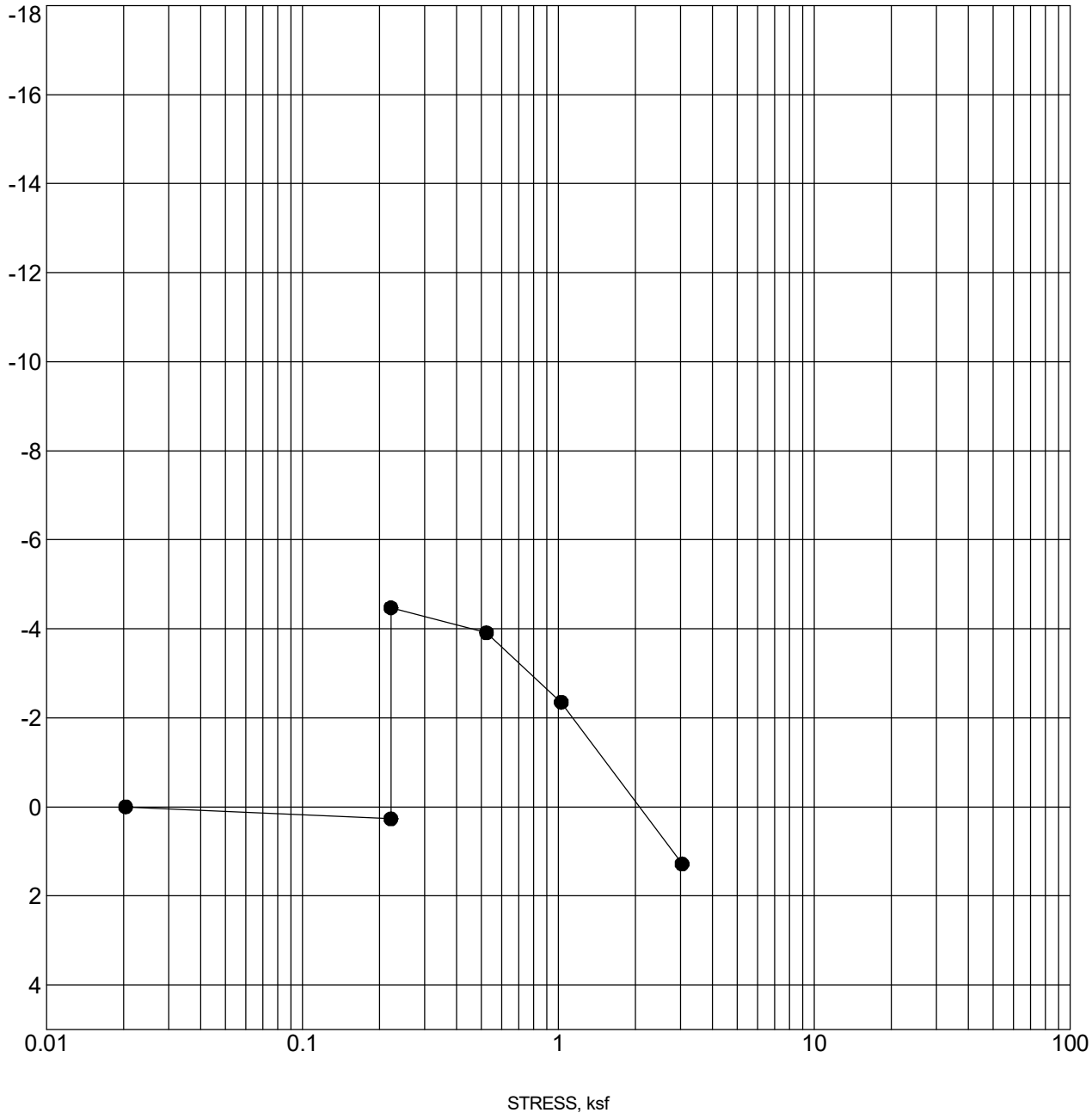
SWELL - STANDARD 599.61_JUNIATA WATER TANK.GPJ ROCKSOL TEMPLATE.GDT 3/24/23

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



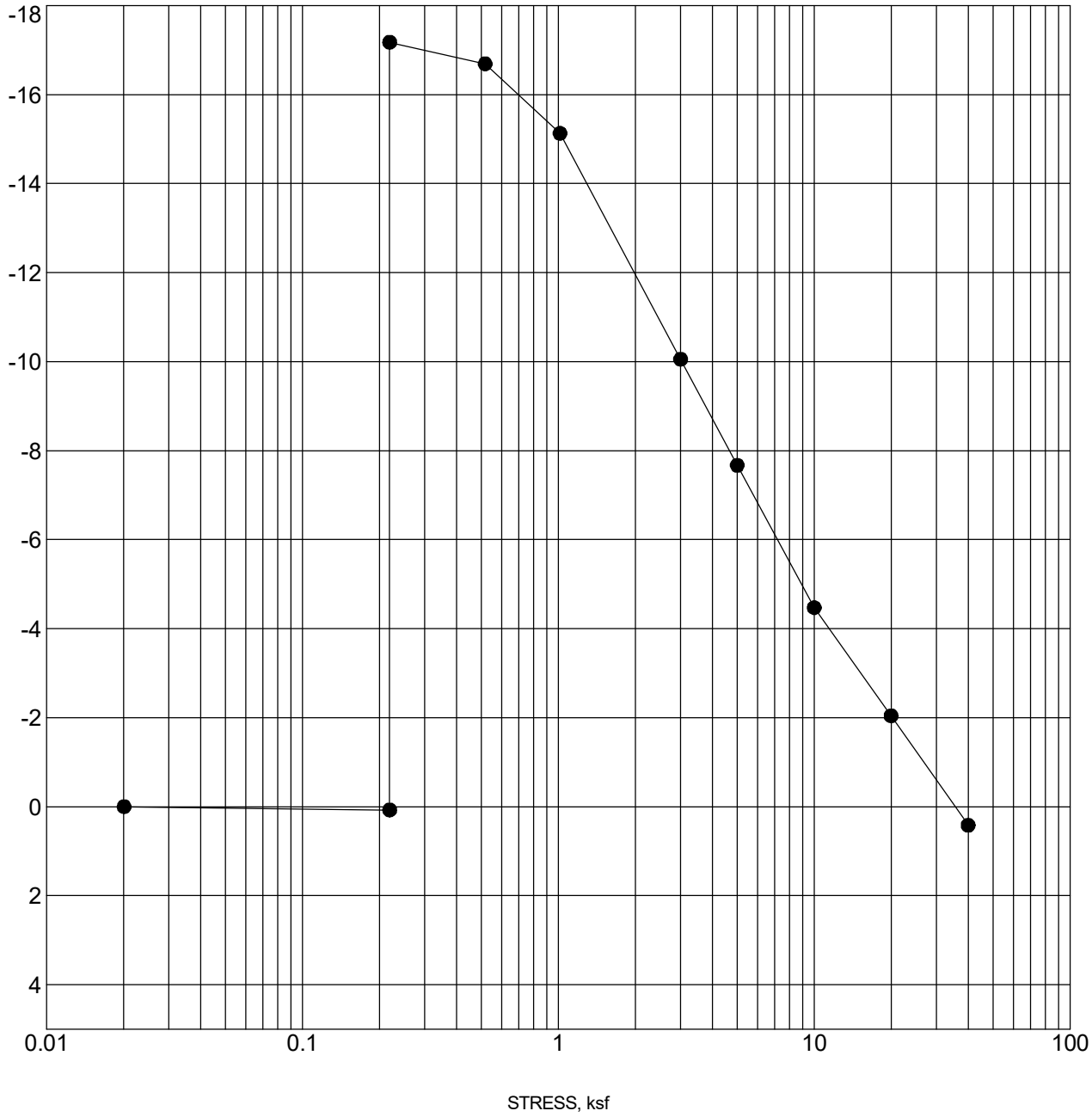
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BH-7**	**18**	**(Bedrock) SHALE with sand in parts**	**4.7**	**-122.0**	**9.6**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Juniata Structural Water Tank Foundation

PROJECT NUMBER 599.61 **PROJECT LOCATION** Mesa County, Colorado



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BH-7**	**23**	**(Bedrock) SHALE with sand in parts**	**17.3**	**126.9**	**9.2**

APPENDIX D

SITE CONDITIONS PHOTOGRAPHS

Borehole B-1

- Top-Left: Borehole location looking northwest
- Top-Right: Borehole with cobbles during drilling with 8-inch diameter hollow-stem auger
- Bottom-Left: 8” cobble removed by hand from the shallow borehole
- Bottom-Right: Cobbles in the borehole after auger refusal

Borehole B-2

- Top-Left: Borehole location looking east
- Top Right: Angular cobbles near the borehole location
- Bottom-Left: Rounded cobble near the borehole location
- Bottom Right: Borehole location looking northwest with cobbles and boulders visible at the ground surface

Borehole B-3

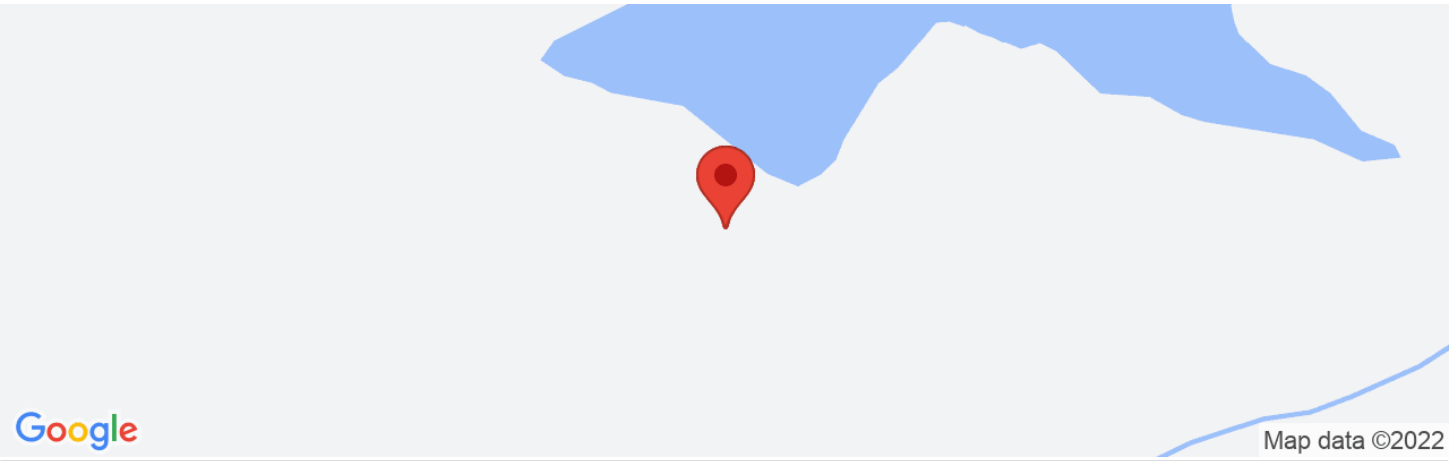
- Borehole location looking north with cobbles and boulders visible at the ground surface

APPENDIX E

SEISMIC DESIGN PARAMETER OUTPUT SHEETS

OSHPD

Latitude, Longitude: 38.96230011, -108.28351666



Date	9/30/2022, 12:51:19 PM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	C - Very Dense Soil and Soft Rock

Type	Value	Description
S_S	0.256	MCE_R ground motion. (for 0.2 second period)
S_1	0.067	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.332	Site-modified spectral acceleration value
S_{M1}	0.1	Site-modified spectral acceleration value
S_{DS}	0.221	Numeric seismic design value at 0.2 second SA
S_{D1}	0.067	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	B	Seismic design category
F_a	1.3	Site amplification factor at 0.2 second
F_v	1.5	Site amplification factor at 1.0 second
PGA	0.144	MCE_G peak ground acceleration
F_{PGA}	1.256	Site amplification factor at PGA
PGA_M	0.181	Site modified peak ground acceleration
T_L	4	Long-period transition period in seconds
SsRT	0.256	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.27	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.067	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.072	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
PGA_{UH}	0.144	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.945	Mapped value of the risk coefficient at short periods
C_{R1}	0.93	Mapped value of the risk coefficient at a period of 1 s
C_V	0.756	Vertical coefficient

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RockSol
Consulting Group, Inc.

September 15, 2023

City of Grand Junction
333 West Avenue, Building C
Grand Junction, Colorado 81501

Attention: Mr. Mark Ritterbush, P.E.

Subject: Addendum Letter, Steel Tank Alternative, Juniata Structural Water Tank Project, Grand Junction, Colorado, RockSol Project No. 599.61

Dear Mr. Ritterbush:

In this letter, RockSol Consulting Group, Inc. (RockSol) presents geotechnical design parameters for the steel tank alternative for the proposed Juniata Structural Water Tank project. The geotechnical paramters are in addition to the recommendations presented by RockSol in our report for the subject project, dated April 6, 2023.

Geotechnical parameters for the steel water tank alternative are primarily related to allowable bearing pressures to limit settlement and corrosion resistance of steel tank and piping. Other considerations such as cement type requirements for structural concrete and frost resistance are addressed in the April 6, 2023 report.

The proposed foundation type for the steel tank is a concrete ring wall with a steel tank bottom.

Rocksol understands that the maximum water elevation in the steel tank will be the same as the concrete tank, with a maximum water height of 17 feet. Both the steel and concrete tanks are planned for the tank bottom to be at elevation 5912.91. For the concrete tank, grade is at 5913.91 around the perimeter and for the steel tank the grade is lowered to 5912.91. A perimeter drain is recommended for both tank types.

For the steel tank alternative with a ring wall foundation and a steel tank bottom we recommend a maximum allowable bearing pressure of 2,000 psf for design purposes. With a 2,000 psf maximum bearing pressure we are estimating a maximum total settlement of ½-inch assuming a minimum ring footing width of 3 feet and a minimum footing embedment of 2-feet.

We recommend at least one-foot (12 inches) of Class 1 Structure Fill material below the bottom of the footing and 3-feet of the same structural fill material below the tank bottom. If the tank designer wants to use an "oiled sand" layer below the tank bottom that is acceptable.

If you have any questions, or need additional information please contact me at (303) 325-6838 or at hunt@rocksol.com.

Respectfully submitted,
RockSol Consulting Group, Inc.

COLORADO REGISTERED
DONALD GORDON HUNT
35249
Sept. 15, 2023
PROFESSIONAL ENGINEER

Donald G. Hunt, P.E.
Senior Geotechnical Engineer

SECTION 01035

MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.

1.2 MINOR CHANGES IN THE WORK

A. The Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time, on a JVA Field Order Form.

B. The Contractor may request additional information or clarification by using and submitting a “Request for Information” (RFI).

1.3 WORK CHANGE DIRECTIVE (WCD)

A. Owner-Initiated Work Change Directive: A written statement to the Contractor issued on or after the Effective Date of the Agreement and signed by the Owner and recommended by the Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.
   1. Within 7 days of receipt of a Work Change Directive Form, submit an estimate of cost necessary to execute the change to the Engineer for the Owner's review.
      a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

1.4 CHANGE ORDER (CO)

A. Owner-Initiated Change Order: The Engineer will issue a detailed Change Order Form indicating any changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. The Change Order Form issued by the Engineer is for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
2. Within 7 days of receipt of a Change Order Form, submit an estimate of cost necessary to execute the change to the Engineer for the Owner's review.
    a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

B. There will be no Contractor initiated Change Orders, the Contractor may only request additional information or clarification by using and submitting a “Request for Information” (RFI), on the Contractor’s RFI form. Additional forms may be obtained from the Engineer, and Contractor-Initiated Proposals may also be provided.

C. Upon the Owner's and the Engineer’s approval and signature from the Contractor the Change Order Form becomes valid

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General requirements

B. Coordination

C. Field engineering

D. Alteration project procedures

E. Preconstruction conference

F. Progress meetings

G. Requests for information

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01340 – Shop Drawings and Product Data

C. Section 01700 – Contract Closeout

1.3 GENERAL REQUIREMENTS

A. Refer to General Conditions for Owner meetings and other requirements

B. Engineer will schedule and administer pre-construction meeting according to agenda
   1. Prepare agenda for meetings including items required by Owner and Contractor
   2. Notify Contractor and Owner 4 days in advance of meeting date
   3. Preside at meeting

C. Contractor will schedule and administer site mobilization and weekly progress meetings. Contractor will also be responsible for coordination, field engineering, alteration, project procedures, cutting and patching procedures outlined herein. If work progress does not warrant a meeting, all parties can mutually agree to postpone meeting.
   1. Arrange for the attendance of Contractor's agents, employees, subcontractors, and suppliers as appropriate to the agenda
   2. Record the minutes; include all significant proceedings and decisions
   3. Reproduce and distribute copies of minutes within one week after each meeting
      a. To all participants in the meetings

b. To Engineer
c. To Owner

4. Owner and other inspecting parties such as the geotechnical engineer/technician as well as plant operators may attend meetings
5. Engineer will attend weekly meetings either via phone or on site

D. Representatives of contractors, subcontractors, and suppliers attending the meetings shall be qualified and authorized to act on behalf of the entity each represents

1.4 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later by others.

B. Verify that utility requirement characteristics of operating equipment are compatible with available utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment, and coordinate preparation of grading and other requirements for installation utility work by others.

C. Coordinate completion and clean-up of Work of separate Sections in preparation for final completion and for portions of Work designated for Owner’s use

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

1.5 FIELD ENGINEERING

A. Employ a Land Surveyor registered in the State of Colorado and acceptable to the Engineer and Owner.

B. Contractor will locate and protect survey control and reference points.

C. Control datum for survey is that established by Owner provided survey and shown on Drawings.

D. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

1.6 ALTERATION PROJECT PROCEDURES

A. Materials: As specified in product Sections; match existing products and work for patching and extending work.

B. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.

C. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Engineer.

D. Where a change of plane of 1/4-inch or more occurs, submit recommendation for providing a smooth transition for Engineer review.

E. Patch or replace portions of existing surfaces, which are damaged, lifted, or showing other imperfections.

F. Finish surfaces as specified in individual product sections.

1.7 PRECONSTRUCTION CONFERENCE

A. Engineer will schedule a conference after Notice of Award

B. Location: On site

C. Attendance
1. Owner's Representative
2. Engineer and his professional consultants
3. Geotechnical Engineer
4. Contractor's Project Manager
5. Contractor's Superintendent
6. Major Subcontractors
7. Others as Appropriate

D. Agenda:
1. Execution of Owner Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors and suppliers, list of products, Schedule of Values, and Construction Project Schedule in critical path format.
5. Designation of personnel representing the parties in Contractor, Owner, and the Engineer.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, cost proposal requests, Change Orders and Contract closeout procedures.
7. Construction scheduling and updates.
8. Scheduling activities of Geotechnical Engineer, equipment manufacturers representatives, and other field tests
9. Critical work sequencing
10. Major equipment deliveries and priorities
11. Procedures for maintaining Record Documents
12. Construction facilities, controls and construction aids
13. Temporary utilities provided by Owner
14. Safety and first-aid procedures
15. Security and housekeeping procedures

16. Procedures for testing

1.8 PROGRESS MEETINGS

A. Contractor will schedule and administer meetings throughout progress of the Work at weekly intervals. If work progress does not warrant meeting, all parties can mutually agree to postpone the weekly meeting.

B. Location of the Meetings: The project field office of the Contractor, or other locations arranged for by Contractor, convenient to all parties

C. Contractor will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within one week to Contractor, Owner, participants, and those affected by decisions made.

D. Attendance
   1. Owner's Representative
   2. Engineer, and his professional consultants as needed
   3. Contractor's Superintendent
   4. Subcontractors as appropriate to the agenda
   5. Suppliers as appropriate to the agenda
   6. Others, as appropriate

E. Suggested Agenda
   1. Review Minutes of Previous meetings
   2. Review Unresolved issues from Last Meeting
   3. Review of Work Progress
   4. Field Observations, Problems, Conflicts and Decisions
   5. RFI Review
   6. Review of Submittals Schedule and Status of Submittals
   7. Schedule
      a. General Schedule Issues
      b. Review of off-site fabrication and delivery schedules
      c. Planned progress during succeeding work period (3-week “Look ahead”)
      d. Maintenance of construction project schedule
      e. Corrective measures to regain project schedules
   8. Maintenance of Quality and Work Standards
   9. Change Orders
   10. New PR’s
   11. Accepted Change Orders
   12. Pay Requests
   13. Other Business

1.9 REQUESTS FOR INFORMATION (RFI)

A. The Contractor shall prepare and submit an RFI upon the discovery of the need for interpretation of the Contract Documents or additional information.
   1. Only the Contractor shall submit RFIs to the Engineer.

2. RFIs shall be submitted on Engineer's RFI form. Engineer will provide a template for the Contractor upon request.

B. RFI shall include:
   1. Project Name
   2. Engineer Job Number
   3. Date
   4. Name of Contractor
   5. Name of Engineer
   6. RFI number, numbered sequentially
   7. Related specification section number, title, and related paragraphs, as needed
   8. Drawing number and detail references, as needed
   9. Field conditions
   10. Contractor's proposed solution. If the Contractor's solution(s) affect contract times or contract price, Contractor shall state the effects on the RFI.
   11. Contractor's signature
   12. Relevant attachments including but not limited to drawings, descriptions, measurements, photos, product data, and shop drawings

C. Electronically Submitted RFIs
   1. Contractor shall submit one (1) complete RFI file in Adobe Acrobat PDF format

D. Engineer's Response
   1. Engineer will review each RFI, determine action required, and respond.
   2. Engineer will review and respond to each RFI within seven (7) working days
   3. If Engineer receives an RFI after 1:00 P.M. local time, the RFI will be considered as received the following working day.
   4. Engineer will not respond to RFIs requesting approval of submittals, approval of substitutions, coordination and information already indicated in Contract Documents, adjustment in contract time or contract amount, or erroneous RFIs.
   5. Engineer may respond to RFIs on related issues with a single response.
   6. If Engineer requests additional information as a result of the RFI, any further action or RFIs submitted by the Contractor will restart a new seven (7) day review period.
   7. Contractor shall submit any request for change of contract time or contract price utilizing proper Change Order forms.

E. Contractor shall log and track all RFIs submitted organized by RFI number.
   1. RFI log shall be submitted at each progress meeting
   2. RFI log shall include:
      a. Project name
      b. Name, address, and phone number of Contractor
      c. Contractor representative name
      d. RFI number
      e. RFI description
      f. RFI submittal date
      g. RFI response date
      h. Related Change Order number, as needed

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01080

IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Color coding, lettering, and tagging of all new exposed pipe and electrical equipment

1.2 RELATED SECTIONS

A. Section 09900 – Coatings

B. Section 16050 – Basic Electrical Materials and Methods

1.3 REFERENCES

A. ANSI 13.1 – Scheme for the Identification of Piping Systems

PART 2 PRODUCTS

2.1 MATERIALS

A. Coatings: As specified in Section 09900

B. Nameplates: Plastic, two colors for surface and core

PART 3 EXECUTION

3.1 LOCATION OF IDENTIFICATION

A. Lettering and flow direction arrows
   1. Near equipment served
   2. Close to valve or flanges
   3. Adjacent to branches, tees and changes in direction of pipeline
   4. At intervals of not more than 20 feet on straight runs, unless otherwise indicated by Engineer

3.2 LETTERING

A. Lettering to be provided by:
   1. Paint, stencil
   2. Cylindrically coiled printed plastic sheets meeting ANSI A13.1-2007
      a. Seton, Setmark Pipe Markers
      b. Or accepted equal

B. Letter size as follows:

Outside Diameter of Pipe Or Covering (inch)	Minimum Height of Letters (inch)
¾ Through 4	¾
>4 to <8	1 1/4
8 or larger	2 1/2

3.3 NAME PLATES

A. Provide nameplates on all electrically powered equipment and electrical enclosures
   1. Size: Approximately 3-inch wide by 2-inch high, on red plastic surface engraved through to a yellow core
   2. Label: "Danger" in capital ½ inch letters on top line. The balance of sign in 3/8-inch capital letters reading: "Do not perform any equipment maintenance until main power disconnect is turned off and padlocked"
   3. Provide additional electrical nameplates of the size and colors indicated in the individual specification sections
   4. Install in prominent location agreed to by the Engineer and Owner

B. Provide nameplate at all non-potable water outlets
   1. Size: approximately 3-inch wide by 2-inch high, on red plastic surface engraved through to a white core
   2. Label: "Non-Potable Water" top line and "Do Not Drink" second line in ½ inch capital letters
   3. Securely attach to wall (if possible) or attach with stainless steel chain

3.4 SCHEDULED COLOR CODING

A. All 24-inch pipe and smaller

B. Bands where scheduled: 6-inch-wide, at 5-foot intervals

C. Provide only bands of color on un-insulated steel and PVC, elsewhere natural finish

3.5 PIPING NOT SCHEDULED

A. Paint to match wall or ceiling, unless otherwise directed by Engineer

B. Appropriately identify and place arrows

C. Un-insulated stainless steel and PVC
   1. Natural finish

3.6 SCHEDULE

A. Paint and letter colors

Piping Description	Pipe Base/Band Color	Color of Letters	Legend
Potable Water	Blue	White	POTABLE WATER
Drain	Dark Gray	White	DRAIN
Overflow	Dark Gray	White	OVERFLOW

B. For piping not specified above refer to “Ten State Standards-Water Works, 2012 Edition” and/or the CDPHE “Design Criteria for Potable Water Systems, September 2013” as well as consult with Engineer

C. Specifically paint the following items:
   1. Valve hand-wheels and levers: Red

END OF SECTION

SECTION 01200

PAYMENT PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

B. This information is supplemental to the requirements as stated in the General Conditions.

1.2 SUMMARY

A. This Section includes additional administrative and procedural requirements necessary to prepare and process Applications for Payment. Refer to General Conditions for most requirements of the Owner.
   1. Schedule of Values assisting in processing Applications for Payment
   2. Construction Progress Schedules

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 PROCEDURES FOR THE SCHEDULE OF VALUES

A. Coordination: coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets
      b. Submittals Schedule
      c. O&M Manuals Schedule
   2. Submit the Schedule of Values to Engineer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment
   3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
   1. Identification: include the following Project identification on the Schedule of Values:
      a. Project name and location

b. Name of Engineer
c. Engineer’s project number.
d. Contractor’s name and address
e. Date of submittal

2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
   a. Related Specification Section or Division.
   b. Description of the Work.
   c. Change Orders (numbers) that affect value.
   d. Dollar value.
   e. Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor’s option.
9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders result in a change in the Contract Sum.

1.5 APPLICATION FOR PAYMENTS

A. General
   1. Submit itemized payment request as required in General Conditions together with Schedule of Values and other submittals as specified herein
   2. Contractor shall not "project" work completed beyond the date of Application for Payment submittal for the purpose of payment request

B. Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect and paid for by the Owner.
   1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements

C. Payment Application Times: Each progress payment date is as indicated in the Agreement. The period of construction Work covered by each Application or Payment is the period indicated in the Agreement

D. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents on behalf of the Owner. Incomplete applications will be returned without action.
   1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions have been made.
   2. Include amounts of Change Orders issued prior to the last day of the construction period covered by the application

E. Transmittal
   1. Submit copy of each Application for Payment to the Engineer by means ensuring receipt within 24 hours
   2. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the Engineer

F. Initial Application for Payment
   1. Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
      a. List of subcontractors
      b. List of principal suppliers and fabricators
      c. Schedule of Values
      d. Contractor's Construction Schedule (preliminary if not final)
      e. Schedule of principal products
      f. List of Contractor's staff assignments
      g. Copies of building permits
      h. Copies of authorizations and licenses from governing authorities for performance of the Work
      i. Certificates of insurance and insurance policies
      j. Performance and payment bonds, if required

G. Application for Payment at Substantial Completion
   1. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment. This application shall reflect any Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of Work
      a. Administrative actions and submittals that shall precede or coincide with this application include:

i) Occupancy permits and similar approvals
ii) Warranties (guarantees) and maintenance agreements
iii) Test/adjust/balance records
iv) Maintenance instructions
v) Meter readings
vi) Start-up performance reports
vii) Change-over information related to Owner's occupancy, use, operation and maintenance
viii) Final cleaning
ix) Application for reduction of retainage, and consent of surety
x) Advice on shifting insurance coverages

b. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion

H. Application for Final Payment
1. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Price, previous payments, and sum remaining due.
2. Application for Final Payment will not be considered until the following have been accomplished:
a. Completion of Project closeout requirements
b. Completion of items specified for completion after Substantial Completion
c. Assurance that unsettled claims will be settled
d. Assurance that Work not complete and accepted will be completed without undue delay
e. Transmittal of required Project construction records to Owner
f. Proof that taxes, fees and similar obligations have been paid
g. Removal of temporary facilities and services
h. Removal of surplus materials, rubbish and similar elements

1.6 PROCEDURES FOR THE CONSTRUCTION PROGRESS SCHEDULE

A. Coordination: coordinate preparation and updates of Contractor’s Construction Schedule with the preparation of Schedule of Values.
1. Correlate line items in the Construction Schedule with required project tasks, including the following:
a. Mobilization/demobilization
b. Permits and regulatory requirements
c. Submittals
d. Equipment
e. O&M Manuals
f. Work breakdown of major project work
g. Major subcontractors work
h. Startup and commissioning
i. Training
j. Substantial completion
k. Final completion
l. Milestones and operational shutdown requirements

B. Utilize the Critical Path Method (CPM) type construction schedule to establish preliminary progress schedule and track Work progress
    1. After acceptance by Engineer of preliminary Progress Schedule submitted per requirements of General Conditions, set preliminary Progress Schedule as the Construction Baseline Schedule
    2. Update and submit the construction progress schedule on a monthly basis with the pay application
        a. Monthly submittal should indicate progress of tasks, changes to baseline schedule logic, work additions such as change orders, milestone and contract date changes
        b. Submit two (2) color print copies, 11” x 17” size, and one pdf copy
        c. Upon request provide copy of project schedule CPM data file

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submission of all shop drawings and product data as required by the Contract Documents for all equipment and materials to be furnished under this contract unless specifically indicated otherwise

1.2 RELATED SECTIONS

A. Section 01600 – Materials and Equipment

B. Section 01730 – Operations and Maintenance Data

C. Specification Divisions 2 thru 16

1.3 SUBMITTALS

A. Definitions
   1. Technical submittals: Shop drawings, product data and samples prepared by Contractor, subcontractors, suppliers, or manufacturers
      a. Shall be submitted by the Contractor to Engineer for approval for the use of Equipment and Materials to complete the Work or as needed to describe the following:
         i) Operation and maintenance
         ii) Technical properties
         iii) Installation
      b. Shop drawings: Custom prepared data for the Project and Work including performance and capacity curves, diagrams, bills of material, instructions, and other information
      c. Product data: Non-custom prepared printed information for the Project and Work on materials and products
      d. Samples: Fabricated and non-fabricated tangible samples of products and material
         i) Used for visual inspection and testing and analysis
   2. Informational submittals: Reports, administrative informational submittals, certification and guarantees not including and defined as shop drawings, samples and product data
      a. Reports: Include laboratory reports and tests, technical procedures and records and design analysis
      b. Administrative informational submittals: Submittals necessary for administrative records such as construction photographs, work records, schedules, standards, record project data, safety data, and similar information submittals
      c. Certification: Includes manufacturer or supplier certificates and guarantees

B. General Requirements
   1. Quality
      a. Shall be of suitable quality for legibility and reproduction purposes
      b. Shall be useable for reproduction yielding legible hard copy
      c. Submittals not conforming to specified requirements herein and as specified in Divisions 2 through 16 shall be subject to rejection by Engineer and upon Engineer request, Contractor shall resubmit documents that are in conformance
   2. Dimensions
      a. English units shall be provided on submittals
      b. Metric units are acceptable in addition to English units
      c. English units shall govern
   3. Form of submittals
      a. Submittals shall be transmitted in electronic format as specified herein
      b. Scanned submittals are acceptable
      c. Electronic project documents and submittals shall be transmitted in the following format:
         i) Native electronic format, nonproprietary
         ii) Adobe PDF produced from native electronic format
      d. Filename:
         i) Shall be consistent for the initial and any subsequent submission revisions for a single submittal
         ii) Contractor shall use a consistent naming convention for all submittals
            a) Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., #001, #001A, #001B, etc.)
   4. Non-conforming submittals shall be subject to rejection by Owner and/or Engineer
   5. Submittal completion requirements
      a. Submittals shall include design criteria, dimensions, construction materials and all other information specified for a complete submittal to facilitate Engineer review of the submittal information adequately
      b. In the event various drawings are included a submittal for a class of Equipment, Contractor shall annotate clearly which parts apply to furnished Equipment
         i) Information not pertaining to the submittal shall be clearly annotated. Highlighting of such information will cause rejection of the submittal by the Engineer
      c. Contract Drawings
         i) Copies or portions thereof will not be allowed as acceptable fabrication or erection drawings
         ii) In the event Contract Drawings are used by the Engineer for erection drawings to annotate information on erection or identify reference details, Engineer title block and professional seal shall be removed and replaced with the Contractor's title block on the Contract Drawing(s). Contractor shall revise such erection drawings for subsequent revisions by the Engineer to Contract Drawings

C. Preparation
   1. Shop Drawings

a. Drawings shall be presented in a clear and thorough manner:
b. Identify details by reference to sheet and detail, schedule or room numbers shown on Contract Drawings
c. Identify equipment by reference to equipment name and tag number shown on Contract Drawings
d. Scale and Measurements: Make drawings accurate to a scale with sufficient detail to show the kind, size, arrangement and function of component materials and devices
e. Minimum sheet size: 8.5" by 11"
f. Fabrication drawing size: 11" by 17" or 24" by 36"

2. Product Data
   a. Clearly mark each copy to identify pertinent products or models submitted for review
   b. Identify equipment by reference to equipment name and P&ID number
   c. Catalog cut sheets: Cross-out or hatch irrelevant data

D. Technical Submittals: Shop Drawings and Product Data Submittal Requirements
   1. Shop Drawings and Product Data shall include the following, at a minimum:
      a. Specifications of manufacturer(s)
      b. Equipment parts and catalogs
      c. Bills of materials, material lists, and schedules
      d. Shop erection and fabrication drawings
      e. Drawings shall include equipment dimensions, weights, installation location requirements, plates required, main components, support details, anchor bolt details/sizes/locations, support base sizes, baseplate sizes, spacing and clearance requirements for installation, erection, operation and maintenance disassembly
      f. Electrical requirements:
         i) Shall include schematic diagrams including one-line diagrams, terminal block numbers, internal wiring diagrams, external connections, controls, and any other information as requested in individual specification sections
      g. List of spare parts
      h. Instruction and Operation and Maintenance (O&M) manuals
         i) As specified herein and in Specification Section 01730
      i. Manufacturer’s performance testing of equipment
      j. Concrete mix design data and information
      k. Performance characteristics and capacities
      l. External connections, anchorages, and supports required
      m. Other drawings, parts, catalogs, specifications, samples, or data necessary for the Engineer to determine conformance with Contract Documents
   2. Samples – Office samples shall be of sufficient size and quantity to clearly illustrate:
      a. Functional characteristics of the product, with integrally related parts and attachment devices
      b. Full range of color, texture and pattern
      c. Comply with requirements identified in individual specification sections

E. Construction Schedule: Designate in the construction schedule, or in a separate coordinated shop drawing schedule, the dates for submission and the dates that reviewed Shop Drawings and Product Data will be needed, if accelerated review is requested

F. Field samples and Mock-ups:
   1. Contractor shall erect, at the Project Site, at a location acceptable to the Engineer and Owner
   2. Size or area: as specified in the respective specification section
   3. Fabricate each sample and mock-up complete and finished
   4. Remove mock-ups at conclusion of Work or when acceptable to Engineer

1.4 CONTRACTOR RESPONSIBILITIES

A. Review shop drawings and product data prior to submission for accuracy and completeness of each submission

B. Approve and stamp each submission before submitting to Engineer

C. Determine and verify:
   1. Field measurements
   2. Field construction criteria
   3. Catalog numbers and similar data
   4. Conformance with specifications and identification of all deviations
   5. Confirm assignment of unit responsibility

D. Prior to each submission, carefully review and coordinate all aspects of each item being submitted

E. Verify that each item and the corresponding submittal conform in all respects with specified requirements of the Work and of the Contract Documents with respect to means, methods, techniques, sequences, and operations of construction, and safety precautions and programs incidental thereto

F. Make submissions promptly in accordance with Construction Schedule, and in such sequence as to cause no delay in the Work or in the work of any other Contractor

G. Limit requirement for accelerated submittal review by Engineer to no more than 10% percent of total number of submittals
   1. Accelerated submittal review period: less than 14 calendar days

H. Notify Engineer in writing, at time of submission, of any deviations in the submittals from Contract Document requirements:
   1. Identify and tabulate all deviations in transmittal letter
   2. Indicate essential details of all changes proposed, including modifications to other facilities that may be a result of the deviation
   3. Include required piping and wiring diagrams

1.5 SUBMISSION REQUIREMENTS

A. Make submissions far enough in advance of scheduled dates for installation to provide time required for reviews, for securing necessary approvals, for possible revisions and resubmissions, and for placing orders and securing delivery

B. In scheduling, allow fourteen (14) calendar days for review by Engineer following receipt of submission in Engineer's office:
   1. Time required to mail submissions or resubmissions is not considered a part of review period

C. Submittal Naming and Numbering
   1. Assign a unique number to include all shop drawings, product data and other information required for individual specification sections, beginning with #001.
   2. Resubmissions shall have the original number with a letter, starting with "A". If the first submittal required resubmission, it would be labeled #001A.
   3. Each specification section may still have more than one submittal number for later submissions (i.e., Preliminary O&M Manuals, Final O&M Manuals, etc.)
   4. Contractor shall use a consistent naming convention for all submittals

D. Quantity of Submittals Required
   1. Shop Drawings and Product Data:
      a. Initial submittal:
         i) Electronic – One (1) copy to Engineer
      b. Resubmittal:
         i) Electronic – One (1) copy to Engineer
      c. Final Submittal for Distribution
         i) Electronic – One (1) copy to Engineer
      d. As –constructed document submittals
         i) Electronic – One (1) copy to Engineer and one (1) copy to Owner
   2. Samples
      a. Initial submittal:
         i) Submit three (3) of each sample unless specified otherwise in individual specification section
      b. Resubmittal:
         i) Submit three (3) to Engineer
      c. One (1) sample of approved sample submittal will be returned to Contractor
   3. Informational submittals
      a. Technical reports and administrative submittals
         i) Electronic – One (1) copy to Engineer
      b. Certificates and guarantees:
         i) Electronic – One (1) copy to Engineer
      c. Test reports
         i) Paper
            a) Owner: Two (2) copies
            b) Engineer: One (1) copy
            c) Contractor: Two (2) copies
            d) Manufacturer/supplier: One (1) copy

4. Instruction and O&M manuals
    a. In accordance to Specification Section 01730
5. At no additional cost to the Owner and whether or not submittals are copyrighted, the Owner may copy and use for staff training and/or internal operations any submittals approved for final distribution as well as required by this Contract

E. Submittal Transmittal Requirements
1. Accompany each submittal with a letter of transmittal showing all information required for identification and checking
2. Shall include:
    a. Drawing numbers and titles
    b. Revision number
    c. Electronic filename
    d. Deviations from Contract Documents: As specified herein
    e. Submittals unidentifiable will be returned for proper identification
    f. Date

F. Submittals Requirements
1. Submittal number
2. Date of submission and dates of any previous submissions
3. Project title and number
4. Owner Contract identification number if applicable
5. Names of:
    a. Contractor
    b. Supplier
    c. Manufacturer
6. Identification of the product, with the specification section number
7. Field dimensions, clearly identified as such
8. Relation to adjacent or critical features of the Work or materials
9. Applicable standards, such as ASTM or Federal Specification numbers
10. Identification of deviations from Contract Documents:
    a. If Contractor proposes to provide material or equipment of Work which deviates from the Project Manual, Contractor shall indicate so under “deviations” on the transmittal form accompanying the submittal copies
    b. Identify all requested deviations as specified and on the copies of Specifications and Drawings required by paragraph below.
11. Confirmation of compliance with Contract Documents and, if applicable, identification of deviations from Contract Documents:
    a. Provide the following documents to demonstrate compliance with the contract specifications:
        i) A copy of the relevant Drawing(s) with all addendum updates that apply to the equipment in various Divisions marked to show specific changes necessary for the equipment proposed in the Contractor’s submittal
            a) If no changes are required, the Drawing(s) shall be clearly marked “No Changes Required”

b) Failure to include copies of relevant Drawing(s) with the submittal, whether changes are required or not, shall be cause for rejection of the entire submittal with no further review by Engineer
c) Relevant Drawing(s) include as a minimum the control diagrams, process and instrumentation diagrams (P&IDs), and Process (P) drawings.

ii) A copy of each pertinent specification section with all addendum updates included, all referenced and applicable specifications sections, with their respective addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements:
a) If deviations from the specifications are indicated and, therefore requested, by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation
b) Failure to include a copy of the marked up specification sections, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further review by Engineer

12. Identification of revisions on resubmissions
13. An 8" by 4" blank space for Contractor's and Engineer's stamps
14. Stamp cover sheet of each submittal as identified in letter of transmittal
15. Contractor's stamp: Initialed or signed, certifying review and approval of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents. Use stamp to include wording similar to the following:

This submittal has been reviewed by [*Name of Contractor*] and approved with respect to the means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incidental thereto. [*Name of Contractor*] also warrants that this submittal complies with contract documents and comprises no deviations thereto: Section No:___ Submittal No: Date:_____ By:

G. For equipment that is provided directly by manufacturer without specification provide:
1. Shop drawings: Illustrate complete assembly of products; foundation, installation and anchor requirements; dimensions and total weights of each, electrical wiring diagrams
2. Product data: Provide manufacturer’s literature including general assembly, materials of construction, model and type, detailed data describing parts and accessories, sufficient data to verify compliance with specifications
3. Manufacturer’s installation instructions: Provide detailed connection requirements and startup instructions
4. Manufacturer’s field report: Indicate personnel present and actual start-up procedures that were performed by manufacturer’s representative
5. Field report and test results shall be submitted to the Engineer by the Contractor

H. Submittal Log:
   1. Maintain an accurate submittal log for duration of the Work showing current status of all submissions
   2. Show submittal number, section number, section title, submittal description, dates and disposition of submittal
   3. Make submittal log available to Engineer for Engineer's review upon request

I. Unless specified otherwise, make submissions in groups to facilitate efficient review and approval:
   1. Include all associated items from individual specification sections to assure that all information is available for checking each item when it is received
   2. Submit a complete initial submittal including all components when an item consists of components from several sources
   3. Partial submittals may be rejected as not complying with provisions of the Contract
   4. Engineer will not be held liable for delays due to poorly organized or incomplete submissions
   5. Do not include items from more than one specification section for any one submittal number

J. Contractor may require subcontractors to provide drawings, setting diagrams and similar information to help coordinate the Work, but such data shall remain between Contractor and his subcontractors and will not be reviewed by Engineer unless specifically called for within the Contract Documents

K. All submittals for each component of multi-component systems shall be compiled and submitted through the Contractor to the Engineer by the manufacturer having System Responsibility

1.6 DISPOSITION OF SHOP DRAWINGS, PRODUCT DATA, AND INFORMATION SUBMITTALS

A. "No Exceptions Taken": Approved with No Corrections Noted
   1. One copy sent to Owner
   2. One copy sent to Resident Project Representative
   3. One copy retained in Engineer's file
   4. Remaining copies returned to Contractor for his use
      a. One copy to be kept on file at Contractor's office at job site
      b. Remaining copies for Contractor's office file, suppliers, or subcontractors
   5. No corrections or comments noted on the submittal or on a Submittal Response Summary Sheet
   6. Issues or miscellaneous comments pertaining to other related items of the Work may be included in transmittal letter
   7. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted
   1. One copy sent to Owner
   2. One copy sent to Resident Project Representative
   3. One copy retained in Engineer's file

4. Remaining copies returned to Contractor for his use
    a. One copy to be kept on file at Contractor's office at job site
    b. Remaining copies for Contractor's office file, suppliers or subcontractors
    c. Copies of submittal data in operation and maintenance manuals to be revised according to corrections
5. Comply with corrections or comments as noted on the submittal or on a Submittal Response Summary Sheet
6. Resubmission not required

C. "Revise And Resubmit": Incorrect information provided or Significant Information Still Required
1. One copy sent to Resident Project Representative
2. One copy retained in Engineer's file
3. All remaining copies returned to Contractor for revision and re-submittal
4. Copy of transmittal letter and/or Submittal Response Summary Sheet sent to Owner. A "No Exceptions Taken" or "Exceptions Noted" submittal it will be forwarded to Owner after review per above disposition requirements
5. Submittal is either: incorrectly annotated; specific comments need to be addressed and incorporated in re-submittal; and/or additional information may be required as noted on the submittal or on a Submittal Response Summary Sheet
6. Submitted information may not include or address specific item required per the specification as identified on the submittal or on a Submittal Response Summary Sheet
7. Specific information related to identified item may be required for final approval of submittal
8. Resubmission of entire submittal may be required or resubmission of specific item may be required as identified on the submittal or on a Submittal Response Summary Sheet

D. "Rejected": Returned for Correction
1. One copy sent to Resident Project Representative
2. One copy retained in Engineer's file
3. All remaining copies returned to Contractor
4. Copy of transmittal letter and/or Submittal Response sent to Owner
5. Contractor required to resubmit complete submittal package in accordance with Contract Documents
6. Submittal does not comply with provisions of Contract Documents as noted on the submittal or on a Submittal Response Summary Sheet
7. Resubmission required

E. “Receipt Acknowledged”: For Reference Purposes Only, or for Record Copy:
1. Applicable to manufacturer or Contractor provided calculations and other miscellaneous documentation no subject to Engineer review and approval
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. One copy returned to Contractor
5. Copy of transmittal letter sent to Owner
6. Remaining submittal copies destroyed

7. Detailed review and comment by Engineer not required
8. Resubmission not required

1.7 DISPOSITION OF SAMPLES

A. "No Exceptions Taken": Approved with No Corrections Noted
   1. One sample sent to Owner
   2. One sample sent to Resident Project Representative
   3. One sample retained in Engineer's file
   4. Acknowledgement: Copy of transmittal letter sent to Contractor
   5. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted
   1. One sample sent to Owner
   2. One sample sent to Resident Project Representative
   3. One sample retained in Engineer's file
   4. Acknowledgement: Copy of transmittal letter sent to Contractor
   5. Work performed or products furnished to comply with exceptions noted in acknowledgement
   6. Resubmission not required

C. "Rejected": Returned for Correction
   1. One sample retained in Engineer's file
   2. Remaining samples sent to Contractor for resubmittal and compliance with the Contract Documents as noted in transmittal letter
   3. Copy of transmittal letter sent to Owner
   4. Resubmission required

1.8 RESUBMISSION REQUIREMENTS

A. Make any corrections or changes in submittals required by Engineer and resubmit until approved

B. Transmit each resubmission under new letter of transmittal. Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., #001, #001A, #001B, etc.)

C. Shop Drawings and Product Data
   1. Revise initial drawings or data and resubmit as specified for the initial submittal
   2. Indicate any changes which have been made other than those requested by Engineer

D. Samples: Submit new samples as required for initial submittal

E. Reimbursement of Resubmission Review Costs:
   1. Review of first submittal and one resubmittal will be performed by Engineer at no cost to Contractor
   2. Cost for review of subsequent resubmissions will be directly paid by Contractor
   3. Engineer will document work-hours required for review and costs for Engineer review will be deducted from payments due Contractor as Change Order deducts

4. Charges for review of resubmissions will include Engineer at maximum rate of $150 per hour and administrative staff at maximum rate of $75 per hour

1.9 PROJECT RECORD SUBMITTALS

A. After completion of the Work and prior to final payment, Contractor shall furnish record documents and final approved shop drawings and samples (as-constructed shop drawings and samples) in the number of copies specified herein.
   1. Contractor shall provide additional copies of final approved shop drawings and samples for insertion in Equipment instruction and O&M manuals as required
   2. All copies shall be clearly marked “Project Record”

1.10 ENGINEER'S DUTIES

A. Review submittals with reasonable promptness and in accordance with approved submission schedule provided that each submittal has been called for by the Contract Documents and is stamped by Contractor as indicated above
   1. No extensions of time are allowed due to Engineer’s delay in reviewing submittals unless all the following criteria are met:
      a. Contractor has notified Engineer in writing that timely review of particular submittal in question is critical to the progress of the Work and Contractor has identified the requested submittal return date.
      b. Engineer has failed to return submittal within 21 days of receipt of the submittal or receipt of said notice, whichever is later
      c. Contractor demonstrates that delay in progress of the Work was directly attributable to Engineer’s failure to return submittal within 21 days
   2. No extensions of time are allowed due to delays in progress of the Work caused by rejection and subsequent resubmission of data, including multiple resubmissions
   3. Engineer’s review shall not extend to means, methods, techniques, sequences, construction operations, and safety precautions and programs incidental thereto. No information regarding these items will be reviewed whether or not included in submittals
   4. In the event that Engineer will require more than 21 calendar days to perform review, Engineer shall so notify Contractor

B. Review drawings and data submitted only for general conformity with Contract Documents
   1. Engineer’s review of drawings and data returned marked No Exceptions Taken or Exceptions Noted does not indicate a thorough review of all dimensions, quantities, and details of material, equipment device or items shown
   2. Engineer’s review does not relieve Contractor of responsibility for errors, omissions or deviations nor responsibility for compliance with the Contract Documents

C. Assume that no shop drawing or related submittal comprises a deviation to the Contract Documents unless Contractor advises Engineer otherwise in writing which is acknowledged by Engineer in writing:
   1. Consider and review only those deviations from the Contract Documents clearly identified as such on the submittal and tabulated on the Contractor’s transmittal sheet.

D. Review informational submittals for indications of Work or Material deficiencies and will respond to Contractor regarding such deficiencies

E. Return submittals to Contractor for distribution or for resubmission

F. Transmit, unreviewed, to Contractor all copies of submittals received directly from suppliers, manufacturers and subcontractors

G. Transmit, unreviewed, to Contractor all copies of submittals not called for by the Contract Documents or which have not been approved by Contractor

H. Engineer will not review uncalled-for shop drawings or product data except by special arrangement

I. Affix stamp and indicate approval for submittal or resubmission requirements with the following stamp:

JVA, Inc. Received: _____

☐ No Exceptions Noted ☐ Exceptions Noted

☐ Revise and Resubmit ☐ Rejected

JVA's review is limited to general conformance with the design intent as expressed in the Construction Documents. Notations and comments made on the product submittal or shop drawing during this review do not relieve the Contractor from compliance with the Construction Documents, as well as applicable laws, codes, and regulations. Review of a specific item shall not be construed to include review of an assembly of which the item is a component. The Contractor is responsible for dimensions and quantities to be confirmed and correlated at the job site; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences, and procedures of construction; coordination of the Work with that of all other trades; and performing all Work in a safe and satisfactory manner.

By: _____ Date: _____ 10/21

1.11 SUBMITTAL SCHEDULE

A. Unless indicated otherwise, provide all submittals required by individual sections of the Contract Documents to establish compliance with the specified requirements.

B. Contractor to produce schedule of submittals for Engineer review

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Construction record photographs prior to commencing and during the course of the Work

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01700 – Contract Closeout: Project Record Documents

1.3 PHOTOGRAPHY REQUIRED

A. Take photographs of the existing conditions prior to commencing work to document existing conditions

B. Take photographs on the date on which each scheduled Application for Payment is due. Intent is for digital photos to be kept as project record

C. Thumb drive of Digital photos become the property of Owner

1.4 COSTS OF PHOTOGRAPHY

A. Pay all costs for specified photography and printing
   1. Parties requiring additional photography or prints will pay for them directly

1.5 DELIVERY OF PHOTOS

A. Submit digital photos to the Engineer with monthly pay requests or within 20 days of photo date

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 TECHNIQUE

A. Factual Presentation

B. Correct Exposure and Focus
   1. High resolution and sharpness

2. Maximum depth-of-field
3. Minimum distortion

3.2 VIEWS REQUIRED

A. Photograph from locations to adequately illustrate the condition of construction and the state of the Project
   1. Photographic survey of the existing site
      a. Show all areas to be modified
      b. Show all areas in which Contractor will conduct operations or store equipment
   2. Weekly photographs
      a. Minimum of eight (8) views weekly until final acceptance
      b. Views as designated by the Engineer or Owner

3.3 PHOTOGRAPH REQUIREMENTS FOR PROGRESS SITE PHOTOGRAPHS

A. Responsibility
   1. Site photographs for Owner record of construction progress shall be the responsibility of the Contractor
   2. Contractor shall be responsible for site photographs including the existing and progress of Work

B. Photographs shall include, but not limited to, the following:
   1. Existing site: Photographs of existing site conditions before site work commences
      a. Number of views shall be sufficient to cover the existing site conditions
   2. Progress of work: Shall include photographs from clearing throughout construction
      a. Number of views shall be sufficient to cover progress in Work and shall include a minimum of eight (8) different views
   3. After completion of Work: Shall be sufficient to show completed and finished Work

C. Digital images
   1. Provide images in uncompressed JPEG format
   2. Minimum resolution: 1500 x 2200
   3. Submitted digital images shall not be cropped

D. Identify each digital image file
   1. Name of project
   2. Orientation and description of view
   3. Date and time of exposure

3.4 ADDITIONAL PHOTOGRAPHS

A. Contractor shall provide additional photographs upon the request of the Engineer

B. Additional photographs may include, but not limited to, the following:
   1. Publicity photographs
   2. Special events at Project site
   3. Major phase of Work

4. Substantial Completion
5. Follow-up investigations for on-site events such as construction damage or losses
6. Additional record photographs during final acceptance

3.5 PROJECT RECORD

A. Submit electronic photos, grouped by date

B. Engineer will distribute, after review
   1. One copy of each view to Owner
   2. One copy of each view to Engineer's file
   3. One copy of each view returned to Contractor for inclusion in Project Record Document

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance / Control of installation

B. Inspection and testing laboratory services

C. Qualification of laboratory

D. Laboratory duties

E. Limitations of authority of testing laboratory

F. Contractor's responsibilities

G. Field testing

H. Testing and services schedule

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01340 - Shop Drawings, Product Data, and Samples

C. Section 01600 - Material and Equipment

1.3 REFERENCES

A. Conform to reference standard by date of issue current on date of Contract Documents

B. Obtain copies of standards when required by Contract Documents

C. Where specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding

D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Provide copies of written reports for materials, equipment or systems as scheduled at the end of this section. Reference each report by respective section number.

C. Laboratory Test Reports: Provide written reports of each test and inspection to Engineer. Each report shall include:
   1. Date issued
   2. Project title and number
   3. Testing laboratory name, address and telephone number
   4. Name and signature of laboratory inspector
   5. Date and time of sampling or inspection
   6. Record of temperature and weather conditions
   7. Date of test
   8. Identification of product and specification section
   9. Location of sample or test in the Project
   10. Type of inspection or test
   11. Results of tests and compliance with Contract Documents
   12. Interpretation of test results when requested by Engineer

D. Shop Test Reports: Provide reports detailing results of tests and certification from manufacturer to verify compliance with specifications

E. Field Test Reports: Provide reports detailing results of the tests. Indicate compliance or non-compliance with Contract Documents. Identify corrective action for materials and equipment which fails to pass field tests.

1.5 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce Work of specified quality

B. Comply fully with manufacturer's instructions, including each step in sequence

C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship

E. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement

F. Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities: Conditions of the Contract

G. Certification of products: Respective sections of specifications

H. Laboratory tests required and standards for testing: Respective sections of specifications

1.6 INSPECTION AND TESTING LABORATORY SERVICES

A. Owner will employ and pay for the services of a testing agency to perform specified laboratory testing of materials where the technical specifications specifically obligate the Owner to provide the services
   1. It is the Contractor’s responsibility to initiate and coordinate all required tests and inspections including conformance with requirements of all applicable public agencies and authorities. Contractor will be responsible for coordinating the testing requirement with testing agency and provide the testing agency no less than two (2) working days advance notification to schedule tests.
   2. Employment of the testing agency shall in no way relieve Contractor's obligations to perform the Work of the Contract
   3. Contractor shall employ and pay for the services of a testing agency to perform all specified services and testing not specifically identified in the technical specifications to be provided by Owner related to the design of mixes, products and equipment, to Engineer's review of proposed materials and equipment before, during and after incorporation in the Work and to retest materials and equipment which fail original tests

B. Retesting required because of non-conformance to specified requirements shall be performed by the same testing agency on instructions by the Engineer. Payment for retesting will be charged to the Contractor by deducting inspection or testing charges from the Contract Sum/Price

1.7 QUALIFICATION OF TESTING AGENCY

A. Meet "Recommended Requirements for Independent Laboratory Qualification", published by American Council of Independent Laboratories

B. Meet basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction" as applicable

C. Authorized to operate in the State in which the Project is located

1.8 TESTING AGENCY DUTIES

A. Cooperate with Engineer and Contractor; provide qualified personnel after due notice

B. Perform specified inspections, sampling, and testing of materials and methods of construction
   1. Comply with specified standards
   2. Ascertain compliance of materials with requirements of Contract Documents

C. Promptly notify Engineer and Contractor of observed irregularities or deficiencies of work or products

1.9 LIMITATIONS OF AUTHORITY OF TESTING AGENCY

A. Testing Agency Is Not Authorized To
   1. Release, revoke, alter or enlarge on requirements of Contract Documents
   2. Approve or accept any portion of the Work
   3. Owner employed testing agency shall not perform any duties of the Contractor

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory and testing agency personnel and provide access to Work

B. Secure and deliver to the laboratory adequate quantities of representative samples of materials proposed to be used and which require testing

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other material mixes which require control by the testing laboratory

D. Furnish copies of product test reports as required

E. Furnish Incidental Labor and Facilities
   1. To provide access to Work to be tested
   2. To obtain and handle samples at the project site or at the source of the product to be tested
   3. To facilitate inspections and tests
   4. For storage and curing of test samples

F. Cooperate with testing agency; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested
   1. Notify Engineer and testing agency 24 hours prior to expected time for operations requiring services to allow for scheduling of tests and laboratory assignment of personnel
   2. Make arrangements with testing agency and pay for additional samples and tests required for Contractor's use

1.11 FIELD TESTING

A. Contractor shall pay all costs associated with standard field testing of materials as detailed in these specifications. Contractor shall pay all costs for testing of piping and equipment as detailed in these specifications. Contractor’s testing agency will take concrete samples, cure and break samples and report results. Contractor's testing agency will also provide compaction testing and proctors for backfill operations. Contractor shall pay for all retesting due to tests indicating failed conditions.

B. Provide all required materials, labor, equipment, water, and power required for testing

C. Perform all tests in presence of Engineer and provide one copy of field test results to Engineer same day of tests

D. Repair with no additional compensation all materials and equipment which fail during testing

1.12 LABORATORY TESTING AND SERVICES SCHEDULE

A. Testing laboratory services shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment, or System	Quality Assurance (QA) or Quality Control (QC)	Owner (O) or Contractor (C) Provided
02300	Earthwork	QA	O
02300	Earthwork	QC	C

1.13 FIELD TESTING AND SERVICES SCHEDULE

A. Field testing shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment, or System	Quality Assurance (QA) or Quality Control (QC)	Owner (O) or Contractor (C) Provided
02300	Earthwork	QA	O
02300	Earthwork	QC	C
02676	Disinfection of Water System	QA	O
02676	Disinfection of Water System	QC	C
03300	Cast-In-Place Concrete	QA	O
03300	Cast-in-Place Concrete	QC	C
13340	Welded Steel Storage Tank	QA	O
13340	Welded Steel Storage Tank	QC	C

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heating, ventilating, telephone service, water and sanitary facilities

B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, and water control.

C. Construction Staging Facilities: Access roads, parking areas, progress cleaning, project signage, storage and temporary buildings.

1.2 GENERAL REQUIREMENTS

A. Furnish, install and maintain all temporary utilities to assure continuous service required for the Work, except as allowed herein, and remove on completion of Work. Modify and extend systems, as work progress requires.

B. Furnish, install and maintain all construction aids required for the Work, except as allowed herein, and remove on completion of the Work

C. Furnish, install and maintain fences and barriers as required for protection of the public, property and the Work

D. Contractor may use existing roadways for access and parking only where designated by Owner.

E. Provide a field office for the use of the Contractor's Superintendent, Owner's Representatives, and Engineer in the designated staging area.

F. Products may be new or used, but must be serviceable, adequate for the intended purpose, and must not violate the requirements of any applicable codes or standards

G. Clean and repair damage caused by temporary installations or use of temporary facilities. Grade and seed all disturbed areas not detailed on the drawings for other treatment

H. Provide contractor information sign posted at accessible location with contractor name and emergency phone contact information.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

1. Comply with applicable Federal and State rules and regulations, local codes and ordinances
2. Comply with utility company requirements

1.4 TEMPORARY ELECTRICITY

A. Contractor shall pay all costs associated with power service to the field offices and pay all costs for energy used.

B. Arrange for and pay all costs associated with temporary power service either from the local utility or a portable engine-generator

C. Provide power outlets for construction operations, with branch wiring and distribution boxes located at the site. Provide flexible power cords as required

D. Provide main service disconnect and over current protection at convenient location

E. Pay all costs for installation and removal of temporary electrical service

1.5 TEMPORARY LIGHTING

A. Provide and maintain lighting to exterior staging and storage areas after dark for security purposes as required

B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required

C. Maintain lighting and provide routine repairs

1.6 TEMPORARY WATER SERVICE

A. Potable water does exist on the site. It will be provided via a fill-station with an account through the city and will be available for non-construction activities only. Non potable water will be available via lake pumping.

B. Provide all drinking water required by construction personnel and Owner's representatives. Pay all costs for temporary water service.

1.7 TEMPORARY SANITARY FACILITIES

A. Provide sanitary facilities at staging area
1. As required by laws and regulations
2. Not less than 1 facility

B. Service, clean and maintain facilities and enclosures

1.8 CONSTRUCTION AIDS

A. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work: scaffolds staging, ladders, stairs, ramps, runways, platforms, railways, hoists, cranes, chutes and other such facilities and equipment

B. Relocate construction aids as required by progress of construction, by storage or work requirements, and to accommodate legitimate requirements by Owner

C. Completely remove temporary materials, equipment, and services at completion of the Project

D. Clean, repair damage caused by installation or by use of temporary facilities
   1. Remove foundations and underground installations for construction aids
   2. Grade the areas for the site affected by temporary installations to required elevations and slopes and clean the area and seed unless specified as shown on the drawings to be different

1.9 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition

B. Provide suitable barriers as required for public protection of Owner's employees

C. Protect non-owned vehicular traffic, stored materials, site and structures from damage

D. Install facilities of a neat and reasonable uniform appearance, structurally adequate for the required purposes

E. Relocate barriers as required by progress of construction

F. Completely remove barriers, including foundations, when construction has progressed to the point that they are no longer needed

G. Clean and repair damage caused by installation, fill and grade the areas of the site to required elevations and slopes and clean the area

1.10 TEMPORARY FENCING

A. Construction: Commercial grade chain link fence

B. Provide additional fencing to protect stored materials & products or to insure public safety and the safety of Owner's employees

C. Provide Owner two (2) keys to lock(s)

D. The site of the work is fenced

1.11 STORMWATER MANAGEMENT

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment as necessary.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

C. Perform work in phases and restore areas where work is complete.

1.12 FUGITIVE DUST PERMIT

A. Comply with all conditions of CDPHE Fugitive Dust Permit. Contractor responsible for both permit filing and any required reporting.

B. Contractor to pay for all metered water used in dust abatement

1.13 CONSTRUCTION DEWATERING

A. Comply will all conditions and requirements of CDPHE Construction Dewatering Permit. The Contractor shall be responsible for any permit filing and reporting necessary.

1.14 EROSION AND SEDIMENT CONTROL

A. Install sediment control fencing at site perimeter where necessary to prevent erosion and sedimentation from occurring off site.

B. During and after site grading, maintain a roughened surface on all disturbed areas to minimize erosion potential.

C. Construct and maintain drainage swales with staked straw bale barriers to control drainage patterns and minimize erosion.

D. Provide and maintain gravel sediment traps at inlets to prevent siltation.

E. Provide and maintain rock check dams if required.

F. Soils can be hauled the Export Material Haul Site as directed by Owner. Rock to be hauled off not crushed and stockpiled to the Export Material Haul Site. Map provided.

1.15 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification Sections

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage

C. Protect finished driving surfaces, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects

D. Prohibit construction traffic from entering future landscaped areas after grades have been established and topsoil restored

1.16 SECURITY

A. Provide security and facilities to protect Work from unauthorized entry, vandalism, or theft

B. Coordinate with Owner's security program

1.17 ACCESS ROADS

A. Maintain existing roads accessing public thoroughfares to construction staging area.

B. Extend and relocate as Work progress requires. Provide detours necessary for unimpeded traffic flow

C. Provide and maintain access to existing fire hydrants free of obstructions

D. Provide means of removing mud from vehicle wheels before entering public paved streets as required by SWMP and Owner

1.18 PARKING

A. Paved and unpaved surfaces adjacent to the staging area can accommodate construction personnel until the designated building staging area has been established

B. If staging area space is not adequate, provide additional off-site parking at location designated by Owner

1.19 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition

B. Remove waste materials, debris, and rubbish from site periodically and dispose off-site in accordance with local and state regulations. Due to high winds experienced at the site, waste removal must be done immediately after it is generated

1.20 FIELD OFFICES AND SHEDS

A. Construction
   1. Structurally sound, weather-tight, with floors raised above ground
   2. Temperature transmission resistance: Compatible with occupancy and storage requirements

3. At Contractor's option, portable or mobile buildings modified for office use may be used
4. Fill and grade sites for temporary structures to provide surface drainage
5. Construct temporary field offices and storage sheds on proper foundations, provide connections for utility services
    a. Secure portable or mobile buildings for winds to 110 mph
    b. Provide steps and landings at entrance door
6. Mount thermometer at convenient outside location, not in direct sunlight
7. Provide periodic maintenance and cleaning for temporary structures, furnishings, equipment and services
8. Remove temporary field offices, contents, and service at a time they are no longer needed
9. Remove storage sheds when they are no longer needed
10. Remove foundations and debris; grade the site to required elevations and clean the areas

B. Contractor's Office and Facilities
    1. Size: As required for general use and to provide space for project progress meetings
    2. Other furnishings: Contractor's option

C. Existing facilities at the site shall not be used for field offices or storage

D. Fire protection equipment. Contractor shall provide and maintain fire extinguishers and active fire hydrants where indicated, maintain fire lanes to hydrants, and provide other equipment as necessary for proper fire protection during construction. Such equipment shall be for fire protection only.

1.21 REMOVAL OF TEMPORARY UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Final Application for Payment

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated

C. Clean and repair damage caused by installation or use of temporary work

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements governing Contractor's selection of products for use in Project and for Work including, but not limited to, the following:
   1. Definitions
   2. General Requirements for Materials and Equipment
   3. Environmental Conditions
   4. Submittals
   5. Quality Assurance and Qualifications
   6. System Responsibility
   7. Transportation and Shipment
   8. Delivery, Storage and Handling
   9. Maintenance Materials
   10. Warranty
   11. Equipment and Product Selection and Identification
   12. Examination, Installation, Adjusting and Cleaning

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01340 – Shop Drawings, Product Data, and Samples

C. Section 01400 – Quality Control

D. Section 01650 – Starting of Systems

E. Section 01730 – Operation and Maintenance Data

1.3 REFERENCES

A. American Gear Manufacturer Association (AGMA)

B. ANSI B1.1-89 – Unified Screw Threads

C. ANSI B 1.20. 1-83-Pipe Threads, General Purpose (Inch)

D. ANSI B16.1-89-Cast Iron Pipe Flanges and Flanged Fittings, Class 125

E. ANSI B18.2.1-81-Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Log Screws

F. ANSI B18.2.2-87-Square and Hex Nuts

G. NSF/ANSI 60-2012 – Drinking Water Treatment Chemicals – Health Effects

H. NSF/ANSI 61-2012 – Drinking Water System Components – Health Effects

I. Hazardous (Classified) Locations: Conform to requirements of NFPA70 Articles 500 through 504

1.4 DEFINITIONS

A. Definitions used in this specification section are not intended to change the meaning of other terms used in the Contract Documents, such as “specialties,” “systems,” “structure,” “finished,” “accessories,” and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry

B. Products: Items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term “product” includes the terms “material”, “equipment”, “system”, and terms of similar intent

C. Named products: Items identified by manufacturer’s product name, including make or model number of other designation, shown or listed in the manufacturer’s published product literature that is current as of date of Contract Documents

D. Foreign products: Distinguished from “domestic products” are items substantially manufactured (50 percent or more of value) outside of the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens or, nor living within, the United States and its possessions are also considered to be foreign products

E. Materials: Products substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form a part of the Work

F. Equipment: Product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping

G. Special tools, instruments, devices, or accessories: Any tools, instruments, devices or accessories required for repair, adjustment or maintenance of equipment which are designed especially for the equipment in question or which are not normally kept in stock by local tool suppliers

H. Responsible manufacturer: Unless otherwise specified, responsible manufacturer shall be manufacturer of driven equipment. Agents, representatives or other entities who are not a direct component of manufacturing corporation will not be acceptable as a substitute for manufacturer's corporation in meeting this requirement

1.5 GENERAL REQUIREMENTS

A. The section applies to all equipment provided under this contract

B. The requirements of detailed specifications take precedence over this section in the event of an apparent conflict

C. Provide all new equipment and materials, except as specified or required by testing

D. Equipment and materials removed from existing structure: Do not use in completed Work except where specifically indicated or specified

E. Contractor to coordinate equipment with other parts of the Work, including verification or compatibility of structures, piping, wiring and equipment components

F. Contractor is responsible for all alterations in the Work to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Drawings or specifications:
   1. The arrangement of equipment shown on the Drawings is based upon information available to the Owner at the time of the design and is not intended to show exact dimensions unique to a specific manufacturer
   2. More than one manufacturer has been used for mechanical layout and design to accommodate all named manufacturer's
   3. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements as provided by the Contractor
   4. Structural supports, foundations, connected piping, valves and electrical conduit specified may have to be altered as coordinated by the Contractor during the submittal process to accommodate the actual equipment provided by the Contractor
   5. No additional payment will be made to the Contractor for such revisions and alterations

G. Do not use any material or equipment for any purpose other than that for which is designed or specified

H. Equipment lists presented in these specifications and as specified on the Drawings are included for the convenience of the Engineer and Contractor and are not to be considered as complete listings of all equipment, devices and material to be provided under this contract:
   1. Contractor shall prepare his own material and equipment take-off lists as necessary from the contract Drawings, addenda and this project manual to meet the requirements of this project

1.6 ENVIRONMENTAL CONDITIONS

A. Minimum Design Criteria:
   1. Altitude: 5,910 feet above mean sea level
   2. Outdoor air temperature: 20 to 100 degrees F
   3. Relative Humidity:
      a. Summer time: 20 percent
      b. Winter time: 0 percent
   4. Wind speed: 115 mph, exp C

5. Seismic Design Site Classification: C

1.7 SUBMITTALS

A. Provide submittals in accordance with Section 01340 – Shop Drawings, Product Data, and Samples

B. Submittals for products are specified in Section 01340 – Shop Drawings, Product Data, and Samples and in Divisions 2 through 16

C. All submittals for each component of multi-component systems shall be compiled and submitted through the Contractor to the Engineer by the manufacturer having system responsibility

D. Provide a copy of this specification section with all addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements.

E. Provide Certificate of System Responsibility

F. Tanks and other equipment mounted outdoors with anchorage and mounting product data for reference purposes:
   1. Include wind loads
   2. Include snow loads

G. Manufacturer's certified data showing location of critical speeds in relation to operating speeds

1.8 QUALITY ASSURANCE AND QUALIFICATIONS

A. Source limitations and interchangeability: To the fullest extent possible, provide products of the same kind from a single source

B. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer’s or producer’s nameplate or trademarks on exposed surface of products that will be exposed to view in occupied spaces or on the exterior
   1. Labels: Locate required product labels and stamps on concealed surfaces, or where required for observation after installation, on inconspicuous, accessible surfaces.
   2. Equipment nameplates: Provide a permanent nameplate on each item of service – connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. Nameplate shall contain, but not limited to, the following information and other essential operating data:
      a. Name of product and manufacturer
      b. Model and serial number
      c. Capacity
      d. Speed
      e. Ratings
      f. Operating and power characteristics

g. Labels of tested compliance with codes and standards
3. Refer to additional requirements specified in Divisions 2 through 16

C. Installers Qualifications:
1. Equipment and material: Installed and placed in service by or under guidance of qualified personnel having knowledge and experience necessary for proper results
2. Where Contractor's or subcontractor's employees are not properly qualified, use personnel such as factory authorized field representative of equipment supplier

1.9 SYSTEM RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a single system by the responsible manufacturer. Unless otherwise specified, the Contractor shall assign system responsibility to, and obtain each system from the manufacturer of the driven equipment. The manufacturer shall design and provide all components of the system to enhance proper operation, compatibility of all components, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components such that all equipment is compatible and operates properly to achieve the performance requirements specified. The Contractor is responsible to the Owner for performance of all systems as provided in the General and Special Conditions.

B. Nothing in this provision shall be construed as relieving the Contractor of overall responsibility for the Work of this Contract and the performance of all systems as specified under paragraphs 00700 – Standard General Conditions, Article 13

1.10 TRANSPORTATION AND SHIPMENT

A. Shipment preparation: Contractor shall require manufacturers and suppliers to prepare equipment and materials for shipment in a manner to facilitate unloading and handling, and to protect against damage or unnecessary exposure in transit and storage, for contractor supplied equipment. Provisions for protection shall include the following:
1. Crates or other suitable packaging materials
2. Covers and other means to prevent corrosion, moisture damage, mechanical, injury, and accumulation of dirt in motors, electrical equipment, and machinery
3. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel
4. Grease packing or oil lubrication in all bearings and similar items

B. Marking
1. Each item of equipment and material shall be tagged or marked as identified in the delivery schedule or on submittals
2. Complete packing lists and bills of material shall be included with each shipment.
3. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together and the packages or bundles are properly tagged or marked

1.11 DELIVERY, STORAGE, AND HANDLING

A. Delivery
   1. Arrange deliveries of equipment and materials in accordance with construction schedules, in ample time to facilitate inspection prior to installation and to avoid delay of Work. Coordinate to avoid conflict with work and conditions at the site
   2. Deliver products in undamaged condition, in manufacturer's sealed, weather tight, original container or packaging, with identifying labels intact and legible, all in accordance with manufacturer's instructions and recommendations using means and methods that will prevent damage, deterioration, and loss, including theft
   3. Control delivery schedules to minimize long-term storage at the Site and to prevent overcrowding of construction spaces. Coordinate delivery and installation to ensure minimum holding or storage times for items known or recognized to be flammable hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss
   4. Products delivered to Work site shall be in undamaged condition, in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing
   5. Mark deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate inspection and measurement of quantity or counting of units
   6. Immediately on delivery, inspect shipment to ensure:
      a. Product complies with requirements of Contract Documents and reviewed Submittals
      b. Quantities are correct
      c. Containers and packages are intact and labels are legible
      d. Equipment and materials are properly protected and undamaged
   7. Include complete packing lists and bills of material with each shipment including equipment identification number assigned by Drawings and Specifications of this Contract
   8. Deliver anchor bolts together with templates sufficiently early to permit setting when structural concrete is placed

B. Storage
   1. If there is no interior space available from the Owner for storage of delivered equipment and material at the project site:
      a. Provide adequate facilities for storage in accordance with Section 01500
      b. Provide off-site storage and protection when site does not permit on-site storage or protection and if acceptable to Owner in accordance with the General Conditions
   2. Submit and maintain insurance for equipment and materials at off-site storage
   3. Requests for payment of stored equipment and materials by the Contractor may be rejected if storage facilities do not conform to these specifications or manufacturer's written recommendations.
   4. Store equipment and materials immediately on delivery, and protect until completion of the Work. Store in accordance with manufacturer’s instructions with seals and labels intact and legible
   5. Store equipment and materials in a manner that will not endanger the supporting construction

6. Store equipment and materials that are subject to damage by elements in weathertight enclosures
7. Maintain temperature and humidity within ranges required by manufacturer
8. Protect motors, electrical equipment, plumbing fixtures, and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter
9. Protect electrical equipment, controls, and insulation against moisture, water, and dust damage
10. Immediately after delivery and inspection, connect and operate continuously all space heaters furnished in electrical equipment
11. Protect exposed-machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds
12. Protect bearings and similar items with grease packing or oil lubrication
13. Handle and store steel plate, sheet metal, and similar items in a manner to prevent deformation
14. Exterior storage:
    a. Provide substantial platforms, blocking, or skids to support fabricated products aboveground and to prevent soiling or staining. Cover products subject to discoloration or deterioration from exposure to elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation
    b. Store loose granular materials on solid surface areas to prevent mixing with foreign matter
    c. Provide surface drainage to prevent flow or ponding of rainwater
15. Equipment and materials shall not show any pitting, rust, decay or other deleterious effects of storage prior to final acceptance of Work
16. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure products are maintained under specified conditions and free from damage or deterioration
    a. Prepare stored materials lists with schedules of maintenance activities and frequency of activities required to maintain the quality of the equipment and the warranty from the manufacturer
    b. List dates and activities of storage requirements such as rotating moveable parts
    c. Update lists weekly and include in progress meeting agenda
17. Protect painted surfaces against impact, abrasion, discoloration or other damage:
    a. Repaint any damaged areas with manufacturer provided touch-up paint
18. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation
19. Installed products stored prior to start-up:
    a. Equipment and materials shall not show any pitting, rust, decay or other deleterious effects of storage when installed in the Work
    b. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations, dust, dirt, water and paint. Remove when no longer needed

C. Handling

1. Provide equipment and personnel necessary to unload and handle equipment and materials, by methods to prevent damage or soiling to equipment and materials or packaging
2. Handle by methods to prevent bending or overstressing. Where lifting points are designated, lift components only at those points
3. Provide additional protection to surrounding surfaces as necessary to prevent damage

D. Maintenance of storage
1. Inspect stored equipment and materials on a scheduled basis
2. Verify that storage facilities comply with manufacturer's product storage requirements, including environmental conditions continually maintained
3. Verify that surfaces of products exposed to elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents
4. For mechanical and electrical equipment in long-term storage, provide manufacturers service instructions to accompany each item, with notice of enclosed instructions on exterior of package. Service equipment on a regularly scheduled basis.

E. Protection after installation
1. Provide substantial coverings as necessary to protect installed equipment and materials from damage from subsequent construction operations
2. Remove when no longer needed or as specified

1.12 MAINTENANCE MATERIALS

A. Spare Parts:
1. Store spare parts, wherever required by detailed technical specification sections, in accordance with the provisions of this paragraph
2. Tag all spare parts with permanent, labeled tags or packaging by equipment designation number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate)
3. Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping
4. Unless otherwise specified, spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box:
   a. Provide box with a hinged wooden cover and locking hasp
   b. Hinges to be strap type
   c. Paint the box and identify with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts"
5. Prepare and provide a neatly typed inventory of spare parts taped to the underside of the box cover

1.13 WARRANTY

A. Warranty all equipment and materials against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, leakage, breakage or other failure

B. Unless otherwise specified, for all equipment and materials provide manufacturer's warranty for a period of 2 years from the date of Substantial Completion

C. Warranties that begin at the time of shipment, delivery or within a limited time period from date of shipment or delivery or any other qualification that does not conform to the definition of Substantial Completion are not acceptable

D. Cost of all manufacturer warranties are considered as part of the Bid price

PART 2 PRODUCTS

2.1 MATERIALS

A. Suitable for the intended service conditions

B. Structural and miscellaneous fabricated steel in equipment shall conform to American Institute of Steel Construction (AISC) standards, except as otherwise specified

2.2 FABRICATION

A. Design, fabricate, and assemble in accordance with the best modern manufacturing and shop practices

B. Manufacture parts to standard sizes and gages

C. Two or more items of the same type shall be identical by the same manufacturer and interchangeable

2.3 EQUIPMENT AND PRODUCT SELECTION

A. General product requirements: Provide products that comply with the Contract Document, are undamaged, and unless otherwise indicated or specified, are new at time of installation
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect
   2. Standard products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects
   3. Continued availability: Where, because of the nature of its application, the Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard, domestically produced product for which the manufacturer has published assurances that the product and its parts shall be available to the Owner at a later date. A reasonable doubt regarding such future availability will be grounds for rejection of products other than named products
   4. As specified in each applicable Specification Sections, Drawings, codes, standards, and regulatory agencies

5. Fabricated products:
    a. Design, fabricate, and assemble products in accordance with best engineering and shop practices
    b. Manufacture like parts of duplicate units to standard interchangeable sizes and gauges. Two or more items of same kind shall be identically made by the same manufacturer
    c. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically accepted in writing by Owner
    d. Ensure that material or equipment are not used for any purpose other than that for which it is designed or is specified
    e. Labels and nameplates shall be provided where required by regulatory agencies or in accordance to state identification and essential operation data
6. Provide products of the same kind from a single source to the fullest extent possible

2.4 EQUIPMENT AND PRODUCT IDENTIFICATION

A. Nametags: Identify all valves, instruments, devices, with the equipment tag designation numbers and prefix and suffix letters as specified and/or shown on the Process and Instrumentation Drawings (P&IDs). Identification shall also be in accordance with Section 01080 – Identification Systems.

B. Nameplates: Identify all pumps and equipment with the equipment tag designation numbers and prefix and suffix letters as specified and/or shown on the Process and Instrumentation Drawings (P&IDs):
    1. Provide engraved or machine stamped non-corrosive metal nameplate fastened to the pump or equipment base plate with screws or drive pins of the same material
    2. Nameplate material shall not corrode or discolor in moist or salt water spray atmosphere
    3. Name plates indicate the following:
        a. Manufacturer
        b. Date of manufacture
        c. Name of product
        d. Model and size
        e. Serial Number
        f. Capacity: Rating in gpm or SCFM (if a fan or blower) and feet of head or inches water column
        g. Impeller or wheel diameter (if a fan)
        h. Impeller diameter
        i. Operating and power characteristics
        j. As specified herein and in Divisions 2 through 16
    4. Motor Nameplates:
        a. All motors for pumps and other equipment having motors shall be identified as specified elsewhere under this Section and in Divisions 2 through 16

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install any equipment showing such effects. Replace damaged equipment with identical new equipment

3.2 INSTALLATION

A. Install all equipment, accessories and materials in accordance with the manufacturer's written recommendations unless otherwise specified in the individual equipment detailed technical specifications

B. Each product shall be securely anchored in place except as required for proper movement and performance

C. Each product shall be located and aligned with other Work

D. Manufacturer’s Instructions
   1. Contractor shall obtain and distribute hard copies and electronic copies of manufacturer’s instructions and recommendations to parties involved in installation including a copy to Engineer
   2. Maintain one (1) set of complete instructions at job site during installation and until completion
   3. Handle, install, connect, clean, conditions, and adjust products in accordance with such instructions and in conformity with specified requirements

3.3 ADJUSTING

A. Perform all required adjustment tests, operation checks, and other startup activities required

3.4 CLEANING

A. Perform under provisions of Section 01700 – Contract Closeout

B. Repaint all painted surfaces which are damaged prior to final equipment acceptance to Owner's satisfaction

C. Clean exposed surfaces and protect as necessary and required to prevent any damage or deterioration at the time of Substantial Completion

END OF SECTION

SECTION 01650

STARTING OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Starting systems

B. Demonstration, instructions, and training

C. Testing

1.2 RELATED SECTIONS

A. Section 01730 – Operation and Maintenance Data

1.3 STARTING SYSTEMS

A. Provide Engineer with start-up and training schedule at least 14 days prior to the startup of the equipment

B. Verify that each piece of equipment or system has been checked for proper control sequence, or other conditions which may cause damage

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

D. Verify wiring and support components for the equipment are complete and tested

E. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturers' instructions

F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and supervise placing equipment or system in operation

G. Submit a written report certifying that equipment or system has been properly installed and is functioning correctly

1.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel within 7 days prior to date of Substantial Completion

B. Utilize Operation and Maintenance Manuals as basis for instruction. Review contents of

manual with Owner's personnel in detail to explain all aspects of operation, maintenance, and troubleshooting

C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled times, at equipment location

D. Prepare and insert additional data in Operations and Maintenance Manuals when need for additional data becomes apparent during instruction

E. The amount of time required for instruction on each item of equipment and system is that specified in individual sections

F. Owner may videotape training sessions. Contractor and manufacturer's trainer to cooperate with videotaping

1.5 TESTING, ADJUSTING, AND BALANCING

A. Contractor will employ and pay for services of an independent firm to perform testing, adjusting, and balancing as required by individual specification sections or on the Drawings

B. Reports will be submitted by an independent firm to the Engineer, through the Contractor, indicating observations and results of tests and indicating compliance or non-compliance with specified or regulatory requirements and with the requirements of the contract

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Substantial completion

B. Final acceptance

C. Project record documents

D. Closeout procedures

E. Final cleaning

F. Final adjustment of accounts

G. Final application for payment

1.2 RELATED SECTIONS

A. Section 00700 – General Conditions

B. Section 01500 – Construction Facilities and Temporary Controls

C. Section 01340 – Shop Drawings and Product Data

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Prior to requesting inspection for certification of Substantial Completion, complete the following and list exceptions in the request:
   1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100% completion for the portion of the Work claimed as Substantially Complete
      a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price
      b. If 100% completion cannot be shown, include a list of incomplete items, the value of incomplete Work, and reasons the Work is not complete. All items remaining outstanding on the Contractor's punch list shall include a projected date of completion and/or correction with an explanation of why such item is not presently completed
   2. Advise Owner of pending insurance changeover requirements
   3. Submit specific warranties, workmanship Bonds, maintenance agreements, final certifications, and similar documents

4. Obtain and submit releases enabling Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases
5. Submit record drawings, instruction books and operating manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information
6. Deliver tools, spare parts, extra stock, and similar items
7. Make final changeover of permanent locks and transmit keys to Owner. Advise Owner's personnel of changeover in security provisions
8. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes

B. Inspection Procedures: On receipt of a request for inspection, Engineer will either proceed with inspection or advise Contractor of unfilled requirements. Engineer will prepare the Certificate of Substantial Completion following inspection or advise Contractor of construction that must be completed or corrected before the certificate will be issued
   1. Engineering will repeat inspection when requested and assured by Contractor that the Work is Substantially Complete.
   2. Results of the completed inspection will form the basis of requirements for final acceptance

1.4 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
   1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required
   2. Submit an updated final statement, accounting for final additional changes to the Contract Price
   3. Submit a certified copy of Engineer’s final inspection list of items to be completed or corrected, endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by Engineer.
   4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the Date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work
   5. Submit consent of surety to final payment
   6. Submit evidence of final, continuing insurance coverage complying with insurance requirements

B. Reinspection Procedure: Engineer will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to Engineer.

1. Upon completion of reinspection, Engineer will prepare a certificate of final acceptance. If the Work is incomplete, Engineer will advise Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance
2. If necessary, reinspection will be repeated, but at the expense of the Contractor who will reimburse the Owner for these services by the Engineer

1.5 PROJECT RECORD DOCUMENTS

A. General
1. Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours
2. Maintain on site, one set of the following record documents; record actual revisions to the Work:
   a. Contract Drawings
   b. Specifications
   c. Addenda
   d. Change Orders and other Modifications to the Contract
   e. Reviewed shop drawings, product data, and samples
   f. Field test reports
   g. Construction photographs
3. Store Record Documents and samples separate from documents used for construction
   a. Provide files and racks for storage of documents
   b. Provide locked cabinet or secure storage space for samples

B. Record Drawings
1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings
2. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown
3. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings
4. Give particular attention to concealed elements that would be difficult to measure and record at a later date
   a. Record information concurrently with construction progress
   b. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work. Mark each document "Project Record" in neat, large, printed letters
   c. Mark new information that is important to Owner but was not shown on Contract Drawings or Shop Drawings
   d. Note related Change Order numbers where applicable
   e. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set

f. Upon completion of the Work, submit record drawings to Engineer for Owner's records

5. Contract Drawings and approved Shop Drawings: Legibly mark each item to record actual construction, including:
   a. Measured depths of elements of foundation in relation to finish grade or first floor datum
   b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvement
   c. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
   d. Field changes of dimensions and details
   e. Changes made by Addenda or Change Order(s), if any
   f. Details not on original Contract Drawings
   g. References to related Shop Drawings and Modifications

C. Record Specifications: Maintain one complete copy of the Project Manual including addenda. Include with the Project Manual one copy of other written construction documents, such as Change Orders and Modifications issued in printed form during construction
   1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
   2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
   3. Note related record drawing information and product data.
   4. Upon completion of the Work, submit record Specifications to Engineer for Owner's records

D. Record Product Data: Maintain one copy of each product data Submittal. Note related Change Orders and markup of record drawings and specifications.
   1. Mark record documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the Site and from the manufacturer's installation instructions and recommendations.
   2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
   3. Upon completion of markup, submit complete set of record product data to Engineer for Owner's records
   4. Legibly mark and record at each Product section description of actual Products installed, including the following:
      a. Manufacturer's name, product model, number, trade name and supplies
      b. Product substitutions or alternates utilized
      c. Changes made by Addenda, field order or change order

E. Record Samples Submitted: Immediately prior to Substantial Completion, Contractor shall meet with Engineer and Owner's personnel at the Project Site to determine which Samples are to be transmitted to Owner for record purposes. Comply with Owner's instructions regarding packaging, identification, and delivery to Owner.

F. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and Submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records, and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to Engineer for Owner's records
   1. For electrical refer to Section 16900

G. Maintenance Manuals: Contractor shall organize operation and maintenance data as specified in Section 01730

H. Submit documents to Engineer with claim for final Application for Payment

I. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes

J. Make documents and samples available at all times for inspection by Engineer

K. Label each document "Project Record" in neat, large printed letters

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 CLOSEOUT PROCEDURES

A. General
   1. Comply with requirements stated in the Owner's General Conditions of the Contract and in these specifications for administrative procedures in closing out the Work
   2. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection
   3. Provide submittals to Engineer/Owner that are required by governing or other authorities
   4. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due

B. Operation and Maintenance Instructions: Arrange for each installer of Equipment that requires regular maintenance to meet with Owner's personnel at Project Site to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
   1. Maintenance manuals
   2. Record documents
   3. Spare parts, materials and tools
   4. Identification systems

5. Control sequences
6. Cleaning
7. Warranties and bonds
8. Maintenance agreements and similar continuing commitments

C. As part of instruction for operating Equipment, demonstrate the following procedures:
1. Startup
2. Shutdown
3. Emergency operations
4. Safety procedures
5. Economy and efficiency adjustments
6. Effective energy utilization

3.2 FINAL CLEANING

A. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion
a. Remove labels that are not permanent labels
b. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition
c. Wipe surfaces of mechanical and electrical Equipment. Remove excess lubrication and other substances
2. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction
3. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of lawfully.
a. Where extra materials of value remaining after completion of associated Work become Owner's property. Dispose of these materials as directed by Owner

3.3 CONTRACTOR'S CLOSEOUT SUBMITTALS

A. Evidence of Payment and Release of Liens: As specified in the General Conditions

B. Final inspection reports by all regulatory agencies demonstrating the agencies' final approval

C. At Contract close-out, deliver Record Documents to Engineer for the Owner

D. Accompany Submittal with Transmittal Letter in Duplicate, Containing
1. Date
2. Project title and number

3. Contractor's name and address
4. Title and number of each Record Document
5. Signature of Contractor or his authorized representative

3.4 FINAL ADJUSTMENTS OF ACCOUNTS

A. Submit a Final Statement of Accounting to Engineer

B. Statement Shall Reflect All Adjustments to the Contract Sum
   1. The original Contract Sum
   2. Additions and deductions resulting from
      a. Previous Change Orders
      b. Deductions for uncorrected Work
      c. Deductions for liquidated damages
      d. Deductions for reinspection payments
      e. Other adjustments
   3. Total Contract Sum, as adjusted
   4. Previous payments
   5. Sum remaining due

3.5 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the General Conditions of the Contract

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittals

B. Format

C. Content of each volume

D. Manual for equipment and systems

E. Instruction of Owner's personnel

1.2 QUALITY ASSURANCE

A. Preparation of data shall be done by personnel
   1. Trained and experienced in maintenance and operation of the described products
   2. Completely familiar with requirements of this section
   3. Skilled as a technical writer to the extent required to communicate essential data
   4. Skilled as a draftsman competent to prepare required drawings

B. Manuals for equipment systems shall be prepared by the equipment manufacturer or system supplier

C. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under the Contract

D. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of Specifications

1.3 SUBMITTALS

A. Submit under provisions of Section 01340

B. Manuals for equipment and systems
   1. Submit three (3) preliminary copies prior to the date of shipment of the equipment or system
      a. Engineer will review
      b. If acceptable, one (1) copy will be returned to Contractor, one (1) copy sent 4Owner, and one (1) copy retained in Engineer's file

c. If unacceptable, two (2) copies will be returned to Contractor with Engineer's comments for revision and one (1) copy retained in Engineer's file. Resubmit three (3) revised preliminary copies for Engineer's review
d. No partial payments will be made for equipment and systems on hand or installed until preliminary manuals are submitted and acceptable
e. See Section 01340 for electronic submittal requirements, for the preliminary copy of the O&M manual an electronic submittal is allowable

C. Submit three (3) final copies no less than 30 days prior to putting the equipment or system in service. If final manuals differ from accepted preliminary manuals, submit two (2) copies of any necessary supplemental material with instructions for insertion for conforming Engineer's and Owner's copies of preliminary manuals to final manuals
1. Engineer will compare with accepted preliminary manual
2. If identical or otherwise acceptable, Contractor will be so notified. Two (2) copies will be transmitted to Contractor, three (3) copies will be held for later transmittal to Owner
3. If not acceptable, four (4) copies will be returned to Contractor for revision or retained by Engineer and the necessary revision data requested from Contractor at Engineer's option
4. No portion of the Work is substantially complete until final equipment and system manuals relating to that portion of the Work are accepted by Engineer
5. Submit three (3) copies of any revisions found desirable during instruction of Owner's personnel with instructions for insertion for revising Owner's and Engineer's copies of manual

D. Manual for materials and finishes
1. Submit two (2) preliminary copies 15 days prior to request for final inspection
a. Engineer will review
b. One copy will be returned to Contractor with comments, one (1) retained in Engineer's file
c. No final inspection shall be conducted until preliminary manuals are submitted
2. Submit three (3) final copies, revised in accordance with Engineer's comments, within 10 days after final inspection
a. One copy will be transmitted to Contractor and two (2) copies retained by Engineer for later transmittal to Owner
b. No final payment shall be made until final manuals are submitted
3. Additional requirements for specialized instruction of Owner's personnel are given in the detailed equipment specifications

1.4 FORMAT

A. Prepare data in the form of an instructional manual for use by Owner's personnel

B. Presentation of Information
1. Size: 8 ½" by 11"
2. Paper: 20 lb weight minimum, white, for typed pages

3. Text: Manufacturer's printed data or neatly typewritten
4. Drawings
    a. Provide reinforced punched binder tab, bind in with text
    b. Reduced to 11" by 17" and folded to 8 ½" by 11"
    c. Where reduction is impractical, folded and placed in 8 ½" by 11" envelopes bound in text
    d. Suitably identified on drawings and envelopes
5. Provide flysheets for each separate product or each piece of operating equipment
    a. Provide typed description of product and major component parts of equipment
    b. Provide indexed tabs, may be in color
6. Spine and cover: identify each volume with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" preceded by the word. "PRELIMINARY" or "FINAL" as applicable. Final manuals to list information on the cover and the spine. List the following:
    a. Title of project, reference Owner and project location as applicable
    b. Identity of separate structure as applicable
    c. Identity of general subject matter covered in manual and specification section number
7. As much as possible, assemble and bind material in the same order as specified

C. Binders
1. Preliminary manuals: Commercial quality permanent 3-ring or 3-post binders with durable, cleanable, hard plastic covers. GBC bound manual may be accepted upon review by Engineer
2. Final manuals: Commercial quality permanent 3-ring or 3-post binders with durable, cleanable, hard plastic covers with clear plastic cover and spine pockets suitable for title and cover inserts. Manufacturer's pre-printed binder may be accepted upon review by Engineer. "Deluxe Round Ring View Binder" as manufactured by Wilson Jones or accepted substitution
3. Final electronic manual: Provide one copy in digital format, all documents to be in native file format (Word, Excel, AutoCAD, pdf) or converted from native file format into Adobe pdf. Provide one copy on an electronic disk, CD or DVD

D. Arrange content by systems under section numbers and sequence of table of contents of this Project Manual

E. Provide tabbed flyleaf for each separate product and system, with typed description of product and major component parts of equipment

F. Electronic Manual: Compile in an electronic book format with Chapter bookmarks (equal to tabbed fly leafs) and OCR (optical character recognition) to allow for document searches.

1.5 CONTENTS OF EACH VOLUME

A. Neatly typewritten table of contents for each volume, arranged in a systematic order

1. Contractor, name of responsible principal, address and telephone number
2. A list of each product required to be included, indexed to the content of the volume
3. List, with each product, the name, address and telephone number of
    a. Subcontractor or installer
    b. Maintenance contractor, as appropriate
    c. Identify the area of responsibility of each
    d. Local source of supply for parts and replacement
4. Identify each product by product name and other identifying symbols as set forth in Contract Documents

B. Product Data
1. Include only those sheets which are pertinent to the specific product
2. Annotate each sheet to
    a. Clearly identify the specific product of part installed
    b. Clearly identify the data applicable to the installation
    c. Delete references to inapplicable information

C. Drawings
1. Supplement product data with drawings as necessary to clearly illustrate
    a. Relations of component parts of equipment and systems
    b. Control and flow diagrams
2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation
3. Do not use Project Record Documents as maintenance drawings

D. Written text, as required to supplement product data for the particular installation
1. Organize in a consistent format under separate headings for different procedures
2. Provide a logical sequence of instructions for each procedure

E. Copy of each warranty, bond and service contract issued
1. Provide information sheet for Owner's personnel, give
    a. Proper procedures in the event of fracture
    b. Instances which might affect the validity of warranties or bonds

1.6 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Provide an operation and maintenance manual for each item of equipment or system listed in the schedule of manuals in the quantity listed in the submittal schedule

B. Content for each of equipment and system as appropriate
1. Description of unit and component parts
    a. Function, normal operating characteristics and limiting conditions
    b. Performance curves, engineering data and tests
    c. Complete nomenclature and commercial number of all replaceable parts
2. Operating procedures
    a. Startup, break-in, routine and normal operating instructions

b. Regulation, control, stopping, shutdown and emergency instructions
c. Summer and winter operating instructions, as applicable
d. Special operating instructions

3. Maintenance procedures
   a. Routine operations
   b. Guide to "trouble-shooting"
   c. Disassembly, repair and reassembly
   d. Alignment, adjusting and checking
4. Servicing and lubrication schedule
   a. List of lubricants required
5. Manufacturer's printed operating and maintenance instructions
6. Description of sequence of operation by control manufacturer
7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance
   a. Predicted life of parts subject to wear
   b. Items recommended to be stocked as spare parts
8. As-installed control diagrams by controls manufacturer
9. Each contractor's coordination drawings
   a. As-installed color-coded piping diagrams
10. Charts of valve tag numbers with the location and function of each valve
11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage
12. Other data as required under pertinent sections of specifications

C. Content for each electric and electronic item or system, as appropriate
   1. Description of system and component parts
      a. Function, normal operating characteristics and limiting conditions
      b. Performance curves, engineering data and tests
      c. Complete nomenclature and commercial number of replaceable parts
   2. Circuit directories of panelboards
      a. Electrical service
      b. Controls
      c. Communications
   3. As-installed color-coded wiring diagrams
   4. Operating procedures
      a. Routine and normal operating instructions
      b. Sequences required
      c. Special operating instructions
   5. Maintenance procedures
      a. Routine operations
      b. Guide to "trouble-shooting"
      c. Adjustment and checking
   6. Manufacturer's printed operating and maintenance instructions
   7. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage
   8. Other data as required under pertinent sections of specifications

D. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel

E. Additional requirements for Operation and Maintenance Data: The respective sections of specifications

1.7 INSTRUCTIONS OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment and system

B. Operation and maintenance manual constitutes the basis of instruction
   1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance

1.8 Additional requirements for specialized instruction of Owner's personnel are given in the detailed equipment specifications

A. Equipment and systems Operation and Maintenance manuals shall be prepared for each of the following

Specification Section	Type of Equipment or System
13340	Welded Steel Storage Tank
16900	Instrumentation

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 02220

DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Demolition, removal, salvage and disposal of existing site features, piping, structures and materials where indicated on the drawings and as specified in this section

B. Demolition and removal of existing site features including but not limited to existing tanks and associated appurtenances.

1.2 RELATED SECTIONS

A. Section 01500 – Construction Facilities and Temporary Controls

B. Section 02300 – Earthwork

C. Section 02950 - Seeding

1.3 SUBMITTALS

A. Permits and Certificates.
   1. Contractor shall obtain all required permitted, such as those needed for transport and disposal of debris

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 specifications

B. Accurately record actual locations of capped utilities and subsurface obstructions

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable State and local codes for demolition of structures, safety of adjacent structures, dust control, and disposal

B. Obtain required permits from authorities

C. Notify affected utility companies before starting work and comply with their requirements

D. Do not close or obstruct roadways, sidewalks, or hydrants without written permission from Owner

E. Conform to applicable regulatory procedures when discovering hazardous or contaminated materials

1.6 SCHEDULING

A. Schedule and submit under provisions of Division 1 specifications

B. Provide detailed descriptions for demolition and removal procedures

C. Notify Engineer and Owner of any demolition work one (1) week prior to commencement

D. Coordinate all demolition work with Engineer and Owner

PART 2 PRODUCTS

2.1 SALVAGE OF MATERIALS

A. Remove and return to Owner the following Equipment and Materials:
1. Not Applicable

B. All existing construction and items not salvaged to Owner shall be considered waste and shall become the property of Contractor for off-site disposal

C. Remove and reinstall as indicated on Drawings and herein the following Equipment and Materials:
1. Not Applicable

2.2 HANDLING AND STORAGE

A. Contractor shall carefully disassemble Equipment and Materials that are to be reused and returned to Owner in such a way to avoid any damage. Contractor shall store such Equipment and Materials in such a way to avoid any damage, corrosion, or staining

2.3 FILL MATERIALS

A. Fill Material: Use on site fill material under provisions of Section 02300 and in accordance with Geotechnical recommendation

PART 3 EXECUTION

3.1 INSPECTION

A. Verify areas to be demolished are unoccupied and discontinued in use

B. Do not commence work until conditions are acceptable to Engineer and Owner

C. Existing conditions of Equipment and Materials, structures, surfaces, or properties that could be misinterpreted as damaged as a result of demolition work shall be photographed and filed with Owner and Engineer prior to commencement of Work

3.2 PREPARATION

A. Provide, erect, and maintain temporary barriers, enclosures, security fences and shoring at demolition locations in accordance with Division 1 and other related specifications to protect personnel

B. Protect existing structures and utilities which are not to be demolished

C. Provide temporary wiring and connections to maintain existing telephone, electrical, instrumentation and control systems in service during construction

D. Protect existing electrical and controls equipment. Set up temporary barriers to preclude dust from being introduced into equipment. Additionally, seal all equipment while demolition is occurring.

E. Mark location of existing utilities

3.3 GENERAL REQUIREMENTS

A. Sprinkle Work with water to minimize dust where applicable. Provide hoses and water connections for this purpose.

B. Do not use water to extent causing flooding, contaminated runoff, or icing

C. Remove demolished material from the site

D. Repair damage to adjacent structures

E. Remove existing exposed piping and electrical wiring and conduit to be abandoned to structural surface, cut flush, and finish to match existing surfaces

F. Remove buried piping, wiring, and conduit to be abandoned as required for the Work. Plug the remainder flush.

3.4 DISPOSAL

A. Do not store or burn waste materials on-site

B. Transport demolition debris to designated off-site disposal area

C. If hazardous materials are encountered during demolition work, Contractor shall comply with applicable regulations and laws regarding the removal, handling, and protection of environment and human health

3.5 CONNECTION TO EXISTING CONSTRUCTION

A. Cut and remove portions of existing construction as necessary to allow for proper installation of new construction Equipment and Materials

B. Shore and brace existing structures to maintain safe structure conditions and until permanent structures and supports are completed
   1. Contractor shall repair all damage in result of installation of shoring and bracing

C. Cap, seal or abandon pipe and cable as indicated on Drawings and specified herein

3.6 CLEANUP AND REPAIR

A. Contractor shall remove tools, equipment and demolished materials from Site upon completion of demolition work
   1. Remove protections
   2. Interior areas shall be broom clean
   3. Inspect and clean all electrical control cabinets, interior and exterior, exposed to dust and debris during the demolition process

B. Contractor shall repair demolition performed in excess of that required or indicated
   1. Surfaces and structures to remain shall be repaired to the existing conditions prior to commencement of demolition work

3.7 SITE DEMOLITION

A. Disconnect, remove, cap and identify designated utilities within demolition area

B. Remove items where shown on the Drawings.

C. Backfill areas excavated caused as a result of demolition, in accordance with Section 02300

D. Rough grade and compact areas affected by demolition to maintain site grades and contours as shown on drawings

E. Remove demolished materials from site

F. Do not burn or bury materials on site, unless otherwise directed by Owner. Leave site in clean condition.

3.8 ELECTRICAL DEMOLITION

A. General:
   1. Remove, relocate and extend existing conduits as shown on the drawings and to aid the City's Electrical and Controls Specialist with their work.
      a. Coordinate all work with the City of Grand Junction and their Specialist

B. Existing electrical service:

1. Work by the City of Grand Junctions Electrical and Controls Specialist
    a. Disconnect power and controls from existing concrete tanks after new tank is operational.
    b. Contractor shall coordinate work with the Specialist and aid with removal of existing items as required.
2. Work by Contractor:
    a. Provide standby power conduit and cables for temporary use during construction. Completely remove temporary service after construction.

3.9 TANK DEMOLITION

A. Remove, dispose and abandon existing concrete tanks as shown on the Drawings.
    1. Coordinate all work with the City of Grand Junction and their Electrical and Controls Specialist

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, and Division One and other related specification sections apply to work of this section.

1.2 SECTION INCLUDES

A. Clearing, grubbing and site preparation

B. Removal and disposal of debris

C. Handling, storage, transportation, and disposal of excavated material

D. Sheeting, shoring, bracing and protection work

E. Pumping and dewatering as required or necessary

F. Backfilling

G. Pipe embedment

H. Construction of fills and embankments

I. Excavation for buildings & structures

J. Trench Stabilization

K. Final grading

L. Slope Stabilization

M. Appurtenant work

1.3 RELATED SECTIONS

A. Section 01020 – Geotechnical Report

B. Section 02950 – Seeding

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)

B. American Society for Testing and Materials (ASTM):
   1. C33 – Concrete Aggregates
   2. C136 – Sieve Analysis of Fine and Coarse Aggregates
   3. D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. Rammer and 12-Inch Drop
   4. D1241 – Material for Soil Aggregate Subbase, Base and Surface Courses
   5. D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
   6. D4253 – Test Methods for Maximum Index Density of Soils and Unit Weight of Soils Using a Vibratory Table
   7. D4254 – Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
   8. D4318 – Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
   9. D6938 – Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)

C. American Concrete Institute (ACI):
   1. 229 – Controlled Low-Strength Materials

D. Council of American Building Officials/American National Standards Institute (CABO/ANSI):
   1. A117.1 – Accessible and Useable Buildings and Facilities Standards

E. Colorado Department of Transportation (CDOT)

F. Occupational Safety and Health Administration (OSHA):
   1. Part 1926 – Safety and Health Regulations for Construction

1.5 SUBMITTALS

A. Submit under provisions of Division One specifications.

B. Product Data: Submit on all products or materials supplied herein

C. Test Reports: Indicate supplier, sieve analysis, optimum moisture content and density in accordance with ASTM D698 if appropriate for crushed rock or gravel, pipe embedment and material for fills and embankment

1.6 REGULATORY REQUIREMENTS

A. Burning will not be allowed on-site. Comply with all applicable codes, regulations, and laws.

B. Comply with applicable requirements of CABO/ANSI A117.1 for accessibility requirements related to walks, ramps, parking areas, drives, curb ramps, etc.

C. Obtain and comply with all requirements of City of Grand Junction and CDPHE Stormwater and/or Groundwater Discharge Permits, as required.

D. For public improvements only, in the event of a conflict between municipal standards and this specification, municipal standards for products and installation will govern.

E. Excavation work will be performed in compliance with the City of Grand Junction and current OSHA requirements.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent structures and surrounding areas from damage during excavation, filling, and backfilling

B. Protect work from erosion or other similar types of damage until the project has been accepted. Leave protection in place for subsequent contractors' use.

C. Do not backfill or construct fills during freezing weather. Backfill or construct fills only when temperature is 35°F and rising

D. Do not use frozen materials, snow, or ice in any backfill or fill area

E. Do not backfill or construct fill on frozen surfaces

F. Protect excavated material from becoming frozen

G. Do not backfill or construct fills or embankments during periods of heavy rainfall or precipitation when soil moisture conditions will not allow proper compaction to be achieved

H. Do not remove trees from outside excavation or fill areas unless authorized by the Owner; protect from permanent damage by construction activities

I. Provide temporary bridges for roadways, walkways, driveways, etc.

1.8 QUALITY ASSURANCE

A. All imported material to be free of hazardous and organic wastes, "clean" as defined by EPA, and approved for its intended use by the Owner or project Geotechnical Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. General - Soil materials, whether from sources on or off the site must be approved by the Geotechnical Engineer as suitable for intended use and specifically for required location or purpose.

B. Classification of Excavated Materials:
   1. No classification applies. Remove and handle all excavated materials regardless of its type, character, composition, condition, or depth. This includes all material that is not classified as rock excavation as described in Paragraph 2.1.B.2 Rock Excavation is included herein.
   2. Rock Excavation: classified as removal of solid material that by actual demonstration, in the Engineer's opinion, cannot be reasonably loosened or ripped by either a single-tooth, hydraulically operated ripper mounted on a crawler tractor in good condition rated at a minimum 300 flywheel horsepower or excavated with a minimum 325 flywheel horsepower hydraulic excavator in good condition equipped with manufacturer's standard boom, two rippers and rock points, or
      a. Material that for convenience or economy is loosened by drilling, or the use of pneumatic tools, is not considered rock excavation
      b. Removal of boulders larger than 1/2 cubic yard will be classified as rock excavation, if drilling or breaking them apart with power operated hammer, hydraulic rock breaker, expansive compounds, or similar means is both necessary and actually used for their removal
      c. Contractor to inform Engineer when rock excavation is required prior to performing Work
      d. Cost of rock excavation to be included in project cost.
   3. Excavation of rock that cannot be excavated as outlined above will be considered rock excavation and may require alternative means that may include drilling, blasting, or expansive compounds.
   4. Waste Materials:
      a. Waste materials are considered unacceptable materials for compaction or placement fill. Site fills will not include environmental pollutants, hazardous substances or waste, hazardous products or by-products.
      b. Transport and properly dispose of any rubble and waste materials found in excavation off the Owner’s property
      c. If hazardous, transite or asbestos containing materials are found in excavation, stop work immediately and notify the Owner within one hour of discovery. Comply with special handling requirements.

C. Fills and Embankments
   1. To the maximum extent practical use excess earth from onsite excavation for fills and embankments.
   2. Free from rocks or stones larger than 12 inch in greatest dimension and free from brush, stumps, logs, roots, debris, and organic and other deleterious materials
   3. Fill and embankment material must be acceptable to Engineer

4. No rocks or stones larger than 6 inch in upper 18 inches of fill or embankment. Where allowed, distribute rocks and stones through the fill to not interfere with compaction.

D. Imported Fill for Fills and Embankments:
   1. The Contractor is responsible for obtaining additional material for fills and embankments as necessary to meet the requirements shown on the Drawings.

E. Structural Fill
   1. Imported structural fill shall be CDOT Class 1 Structural Fill, per the Geotechnical Report, for a mat slab shallow foundation, conforming to the following:
      a. Gradation: 2" – 100% passing (percent finer by weight ASTM C136), No. 4 Sieve – 30-100% passing, No. 50 Sieve – 10-60% passing, and No. 200 Sieve – 5-20% (maximum) passing.
      b. Liquid Limit: 35 (maximum), Plasticity Index: 6 (maximum)

F. Topsoil
   1. Topsoil is defined as fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of rocks, stumps, stones larger than 2 inches in any dimension, and other extraneous or toxic matter harmful to plant growth for areas to be seeded or planted. Coordinate testing requirements with Owner.
   2. Clean topsoil free of plants and seeds will be spread to 4-inch minimum depth or as specified by Drawings, whichever is greater.

G. Grubbings
   1. Grubbings are defined as the first 1 inch of surface vegetation and topsoil consisting of primarily existing grass groundcover free of roots, brush, and other objectionable material and debris.
   2. Reuse grubbing and surface topsoil containing plants and seeds in designated revegetation areas only.

H. Pipe Embedment: Graded gravel
   1. Comply with City of Grand Junction requirements for pipe embedment for public utilities.

   2. Drain Gravel
      a. Crushed rock, granular material with a maximum size of 1-1/2 inch.
      b. Minimum 50% passing No. 4 sieve, maximum 5% retained on No. 200 sieve

I. Compacted Trench Backfill
   1. Job excavated material finely divided, free of debris, organic material, and stones larger than 6 inches in greatest dimension without masses of moist, stiff clay, or topsoil
   2. In upper 18 inches, no rock or rock excavated detritus, larger than 6 inches except with specific approval from Geotechnical Engineer.
   3. No rock greater than 3 inches in greatest dimension within 3 feet of top of pipe

J. Coarse Base Rock
   1. Granular material, maximum 3 inches, less than 10% passing 1-inch sieve.
   2. Free of trash, clay and dust
   3. Compaction as specified by Geotechnical Engineer

K. Road Base
   1. Will meet ASTM specification for Class II aggregate base and CDOT Class 6 gradation

Sieve Size	Percent Passing by Weight
3/4"	90-100
No. 4	30-65
No. 8	22-55
No. 200	3-12

2.2 ACCESSORIES

A. Non-woven geotextile fabric
   1. Needle-punched nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Product must be inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. Product must meet AASHTO M288-06 Class 3 for elongation > 50%.
      a. Mirafi 140N or accepted substitution

B. Silt Fence Fabric: woven polypropylene
   1. Mirafi 100X, "Envirofence"
   2. Or accepted substitution

PART 3 EXECUTION

3.1 EXAMINATION

A. Field verify the location of all underground utilities, pipelines and structures prior to excavation

3.2 PERFORMANCE — GENERAL

A. Contractor to verify quantities of cuts and fills and perform all earthwork required to meet the grades as shown on the Drawings, including but not limited to, additional import or export required to handle compaction, building and pavement subgrade preparation, and pipe bedding.

B. Perform work in a safe and proper manner with appropriate precautions against hazard

C. Provide adequate working space and clearances for work performed within excavations and for installation and removal of utilities

D. Contain all construction activity on the designated site and within the limits of work. Cost of restoration offsite will be the responsibility of the Contractor

E. Maintain service to pipelines and utilities indicated on Drawings during construction

3.3 PREPARATION

A. Clearing and Grubbing
   1. Clear all site areas within the limits of work of grasses, roots, brush, and other objectionable material and debris
   2. Strip subgrade for fills and embankments of surface vegetation, sod, tree stumps and organic topsoil. Strip and stockpile all on-site material at the Cooper/Laurie site near fisherman parking. Rocks and boulders can also be stockpiled there.
   3. Remove all waste materials from site and dispose. Stockpile all acceptable grubbings for reuse in the aforementioned area.
   4. Remove and dispose of tree stumps and roots over 3 inches in diameter to a minimum depth of 18 inches below the natural surface or 5 feet below finished surface level, whichever is lower
   5. Remove debris including all demolished trees, underbrush, stumps, roots and other combustible materials from site and dispose of off-site; on-site burning is not permitted
   6. Backfill all excavated depression include grub holes with approved material

B. Preservation of Trees
   1. Do not remove trees outside fill or excavated areas, except as authorized by Engineer
   2. Protect trees and their roots within the drip line that are to remain from permanent damage by construction operation
   3. Trim standing trees in conflict with construction operations as directed by Owner

C. Topsoil Stripping
   1. Strip onsite material meeting the topsoil definition to minimum depth of 4 inches from areas to receive grading as shown on Drawings.
   2. Stockpile topsoil in areas designated by Owner and indicated on Drawings where it will not interfere with construction operations and activities and existing facilities
   3. At the completion of work in each area, place and grade topsoil to maintain gradient as indicated and required. Roughen surface as required for erosion control.

D. Waste and Debris
   1. Stockpile all acceptable grubbing for reuse in native revegetation areas
   2. Remove and dispose of all waste materials and debris from clearing, grubbing, stripping and demolition off site

E. Stockpiles
   1. Segregate materials suitable for the following:
      a. Topsoil
      b. Embankments and fills
      c. Backfill

d. Spoils and waste only

2. No excavation will be deposited or stockpiled at any time so as to endanger stability of banks or structures, health of trees and shrubs to be protected, or portions of the Work, either by direct pressure or indirectly by overloading banks contiguous to the operation
3. Stockpile soil materials away from edge of excavations
4. Do not obstruct or prevent access to roads, driveways, ditches, natural drainage channels, and utility control devices
5. If in result of adjacent structures, easement limitations, or other restrictions sufficient storage is not available within Project limits, Contractor will arrange for off-site areas for stockpiling and for moving material to and from the storage area at no additional cost to the Owner

3.4 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. Excavation and backfill operations will be performed in such a manner to prevent cave-ins of excavations or the undermining, damage or disturbing of existing utilities and structures or of new work.

B. Backfill will be placed and compacted so as to prevent future settlement or damage to existing utilities and structures and new work

C. Any excavations improperly backfilled or where settlement occurs will be reopened to the depth required then refilled with approved materials and compacted, and the surface restored to the required grade and condition, at no additional costs to the Owner

D. Any damage due to excavation, backfilling, or settlement of the backfill, or injury to persons or damage to property occurring as a result of such damage will be the responsibility of the Contractor. All costs to repair such damage, in a manner satisfactory to the Engineer, will be borne by the Contractor at no additional expense to the Owner

3.5 DEWATERING

A. General
1. All dewatering activities in accordance with all federal, state, and local regulations regarding site drainage, dewatering, and erosion and sediment control including permitting requirements
2. Design and provide dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom and/or sides. Design system to prevent differential hydrostatic head, which would result in floating out soil particles in a manner, termed as a “quick” or “boiling” condition. System will not be dependent solely upon sumps and/or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation’s stability

3. Provide and maintain adequate dewatering equipment including power supply, if necessary, to remove and dispose of surface and groundwater entering excavations, trenches, and other parts of the Work
4. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow all Work to be installed in a dry condition
5. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary to these purposes, lower water level in advance of excavation, utilizing wells, wellpoints, jet educators, or similar positive methods
6. Keep each excavation dry during subgrade preparation and continually thereafter until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result
7. Dewater excavations which extend to or below groundwater by lowering and keeping the groundwater level beneath such excavation at least 12 inches below the bottom of the excavation
8. Design, furnish, install, test, operate, monitor and maintain dewatering system of sufficient scope, size and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades
9. Divert surface water or otherwise prevent it from entering excavated areas or trenches to the extent practical without damaging adjacent property
10. Maintain all drainage pipes, keep clean and free of sediment during construction and final cleanup
11. Open pumping with sumps and ditches will be allowed, provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes
12. No additional payment will be made for any supplemental measures to control seepage, groundwater, or artesian head
13. Dewatering to surface waterways requires Colorado Department of Public Health and Environment dewatering permit. Contractor must obtain dewatering permit and comply with discharge requirements therein, including water treatment prior to discharge, if necessary

B. Design
1. Contractor will be responsible for the accuracy of the Drawings, design data, and operational records required
2. Contractor will be solely responsible for the design, installation, operation, maintenance, and any failure of any component of the system

C. Damages
1. Contractor will be responsible for and will repair without cost to the Owner any damage to work in place, or other contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation including, damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper

design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system
2. Remove sub grade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to the Owner

D. Maintaining Excavation in Dewatered Condition
1. Dewatering will be a continuous operation. Interruptions due to power outages, or any other reason will not be permitted
2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction and/or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance
3. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to Owner
4. System maintenance will include supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain excavation in dewatered condition

E. System Removal
1. Remove dewatering equipment from the site, including related temporary electrical service
2. Wells will be removed or cut off a minimum of 3 feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction

3.6 SHEETING, SHORING AND BRACING

A. All sheeting, shoring and bracing in accordance with OSHA and IBC requirements

B. Prevent undermining and damage to all structures, buildings, underground facilities, pavements and slabs

C. Contractor will responsible for obtaining all required permits or easements for encroachments into the public right-of-way and for coordinating any encroachments onto adjacent properties.

D. If sheet pile cut off walls are required, submit design calculations, stamped by a Colorado licensed Professional Engineer

E. Contractor will be solely responsible for proper design, installation, operation, maintenance, and any failure of any system component
1. Engineer review of Contractor’s design and data does not relieve the Contractor from full responsibility for errors or from the entire responsibility for complete and adequate design and performance of the sheeting, shoring and bracing system

F. Provide proper and substantial sheeting, shoring, and bracing, in accordance with OSHA Standards as required, to prevent caving or sliding, to protect workmen and the Work, and to protect existing structures and facilities

G. Design, furnish, build, maintain and subsequently remove, to extent required a system of temporary supports for cut and cover, open cut, temporary bypass road, or trench excavations, including bracing, dewatering, and all associated items to support the sides and ends of excavations where excavation slopes may endanger in-place or proposed improvements, extend beyond construction right-of-ways or as otherwise specified or indicated in the Drawings
   1. Design and build sheeting, shoring, and bracing to withstand all loads that might be caused by earth movement or pressure
   2. Design and build sheeting, shoring and bracing to be rigid, maintain shape and position under all circumstances.

H. Design excavation support system and components for the following to allow safe and expeditious construction of permanent structures without movement/settlement of the ground and to prevent damage to or movement of adjacent buildings, structures, other improvements and underground facilities
   1. To support lateral earth pressures
   2. Loads from utilities, traffic, construction, buildings and surcharge loads

I. Provide sheeting, shoring and bracing equipment and materials onsite prior to start of excavation in each section, making adjustments as required to meet unexpected conditions

J. Contractor will make his own assessment of existing conditions including adjacent property, the possible effects of his proposed temporary works and construction methods, and will select and design support systems, methods, and details as will assure safety to the public, adjacent property, and the completed Work.

K. Employ caution in areas of underground facilities, which will be exposed by hand or other excavation methods acceptable to Owner and Engineer.

L. Space and arrange sheeting and bracing as required to exclude adjacent material and according to the stability of excavation slopes

M. Do not pull trench sheeting before backfilling

N. Do not brace sheeting left in place against the pipe, but support it in a manner that precludes concentrated loads or horizontal thrusts on pipe

O. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment is completed

P. Damages
   1. Contractor will document and all existing damage to adjacent facilities and submit written documentation to Owner and Engineer prior to performing any excavation.

Documentation will include written description of existing damages, measurements, diagrams, maps and associated photographs

2. Repair all damage resulting from excavation and remove and place any existing structure or underground facility damaged during shoring and sheeting and all undermined pavements with Owner-approved equal, concrete or asphalt, at no cost to the Owner.

3.7 TRENCH STABILIZATION

A. Thoroughly compact and consolidate subgrades for concrete structures, precast structures, and utility trench bottoms so they remain firm, dense and intact during required construction activities

B. Remove all mud and muck during excavation

C. Reinforce subgrades with crushed rock or gravel if they become mucky during construction activities

D. Finished elevation of stabilized subgrades are to be at or below subgrade elevations indicated on Drawings

E. Allow no more than ½ inch depth of mud or muck to remain on trench bottoms when pipe bedding material is placed thereon

F. Scarify trench subgrade to a depth of 6 to 8 inches before compaction

3.8 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 foot

B. Remove existing unsuitable/uncompacted fill, old foundations, rubble/debris, soft or otherwise unsuitable material, and replace with suitable material in excavation

C. Extend excavations to a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction and inspections

D. Trim to neat lines where details call for concrete to be deposited against earth

E. Excavate by hand in areas where space and access will not permit use of machines

F. Provide dewatering and temporary drainage as required to keep excavations dry.

G. Reshape subgrade and wet as required

H. Notify Geotechnical Engineer when structure excavation has reached designated depth. Do not proceed with structure construction until excavation is approved by Geotechnical Engineer.

I. Per the geotechnical report, for over-excavation and recompaction areas at structures. Soils will be over-excavation of at least one foot below the bottom of the mat slab and replacement with properly compacted CDOT Class 1 Structural Fill to provide a uniform bearing surface material. Unsupported temporary excavation slopes in the existing soils and new embankment must not be steeper than 1.5H:1V. Excavations that cannot meet 1.5H:1V, or flatter, will require temporary shoring. New unsupported embankment slopes shall not be steeper than 3H:1V and if required to support any structure, additional evaluation of slope stability will be required.

J. Remove all existing fill material as directed by Geotechnical Engineer below facility mat foundation to existing undisturbed natural soils or bedrock. Geotechnical Engineer will inspect excavation to ensure all previous fill material meets design requirements.

3.9 FILLS AND EMBANKMENTS

A. Using suitable approved materials, shape, trim, and finish cut slopes to conform with contours and elevations indicated on Drawings

B. Suitable materials will consist of excavations or borrow areas
   1. Borrow
      a. Borrow areas will be arranged by Contractor at no additional cost to Owner and will be subject to approval by Engineer and Geotechnical Engineer
      b. Includes all topsoils and fill materials from approved offsite locations

C. Place in layers of 6 inches. Will be placed on subgrades approved by Engineer and Geotechnical Engineer

D. Will not be placed on frozen surface. Do not place snow, ice or frozen materials in fill

E. Level and roll subgrade so surface materials will be compact and bond with the first layer of fill or embankment
   1. Plow and scarify subgrade to a minimum depth of 6 inches until uniform and free of large clods

F. Place in horizontal layers at maximum uncompacted depth per compaction specifications herein.

G. Spread and level material deposited in piles and windrows before compacting

H. Thoroughly compact each layer by rolling or other means acceptable to Geotechnical Engineer to meet the moisture and compaction specifications herein.

I. Alter compaction methods if material fails to meet specified density

J. Where a trench passes through a fill or embankment, place and compact fill or embankment to 12 inch above the top of the pipe before excavating the trench

K. Add water and harrow, disc, blade, or otherwise work each layer to obtain the uniform moisture content and adequate compaction

L. Refer to geotechnical report for additional requirements for fill and embankment preparation requirements.

3.10 COMPACTION

A. Place backfill and fill materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure as described herein.

C. Refer to geotechnical report for additional requirements for site development material, subexcavation, compaction and related earthwork operations.

D. Percentage of Maximum Dry Density Requirements: Moisture treat and compact soil to not less than the following percentages of maximum dry density and to within the specified moisture content range of optimum moisture content according to ASTM D698 as follows:

Surface Improvement	Compaction %	Moisture Content
Structures	98%	-2 to +2
Utility Trenches	95%	-2 to +2

1. Do not deposit or compact tamped or otherwise mechanically compacted backfill if frozen or if in water.
2. Take particular care to compact backfill which will be beneath slabs, pipes, drives, roads, parking areas, curb, gutters, or other surface construction.

3.11 BORROW OR SPOIL AREA

A. Obtain suitable material required to complete fill and embankments from excavation, on-site areas.

B. Offsite borrow areas shall be approved by Owner and Engineer.

C. The location, size, shape, depth, drainage, and surfacing of borrow or spoil pits will be acceptable to Owner.

D. Make all areas regular in shape with graded and surfaced side and bottom slopes when completed

E. Cut side slopes not steeper than 1:1 and uniform for the entire length of any one side

F. Final grade disturbed areas of borrow to uniform slope (maximum slope = 4:1, minimum slope = 50:1).

G. Use material free of debris and deleterious material

H. Contractor is responsible for compliance with Colorado Discharge Permit System and local erosion control permitting requirements for any and all onsite and offsite, disturbed spoil and borrow areas. Upon completion of spoil and/or borrow operations, clean up spoil and/or borrow areas in a neat and reasonable manner to the satisfaction of the offsite property owner, Owner and Engineer.

3.12 DISPOSAL OF EXCESS EXCAVATED MATERIALS

A. Use excess excavated materials in fills and embankments as indicated on the Drawings to the extent needed. Coordinate with Owner and Engineer on locations for excess material placement.

B. The Contractor is responsible for disposing of all excess excavated materials from the site to a location approved by the Owner or Engineer and permitted with the local authorities.

1. The Owner is providing a site for disposing of excess, approved material. All excavated materials must meet all applicable local, state and federal requirements. The site for disposing of materials is located at 5321 Purdy Mesa Rd accessed at the Juniata Trailhead gates. It will be approximately 5-miles round trip from any point along the project to the disposal site. Contractor shall verify all distances and coordinate the approved route with the Owner.
2. A map is included as Supplement A (02300).

C. Remove debris, junk, broken concrete, broken asphalt, rock, stones, stumps, logs, roots, and other unsuitable material from the site and dispose of it.

3.13 TRENCH EXCAVATION

A. Establish alignment and grade or elevation from offset stakes provided by the Contractor's surveyor.

B. Excavate trenches so pipes can be laid straight at uniform grade without dips or bumps, between the terminal elevations indicated on the Drawings

C. Comply with pipe specification sections regarding vertical and horizontal alignment and maximum joint deflection

D. Where grades or elevations are not fixed on the Drawings, excavate trenches to provide a minimum depth of backfill cover over the top of pipe as follows. Coordinate depth of cover with utility owners. Increase depth as required by utility owner and at crossings. Minimum depths are:
1. 2.0 feet for drainage piping
2. 2.5 feet for electric, telecom, and fiber optic conduit

3. 4.0 feet for water piping
4. Increase depth as required at vertical curves and for clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades

E. Measure pipe cover depth vertically from top of pipe to finished ground or surface elevation

F. Do not open more trench in advance of pipe laying than is necessary to expedite the work; not more than 200 feet

G. Total length of open trench will be limited to 200 feet unless otherwise approved by the Engineer

H. Except where tunneling or boring is indicated on the Drawings, specified, required by jurisdictional agency or permitted by Engineer, excavate trenches by open cut from the surface

I. Limiting trench widths
1. Excavate to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, embedment
2. If needed to reduce earth loads to prevent sliding, cut banks back on slopes which extend not lower than 1 foot above the top of the pipe
3. Stipulated minimum clearances are minimum clear distances, not minimum average distances
4. Maximum trench width from six inches above the top of pipe to trench bottom is the pipe outside diameter plus 24 inches
5. Limiting trench widths and permissible clearances from 6 inches above top of pipe to trench bottom for installed pressure and non-pressure piping

Pipe Size (inch)	Minimum Trench Width	Maximum Trench Width
3	1’ 6”	2’ 6”
4	1’ 6”	2’ 6”
6	1’ 6”	2’ 6”
8	1’ 8”	2” 8”

6. If the width of the lower portion of the trench exceeds the maximum permitted, provide special pipe embedment, or concrete encasement as required by loading conditions
7. No excessive trench widths will be allowed to avoid the use of sheeting or shoring and bracing

J. Trench Side Walls
1. Will be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the federal, state, and local ordinances and regulations
2. Sheet and brace where necessary and as specified herein

3. Excavate without undercutting

K. Trench Bottom
   1. Will be thoroughly protected and maintained when suitable natural materials are encountered
   2. Will be thoroughly compacted and in approved condition prior to placing gravel bedding, if required
   3. Where in earth, trench bottoms for 6 inches and smaller pipe may be excavated below pipe subgrade and granular embedment provided or the trench may be graded to provide uniform and continuous support between bell holes or end joints of the installed pipe at the Contractor's option
   4. Whenever so directed by Engineer, excavate to such depth below grade as Engineer directs and bring the trench bottom to grade with such material approved by Engineer
   5. Do not allow any part of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined
   6. PVC pipe will not be laid directly on trench bottom

L. Mechanical excavation
   1. Do not use where its operation would damage buildings, culverts, or other existing property, structures, or utilities above or below ground; hand excavate only in such areas
   2. Use mechanical equipment of a type and design which can be operated to provide the following:
      a. Rough trench bottom to a controlled elevation
      b. Uniform trench widths and vertical sidewalls are obtained from 1 foot above the top of the installed pipe to the bottom of the trench
      c. Trench alignment is such that pipe is accurately laid to specified alignment and is centered in the trench with adequate clearance between pipe and trench sidewalls
   3. Do not undercut trench sidewalls
   4. Recompact trench bottom disturbed by bucket teeth prior to placement of embedment material

M. Except as otherwise required, excavate trenches below the underside of pipes as indicated in the Drawings to provide for installation of granular embedment pipe foundation material

N. Whenever so directed by Engineer, excavate to such depth below grade as Engineer directs and bring the trench bottom to grade with such material as Engineer may direct

O. For unstable soils, provide concrete or other bedding as directed by Engineer

P. Do not allow any part of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined

Q. Cuts in existing surface construction
   1. No larger than necessary to provide adequate working space

2. Cut a clean groove not less than 1½ inch deep along each side of trench or around perimeter of excavation area
3. Remove pavement and base pavement to provide shoulder not less than 6 feet wide between cut edge and top edge of trench
4. Do not undercut trenches, resulting in bottom trench width greater than top widths
5. Make pavement cuts to and between straight or accurately marked curved lines parallel to trench centerline or limits of excavation
6. Remove pavement for connections to existing lines or structures only to the extent required for the installation
7. Replace the pavements between saw cuts to match original surface construction

3.14 PIPE EMBEDMENT

A. Embed pipes above and below the bottom of pipe as indicated on the Drawings and as specified herein

B. Granular embedment
   1. Spread and surface grade granular embedment to provide continuous and uniform support beneath pipe at all points between pipe joints.
      a. Level bottom layer at proper grade to receive and uniformly support pipe barrel throughout length
      b. Barrel of pipe will have a bearing for its full length
   2. Form depressions under each joint to permit the proper jointing. No part of joint will be in contact with trench when pipe is placed in position
   3. After grading, aligning, and placing pipe in final position, and shoring home, deposit and compact sufficient embedment under and around each side of the pipe to hold the pipe in proper position and alignment during subsequent operations
   4. Place and compact embedment material uniformly and simultaneously on both sides of pipe to prevent displacement
   5. Complete embedment promptly after jointing operations and approval to proceed by Engineer
   6. Granular embedment compaction by slicing with shovel or vibrating
      a. Maximum uncompacted thickness of layers: 6 inch
   7. Compacted embedment will be compacted to 90 percent maximum density per ASTM D1557
      a. Maximum uncompacted depth thickness of horizontal layers: 6 inch

C. Arch and concrete encasement
   1. Include in locations indicated on Drawings or where over-width trench conditions need correction as approved by Engineer
   2. Install and form as indicated on Drawings or as specified
   3. Concrete will have a 28-day minimum 3,000 psi compressive strength

D. Do not backfill until tests and inspections have been made and backfilling is authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems

3.15 TRENCH BACKFILL

A. Backfilling will be conducted in a continuous manner to prevent damage to the pipe and its coating and kept as close to the pipe laying operation as possible. Backfilling procedures will be in accordance with additional requirements, if any, of local authorities or private right-of-way agreements.

B. Compacted backfill
   1. Provide full depth of trench above embedment at all locations
   2. Beneath pavements, surfacing, driveways, curbs, gutters, walks or other surface construction or structures
   3. In street or highway shoulders
   4. Beneath fills and embankments

C. Where the trench for one pipe passes beneath the trench of another pipe, compact the backfill for the lower trench to the bottom of the upper trench

D. Site excavated materials
   1. Place job excavated materials in 6 inches maximum uncompacted thickness, uniform layers.
   2. Increased layer thickness may be permitted for incohesive material if Contractor demonstrates to Engineer's satisfaction that specified compacted density will be achieved
   3. Use methods and equipment appropriate to the material to be compacted to prevent transmission of damaging shocks to pipe
   4. Thoroughly compact each layer to meet the moisture and compaction specifications herein.

E. Graded gravel
   1. Deposit in uniform layers of 6 inches maximum uncompacted thickness
   2. Compact with suitable vibrating roller or platform vibrator to not less than 70 percent relative density per ASTM D4253/D4254

F. Uncompacted backfill
   1. Compaction of backfill above pipe embedment in locations other than those specified, is required only to prevent future settlement
   2. May be placed by any method acceptable to Engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on, and will not result in displacement of installed pipe
   3. Until compacted depth over conduit exceeds 3 feet, do not drop fill material over 5 feet. Distance may be increased 2 feet for each additional 1 foot of cover

G. Finish the top portion of backfill with at least 4 inches of topsoil or as specified by landscaping specifications, whichever is greater, corresponding to, or better than, that underlying adjoining turf areas.

H. Trench backfill within the public right-of-way will conform to municipal street and utility standards.

I. Trench backfills through unimproved areas should be restored to previous conditions and left 3" above adjacent grades to allow for settlement. Seed all disturbed areas according to erosion control and landscape specifications.

J. Protection of trench backfill
   1. Where trenches are constructed in ditches or other water courses, protect backfill from erosion
   2. Install ditch checks where the ditch grade exceeds 1 percent
      a. Minimum depth: 2 feet below the original ditch or water course bottom for the full bottom width
      b. Minimum width: 18 inches into the side slopes
      c. Minimum thickness: 12 inches

3.16 DRAINAGE MAINTENANCE

A. Do not backfill trenches across roadways, drives, walks or other trafficways adjacent to drainage ditches or water courses prior to backfilling the trench on the upstream side of the trafficway to prevent impounding water after pipe is laid

B. Backfill so that water does not accumulate in unfilled or partially filled trenches

C. Remove materials deposited in roadway ditches or other water courses crossed by the trench line immediately after backfilling is completed and restore ditches and water courses to original section, grade, and contours

D. Do not obstruct surface drainage any longer than necessary

E. Provide and maintain temporary bridges and other structures across unfilled trenches as required to maintain traffic

F. Provide adequate storm flow conveyance through the site at all times during construction to avoid flooding of any buildings or adjacent property. Provide overland drainage routing when storm sewer inlets are not fully functioning due to erosion and sediment control measures.

3.17 FINAL GRADING

A. After completion of all other outside work and after backfilling is completed and settled, bring to grade at the indicated elevations, slopes and contours, all areas being graded on site

B. Graders and other power equipment may be used for final grading and slope dressing if the result is uniform and equivalent to hand work

C. Grade all surfaces for effective drainage, provide a 2 percent minimum slope except as otherwise shown on the Drawings

D. Provide a smooth transition between adjacent existing grades and new grades

E. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances

F. Slope grades to direct water away from buildings and prevent ponds from forming where not intended

G. Finish subgrades at lawns and unpaved areas to required elevations within a tolerance of plus or minus one (1) inch

H. Finish grades will be no more than 0.1 foot above or below those indicated

I. Finish all ditches, swales and gutters to drain readily

J. Coordinate final subgrade depth with finish landscape treatment and required topsoil depths

K. Topsoil
   1. Clean topsoil, free of plants and seed will be spread to 4-inch minimum depth, or as specified by Drawings, whichever is greater, for areas of the site as detailed by the Drawings.
   2. Reuse grubbings and surface topsoil containing plants and seeds in designated revegetation areas only.

3.18 SLOPE AND CHANNEL STABILIZATION

A. Cover channel banks, slopes, bottom and thalweg (water flowline at lowest point in channel) with erosion control fabric mat where grade is steeper than 3:1and where indicated on the Drawings

B. Lay fabric smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 6-inch overlap minimum of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil

C. Secure outside edges and overlaps at 48 inch intervals with 4-inch to 6-inch U-shaped type pins or wooden stakes depending on ground condition

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches

F. Maintain integrity of erosion control fabric

G. Prior to laying fabric, seed disturbed areas under provisions of related seeding specification.

3.19 SETTLEMENT

A. Warranty for settlement of all fills, embankments, and backfills is stipulated in the General Conditions from final completion of Contract under which Work is performed

B. Repair or replace within 30 days after notice by Engineer or Owner

3.20 FIELD QUALITY CONTROL

A. Provide under provisions of General Conditions and Division One Specifications

B. Coordinate testing with Owner. Owner will employ testing agency for field testing to determine compliance of in-place and backfill materials and compaction in accordance with the specifications, and to verify design bearing capacities.

C. It is the Contractor's responsibility to initiate, coordinate and accommodate all required tests and inspections including conformance with requirements of all applicable public agencies and authorities. Contractor will be responsible for coordinating the testing requirement with testing agency and provide the testing agency 48 hours (two business days) advance notification to schedule tests.

D. Fills and Embankment Testing
   1. Two moisture-density relationship tests, ASTM D698, on each type of fill material
   2. One in-place compaction test for each 5,000 square feet every 1.5 feet of vertical lift of material placed
   3. Additional in-place compaction tests at the discretion of the Owner

E. Pipe Embedment and Backfill Testing
   1. Two moisture-density relationship tests, ASTM D698, or two relative density tests, ASTM D4253/D4254, as appropriate for each type of embedment on backfill material proposed, except granular embedment material
   2. One in-place compaction test every 200 lineal feet of trench in the compacted embedment zone and at every 1.5 feet of vertical lift of backfill materials, per ASTM D6938
   3. One in-place compaction test near top of trench for trench depth of 2 feet or less, per ASTM D6938
   4. Additional in-place compaction tests at the discretion of the Owner

F. Pavement and Structural Subgrade Testing
   1. At a minimum, two moisture-density relationship tests, ASTM D698, or two relative density tests, ASTM D4253/D4254, as appropriate and adequate for each type backfill material proposed.
   2. Perform tests for each footing, concrete site feature, and drainage structure subgrade. Perform tests at every 100 linear feet of subgrade of foundation walls, retaining walls, and every 150 feet for curbing, pans, drainage features, walks, etc. (or portions thereof). Perform tests every 2,000 square feet required of building slab area, exterior slabs and pavement/flatwork areas (with no less than 3 tests). Test at subgrade and at every vertical lift of backfill materials placed.

3. Additional in-place compaction tests at the discretion of the Owner

G. Inspection and approval
   1. A qualified Geotechnical Engineer will inspect the natural soil at bottom of excavations for structures
   2. Do not prepare subgrade or place concrete until Geotechnical Engineer's inspection has taken place and any resulting recommendations of the Geotechnical Engineer have been fulfilled or until the inspection has been waived by the Geotechnical Engineer
   3. Prior to placement of structural fill, overexcavated foundations subgrades will be observed and tested by a qualified Geotechnical Engineer to ensure suitable bearing materials exist
   4. Geotechnical Engineer will provide a letter to Engineer to confirm the presence of suitable subgrade material and properly placed fill materials by Contractor in accordance with Drawings and geotechnical report.

H. Retesting of failed compaction will be performed by Geotechnical Engineer for Owner, but paid for the Contractor

END OF SECTION

Export Location South of Juniata Res.

N

0 0.25 0.5 mi

Printed: 1/4/2023

1 inch equals 717 feet

Scale: 1:8,598

CITY OF Grand Junction COLORADO GEOGRAPHIC INFORMATION SYSTEM

SECTION 02510

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Buried pipe, fittings, valves, appurtenances, and associated accessories for water distribution, potable water storage tank, and transmission lines

B. Disinfection of potable water piping

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

B. Section 02676 – Disinfection of Water Systems

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. A36 – Standard Specification for Carbon Structural Steel
2. A48 – Standard Specification for Gray Iron Castings
3. A53 – Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
4. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
5. A185 – Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
6. A242 – Standard Specification for High-Strength Low-Allow Structural Steel
7. A276 – Standard Specification for Stainless Steel Bars and Shapes
8. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
9. A449 – Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
10. A536 – Standard Specification for Ductile Iron Castings
11. A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids
12. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
13. A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
14. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings
15. B88 – Standard Specification for Seamless Copper Water Tube

16. B96 – Standard Specification for Copper-Silicon Alloy Plate, Sheet, Strip, and Rolled Bar for General Purposes and Pressure Vessels
17. B763 – Standard Specification for Copper Alloy Sand Castings for Valve Applications
18. B843 – Magnesium Alloy Anodes for Cathodic Protection
19. C33 – Standard Specification for Concrete Aggregates
20. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
21. C150 – Standard Specification for Portland Cement
22. C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
23. C1227 – Standard Specification for Precast Concrete Septic Tanks
24. D429 – Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates
25. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kn-m/m3))
26. D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses
27. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
28. D1330 – Standard Specification for Rubber Sheet Gaskets
29. D1351 – Standard Specification for Thermoplastic Polyethylene Insulation for Electrical Wire and Cable
30. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
31. D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
32. D2000 – Standard Classification System for Rubber Products in Automotive Applications
33. D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
34. D2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
35. D2467 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
36. D2454 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
37. D2737 – Standard Specification for Polyethylene (PE) Plastic Tubing
38. D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
39. D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
40. D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
41. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
42. D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

43. D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
44. D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
45. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
46. D3950 – Standard Specification for Strapping, Nonmetallic (and Joining Methods)
47. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
48. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
49. D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
50. E8 – Standard Test Methods for Tension Testing of Metallic Materials
51. F412 – Standard Terminology Relating to Plastic Piping Systems
52. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
53. F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
54. G97 – Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

B. American Water Works Association (AWWA)
1. B300 – Standard for Hypochlorites
2. B301 – Standard for Liquid Chlorine
3. B302 – Standard for Ammonium Sulfate
4. B303 – Standard for Sodium Chlorite
5. C104 – Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
6. C105 – Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
7. C110 – Standard for Ductile-Iron and Gray-Iron Fittings
8. C111 – Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
9. C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Grey-Iron Threaded Flanges
10. C116 – Standard for Protective Fusion-Bonded Epoxy Coatings for Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
11. C150 – Standard for Thickness Design of Ductile-Iron Pipe
12. C151 – Standard for Ductile-Iron Pipe, Centrifugally Cast
13. C153 – Standard for Ductile-Iron Compact Fittings
14. C200 – Standard for Steel Water Pipe 6 In. (150 mm) and Larger
15. C203 – Standard for Coal-Tar Protective Coatings & Linings for Steel Water Pipes
16. C206 – Standard for Field Welding of Steel Water Pipe
17. C207 – Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
18. C213 – Standard for Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
19. C214 – Standard for Tape Coatings for Steel Water Pipelines
20. C219 – Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
21. C500 – Standard for Metal-Seated Gate Valves for Water Supply Service
22. C502 – Standard for Dry-Barrel Fire Hydrants

23. C504 – Standard for Rubber-Seated Butterfly Valves
24. C509 – Standard for Resilient-Seated Gate Valves for Water Supply Service
25. C515 – Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
26. C550 – Standard for Protective Epoxy Interior Coatings for Valves and Hydrants
27. C600 – Standard for Installation of Ductile Iron Mains and Their Appurtenances
28. C604 – Standard for Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger
29. C605 – Standard for Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
30. C651 – Disinfecting Water Mains
31. C700 – Standard for Cold-Water Meters – Displacement Type, Metal Alloy Main Case
32. C800 – Standard for Underground Service Line Valves and Fittings
33. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm) for Water Transmission and Distribution
34. C901 – Standard for Polyethylene (PE) Pressure Pipe and Tubing 1/2 In. (13 mm) Through 3 In. (76 mm) for Water Service
35. C906 – Polyethylene (PE) Pressure Pipe and Fittings 4 in. (100 mm) Through 63 In. (1,600 mm) for Water Distribution and Transmission
36. M11 – Steel Pipe: A Guide for Design and Installation
37. M17 – Standard for Installation, Field Testing, and Maintenance of Fire Hydrants
38. M23 – Standard for PVC Pipe Design and Installation
39. M41 – Standard for Ductile-Iron Pipe and Fittings

C. Colorado Department of Transportation (CDOT)

D. National Fire Protection Agency (NFPA)

E. Occupational Safety and Health Administration (OSHA)

F. NSF International:
   1. Standard 60 – Drinking Water Treatment Chemicals – Health Effects
   2. Standard 61 – Drinking Water System Components – Health Effects

G. Surface Preparation Standards (SSPC)

H. American Welding Society (AWS):
   1. D1.1 – Structural Welding Code – Steel

I. National Association of Corrosion Engineers (NACE):
   1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
   2. SP0286 – Electrical Isolation of Cathodically Protected Pipelines

J. Uni-Bell PVC Pipe Association:
   1. Uni-Pub-8: Tapping Guide for PVC Pressure Pipe

K. Plastics Pipe Institute (PPI):
   1. TR-4 – HDB / HDS / SDB / PDB / MRS Ratings for Thermoplastic Piping Materials or Pipe
   2. TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
   3. Handbook of Polyethylene Pipe
   4. Material Handling Guide

L. Ductile Iron Pipe Research Association (DIPRA):
   1. Thrust Restraint Design for Ductile Iron Pipe

M. American Railway Engineering and Maintenance-Of-Way Association (AREMA)

N. International Plumbing Code (IPC)

O. International Code Council (ICC)

P. Underwriters' Laboratories (UL)

1.4 SUBMITTALS

A. Submit under provisions of Division 1 Specifications

B. Shop Drawings: Provide piping layout and assembly drawings with fitting dimensions. Provide sufficient information to verify compliance with specifications

C. Product Data: Provide manufacturer's catalog information with dimensions, material and assembled weight. Indicate pressure ratings for pipe, fittings, valves
   1. Pipe materials
   2. Special, fitting, and coupling details
   3. Joint restraint system
   4. Valves
   5. Laying and installation schedule
   6. Specifications and data sheets
   7. Affidavits of compliance for protective shop coatings and linings

D. Product Data: Provide manufacturer catalog information on castings, grating, and accessories to indicate compliance with specifications of precast vault

E. Design Data: Include calculations prepared by precast manufacturer indicating design loads and material requirements for reinforcement

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements and applicable standards. Provide prior to shipment.

G. Test Reports: Submit reports of field pressure and disinfection tests under provisions of Section 01340

H. Test Reports: Indicate disinfection results comparative to specified requirements

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 Specifications

B. Accurately record actual locations using a surveyor of piping mains, valves, connections, top of pipe elevations, and any mapped or unmapped utilities.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities

1.6 QUALITY ASSURANCE

A. Manufacturers shall be experienced in the design and manufacturing of materials specified herein for a minimum period of 5 years

B. All PVC pipe, regardless of diameter, shall be supplied by a single manufacturer

C. Perform Work in accordance with AWWA C651, and the Colorado Department of Public Health and Environment (CDPHE), Mesa County, and City of Grand Junction.

D. Contractor shall conduct visual inspection before installation

E. Provide manufacturer's name and pressure rating marked on piping and valves

F. Provide piping complete with all fittings, jointing materials, supports, joint restraint system, and necessary appurtenances for watertight, fully operational water lines

1.7 REGULATORY REQUIREMENTS

A. Conform to all municipal codes and ordinances, laws and regulations of Mesa County, City of Grand Junction, CDPHE, the notes and details on the drawings and as specified herein, and CDPHE Stormwater Management and/or Construction Dewatering Permit

B. Conform to AWWA C651, as appropriate, and CDPHE Design Criteria for Potable Water Systems for performing the work of this Section

C. In case of apparent conflict, CDPHE requirements govern over these specifications

D. In absence of State and local regulations, International Plumbing Code applies

E. NFPA Compliance: Install fire water systems in accordance with NFPA 24 “Standard for the Installation of Private Fire Service Mains and Their Appurtenances”

F. UL Compliance: Provide fire hydrants that comply with UL 246 “Hydrants for Fire-Protection Service,” and are listed by UL.

G. Contractor, not Owner, shall prepare, submit, pay, and otherwise obtain all necessary permits from all appropriate entities

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 specifications

B. Delivery
   1. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct sunlight

C. Storage
   1. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: direct sunlight, mud, etc.
   2. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
   3. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
      a. Do not stack pipe higher than 5 feet

D. Storage: Use the following precautions for valves, during storage:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      a. Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary

E. Handling
   1. Handle so as to insure installation in sound undamaged condition
   2. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection.
   3. Use hooks or straps with broad, well-padded contact surfaces for lifting sections of pipe

F. Preparation for Transport: Prepare valves, for shipping as follows: Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends, flange faces, and weld ends. Set valves in best position for handling. Set valves closed to prevent rattling

G. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C500

H. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation

I. Seal valve ends to prevent entry of foreign materials into valve body

J. During loading, transporting and unloading, exercise care to prevent damage to material

1. Use nylon slings only
2. Do not drop pipe or fittings
3. Do not roll or skid against pipe already on ground
4. Repair any damage done to coating or lining
5. Handle per manufacturer's recommendations
6. Store rubber gaskets in cool dark location
7. Store all material on wood pallets or timbers

K. Adequately tag or otherwise mark all piping, fittings, and valves as to size per AWWA C509 and C900

L. Shop coated materials shall be handled, transported, stored and shipped in a manner that will prevent damage to the coating and lining. Coating or lining damaged in handling or other operations shall be repaired to the approval of and at no additional cost to the Owner

M. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Engineer shall be repaired in accordance with these Specifications and at no additional cost to the Owner

1.9 JOB CONDITIONS

A. All work which requires the interruption of active water service lines must be completed as quickly as possible in order to minimize inconvenience to customers and risk to the City of Grand Junction and coordinated as specified in Division 1

B. Underground Obstructions
1. Underground Obstructions known to Engineer are shown on Drawings
   a. Locations shown may prove inaccurate and other obstructions not known to Engineer may be encountered
   b. Contractor shall field locate and verify all obstructions where or not shown on the Drawings
2. Notify each utility owner and request utility be field located by surface reference at least 48 hours prior to trenching or excavation
3. Expose and verify size, location and elevation of underground utilities and other obstructions where conflicts might exist sufficiently in advance to permit changes in the event of a conflict
   a. Notify Engineer and Owner in case of a conflict
   b. In case of a conflict, the proposed work may be changed by Engineer
4. Maintain, protect, and support by shoring, bracing or other means existing utilities and appurtenances

C. Verify existing system operation, pressures, and valve settings (open or closed) prior to construction

PART 2 PRODUCTS

2.1 PIPE, FITTINGS, AND ACCESSORIES

A. Comply with the most current City of Grand Junction standards and specifications for the public water system products and accessories.

END OF SECTION

SECTION 02920

SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Soil preparation

B. Fertilization

C. Seeding methods

D. Areas to be reseeded

E. Seed Mix

F. Maintenance

G. Seed protection and slope stabilization

1.2 RELATED SECTIONS

A. Section 01500 – Construction Facilities and Temporary Controls

B. Section 02300 – Earthwork

1.3 REFERENCES

A. Federal Specification (FS) O-F-241 - Fertilizers, Mixed, Commercial

B. American Association of Nurserymen - Standardized Plant Names

C. Association of Official Seed Analysts (AOSA)

D. Colorado Department of Agriculture (CDA) Seed Act

E. Colorado Department of Transportation (CDOT) Construction Specifications

1.4 SUBMITTALS

A. Submit under Division One Specifications for products related to seeding work including but not limited to seed mixes, mulches, composts, tackifiers, fertilizers and herbicides.

B. Product Data:

1. Certified Live Seed analyses not more than 6 months old by a recognized laboratory of seed testing for grass mixtures including percent of live seed (PLS), germination, all crop seeds in excess of 1 percent, inerts and weeds
2. Manufactures guaranteed chemical analysis, name, trade name, trademark and conformance to state and local laws of all fertilizers and herbicides

1.5 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging

B. Provide a certificate of the PLS test of the grass seed intended for the project, certifying that the seed furnished is from a lot that has been tested by a recognized laboratory within the last 6 months

C. All brands furnished shall be free from such noxious seeds as Russian or Canadian Thistle, Coarse Fescue, European Birdweed, Johnson Grass, Leafy Spurge, field bindweed, kochia, or any state-listed, City of Grand Junction listed, or Mesa County-listed noxious weed species

D. Any materials that have become wet, moldy or otherwise damaged in transit or in storage will not be used

1.6 QUALIFICATIONS

A. Applicator: Company specializing in performing work of this section with landscaping license from State of Colorado
   1. Experienced with type, elevation, topography and scale of work specified
   2. Adequate equipment and personnel to perform work

1.7 REGULATORY REQUIREMENTS

A. Comply with codes and ordinances of local regulatory agencies for fertilizer and herbicide composition and regulations of the City of Grand Junction, Mesa County, and the State of Colorado.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division One specifications

B. All materials and products will remain in original manufacturers shipping bags or containers until they are used. All material or products will be stored in a manner to prevent them from coming into contact with water or other contaminating substance and in a manner that product effectiveness will not be impaired

C. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable

D. Commercial fertilizer or commercial herbicide: mixed in original bags or containers of the manufacturer, showing weight, chemical analysis and manufacturer name. Store in such a manner such that product effectiveness will not be impaired

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not prepare or seed frozen soils

B. Perform seeding and planting only after preceding work establishing final ground surface is completed

C. Conduct minimum of two (2) soil tests to confirm fertilizer type and application rates

1.10 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement until grass is well established and exhibits vigorous growing condition

1.11 WARRANTY

A. All plant material and work accomplished under this section shall be guaranteed to provide a uniform stand of grass acceptable to the Owner at the end of a one (1) year time period from the completion of the Seeding and Erosion Control work

PART 2 PRODUCTS

2.1 SEED

A. In conformance with State and Federal regulations and subject to the testing provisions of the Associate of Official Seed Analysts (AOSA)

B. Seed Suppliers: Licensed Seed Dealer with Colorado Department of Agriculture

C. Provide the latest crop available in accordance with Colorado Department of Agriculture Seed Laws, Chapter 35, Article 27

D. Compensate for percentage of purity and germination by furnishing sufficient additional seed to equal the specified pure live seed product. The formula for determining the quantity of pure live seed (PLS) is as follows:

Pounds of Seed (Bulk) x Purity x Germination = Pounds of Pure Live Seed (PLS)

E. See City of Grand Junction specification section 212 of the Road and Bridge Construction chapter for approved seed mixes.

2.2 SOIL MATERIALS

A. Select onsite topsoil: Earth material of loose friable clay loam reasonably free of admixtures of subsoil, refuse stumps, roots, rocks, brush, weeds or other material which can be detrimental to the proper development of site revegetation

2.3 ACCESSORIES

A. Soil Additives (Fertilizer)
   1. Dry fertilizers: Primary element composition by weight of 6-10-5
      a. Nitrogen (N) six (6%) percent of which fifty (50%) per-cent inorganic, phosphoric acid (P_2O_5) ten (10%) percent, and potash (K_2O) five (5%) percent
   2. Commercial fertilizer: Primary element composition by weight of 18-46-0
      a. Nitrogen, eighteen (18%) percent, of which fifty (50%) percent is organic, and phosphoric acid (P_20_5), forty-six (46%) percent
      b. These elements may be organic, inorganic, or a combination and shall be available according to the methods adopted by the Association of Official Chemists
   3. Dry, pelletized or granular, uniform in composition and a free flowing product. Do not use material which has caked, segregated, exceeded the expiration date of application, or be otherwise damaged
   4. Thoroughly mixed by the manufacturer. Clearly identify the contents of each container. Do not use materials and containers previously opened, exceeding the expiration date for application or otherwise damaged

B. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass

C. Mulching Material: Straw or onsite grasses from grubbing operation, dry, free from foreign matter detrimental to plant life

PART 3 EXECUTION

3.1 GENERAL

A. Seed all areas disturbed by construction, including all areas along the roadside ditches

B. Pattern for seeding and fertilization as required by field conditions. In no case shall revegetation occur within 30 days of the application of any chemical weed control substance

C. Engineer to review grading prior to seeding

3.2 SOIL PREPARATION

A. Uniformly place and spread topsoil removed during grubbing and stored on site. Provide minimum thickness of 4 inches to meet finished grade. Key topsoil to the underlying and

surrounding material by the use of harrows, rollers or other equipment suitable for the purpose

B. Apply water to the topsoil for compaction purposes in a fine spray by nozzles in such a manner that it will not wash or erode the newly placed soil

C. Exercise care during soil preparation on all embankments so as not to disturb established ground cover. Areas disturbed during the soil preparation will be fertilized and seeded at the discretion of the Engineer in accordance with these documents

3.3 FERTILIZATION

A. Do not proceed with fertilization in adverse weather and unsuitable ground conditions. Examples of these respective conditions may be wind, precipitation, frozen and untillable ground or conditions detrimental to the effectiveness of the application

B. Apply fertilizer in a manner to assure uniform distribution, light watering is acceptable for dispersion

C. In cases where work progress is stopped due to the above conditions, fertilization will begin again, when appropriate conditions exist. The application will begin again with a reasonable overlapping of the previously applied area

3.4 SEEDING METHODS

A. All seeding shall be installed by broadcasting, drilling method, or hydroseed. Small areas of restoration may be broadcast seeded if directed by Engineer.

B. Do not proceed with seeding in adverse weather and unsuitable ground conditions. Examples of these respective conditions may be wind, precipitation, frozen or untillable ground or conditions detrimental to the effectiveness of the application. All seeding shall be performed between either March 1st to May 30th of the calendar year of construction unless indicated otherwise by Engineer

C. Drilling:
   1. Accomplish seeding by means of an approved power drawn drill, followed by drag chains. The grass drill should be equipped with a satisfactory feeding mechanism, agitation, and double disk furrow openers. Equip drills with depth bands set to maintain a planting depth of approximately 3 to 2 inch and shall be set to space rows not more than 7 inches apart
   2. If inspections indicate that strips wider than the specified space between the rows planted have been left or other areas skipped, the Engineer will require immediate resowing of seed in such areas at the Contractor's expense. The seeding mixture shown in the Materials Section applies at a pure live seed rate per acre
   3. Immediately following seeding apply straw mulch at a rate of one (1) ton per acre
   4. Apply water with a fine spray immediately after each area has been mulched. Saturate to four (4) inches of soil depth
   5. Provide additional watering weekly until revegetation seed has germinated

D. Hydroseeding:
   1. Apply seeded slurry with hydraulic seed at a rate of 160 lbs live seed per 1,000 square feet, evenly in two intersecting directions
   2. Do not hydroseed areas in excess of that which can be mulched on same day
   3. Immediately following seeding apply mulch to a thickness of 1/8 inch
   4. Apply water with a fine sprat immediately after each area has been mulched. Saturate to four (4) inches of soil

3.5 AREAS TO BE RESEEDED

A. Seed all disturbed areas that are damaged or disturbed by the Contractor's activities during the entire project scope

B. Additional areas as requested by the Owner and approved by the Engineer

3.6 MAINTENANCE

A. Fertilize the seeded areas once a uniform stand of grass has been established

B. Maintain seeded areas until there is an acceptable uniform plant growth. Reseed areas that are not producing a uniform plant growth within five (5) weeks following seeding. Acceptable uniform plant growth shall be defined as that time when the scattered bare spots, not greater than 1 square foot in area, do not exceed three percent (3%) of the seeded area

C. Maintenance period - 1 year

D. Areas that are seeded late in the fall planting season which are not producing acceptable uniform plant growth, as described above, shall be reseeded during the following spring planting season. If such a condition exists, and the Contractor has diligently, in the opinion of the Engineer, pursued the performance of his work, the Owner at his option, may extend the contract completion date and reduce contract retainage. Retainage may be reduced to less than five percent (5%) of the total contract amount, but shall be at least two (2) times the estimated cost of obtaining the required growth in the indicated areas, plus areas which are susceptible to damage by winter kill, washout or other causes

E. Contractor shall control perennial weeds, thistle, spotted and napweed, spurge and other weeds during the maintenance period

3.7 SEED PROTECTION AND SLOPE STABILIZATION

A. Cover seeded slopes with erosion control fabric where grade is 4 to 1 or greater and where indicated on the Drawings and/or Section 02300. Cover seed with mulch in all other areas

B. Lay fabric smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 6-inch overlap minimum of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil

C. Secure outside edges and overlaps at 48 inch intervals with 4-inch to 6-inch U-shaped type pins or wooden stakes depending on ground condition

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches

F. Maintain integrity of erosion control fabric until seed germination. If seed is washed out before germination, fertilize, reseed and restore affected areas

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete

B. Reinforcing steel

C. Forms

D. Concrete accessories

1.2 RELATED SECTIONS

A. 03600 - Grout

1.3 REFERENCE STANDARDS AND GUIDES

A. Comply with the following except as modified by supplementary requirements of this Project Specification.

B. American Concrete Institute – ACI:
1. 117 – Standard Specifications for Tolerances for Concrete Construction and Materials
2. 214R – Guide to Evaluation of Strength Test Results of Concrete
3. 301 – Specifications for Concrete Construction
4. 302.1R Guide to Concrete Floor and Slab Construction
5. 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
6. 304.2R – Guide to Placing Concrete by Pumping Methods
7. 305.1 – Specification for Hot Weather Concreting
8. 306.1 – Standard Specification for Cold Weather Concreting
9. 308.1 – Specification for Curing Concrete
10. 309 – Guide for Consolidation of Concrete
11. 318 – Building Code Requirements for Structural Concrete
12. 347 – Guide to Formwork for Concrete
13. 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

C. American Standards and Testing Materials (ASTM)
1. A615 – Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
2. C31 – Practice for Making and Curing Concrete Test Specimens in the Field
3. C33 – Concrete Aggregates
4. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

5. C94 – Specification for Ready-Mixed Concrete
6. C115 – Length Change of Hardened Hydraulic-Cement Mortar and Concrete
7. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
8. C150 – Specification for Portland Cement
9. C173 or C231 – Test Methods for Air Content of Freshly Mixed Concrete
10. C260 – Air Entraining Admixtures for Concrete
11. C309 – Liquid Membrane-Forming Compounds for Curing Concrete
12. C452 – Standard Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate
13. C494 – Chemical Admixtures for Concrete
14. C595 – Standard Specification for Blended Hydraulic Cements
15. C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete
16. C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
17. C1012 – Length Change of Hydraulic-Cement Mortars
18. C1157 – Performance Specification for Hydraulic Cement
19. C1567 - Determining the potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate
20. C1602 – Mixing Water Used in the Production of Hydraulic Cement Concrete
21. D1751 – Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

D. Concrete Reinforcing Steel Institute (CRSI)
1. Manual of Standard Practice

E. National Institute of Standards and Technology (NIST)
1. PS 1 – Structural Plywood

1.4 PERFORMANCE TOLERANCES

A. Confirm to ACI 117, ACI 301, ACI 347 and ACI 350 as modified herein. In case of conflict, ACI 117 governs. ACI 350 governs where ACI 117 does not apply.

B. Shrinkage Test Procedure for Tank Lid:
1. Testing and reporting shall conform to ASTM C157-17 with the following modifications:
   a. Wet cure specimens for a period of 7 days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water. Drying age zero (0) shall be deemed after the specimen has completed its wetting period.
   b. Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 .
   c. Report results in accordance with ASTM C 157 at 0, 7, 14 & 28 days of drying.

1.5 SUBMITTALS

A. Submit under provisions of Division 1 specifications

B. Shop Drawings: Reinforcing bar lists, fabrication and placement drawings
   1. Indicated bar sizes, spacing, locations, and quantities of reinforcing steel. Bending and cutting schedules shall be included in all shop drawings.
   2. Indicate pertinent dimensions, materials, bracing, arrangement of joints and ties, and exact location of openings, framing, and special conditions affecting work
   3. All shop drawings shall be original drawings produced by the supplier and shall not be reproductions of the Contract Documents

C. Product Data: Provide sufficient information on products specified to verify compliance with specifications. Provide data on
   1. Joint devices
   2. Attachment accessories
   3. Admixtures and mixes
   4. Curing Compounds
   5. Sealers

D. Test Reports
   1. Submit reports of tentative concrete mix designs and testing prior to placing any concrete, including
      a. Slump range on which the design is based
      b. Total gal of water per cu yd
      c. Brand, type, composition, and quantity of cement with manufacturer and plant location identified
      d. Brand, type, composition and quantity of fly ash
      e. Specific gravity and gradation of each aggregate
      f. Ratio of fine to total aggregates
      g. Surface-dry weight of each aggregate per cu yd
      h. Brand, type ASTM designation, active chemical ingredients and quantity of each admixture
      i. Air content and tolerance
      j. Water/cementitious material ratio and tolerance
      k. Compressive strength based at 7- and 28-day compression tests
      l. Submit reports of field quality control testing
      m. Time of initial set
   2. Submit suppliers certified fly ash test reports for each shipment delivered to concrete supplier
      a. Physical and chemical characteristics
      b. Certification of compliance with the specifications
      c. Signed by Contractor and concrete supplier
   3. Existing data on proposed design mixes are acceptable if certified and complete

E. Construction Joint Locations: Submit all proposed construction joint locations in slabs and walls to Engineer two (2) weeks prior to placing any concrete.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301 and ACI 350. Maintain one copy of each document on site.

B. Follow recommendations of ACI 305.1 when concreting in hot weather.

C. Follow recommendations of ACI 306.1 when concreting in cold weather.

D. Acquire cement and aggregate from same source for all work

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle materials under provisions of Division 1 Specifications

B. Cement. fly ash, and other cementitious materials: Store in moisture proof enclosures, do not use if caked or lumpy

C. Aggregate: Store to prevent segregation and inclusion of foreign materials, do not use the bottom 6-inch of piles in contact with the ground

D. Reinforcing steel
   1. Store on supports 6” minimum off of ground, which will keep it from contact with ground and protected from oil or other materials detrimental to steel or bonding capability. Cover to prevent unacceptable surface corrosion and contamination.
   2. Tag bundles of reinforcing bars and wire spirals with metal tag showing specification, grade, size, quantity and suitable identification to permit checking, sorting and placing.

E. Rubber and plastic materials: Store in a cool place, do not expose to direct sunlight

F. Prepare a delivery ticket for each load of ready-mixed concrete

G. Truck operator shall hand ticket to Geotechnical Engineer or Third Party Inspector at the time of delivery with ticket to show:
   1. Quantity delivered
   2. Actual quantity of each material in batch
   3. Outdoor temp in the shade
   4. Time at which cement was added
   5. Numerical sequence of the delivery
   6. Quantity of water that can be added in the field based on mix design
   7. Free moisture in fine and coarse aggregate in percent by weight
   8. Temperature of batch

PART 2 PRODUCTS

2.1 FORMS

A. Prefabricated: Symons "Steel-Ply" or accepted substitution

B. Plywood: PS 1, waterproof resin-bonded, exterior type Douglas Fir; face adjacent to concrete Grade B or better

C. Lumber: Straight, uniform width and thickness; free from knots, offsets, holes, dents, and other surface defects

D. Chamfer strips: Clear, white pine, surface against concrete planed

E. Form coating: Colorless biodegradable oil or water based release agent that will not stain concrete and is VOC compliant. Acceptable products: Nox-Crete "Nox-Crete Form Coating", L & M "Debond", or accepted substitution

F. Form Coating where exposed to potable water: Meets NSF Standard 61, Dayton Superior “Clean Strip J1EF”, Hill and Griffith Company “Grifcote LV-50-Plus”

G. Form ties: Removable end, permanently embedded body types with waterstops not requiring auxiliary spreaders, with cones on both ends, embedded portion 1-inch minimum back from concrete face. If not provided with threaded ends, constructed for breaking off ends without damage to concrete.

2.2 REINFORCING STEEL

A. Bars: ASTM A615, Grade 60

B. Bars to be field bent: ASTM A706, grade 60.

C. Bar supports: CRSI Class 1, fabricated from galvanized wire having PVC coated legs

D. Tie wire: 16 ½ gage or heavier, black annealed wire

E. Form and fabricate reinforcing steel in accordance with ACI 315 and 318 and CRSI DA4 free from rust, scale and contaminants which will reduce bond.

F. Dowel Adhesive: Hilti “HIT-RE 500 V3”, Powers “PE 1000+”, Simpson “SET-XP”, or accepted substitution.

2.3 CONCRETE

A. Cements listed below are considered appropriate for Class 2 sulphate resistance and water/wastewater applications. Cement options:
   1. ASTM C595 TYPE IL plus Class F fly ash of High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months of 0.10 percent expansion at 12 months when tested according to ASTM C1012

   2. ASTM C150 Type V with a minimum of a 20 substitution of Class F fly ash by weight.
   3. ASTM C150 TYPE II or III with a minimum of a 20% substitution of Class F fly ash by weight. The Type II or III cement shall have no more than 0.040 percent expansion at 14 days when tested according to ASTM C452.
   4. ASTM C1157 TYPE HS: Class C fly ash shall not be substituted for cement.

5. ASTM C150 TYPE II, III, or V plus High-Reactivity Pozzolan where blend has less than 0.05 percent expansion at 6 months of 0.10 percent expansion at 12 months when tested according to ASTM 1012.
6. ASTM C1157 Type MS plus Class F fly ash or High-Reactivity Pozzolan where the blend has less that 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012.
7. A blend of Portland cement meeting ASTM C150 Type II or III with a minimum of 20 percent Class F fly ash by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 21 months when tested according to ASTM C1012.
8. ASTM C595 TYPE IP(HS)
9. ASTM C595 Type IT; having less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012.

B. Fly ash: ASTM C618, Class F

C. Blast Furnace Slag: ASTM C989, Grade 100 or 120

D. Fine aggregate: Clean, natural sand, ASTM C33; no manufactured or artificial sand

E. Coarse aggregate: Crushed rock, natural gravel, or other inert granular material, ASTM C33 except clay and shale particles no more than 1%.
1. Alkali Silica Reactivity: Aggregate shall be considered non-reactive with a documented satisfactory service record for a minimum ten year period used in concrete with similar cementitious material or with an alkali (Na_2O eq.) content in concrete equal or higher than that in the proposed mixture. In the absence of service record the aggregate shall be tested and will be considered non-reactive if it complies with a) or b) or c)
   a. ASTM C1260 14-day expansion less than or equal to 0.1%, or
   b. ASTM C1293 1-year expansion less than or equal to 0.040%
   c. ASTM C1567 16-day expansion less than or equal to 0.1%

F. Water: ASTM 1602

G. Admixtures
1. Air entraining agent: ASTM C260; Grace "Darex AEA", Master Builders "VR-10", Sika Chemical "AEA", or accepted substitution
2. Chemical Admixtures: ASTM C494, non-corrosive and chloride free.
3. Shrinkage reducing admixture: Dosage 1% of weight of cement and fly ash; “Eclipse 4500” by GCP Applied Technologies (Grace) “SikaControl-75” by Sika

2.4 ACCESSORIES

A. Membrane Forming Curing Compound: ASTM C309, L&M Construction Materials “Dress & Seal WB30”, BASF "MasterKure CC 200WB”, Euclid “Super Diamond Clear VOX”, Dayton Superior “Cure & Seal 1315 EF”, W.R. Meadows “VOCOMP-20”, or accepted substitution.

B. Curing Compound for surfaces in contact with potable water: Meets NSF Standard 61, Dayton Superior “Clear Cure VOC J7WB”, Atlas Tech Products “Atlas Quantum-Cure NSF”,

C. Floor Sealer: L&M Construction Materials “ Dress and Seal WB30”, BASF “MasterKure CC 200WB” , Euclid “Super Diamond Clear VOX”, Dayton Superior “Cure & Seal 1315 EF”, or accepted substitution.

D. Epoxy Bonding Agent: ASTM C881, Sika “Sikadur 32 Hi-Mod”, Dayton Superior “Sure Bond J58”, L&M Construction Materials “Epobond”, or accepted substitution. Use when joining new to existing concrete.

E. Non-Epoxy Bonding Agent: ASTM C1059 Type II, BASF “MasterEmaco A 660”, L&M Construction Materials “Everbond”, Dayton Superior “Acrylic Bonding Agent J40”, or accepted substitution. Use when joining new to existing concrete when bonding agent cannot be placed immediately prior to placement of new concrete.

F. Patching Mortar: Sika “Sikatop”, L&M Construction Materials “Durapatch VOH”, or accepted substitution.

G. Premolded Joint Filler: ASTM D1751, ASTM D1752 Type I, II, or III.

H. Macro Fiber Reinforcement: 1-1/2 to 2 inch monofilament polypropylene fibers, ASTM C1116 Type III. Manufacturers: GCP Applied Technologies (Strux 90/40), Propex (novamesh 650), or Euclid Chemical Co. (Tuf-Strand SF), or accepted substitution.

2.5 CONCRETE MIX DESIGN

A. Concrete Mix: Measure and combine cement, aggregate, water, and admixtures in accordance with ASTM C94 and ACI 211.1.
   1. Cementitious materials: When used in exposed concrete shall be one brand from one source. Do not mix different cements in same element of Work unless used in accordance with ASTM C595. Water to Cementitious materials Ratio:, 0.45 maximum for 4500 psi and 4000 psi concrete.
   2. Air-Entrainment: Air-entrain concrete exposed to exterior or exposed to liquids. See Table below for requirements.
   3. Chemical Admixtures: Use is optional to aid concrete properties and allow for efficient placement. Manner of use and amount shall be in accordance with manufacturer’s written recommendations and as approved by Engineer. Do not use admixtures that increase early shrinkage or negatively affect finishing.
   4. Fly Ash: Use is optional unless otherwise noted. Combine fly ash with cement at a rate of 1 pound fly ash for each pound reduction of cement. Amount of fly ash shall not be less than 15% or more than 25% of weight of cement plus fly ash. When fly ash used, minimum amount of cement designated may be proportionately reduced.
   5. Blast Furnace Slag: Use is optional unless otherwise noted. Combine blast furnace slag with cement at a rate of 1 pound of blast furnace slag for each pound reduction of cement. When blast furnace slag is used as cement replacement, blast furnace slag shall comprise 40-65 percent of the cementitious materials.

6. Concrete for fillets in tanks shall be fiber reinforced.
   a. Dosage Rate: for macrofiber reinforcement 4 pounds per cubic yard minimum
   b. Use in strict accordance with manufacturer's written recommendation and ASTM C94.
7. Shrinkage requirement: For locations identified to include shrinkage reducing admixture concrete shall be proportioned such that the results of shrinkage test as defined in Part 1 of this section do not exceed 0.040% at 28 days of drying for laboratory cast specimens. Shrinkage reducing admixture shall be dosed at a minimum rate of 1.0 gal/ cubic yard, but not required to exceed more than 1.5 gal/ cubic yard. Where the 0.04% shrinkage cannot be obtained within the dosage rates prescribed, Contractor shall coordinate with Engineer on an acceptable solution.
8. Provide shrinkage reducing admixture in the following areas:
   a. Tank lid
9. Use no admixtures other than specified, unless approved by Engineer.

B. Concrete:
1. Furnish as required to meet tabulated requirements.
2. Slump requirements are intentionally not listed but slump shall be tested as specified in Part 3 of this section to record variability across same mix design.
3. Chloride ion content shall not exceed values listed in ACI 318, Table 19.3.2.1.

Use	28-Day Compressive Strength (psi)	Coarse Aggregate (size no.)	Water to Cementitious Materials ratio	Air Content (%)
Walls	4500	67	0.45	6±1.5
Base Slabs	4500	67	0.45	3±1.5
Formed Structural Slabs	4500	67	0.45	6±1.5

2.6 FABRICATION

A. Reinforcing Steel: Accurately formed, fabricated in accordance with ACI 315 and 318 free from rust, scale and contaminants which will reduce bond

2.7 SOURCE QUALITY CONTROL

A. Test the proposed concrete mix for each size and gradation of aggregates and each consistency intended for use in the project

B. Aggregates
1. Sample and test according to ASTM C33
2. Determine bulk specific gravity in accordance with ASTM C127 and C128

C. Fly Ash and Blast Furnace Slag: Supplier's chemical composition and physical analysis test

D. Initial set test

1. In accordance with ASTM C403
2. Test at 70 degrees F and 90 degrees ambient
3. Test at 70 degrees F on mix including specific plasticizing and entraining admixtures
4. Test at 90 degrees F on mix including specified retarding and air entraining admixtures
5. Fly ash and Blast Furnace Slag : Supplier's chemical composition and physical analysis test

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions in field or under provisions of Division 1 Specifications

B. Verify requirements for concrete cover over reinforcement

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions

B. Subgrade and bedding shall be compacted and free of frost. If placement occurs at temperatures below freezing, provide temporary heat and protection to remove frost. Do not place concrete on frozen material.

C. Provide mud slabs where noted, where necessary, and when required by the Engineer to obtain a dry and stable working platform for placement of concrete. Unless otherwise approved by Engineer, 2 inch thick mud slabs shall be provided between free-draining fill and concrete as detailed.

D. Remove standing water, ice, mud, and foreign matter before placing concrete

3.3 FORMS

A. Formwork design, detailing, and installation shall be Contractor’s responsibility and shall conform to ACI 347.

B. Type of forms used is Contractor’s option, except as otherwise indicated or shown. Plywood and other wood forms shall have smooth level surfaces treated with form oil or sealer to produce clean release of concrete from forms.
   1. Where wall remain exposed use plywood, prefabricated metal or wood forms; do not use boards. Lay forms out in a uniform pattern with the long dimension of the form placed vertically and joints aligned.

2. Form ties shall be plastic cone snap ties. Cone shall be min ¾ inch diameter by 1 inch deep. Ties for liquid holding structures or dry structures below grade shall have integral waterstop. Taper tie through-bolt form ties may be used as an alternate to plastic cone snap ties; conform to details shown. Do not use wire ties on exposed concrete.
3. Provide ¾ inch chamfer on external corners of exposed concrete walls, beams, columns, equipment bases and exposed edges of construction joints. Do not chamfer edges flush with concrete walls.

C. Coat plywood and wood forms with non-staining form release agent. Apply release agent before reinforcement is placed.

D. Clean, patch, and repair form material before reuse.

E. Formwork shall prevent leakage of mortar, shall not deflect under weight of concrete and workmen, and shall withstand fluid pressure of concrete. Maximum deviation from a true plane: 1/8 inch within 6 feet

F. Brace or tie forms to maintain desired position, shape, and alignment during and after concrete placement

G. Design to produce hardened concrete to the shape, lines, and dimensions indicated on the drawings

H. Plywood or lined forms are not required for surface normally submerged or not normally exposed to view

I. Other type of forms may be used for surfaces not restricted to plywood or lined forms as backing for form lining

J. Flat segmental forms, 2 foot maximum width, may be used for curved surfaces 25 feet minimum diameter

K. Provide polyethylene film to protect concrete from water loss when placing concrete against gravel or crushed rock not containing 25 percent minimum material passing a No. 4 sieve, lap joint 4 inches

L. When placing concrete against rock, remove all loose pieces of rock and clean exposed surface with high pressure hose

M. Size and space wailers, studs, internal ties and other form supports so proper working stresses are not exceeded

N. Locations to be finished to a specified elevation, slope, or contour, bring form to true line and grade and provide a wooden guide strip at the proper location in the forms for finishing the top surface with a screed or template

O. At horizontal construction joints in walls, stop the forms on one side not more than 2 feet above the joint

P. Provide temporary opening at the bottom of columns and wall forms and wherever necessary for cleaning and inspection

Q. Install form ties on exposed surfaces in uniformly spaced vertical and horizontal rows

R. Do not remove or disturb until concrete has attained sufficient strength to safely support all dead and live loads

S. Leave shoring beneath beams and slabs in place and reinforce as required for construction equipment and materials

T. Maintain forms in place for a minimum of 40 hours for length of curing time in accordance with ACI 306.1 when temperature is 45 deg F and below

U. Remove forms carefully to prevent surface gouging, corner or edge breakage and other damage

3.4 REINFORCING STEEL

A. Accurately position reinforcing steel on supports, spacers, hangers, or other reinforcing steel at maximum intervals of 4 feet on center

B. Secure with wire ties or suitable clips. Tie 50 percent of all reinforcement and reinforcement at intersections for wall and floor construction

C. Except at contact splices, minimum clear distances between bars, the greater of
   1. Nominal diameter of bars
   2. 1.5 times max size of coarse aggregate

D. Splices
   1. Splices at other locations will be acceptable, if approved by the Engineer
   2. Do not weld or tack weld reinforcing steel
   3. Remove and replace steel upon which any unauthorized welding has been performed

3.5 EMBEDMENTS

A. Accurately position and securely anchor in forms, anchor bolts, steel shapes, conduit, sleeves, masonry anchorages, and other materials to be embedded in concrete

B. Cast pipe and other embedded items into concrete as placement progresses. Do not provide blockouts.

C. Do not place ducts, conduit, and pipes in slabs on grade. Place minimum 4 inches below slab

D. Place items constructed of dissimilar metals to avoid physical contact with reinforcing. Secure item and reinforcing to ensure they will not shift and come into contact during concrete placement. Contact between reinforcing steel and other metal, other than bare, coated, or plated carbon steel not permitted.

E. The following restrictions shall be adhered to, unless otherwise noted
   1. No duct, conduit, pipe, or fitting placed vertically shall be larger in cross-sectional area than 4% oc column into which it is placed.
   2. Duct, conduit, pipe, and fittings, when placed within slabs or walls
      a. Shall not be larger than 1/3 thickness of slab or wall
      b. Shall be placed within the middle 1/3 of slab or wall where possible
      c. Shall not be placed closer than 3 outside diameters clear from each other when parallel
      d. Shall cross each other at right angles
      e. Shall be secured to prevent shifting of "floating" during concrete placement
      f. Multiple conduits shall not cross each other at the same location
      g. Except for conduits that must run up a column, keep conduits a minimum of 2 to 3 feet away from columns
      h. Where conditions require conduit to be tied to the inside face of the reinforcing mat, the conduit shall be galvanized steel or PVC, shall be placed 3 outside diameter clear away from the parallel reinforcement bar.
   3. Reinforcing steel shall be in place before embedded items placed and reinforcing cut or removed shall be replaced with additional reinforcing as indicated.
   4. Do not pass sleeves through columns or beams without Engineer's approval.

F. Anchor bolts
   1. Unless installed in pipe sleeves, provide sufficient threads on anchor bolts to permit a nut on the concrete side of the form or template
   2. Install a second nut on the other side of the form or template
   3. Adjust the nuts to hold the bolt rigidly in the proper position

G. Clean embedments before installation

3.6 TRANSPORTING MIXED CONCRETE

A. Transporting of mixed concrete shall conform to ACI 304R.

B. Maximum delivery time from batch plant is 90 minutes unless stated otherwise by the supplier and approved by the Owner/Engineer.

C. Mix concrete in accordance with ASTM C94.

D. Do not exceed manufacturer's guaranteed capacity of truck agitators. Maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

E. Additional mixing water is permitted as long as the specified water cement ratio of the mix is not exceeded. Batched water quantities and added water quantities must be accurately recorded for verification. If additional water is to be incorporated into the concrete, revolve the drum not less than 30 revolutions at mixing speed after the water is added and before placing concrete. Addition of water is not permitted after concrete testing has occurred.

F. Notify Special Inspector of any water added to the concrete mixture

G. A water measuring device in good working condition, mounted on each transit mix truck, shall be used for measuring the water added to the mix on site or in transit.

H. Provide delivery ticket to Special Inspector or Owner and comply with delivery requirements of this section

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 304, ACI 301, and ACI 318

B. Schedule and attend pre-pour meeting with Owner at least 7 days before first pour to review requirements of this specification

C. Notify Engineer and Owner not less than 48 hours in advance of the times and places at which contractor intends to place concrete

D. Predetermine limits at each pour and place all concrete within limits of pour in one continuous operation

E. Construction joint locations shall be approved by the Engineer

F. Rigidly secure forms, reinforcing steel, embedment, and anchor bolts in proper position

G. Remove all mud, water, ice, snow, frozen material, and debris from space to be occupied by concrete

H. Clean surfaces encrusted with dried concrete from previous concrete operations

I. Convey to the point of final deposit by methods which will prevent separation or loss of ingredients

J. Place concrete in final position without being moved laterally more than 5 feet

K. Place concrete in horizontal layers not more than 2 feet of depth to allow for proper consolidation

L. Place subsequent layer while the preceding layer is still plastic

M. Top finish concrete when thoroughly settled

N. Remove all laitance, debris, and surplus water from the tops of the forms by screeding, scraping or other effective means

O. Overfill the forms for walls whose tops will be exposed to the weather and screed off the excess after the concrete has settled

P. Provide vertical construction joints as required to comply with these requirements

Q. Allow concrete in walls and columns to settle at least 2 hours before concrete is placed in structural systems to be supported by the walls and columns

R. Clean concrete spatter and other foreign substances from surfaces not in contact with concrete.

3.8 BONDING TO HARDENED CONCRETE

A. Place new concrete on rough, clean, damp faces of existing concrete

B. Roughen concrete to be bonded to future concrete to 1/4 inch amplitude

C. Remove surface mortar of smooth surfaces to expose aggregate

D. Clean hardened concrete of all foreign substances, including curing compound, washed with clean water, and keep saturated for 24 hrs preceding placement of fresh concrete

E. Apply epoxy bonding agent for bonding to hardened concrete

3.9 CONSOLIDATION

A. Thoroughly consolidate concrete during and immediately after placement

B. Work concrete around all reinforcements and embedments and into the corners of the forms

C. Use mechanical vibrators which will maintain 9,000 cycles per minutes when immersed in the concrete, 1 ½ hp motor minimum

3.10 COLD WEATHER CONCRETING

A. Conform to ACI 306.1

B. Minimum concrete temp at the time of mixing: Refer to Table 5.1 of ACI 306R-16

Outdoor Temp at Placement (in shade)	Minimum Concrete Temp at Mixing (Concrete Sections 12" or Greater)
Below 0°F	65°F
Between 0°F & 30°F	60°F
Above 30°F	55°F

C. Do not place heated concrete which is warmer than 15 degrees above the minimum concrete temperatures defined above.

D. If freezing temperatures are expected during curing, maintain the concrete temperature for the protection period in accordance with ACI 306R-16, Table 7.2

E. Do not allow concrete to cool suddenly.

3.11 HOT WEATHER CONCRETING

A. Conform to ACI 305.1, except as modified herein

B. At air temp of 90 degrees F and above keep concrete as cool as possible during placement and curing

C. Do not allow concrete temperature to exceed 85 deg F at placement

D. Prevent plastic shrinkage cracking due to rapid evaporation of moisture

E. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 lbs per sq ft per hr as determined from ACI 305R-10, Fig 4.2

3.12 CONSTRUCTION JOINTS

A. Unless otherwise noted, construction joints shown are optional. Locate to miss splices in reinforcement.

B. Before concrete placed, construction joints shall be cleaned, laitance removed, and surface wetted. Remove standing water.

C. Locate construction joints in floors within middle third of span. Construction joints in floors supported by walls may be located at center of wall.

D. Locate vertical joints in walls a minimum of one-half wall height from corners or other intersecting walls or at midpoint between corners or intersecting walls. Locate horizontal joints in walls within the middle third of wall height.

E. Construction joints shall have keys or roughened surfaces. Where roughened surfaces are used, surface shall have amplitude of ¼ inch minimum.

F. Install premolded joint filler where noted in accordance with manufacturer's recommendations. Joint filler shall be compatible with sealant and suitable for intended purpose.

G. Install construction joints in slabs perpendicular to the planes of their surfaces

3.13 WATERTIGHT JOINTS

A. Provide waterstop in construction joints at the following locations:
   1. Walls and slabs separating dry interior from earth or liquid.
   2. Exterior walls and slabs of liquid holding tanks.
   3. Slabs above occupied areas

B. Hydrophilic and non-swelling gasket type waterstops
   1. Follow all manufacturer's recommendations and instructions for installation.
   2. Provide a smooth even surface to ensure good bond between waterstop and substrate.
   3. Locate waterstops in center of construction joints.

4. Splice waterstops in accordance with manufacturer's recommendations.
5. Prior to application of waterstop remove all dust, oil, or other contaminants from the concrete surface prior to adhering the waterstop.
6. Secure waterstop sufficiently to substrate to prohibit movement of waterstop during placement of fresh concrete.

3.14 EXPANSION AND CONTRACTION JOINTS

A. Contraction joints
   1. Provide as designated by Engineer
   2. Seal accessible edges

B. Expansion material
   1. Firmly bond to previously poured joint. Face with a suitable adhesive
   2. Pour new concrete directly against joint filler
   3. Seal accessible edges

3.15 FINISHING SLABS AND FLATWORK

A. Slab Finishes:

Description	Concrete Finish
Submerged and Buried Slabs	Float
Exterior Exposed Slabs	Float and Broom Finish

B. After placement, screed concrete with straightedges, power strike-offs or vibrating screeds.

C. After screeding, bull float or darby surfaces to eliminate ridges and to fill in voids left by screeding.

D. Float:
   1. Use magnesium or aluminum hand floats or power floats with slip on float shoes.
   2. Float finish shall result in uniform smooth granular texture.

E. Broom Finish: Use fine, soft-bristled broom and broom at right angles to direction of traffic to give nonskid finish approved by Engineer.

F. Tolerances:
   1. Concrete slabs shall be within 3/16 inch of 10 foot straightedge in all directions except where slabs are dished for drains. Deviations from elevation indicated shall not exceed 3/4 inch.
   2. Pitch floor to floor drains minimum 1/8 inch per foot or as shown. Pitch bottom of slab or beam to match top slope to maintain thickness or depth indicated. As an alternate, bottom of slab or beam may be placed level provided that min thickness or depth is maintained.

3.16 FINISHING FORMED SURFACES

A. Remove fins and other surface projections from all formed surfaces except exterior surfaces that will be in contact with earth backfill and are not specified to be dampproofed

B. Use a power grinder, if necessary, to remove projections and provide a flush surface

C. Remove fins and fill all tie holes on surfaces exposed to view
   1. Clean, dry and fill plastic cone snap tie holes with Patching Mortar. Fill taper tie through-bolt form tie holes with Non-Shrink Grout.
   2. Finish flush to match the texture of adjacent concrete

D. Surface finishes shall meet requirements noted below.
   1. All formed surfaces not exposed to view and not resisting hydrostatic pressure shall have a surface finish of 1.0 as defined in section 5 of ACI 301.
      a. Patch voids larger than 1 1/2 inches wide or ½" deep.
      b. Remove projections larger than 1 inch.
      c. Tie holes need not be patched
      d. Surface tolerance Class D as specified ACI 117
   2. All formed surfaces not exposed to view, but resisting hydrostatic pressure shall have a surface finish of 2.0 as defined in section 5 of ACI 301.
      a. Patch voids larger than ¾ inches wide or ½" deep.
      b. Remove projections larger than 1/4 inch.
      c. Tie holes shall be patched
      d. Surface tolerance Class B as specified ACI 117
      e. Grout clean surfaces exposed to view to produce a smooth uniform surface free of marks, voids, surface glaze and cement dust
   3. All surfaces exposed to view shall have grout cleaned rubbed finish
      a. Use non-shrink grout mix with bonding agent.
      b. Wet surface and scrub grout into voids and remove excess material.
      c. Finished surface shall have smooth appearance free of marks, voids, surface glaze, and cement dust.

3.17 CURING AND PROTECTION

A. Protect concrete from frost and keep moist for min curing period of 7 days after placement in accordance with ACI 308.
   1. Formed Surfaces:
      a. Wet cure by spraying surfaces as frequently as drying conditions may require to keep concrete surfaces moist.
      b. Surfaces may be cured by leaving forms in-place. For vertical surfaces, apply water to run down inside of forms, if necessary, to keep concrete moist.
      c. After forms are removed, wet cure for remainder of curing period or apply curing compound.
      d. Do not use curing compound where mortar, grout, concrete, or other coatings or adhesives will be applied.

B. Flatwork:
   1. Cure using curing compound or wet cure.
   2. Do not use curing compound where mortar, grout, concrete, or other coatings or adhesives will be applied.

C. Curing Compound:
   1. Apply curing compound at uniform rate sufficient to comply with requirements for water retention as specified and as measured in accordance with ASTM C156.
   2. Cover areas subjected to direct sunlight with ambient temperature expected to exceed 80°F with white pigmented compound, other surfaces may be covered with fugitive dye compound.

D. Water curing
   1. Begin water saturation as quickly as possible after initial set
   2. Regulate water application to provide complete surface coverage with minimum runoff
   3. Interrupt the application of water to walls for grout cleaning only over the area being cleaned at the time and do not permit the surface to become dry during such an interruption

E. Protect from damaging mechanical disturbances, load stresses, heavy shock, and excessive vibration.

F. Protect finished concrete surfaces from damage caused by construction equipment, materials, and methods, and from rain or running water.

G. Do not load self-supporting structures to overstress concrete.

3.18 REMOVAL OF FORMING AND SHORING

A. Do not remove forming or shoring until member supported has acquired sufficient strength to safely support own weight and any imposed loads. Forming shall remain in place for at least min time recommended by ACI 347. In addition, forming for horizontal members shall remain in place minimum 7 days. In no case shall forming for horizontal members be removed before concrete has reached 85% of specified design strength.

B. Reshore areas as required to carry additional imposed loads.

3.19 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. General:
   1. Prior to starting repair work, obtain Engineer’s approval of proposed repair techniques and materials.
   2. Method of repair shall not adversely affect the appearance of the finished structure.

3. Develop repair techniques on portion of as-cast surface selected by Engineer. Surface of repair remaining exposed to view shall match color and texture of adjacent surfaces.
4. Prepare surfaces, apply and install materials, and cure as recommended by material manufacturers.

C. Defective Areas:
1. Remove honeycombing, stone packets, spalls, and other defective concrete down to sound concrete. If chipping required, make edges perpendicular to surface. Do not feather edges.
2. Fill defective area with patching mortar

D. Leaks or wet spots:
1. Inject, patch and repair areas where leaks or wet spots have occurred inside dry structures.
2. Inject, patch and repair areas where leaks or wet spots have occurred in wet wells, basins, tanks, and other structures which are to hold water and exceed the allowable leakage rate specified in this section.

3.20 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 under provisions of Section 01400

B. Owner's geotechnical consultant provide field and compressive strength tests to determine compliance of concrete materials in accordance with the specifications except as indicated otherwise under provisions of Section 01400

C. The Owner shall pay for compressive strength tests to determine compliance of concrete material in accordance with the specifications

D. Concrete Field Tests
1. Tests by ACI certified technician
2. Concrete Test Samples: Samples for acceptance tests on concrete shall be obtained in accordance with ASTM C172 at the point of placement or discharge.
3. Provide all equipment, supplies, and the services of one or more employees, as required
4. The test frequencies specified are minimum. Additional tests may be performed as required by the job conditions

E. Slump: Provide a sample from each truck load in accordance with ASTM C143 if requested by Engineer and when making test cylinders

F. Air Content: Provide a sample from each truck load if requested by Engineer and when making test cylinders

G. Compression Tests
1. Provide one set of 6 cylinders each day when up to 50 cu yds have been placed in accordance with ASTM C172

2. Make one additional set of 6 cylinders for each additional 50 cu yds or each major pour placed in one day
3. Testa minimum of one cylinder in each set at 7 days
4. Test at least two 6x12 cylinders or at least three 4x8 cylinders in each set at 28 days

5. The other two cylinders to be used as directed by Engineer at any time
6. Engineer will evaluate in accordance with ACI 214 and 318
7. Make, cure, store, and deliver cylinders in accordance with ASTM C31
8. Test in accordance with ASTM C39
9. Mark or tag each set of test cylinders with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump

H. Storage Facilities for Concrete Test Cylinders
1. Including water necessary, a specially prepared box with high-low thermometer and thermostatically controlled heating devices in accordance with ASTM C31

I. Failure of Test Cylinder Results: Evaluation of concrete structures where laboratory-cured cylinders fail to meet 28-day concrete strength requirements of the contract documents will be subject to, but not limited to, the following measures.
1. Upon failure of 28-day test cylinder results, the Engineer may require the Contractor, at his expense, to obtain and test at least three 4-inch diameter cored samples from area in question
2. Concrete will be considered adequate if average of three core tests is at least 85 percent of, and if no single core is less than 75 percent of, the specified 28-day strength. Where concrete durability is a concern due to freeze thaw or sulfate exposure the Engineer may reject concrete that passes ACI 318 core testing criteria for strength, but fails to meet acceptance criteria for cylinder testing.
3. In the event an area is found to be structurally unsound, the Engineer may order removal and replacement of concrete as required. The cost of the core tests and removal and replacement of defective concrete shall be borne by the Contractor
4. Fill all core holes as specified for repairing defective concrete
5. Additional measures may be required at the direction of the Engineer in accordance with ACI 350

3.21 LEAKAGE TESTING OF WATER HOLDING STRUCTURES

A. The tank shall be subjected to leakage tests after concrete has obtained specified design strength, and before backfilling or other Work which will cover faces of walls is begun

B. Tanks laterally restrained or supported by cross-walls, beams or slabs shall not be tested until such restraining or supporting construction is placed and has obtained its specified design strength

C. Fill structure with water to elevation given in the Table 1. After structure has been full for 24 hrs, it will be assumed for purposes of test that absorption of moisture by concrete in structure is complete. Measure change in water level after 24 hours have elapsed.

D. Fill container with water and place next to or in structure being tested. Locate container so it experiences environmental conditions as close as possible to those experienced by structure. Container shall be used as an indicator to measure loss of water due to evaporation. Level of water in container shall be measured and recorded over same period as structure.

E. If drop in water level, adjusted for evaporation in 24-hr period, exceeds 1/32 of an inch leakage shall be considered excessive

F. During test period, examine structure and mark visible leaks or damp spots

G. Damp spots on the exterior wall faces or footings shall be qualified as leaks. All leaks shall be repaired.

H. Drain structure to 2-ft minimum below leaks and damp spots and repair. Method of repair shall be Contractor's option, subject to requirements of these Contract Documents and review by Engineer.

I. If leakage was determined to be excessive, refill structure to specified level and retest

J. Continue this process until drop in water level in 24-hr period is less than 1/32 of an inch

K. Repairs and additional tests shall be made by Contractor, in acceptable manner, at no additional cost to Owner

TABLE 1
LEAKAGE TEST ELEVATIONS

Structure No. and Name	Test Elevation
Tank	5930.00

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Patching cavities in concrete

B. Other grouting specified or indicated on Drawings

1.2 RELATED SECTIONS

A. Section 03300 – Concrete

1.3 REFERENCES

A. ASTM C109 – Test Method for Compressive Strength of Hydraulic Cement Mortars

B. ASTM C191 – Time of Setting of Hydraulic Cement by Vicat Needle

C. ASTM C1107 – Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

D. ICRI Technical Guileline No 310.2R Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Product Data: Provide manufacturer's catalog sheet for material indicating test data and physical properties

1.5 QUALITY ASSURANCE

A. Conform to applicable industry standard, Corps of Engineers, Specification CRD-C 621 - Specification for non-shrink grout

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout
   1. Master Builders - Masterflow 928
   2. W.R. Meadows - Sealtight 588-10K
   3. Sika - SikaGrout 212

4. Quikrete – Non-Shrink Precision Grout
5. Euclid - Tammsgrout Supreme
6. Five Star – High Strength Grout
7. Or accepted substitution

B. Epoxy Grout
1. L&M Inc. – Epogrout 758
2. Sika - Sikadur 42, Grout Pak
3. Five Star – DP Epoxy Grout
4. Or accepted substitution

2.2 MATERIALS

A. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4000 psi in one day and 7000 psi in 7 days

B. Epoxy Grout: Three Component Epoxy Resin System
1. Two liquid epoxy components
2. One inert aggregate filtered component
3. Each component furnished in separate package for mixing at job site

C. Water: Clean and free from deleterious substances

PART 3 EXECUTION

3.1 PREPARATION

A. Non-Shrink, Non-Metallic Grout
1. Clean concrete surface to receive grout
2. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout
3. Cold weather conditions
   a. Warm concrete, substrate and base plate to 40 deg F, or above; store grout in warm area
   b. Follow manufacturer's recommendations for cold weather application
4. Hot weather conditions
   a. Use cold mixing water and cool base plate if possible; store grout in cool area
   b. Follow manufacturer's recommendations for hot weather application
5. Apply to clean, sound surface, roughened to a CSP of 5-9 following ICRI Guideline 310.2R.

B. Epoxy Grout: Apply only to clean, dry, sound surface

3.2 APPLICATION

A. Non-Shrink, Non-Metallic Grout
1. Mix in a mechanical mixer

2. Use no more water than necessary to produce flowable grout
3. Provide air vents where necessary to eliminate air pockets
4. Place in accordance with manufacturer's instructions
5. Where exposed to view finish grout edges smooth
6. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound
7. Wet cure grout for 7 days, minimum
8. Maintain the temperature at a minimum of 40 deg F until grout reaches 3000 psi
9. After placement of grout, eliminate excessive external vibration

B. Epoxy Grout
1. Mix and place in accordance with manufacturer's instructions
2. Completely fill all cavities and spaces around dowels and anchors without voids
3. Obtain manufacturer's technical assistance as required to insure proper placement

3.3 SCHEDULE

A. Non-Shrink, Non-Metallic Grout: General Use
1. Grouting of equipment and column baseplates, manhole covers, pipe inlets, and precast manholes and vaults

B. Epoxy Grout
1. Patching cavities in concrete of tank walls or other wet environments including, but not limited to tie holes.
2. May be used as an alternative to non-shrink grout for structural and equipment support.
3. Use in locations where grout will be exposed to harsh chemicals.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provide miscellaneous metal work shown as needed for a complete and proper installation.

B. Section Includes:
   1. Concrete anchors
   2. Aluminum handrail
   3. Ladders
   4. Access hatch
   5. Miscellaneous items

1.2 RELATED SECTIONS

A. Section 09900 – Coatings

1.3 DEFINITIONS

A. Submerged: At or below level 1 foot 6 inches above maximum water level in water holding structures

1.4 REFERENCES AND STANDARDS

A. AISC: American Institute of Steel Construction

B. AA: Aluminum Association

C. AWS: American Welding Society

D. ASTM: American Society for Testing and Materials

E. AISI: American Iron and Steel Institute

F. OSHA: Occupational Safety and Health Administration

1.5 SUBMITTALS

A. Shop Drawings:
   1. Indicate materials, sizes, connections, anchors, and finishes.

B. Product Data

1. Manufacturer’s catalog sheets and premanufactured items.

C. Miscellaneous Submittals:
   1. Floor access hatch warranty.

D. Submit in accordance with Section 01340.

1.6 QUALITY ASSURANCE

A. Perform shop and/or field welding required in connection with the work of this Section by certified welders in strict accordance with pertinent recommendation of AWS.

B. Conform to AISC and AA standards.

C. Provide periodic shop inspection and final inspection prior to shipment of welds for railing systems.

PART 2 GENERAL

2.1 MATERIALS

A. In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, and roughness.

B. Comply with following standards, as pertinent.
   1. Pipe: ASTM A53, Grade B
   2. Stainless Steel:
      a. Exterior and submerged uses: AISI, Type 316
   3. Aluminum shapes and plates: Alloy 6061-T6 or 6063-T6
   4. Connection Bolts:
      a. For aluminum and galvanized steel members: Stainless steel
   5. Cast-in-place anchor bolts:
      a. ½ inch minimum diameter
      b. Nonsubmerged: ASTM A307, galvanized
      c. Submerged: Stainless steel

2.2 CONCRETE ANCHORS

A. Expansion Anchors:
   1. Manufacturers:
      a. Kwik Bolt 3 or Kwik Bolt TZ by Hilti
      b. Power-Stud+ SD1 or SD2 by Powers Fasteners
      c. Strong-Bolt or Strong-Bolt 2 by Simpson Strong-Tie Co., Inc.
      d. Red Head Trubolt+ or Trubolt Wedge Anchor by ITW Commercial Construction
   2. Usage: In concrete
      a. 316 Stainless Steel
      b. Do not use when submerged or subjected to dynamic loads.

B. Adhesive Anchors:
   1. Manufacturers:
      a. HIT RE-500-V3 or HIT-HY 200-A by Hilti Corp.
      b. AC100+ Gold or PE 1000+ by Powers Fasteners
      c. AT or SET-XP Epoxy Adhesive System by Simpson Strong-Tie Co., Inc.
      d. Red Head Epcon S7, A7, G5 or C6 Adhesives by ITW Commercial Construction
   2. Epoxy adhesive with 316 Stainless steel stud assembly.
   3. Usage:
      a. In concrete, submerged
      b. Do not use in overhead applications

C. Screw Anchors:
   1. Manufacturers:
      a. Kwik-Con II or Kwik HUS / HUS-EZ by Hilti Corp.
      b. Wedge-Bolt+ or Tapper+ by Powers Fasteners
      c. Titen or Titen HD by Simpson Strong-Tie CO., Inc.
      d. Red Head Tapcon or Large Tapcon (LDT) anchors by ITW Commercial Construction
   2. Stainless steel concrete screw with hex head.
   3. Usage:
      a. In concrete, only where noted

2.3 FINISHES

A. Galvanizing Repair Paint: High zinc-dust content paint complying with MIL-P-21035

2.4 FABRICATION

A. Use materials of size, thickness, and type required to produce reasonable strength and durability in the work of this Section.

B. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.

C. Fabricate with accurate angles and surfaces which are true to the required lines and levels, with projecting corners clipped, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.

D. Weld shop connection and bolt or weld field connections.

E. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item. Conform to Section 09900.
   1. Do not coat ferrous metal surfaces embedded in concrete.
   2. Coating of cast iron or ductile iron floor access hatches and pressure relief valves not required.
   3. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.

4. Coat aluminum surfaces in contact with concrete in accordance with AA and Section 09900. Under no circumstances shall aluminum contact dissimilar metal.

F. Galvanizing:
   1. Galvanize after fabrication.
   2. Galvanize by hot-dip process conforming to ASTM A123 and AHDGA specifications.

2.5 ALUMINUM HANDRAIL

A. Handrail and railing shall meet requirements of OSHA and local building code

B. Provide end products of one manufacturer to achieve standardization of appearance

C. Materials:
   1. Rails, posts, and formed elbows: 1-1/2 inch diameter schedule 40 aluminum pipe (1.90 inch outside diameter, 0.145 inch wall thickness) allow 6063-T6
   2. Fittings:
      a. Riveted type fabricated from material similar to rails and posts
      b. Connections shall be continuous type to permit sliding of hands.
      c. Fittings for open railing extensions shall be welded construction and welded to posts to comply with OSHA loading requirements. Welds shall be ground smooth and finished to match adjacent finish.
      d. Base plates and side mounted flanges shall be aluminum or stainless steel.
   3. Toe Plate shall be ¼ inch by 4 inch flat aluminum plate or manufacturer's standard z-type toe plate, alloy 6063-T6
   4. Mechanical fasteners shall be stainless steel.

D. Finishes:
   1. Clear satin anodized finish
      a. Extruded components: 0.7 mil
      b. Cast components: 0.4 mil

E. Fabrication
   1. Use materials of size thickness, and type required to produce required strength and durability.
   2. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
   3. Form connections and changes in direction by using prefabricated fittings or radius bends.
   4. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces
   5. Remove burrs from exposed cut edges
   6. Close pipe ends using prefabricated fittings
   7. Fabricate joints of exterior units to exclude water or provide weep holes where water may accumulate

8. Provide base flange or side mounted base plate.
9. Coat surfaces to be in contact with concrete with bituminous paint

2.6 LADDERS

A. Ladders shall conform to OSHA and local building code safety requirements

B. Construct from stainless steel or hot dip galvanized steel
   1. Stringers: 3-1/2 inch by 3/8 inch bar
   2. Rungs: 1 inch diameter rod.
   3. Other materials shall be minimum ¼ inch thick
   4. Weld rungs to stringers
   5. Fabricate brackets for fastening ladders to wall, weld to ladder.

C. Safety Devices:
   1. Unless otherwise noted, equip ladders over 10 feet tall with aluminum safety climbing devices as manufactured by TS Products, Inc.
      a. Safety rail shall be TS rail
      b. 2 TS trolleys at each ladder
      c. 10TS safety belts, Verify size with Owner
      d. 1 TS ice guard for each exterior ladder
      e. TS removable extension safety rail extensions on ladders accessible from top. Where permanent installation not possible, provide removable extension. Position extension on brackets near top of ladder so climber can readily install extension.
      f. Safety rail climbing devices shall allow worker to operate freely in normal climbing position during ascent or descent. Device shall enable worker to be attached to device during climb without having to remove hands from ladder to operate system effectively, and be able to easily pivot onto and off work platforms or landings while safely attached to device.

D. Provide retractable safety post extension at top of ladder
   1. Bilco LadderUP model LU-3 or accepted substitution.

2.7 ACCESS HATCH

A. Prefabricated Surface Mount Type:
   1. Manufacturers:
      a. Bilco type SM
      b. Halliday Series F-R
   2. Provide aluminum access hatch and frame
   3. Door leaves shall be 1/8 inch minimum diamond pattern plate with reinforcing on underside to withstand live load of 105 pounds per square foot and shall have 90 degree return flange around perimeter
   4. Frames shall be ¼ inch minimum thick raised style for surface mounting flange set in sealant.
   5. Equip hatches with stainless steel hinges

6. Equip hatches with hold-open arm with positive locking device with conveniently positioned release handle for easy and controlled closing
7. Provide exterior 316 stainless steel pad lock lug and pressure locks
8. Provide ¼ inch neoprene compression gasket at underside of cover.
9. Hardware shall be stainless steel
10. Factory finish on aluminum surfaces shall be mill finish with bituminous coating applied to surfaces in contact with concrete
11. Manufacturer shall warranty in writing against defects in material and workmanship for 5 years

2.8 MISCELLANEOUS ITEMS

A. Fabricate miscellaneous framing, supports, and items of structural shapes, plates, bars, and tubing or sizes and arrangements indicated and as required.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Set work accurately into position, plumb, level, true and free from rack.
   2. Tolerance: 1/8 inch in 10 feet
   3. Anchor firmly into position
   4. Where field welding is required, comply with AWS recommended procedures for appearance and quality of weld and for methods to be used in correction welding work.
   5. Grind exposed welds smooth, and touchup shop prime coats.
   6. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for proper installation. Drill field holes for bolts, for not burn holes.
   7. Perform cutting, drilling, and fitting as required for proper installation. Drill field holes for bolts, do not burn holes.
   8. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint the exposed areas with same material used for shop priming.

B. Concrete Anchors:
   1. Do not install until concrete or masonry has reached design strength.
   2. Do not install closer than 6 bolt diameters to edge of concrete or masonry, or closer than 12 bolt diameters to another anchor unless noted otherwise.
   3. Minimum embedment shall be 8 bolt diameters unless noted otherwise.
   4. Install in accordance with manufacturer’s recommendations.

3.3 ALUMINUM HANDRAIL AND RAILING

A. Assemble and install in accordance with manufacturer's written instructions.

B. Set posts plumb and align in each direction to within 1/8 inch in 10 feet

C. Provide expansion joints in rails and toe plate at 30 feet maximum on center. Locate within 12 inches of post

D. Support handrail on brackets having 2 inch clearance between handrail and wall spaced not more than 5 feet on center and within 12 inches of each end of rail. Return handrail ends to within ½ inch of wall.

E. Provide toe plate except on stairs where concrete curb provided, and on top of walls that project above grade where foot traffic is not feasible.

F. Bolt to top of concrete or stair stringers. Bolt to side of platform framing.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces, removing dirt, dust, and other foreign matter.

B. Prepare surfaces for finished painting as specified in Section 09900

C. Field repair of damaged galvanized coatings:
   1. Repair surfaces damaged during shipping, erection, or construction operations.
   2. Use zinc rich paint
   3. Prepare surfaces and apply in accordance with ASTM A780, Annex A2.

END OF SECTION

SECTION 09900

COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Coating of surfaces as specified herein, including:
   1. New and existing surfaces described in Finish Schedules
   2. Exposed interior and exterior ferrous metal, ductile iron, or cast iron piping, regardless of factory-applied finish.
   3. Exterior and interior equipment, valves, all appurtenances.

B. Labeling and directional arrows on piping, equipment, valves, and ducts whether coated or not coated is specified in Section 01080. Do not coat the following unless specifically noted otherwise:
   1. Moving parts of operating units, electrical parts, linkages, sensing devices, and motor shafts.
   2. Buried equipment and piping.
   3. Stainless steel, chrome plate, copper, bronze, galvanized surfaces, and similar finished materials.
   4. Concrete tanks.
   5. Plastic and FRP piping, equipment, and ductwork.

C. Do not coat over any code-required labels such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

D. Equipment manufacturers are responsible for surface preparation and coating of equipment, motors, and appurtenances. Equipment to be coated and coating system is identified in the equipment specification sections.

1.2 DEFINITIONS

A. Definitions as used in Finish Schedule shown on Coating Schedule included herein.
   1. Coatings: Paint or heavy duty finishes for use on surfaces subject to interior and exterior exposure, submergence, high moisture, splash, or chemical environment, including primers, sealers, fillers, and intermediate and finished coats.
   2. Submerged P: Surfaces submerged in potable water plus 1 foot-6 inches above high water level.
   3. Submerged NP: Surfaces submerged in non-potable liquid plus 1 foot-6inches above high liquid level.
   4. First Coat: Field primer, factory primer, or shop primer. When only one coat is required, first coat is the finished coat.
   5. Second, Third, or Intermediate Coats: Successive finished coats applied over first coat.
   6. DFT: Dry film thickness (mils/coat).

7. sfpg: Square feet per gallon (per coat).

1.3 REFERENCES

A. MSDS: Material Safety Data Sheets

B. ASTM: American Society for Testing and Materials

C. SSPC: The Society for Protective Coatings

D. OSHA: Occupational Safety and Health Administration

E. NSF: National Sanitation Foundation

1.4 SUBMITTALS

A. Product Data:
   1. Manufacturer's literature including application recommendations and generic makeup for each coating scheduled.
   2. Factory or shop-applied primer manufacturer's literature including application recommendations and generic makeup shall be submitted with all material and equipment submittals. All primers shall conform to the requirements of this Section.

B. Samples:
   1. Actual color samples available for each coating scheduled.

C. Miscellaneous:
   1. Schedules:
      a. Schedule of proposed coating systems within 60 days after Notice to Proceed.
      b. Schedule of proposed coating systems shall contain all information as indicated in Coating Schedule included herein.
   2. Submit one copy of manufacturer's MSDS, for each type of coating, to Engineer's field office for information. Contractor shall post copy of MSDS on Site at all times coating is in progress.

D. Submit in accordance with Section 01340.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All coatings shall conform to OSHA requirements for allowable exposure to lead and other hazardous substances.
   2. All coatings in contact with potable water or within potable water reservoirs shall be NSF 61 approved.

B. Applicator Qualifications:
   1. Engage an experienced field applicator with a minimum of 5 yrs successful experience and who has successfully completed coating system applications similar in material and extent to those indicated.

C. Single-Scource Responsibility:
   1. Provide coating material produced by same manufacturer for each system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered to site in original containers with labels intact and seals unbroken.

B. Protect and heat or cool material storage location to maintain temperature ranges recommended by coating manufacturers, but not less than 55° F.

C. Avoid danger of fire. Oily rags and waste must be removed from buildings each night or kept in appropriate metal containers. Provide fire extinguishers of type recommended by coating manufacturer's in areas of storage and where finishing is occurring. Allow no smoking or open containers of solvent.

D. Empty containers shall have labels canceled and clearly marked as to use.

1.7 PROJECT / SITE CONDITIONS

A. Environmental Requirements:
   1. Dry-heat and ventilate areas to obtain conditions recommended by coating manufacturer.
   2. Relative humidity conditions as specified by coating manufacturer shall be adhered to.
   3. No unprotected, unheated exterior coating shall be undertaken when cold, damp, foggy, or rainy weather appears probable, nor when the temperature of the substrate is below 55° F, unless approved in writing by coating manufacturer.
   4. Maintain manufacturer's environmental requirements until coating is fully cured.
   5. Apply no coating in areas where dust is being generated.
   6. Testing and disposal of any waste and coating shall be the responsibility of the Contactor.

B. Protection:
   1. Drop cloths shall be provided in all areas where coating is done to fully protect other surfaces.
   2. Remove hardware, accessories, plates, lighting fixtures, and similar items or provide protection by masking. Upon completion, replace items or remove protection and clean.

C. It is the intent of this Section that all ferrous metal items scheduled for coating be shop-primed. If items are not shop-primed, surfaces shall be prepared and coated in the field as specified.

D. Upon Substantial Completion, remaining unused material will become property of Owner. Seal material as required for storage, mark contents with color, type, location, and shelf life, and store on Site where required by Owner. Provide minimum of two gallons of each system component and color used.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Tnemec.

B. Sherwin Williams.

2.2 MATERIALS

A. Coatings shall meet surface burning characteristics as required by code and established by ASTM E84.

B. Coating products of Tnemec or Sherwin Williams, listed in the Coating Schedule, are set as a standard of quality. Coatings of substitute manufacturers shall meet or exceed the characteristics of the products listed as established by the following ASTM standards; B117, C307, C413, C579, C580, C868, D870, D1014, D1653, D2047, D2240, D2370, D2794, D3363, D4060, D4141, D4541, D4585, D4587, and G85.

C. If the Contractor wishes to offer a substitute to the Tnemec or Sherwin Williams products specified, the request for a substitute shall conform to the requirements of Section 01650.

D. The Contractor and top coat coating manufacturer shall verify the compatibility of their products with the various primers used on shop primed materials and equipment.

2.3 COLORS

A. Color shall be formed of pigments free of lead, lead compounds, or other materials which might be affected by presence of hydrogen sulfide or other gases likely to be present at Site.

B. Colors shall be as selected by Owner. System color-coding shall be as specified in Section 01080.

C. Coat access doors of electrical distribution panels and grilles to match color of adjacent wall or ceiling surfaces.

D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.

E. In areas where existing surfaces are finished, coat new exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.

F. Equipment Colors:
   1. Equipment includes pumps, blowers, valves, flow meters, etc, and associated motors, structural supports, hangers, and attached portions of electrical conduit, and other associated components.

2. Color of non-submerged equipment, including equipment with a manufacturer-applied finish coat, shall be same color as piping equipment serves; see Section 01080.
3. Color of submerged equipment can be manufacturer's standard color.

2.4 THINNING, MIXING, AND TINTING

A. Where thinning is necessary, only the products of the manufacturer furnishing the coating will be allowed. All such thinning shall be done in strict accordance with coating manufacturer's recommendations.

B. Mix in accordance with manufacturer's recommendations.

C. Each coat shall be slightly darker than preceding coat, unless otherwise noted. Tint undercoats similar to finish coat.

PART 3 PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor's expense.

3.2 SURFACE PREPARATION

A. All surfaces to be coated shall be prepared as specified herein and in accordance with coating manufacturer's recommendations. The object shall be to obtain a uniform, clean, and dry surface.

B. Quality of surface preparation described herein is considered a minimum. If coating manufacturer requires a higher degree of preparation, comply with coating manufacturer's recommendations.

C. Where surface dryness is questioned, test with dampness indicating instrument. Do not apply coatings over surfaces where moisture content exceeds that permitted by coating manufacturer.

D. Shop primed surfaces shall be scarified before applying top coats. Conform to top coat manufacturers recommendations.

E. If recoat time between application of primer and second coat or between top coats is exceeded, scarify surface before applying coatings. Conform to top coat manufacturers recommendations.

F. Workmanship for surface preparation shall conform to the following SSPC specifications:

a. Solvent Clean: SP-1.
b. Hand Tool Cleaning: SP-2.
c. Power Tool Cleaning: SP-3.
d. White Metal Blast Cleaning: SP-5.
e. Commercial Blast Cleaning: SP-6.
f. Brush-Off Blast Cleaning: SP-7.
g. Pickling: SP-8.
h. Near-White Blast Cleaning: SP-10.

G. Ferrous Metal:
1. Ferrous metal primed in the shop shall have all rust, dust, scale, and other foreign substances removed by abrasive cleaning conforming to SSPC SP-10. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting.
2. Ferrous metal not primed in the shop shall be abrasive blast cleaned in the field prior to application of primer, pretreatment, or coating. Blast cleaning shall conform to SSPC
SP-10 for submerged service. Blast cleaning shall conform to SSPC SP-6 for non-submerged service.
3. Prior to finish coating, primed areas that are damaged shall be cleaned and spot primed.

3.3 APPLICATION

A. Surfaces shall be dry at time of application.

B. The minimum surface temperature shall be 55°F and rising. Some coatings are modified so that they may be applied at lower temperatures, conform to manufacturer's recommendations.

C. Apply in strict accordance with manufacturer's recommendations by brush, roller, spray, or other application method. The number of coats and thickness required is the same regardless of application method.

D. Each coat shall be allowed to dry in accordance with manufacturer's requirements. Drying time shall be construed to mean "under normal conditions". Where conditions other than normal exist, because of weather or because of confined space, longer times will be necessary. Units shall not be put in service until coatings are thoroughly dry and cured.

E. Surfaces to be coated that will be inaccessible in the completed work shall receive the final coat before enclosure.

F. Coatings shall be applied to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable. Areas cut-in by brush prior to rolling shall have uniform appearance in comparison with adjoining surfaces.

G. Make edges of coating adjoining other materials or colors sharp and clean without overlapping.

H. Crevices and other hard-to-apply areas shall be back-rolled/back-brushed in conjunction with application of field applied prime coat or intermediate coat. This includes, but is not limited to: between pipe flanges, pipe flange/barrel joints, equipment fittings, and other narrow openings.

I. Manufacturer-Applied Coatings:
   1. Repair abraded areas on factory-finished items in accordance with equipment manufacturer's recommendations.
   2. Blend repaired areas into original finish.

3.4 FIELD QUALITY CONTROL

A. Examination of Work on Site by coating manufacturer's representative shall be performed when requested by Engineer or Owner.

B. Sampling of Materials:
   1. Engineer reserves the right to select unopened containers of materials furnished for the Project and have the materials tested at an independent laboratory. Owner will pay for first tests.
   2. Retests of rejected materials and tests of replacement materials shall be paid for by Contractor.
   3. Remainder of contents of containers not required for testing will be returned to Contractor.

C. Coverage:
   1. 1. Before beginning Work, finish one complete room, space, surface, and item of each color scheme required, showing selected colors, finished texture, material, and workmanship. After approval, sample room, space, surface, and item shall serve as standard for similar Work.
   2. 2. If coverage is not acceptable to Engineer, Engineer reserves the right to require additional application of coating at no extra cost to Owner.

D. Where coatings are to be applied at the Site, Engineer reserves the right to observe the Work. After surface has been prepared and before application of specified prime coat and each succeeding finish coat, Contractor shall provide three days notice to Engineer to allow the Engineer time to observe the Work. If notification is not provided, no credit for applied coat will be given and Contractor automatically assumes responsibility to recoat Work in question. Surfaces coated without notification shall be abrasive blast cleaned, re-prepared, and recoated at no addition cost to Owner.

3.5 FINAL TOUCH-UP AND CLEANING

A. Prior to Substantial completion, examine coated surfaces and retouch or refinish surfaces to leave in condition acceptable to Engineer.

B. Remove masking, coatings, and other material from floors, glass, and other surfaces not scheduled to be coated.

3.6 COATING SCHEDULE

A. Scheduled thickness or coverage rate is minimum as recommended by Tnemec or Sherwin Williams. If other manufacturer is used, manufacturer's recommendations shall be followed, but in no case shall the thickness or coverage rate be less than scheduled.

B. Coatings shall conform to the following schedule and coating manufacturer's recommendations. Examples of surfaces to be coated may not be all inclusive.

C. Coating representatives may submit on coatings if revised to be in alignment with state and federal regulations on coating requirements such as VOC limits.

COATINGS SCHEDULE

System No.	Application	Tnemec Coating System	Sherwin Williams Coating System
20	Dissimilar Metal Protection / Semi-Gloss	Scarify the Surface, SP-1 First Coat – Series 46H-413 @ 16 mils DFT	Scarify the Surface, SP-1 First Coat – TarGuard @ 16 mils DFT
27	Ferrous Metal, Cast Iron, Ductile Iron / Interior Non-Submerged / Submerged P / Satin	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series L140 @ 5 mils DFT Third Coat – Series L140 @ 5 mils DFT	First Coat – Corothane I Galvapac Zin-rich Primer @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Macropoxy 5500LT @ 5 mils DFT Third Coat – Macropoxy 5500LT @ 5 mils DFT
32	Steel/ Submerged P/ Interior	**Interior Overhead Structural Steel and Ceiling Primer to High Water Level**: Apply 1 coat of Tnemec 91-H20 Hydro-Zinc at 2.5-3.5 mils DFT. **Interior Wet Area Primer:** Apply 1 coat of Tnemec L140 Pota-Pox at 4.0- 6.0 mils DFT. **Stripe Coat Wet Area Welds/Scab Marks**: Apply 1 additional stripe coat of L140 at 2.0-4.0 mils DFT. Work coating into and around all welds and erection scab marks **Overhead 2nd Coat:** Apply 1 coat of Tnemec FC20HS-1255/20HS-1255 (Beige) Pota-Pox at 4.0- 6.0 mils DFT. **Finish Coat, All areas:** Apply 1 coat of Tnemec FC20HS-15BL/20HS-15BL (Tank White) Pota-Pox at 4.0-6.0 mils DFT. Total Dry Film Thickness Interior OH: 10.5-15.5 mils Total Dry Film Thickness Interior Wet Areas: 8.0-12.0 mils	**Stripe Coat:** Corothane I Galvapac Zinc-rich Primer to all weld seams, edges, crevices and corners **Primer:** Corothane I Galvapac Zinc-rich Primer at 2.0-4.0 mils DFT **Stripe Coat:** Macropoxy 5500LT Potable Water Epoxy with Opti-Check OAP Pigment Technology to all weld seams, edges, crevices and corners **2nd Coat:** Macropoxy 5500LT Potable Water Epoxy with Opti-Check OAP pigment Technology at 4.0-8.0 mils DFT **Finish Coat:** Macropoxy 5500LT Potable Water Epoxy at 4.0-8.0 mils DFT

System No.	Application	Tnemec Coating System	Sherwin Williams Coating System
33	Steel Water storage Tanks/ Exterior Non-Submerged	**Primer:** Apply 1 coat of Tnemec 91H20 at 2.5 - 3.5 mils DFT. **Stripe Coat:** Series V69 **2nd Coat:** Apply 1 coat of Seroes V69 at 4.0-6.0 mils DFT. **Finish Coat:** Series 1095 Endurashield at 2.0 - 5.0 mils Color 1095 G8012 Shale Green with 44-600 UV protection additive. Consult Tnemec if Owner would like a floropolymer finish coat which provides much higher color retention (Hydroflon V700 is Tnemec's current product)	**Primer:** Corothane I Galvapac Zinc 2K 100 Primer at 2.0-4.0 mils DFT **Stripe Coat:** Macropoxy 5500LT Potable Water Epoxy to all weld seams, edges, crevices and corners **2nd Coat:** Macropoxy 5500LT Potable Water Epoxy at 3.0-5.0 mils DFT **Finish Coat:** Hi-Solids Polyurethane 250 at 2.0-3.0 mils DFT Consult Sherwin Williams if Owner would like a floropolymer finish coat which provides much higher color retention

END OF SECTION

SECTION 13340

WELDED STEEL STORAGE TANK
AWWA D100-11
(BID ALTERNATIVE)

PART 1 GENERAL

1.1 SECTION INCLUDES

This section includes furnishing and erecting a 150,000 gallon welded steel tank and necessary piping and appurtenances in accordance with AWWA D100-11.

A. Tank design and installation shall be in accordance with all recommendations in the geotechnical report, per Section 01020.

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01020 –Geotechnical Report

C. Section 02300 – Earthwork

D. Section 03300 – Cast-in-Place Concrete

E. Section 05500 – Metal Fabrications

1.3 References

A. When an edition or effective date of a reference is not given, it shall be understood to be the current edition or latest revision published.

B. The following documents may be referenced in this section:
   1. American Concrete Institute (ACI):
      a. 301 Specifications for Structural Concrete
      b. 305 Hot Weather Concreting
      c. 306 Cold Weather Concreting
      d. 309R Guide for Consolidation of Concrete
      e. 350 Code Requirements for Environmental Engineering Concrete Structures and Commentary
      f. 350.3 Seismic Design of Liquid Containing Concrete Structures and Commentary
      g. 350.5 Specification for Environmental Concrete Structures
   2. American National Standards Institute (ANSI)/National Science Foundation (NSF)
      a. Additives Standard No. 61 Drinking Water System Standards
   3. American Society of Testing and Materials (ASTM):

a. A120 Standard Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
b. A123 Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
c. A153/153M Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Hardware
d. A233 Specification for Mild Steel Covered Arc-Welding Electrodes
e. A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
f. A615/615M Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
g. A1008/1008M Standard Specification for Steel, Sheet, Cold-Rolled Carbon Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
h. C31/31M Standard Practice for Making and Curing Concrete Test Specimens in the Field
i. C33/33M Standard Specification for Concrete Aggregates
j. C39/39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
k. C42/42M Standard Test Method for Obtaining and Testing Drilled Cores and sawed Beams of Concrete
l. C618/618M Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
m. C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
n. C920 Standard Specification for Elastomeric Joint Sealants
o. D1056/1056M Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber
p. D1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
q. D1556 Standard Test Method for Density and Unity Weight of Soil in Place by the Sand-Cone Method
r. D2000 Classification System for Rubber Products in Automotive Applications
s. D2240 Standard Test Method for Rubber property – Durometer Hardness

4. American Society of Civil Engineers (ASCE): ASCE 7-16 Minimum Design Loads for Buildings and Other Structures
5. American Water Works Association (AWWA):
   a. C652 Standard Disinfection of Water-Storage Facilities
   b. D100-11 Welded Carbon Steel Tanks for Water Storage
   c. D102-11 Coating Steel Water-Storage Tanks
6. US Army Corps of Engineers: CRD-C572 Specification for Polyvinylchloride Waterstop

1.4 PERFORMANCE REQUIREMNTS

A. Accessories: The tank shall include accessories as specified in this specification.

B. Interior Coating System: See Section 09900

C. Design Requirements: The materials, design, fabrication and erection of the welded tank shall conform to AWWA Standard D100-11, latest edition. The welded steel reservoir will rest on an oiled sand base contained by a concrete ring-wall foundation. The reservoir shall be furnished with piping and appurtenances as shown on the plans and as follows:
   1. Inlet pipe
   2. Overflow pipe
   3. Outlet pipe
   4. Drain pipe
   5. 36" square, hinged, lockable roof hatch
   6. Two shell manholes with hinged covers
   7. Outside ladder with ladder gate and lock, with fall protection
   8. Inside ladder with fall protection
   9. Screened roof vent
   10. Level indicator
   11. Identification name plate
   12. Welded steel sump pit centered on drain pipe

D. Design Criteria for Potable Water Storage Tank: Loads and conditions to be considered in the design of the tank shall include; internal liquid pressure, backfill, seismic loads, prestressing, edge restraint, temperature and moisture gradients and dead and live loads. The following criteria shall be used:
   1. Storage Capacity: 150,000-Gallons
   2. Dimensions: See Plan
   3. Inside Diameter: 40 ft (minimum), 55 ft (maximum including ring wall foundation)
   4. Liquid Depth: 17 ft
   5. Minimum Wall Height: 18 ft
      a. Freeboard space in top of tank shall be a minimum of 1 ft
   6. Liquid Unit Weight: 62.4 lbs/ft3
   7. Maximum Liquid Fill/Withdraw Rates:
      a. Fill Rate: 160 GPM
      b. Withdraw Rate: 200 GPM
   8. Wind and Snow Load:
      a. Importance Category: III
      b. Basic Wind Speed, V: 115 mph
      c. Exposure Category: C
   9. Seismic Load:
      a. Seismic design shall be in accordance with the requirements of the ASCE 7-16 and AWWA D100-11 with the most stringent requirements controlling with the following design loads. Tank Contractor shall provide summary of seismic calculations and results. Mapped Spectral Response Accelerations
         i) 1 Second Mapped Response Acceleration, S1: 0.067 g
         ii) Short Period Mapped Response Acceleration, Ss: 0.256 g

b. Site Classification: Type C
10. Allowable Soil Bearing Pressure: In accordance with geotechnical report

E. Disinfection: The tank structure shall be disinfected at the time of testing in accordance with AWWA Standard C652-02 “Disinfection of Water Storage Facilities” using chlorination method number two. Disinfection shall be performed by a competent water treatment contractor.

1.5 SUBMITTALS

A. Approved Manufacturers:
1. Pittsburg Tank & Tower
2. Maguire Iron
3. Rocky Mountain Fabricators
4. Or engineer approved alternative

B. Design: The following items shall be submitted for review and approval by the Engineer prior to the start of construction:
1. Drawings: Provide complete plan, elevation, and sectional views of the welded concrete tank which detail the tank geometry, materials of construction, and primary dimensions. Construction drawings shall be signed and sealed by a licensed design professional Registered in the State of Colorado. Construction drawings should clearly show the following:
a. Details of foundation preparation.
b. Thickness of all concrete sections.
c. Details of reinforcement in concrete sections including location, spacing, splice dimensions, and fabrication dimensions.
d. All pipe penetrations in the tank wall as well as under floor piping and encasement details.
e. Details of accessories as well as their location on the tank structure.
f. Tank wall and lid thicknesses.
2. Design Calculations: Provide complete design calculations for tank design and foundation design. The design calculations shall be signed and sealed by a licensed tank professional.
a. The tank manufacturer shall design the tank foundation to conform to ACI 318 requirements and to safely sustain the structure and its live loads.

C. Construction: The following items shall be submitted for review by the Engineer and approved prior to use in the construction of the finished product:
1. Concrete Mix Designs: Provide mix design and strength data for each concrete proposed for individual portions of the work. Mix designs shall clearly show ingredient proportions and quantities of admixtures which are used
2. Quality Control Plan: Provide a written quality control plan for compliance and monitoring of quality on the project.
3. Accessories: Provide product data for all accessories required which demonstrate compliance with this specification.

4. Coatings: Provide product data for all coatings which demonstrate compliance with this specification.

D. Project Close Out Documents:
   1. Quality Control Reports: The following quality control reports shall be submitted to the engineer for record purposes prior to final inspection of the project:
      a. Concrete Testing Reports: Submit test reports from an independent laboratory demonstrating concrete quality which meets this specification.
      b. Quality Control Checklist: Submit completed quality control checklists for each portion of the work.
   2. Record Drawings: Record actual locations and final configuration of the tank and accessories on the shop drawings.
   3. Warranty Document: Submit warranty document in Owner's name.

1.6 QUALITY ASSURANCE

A. Qualification of Bidders:
   1. The Engineer's selection of a welded steel tank is predicated on a thorough examination of design criteria, construction methods, and optimum coating for resistance to internal and external tank corrosion. Deviations from the specified design, construction or coating details will not be permitted.
   2. The bidder shall offer a new tank reservoir as supplied from a manufacturer who has furnished and erected at least ten tanks of equal or greater capacity.
   3. Tank suppliers wishing to pre-qualify shall submit the following to the Engineer for consideration a minimum of 7 days prior to the bid date:
      a. List of ten tanks of equal or greater capacity that have been fabricated and erected in the past five years. The list must include the owner/engineer's contact information.
      b. The components of the tank that come in contact with stored water shall be certified to meet ANSI/NSF Additives Standard No. 61.

1.7 WARRANTY

A. The tank manufacturer shall include a warranty on tank materials and workmanship for a specified period. As a minimum, the warranty shall provide assurance against defects in material, coatings, and workmanship for a period of one (1) year.

PART 2 PRODUCTS

2.1 TANK MATERIALS

A. Furnish steel plate and structural shapes per AWWA D100, Section 2.
B. Steel pipe and pipe fittings shall conform to ASTM A-120.
C. Structural bolts shall conform to ASTM A-307.
D. Welding electrodes shall conform to ASTM A-233 E60 or E70.
E. Asphalt board or asphalt expansion joint material shall be furnished which complies with

ASTM D-994.

2.2 TANK FABRICATION

A. All reservoir sub-assemblies and accessories, including shell manholes, ladders, and overflow pipes, shall be fabricated in accordance with AWWA D-100, Section 7.
B. All exterior ladders, guard rails, brackets, hatch covers, pins and fasteners shall be steel that is hot dipped galvanized per ASTM A123/153 after fabrication.
C. Welded steel roof in accordance with AWWA D100.

2.3 CONCRETE

A. Pipe Encasement: Concrete used for pipe encasement shall have minimum 28-day strength of 4500 psi. The course and fine aggregate shall meet the requirements of ASTM C33.

B. Ring Wall Foundation: Foundation concrete to comply with cast-in-place concrete specification 03300. Concrete used for the foundation shall have a minimum 28-day compressive strength of 4500 psi and shall have the following properties:
   1. Air Content: 6%
   2. Maximum Water-Cementitious Material Ratio: 0.45
   3. Fine and Coarse Aggregate: Meeting requirements of ASTM C33
   4. The minimum ring footing width of 3-feet and a minimum footing embedment of 2-feet.
   5. Perimeter drain to be installed

2.4 ACCESSORIES

A. The tank construction company shall provide and install all appurtenances. Appurtenances shall include the following:
   1. Pipe Connections:
      a. Overflow piping shall be 6 inches nominal diameter schedule 10 carbon steel coated externally. A 90 degree internal weir elbow with external downcomer pipe and flap valve shall be provided for the overflow.
      b. Inlet and outlet connections shall conform to the sizes and locations specified on the plan sheets.
      c. Welded steel sump pit centered on drain pipe.
   2. Roof Vent:
      a. A properly sized vent assembly in accordance with AWWA D100 shall be furnished and installed above the maximum water level of sufficient capacity so that at maximum design rate of water fill or withdrawal, the resulting interior design pressure / vacuum will not exceed +2.0 / -0.5 ounces per square inch.
      b. The overflow pipe shall not be considered to be a tank vent.
      c. The vent shall be so designed in construction as to prevent the entrance of birds and/or animals by including a 4 mesh (1/4” opening size)

galvanized screen. If required by the contract drawings, a 16 mesh (1/16" opening size) galvanized screen will be installed to prevent the entrance of insects. However, if the tank is located in an area where heavy frost is common during the winter months an additional pressure / vacuum relief valve must also be provided.

3. Interior Ladder: The interior ladder shall be fabricated from fiberglass or aluminum with 316SS fasteners and a safety climbing device conforming to applicable OSHA standards.
4. Outside Tank Ladder: An outside tank ladder shall be furnished and installed. Safety cage and step-off platforms shall be fabricated of galvanized steel or coated with the exterior paint system. Ladders shall be equipped with a hinged lockable entry device.
5. Roof Hatch: The manufacturer shall furnish a roof opening which shall be placed near the outside tank ladder and which shall be provided with a hinged cover and a hasp for locking. The opening shall have a clear dimension of at least thirty (30) inches square. The opening shall have a curb, at least four (4) inches in height and the cover shall have a downward overlap of at least two (2) inches.
6. Roof Perimeter Guardrail: Perimeter guardrail and toeplate ten feet beyond any access points on the roof shall be provided and installed in accordance with OSHA
7. Access
   a. One manway shall be provided in accordance with AWWA D100.
   b. The manhole opening shall be a minimum of 24 inches in diameter. The access door (shell manhole) and the tank shell reinforcing shall comply with AWWA D100.
8. Liquid Level Indicator
   a. A liquid level indicator with stainless steel float, number board and high visibility target shall be provided and installed.
9. Identification Plate
   a. Manufacturer's nameplate shall list the tank serial number, tank diameter and height, and maximum design capacity. The nameplate shall be affixed to the tank exterior sidewall location approximately five (5) feet from the grade elevation.

PART 3 EXECUTION

3.1 SAFETY

A. Tank contractor shall conform to all Local & Federal Safety rules & regulations.

3.2 SITE PREPARATION

A. Clearing and Grubbing: All trees, shrubs and other vegetation in the tank area and temporary work areas designated for construction shall be removed as follows:
   1. All trees and vegetation will be disposed of offsite in an approved landfill.
   2. All approved topsoil deemed suitable by the Engineer for finish grading may be stockpiled on the site as directed by the Engineer.

B. Field Examination: The tank fabricator shall field verify the foundation elevation and the tolerances of the in-place foundation. Any deviations shall be reported to the Engineer for correction before proceeding with any work. All tank piping must be in place prior to the

commencement of tank erection.

C. Excavation:
   1. The site shall be excavated to an elevation and width as necessary to provide adequate work room for tank construction. All trees, shrubs, brush, stumps, roots, and other unsuitable material shall be removed to a minimum distance of 12 feet outside the edge of the tank foundation, plus additional areas necessary for the tank construction. The working area surface shall be at an elevation of 12" below the top of foundation.
   2. The tank site shall be dewatered when required. The dewatering method shall prevent disturbance of the foundations soils.

D. Subgrade Preparation
   1. See attached Geotechnical Report and addendum letter. The steel tank shall have a ring wall foundation and a steel tank bottom. Over-excavation of at least one foot below the bottom of the footing and replacement with properly compacted CDOT Class 1 Structure Fill to provide a uniform bearing surface material.
   2. Subgrade material which is disturbed or over excavated during the preparation of the site or loose foundation material shall be removed and replaced with compacted select fill.
   3. After the excavation is complete, the site shall be proof rolled in the presence of the Owner's geotechnical professional prior to placement of any compacted select fill to determine the suitability of the subgrade for the tank foundation. Select fill shall consist of a clean, well graded angular or subangular material as directed by the Owner's geotechnical professional.

E. Granular Subbase
   1. A minimum 6-inch thick layer of a granular leveling base shall be placed beneath the tank foundation prior to construction of the tank floor. The leveling base material shall be a clean, densely-graded crushed stone material with a balanced fine content to produce an easily constructed, low friction surface meeting the requirements of ASTM C33 with 100% of the material passing the 1" US Sieve size and not more than 8% passing the #200 Sieve size.
   2. The leveling base material shall be fine graded to produce a subgrade elevation that is within a tolerance of +0", - ½" over the entire tank subgrade.
   3. Compaction shall be by capable vibratory roller with a minimum of two passes in each direction.
   4. Tank designer to determine if "oiled sand" layer below the tank bottom is required.

3.3 INSTALLATION

A. Tank Erection
   1. The contractor shall furnish all labor, tools, scaffolding, and other equipment necessary to properly erect the tank complete and ready for use.
   2. Erection shall be completed in compliance with Section 10 of AWWA D100 for welded steel tanks.

B. Concrete: All concrete shall be placed and cured as required to meet applicable ACI standards and the following requirements:
   1. Curing shall be by membrane-forming curing compound, by covering exposed surfaces with polyethylene sheets, or by water curing.
   2. Environmental Requirements: The following shall be required when placing concrete:
      a. Cold Weather: Concrete shall not be placed without special protection when the ambient temperature drops below 35 degrees Fahrenheit and the concrete is likely to be subjected to freezing temperatures before the initial set has occurred and the concrete strength has reached 500 psi. Concrete shall be protected in accordance with ACI 306R. The temperature of the concrete shall be maintained in accordance with the requirements of ACI 301 and ACI 306R.
      b. Hot Weather: In periods of high ambient temperature, low relative humidity, and high wind, concrete shall be placed in accordance with the requirements of ACI 305R.

C. Coating Applications:
   1. Clean all concrete surfaces to be coated to remove dust, laitance, efflorescence or other foreign matter.
   2. Repair any surface defects prior to the application of coatings with materials which are compatible with the coating. Repair materials shall provide a consistent finish with the exterior finish of the tank surfaces and shall be applied in accordance with the recommendations of the manufacturer.
   3. Apply coatings in accordance with the recommendations of the manufacturer.

3.4 FIELD QUALITY CONTROL TESTING

A. After the erection of the reservoir is completed and before it is painted, it shall be tested for leaks. Any leaks that are disclosed in the shell bottom, roof, manhole, or piping shall be repaired prior to painting.

B. Inspection and testing shall be in accordance with Section 11 of AWWA D100, latest revision.

C. All defective welds shall be removed and repaired in accordance with Section 11 of AWWA D100, latest revision.

D. Make available all radiographs and other testing information to the Owner's representative during construction.

E. After completion of the work, the Contractor shall submit a written report and certification that all work has been inspected and tested and is in accordance with all applicable provisions of AWWA D100, latest revision.

F. All costs associated with testing shall be paid by the Contractor.

G. All concrete used in the construction of the tank shall be tested in accordance with the following requirements by an independent testing laboratory at the tank construction company's expense:
   1. Concrete: Concrete shall be tested in accordance with ASTM C31 and C39 by an independent testing laboratory. A minimum of one set of 6 cylinders for each 50 cubic yards shall be taken as follows:
      a. Comply with field quality control and concrete field test procedures in Section 03300 cast-in-place concrete.
      b. Slump and Air: Slump and air content shall be tested once for each 50 cubic yards of material placed.

H. Quality Program: See Section 01400. The tank contractor shall employ, within its normal construction practices, a first-time quality control program which includes but is not limited to:
   1. Written quality control program.
   2. Inspection checklists which ensure the quality of construction practices, materials, and equipment.
   3. Detailed inspection reports with critical hold points
   4. Detailed procedures for the control of any identified deficiencies during construction.
   5. Retention of quality control measures through a cloud-based database.

3.5 CLEANUP

A. Tank Interior: Remove all construction debris and thoroughly clean interior floor and wall surfaces, and piping, using a low-pressure wash.

B. Exterior Site: Remove and dispose of all construction debris, materials and equipment prior to leaving site. Dispose of all construction waste in an approved landfill.

3.6 WATERTIGHTNESS TESTING

A. Upon completion of the tank, it shall be filled to overflowing with water furnished to the tank by the Owner. The tank shall remain filled for a period of at least 24 hours to allow for absorption and initial settlement.

B. Measure the drop in liquid level over the next 72 hours. The net drop in liquid level shall not exceed the maximum allowable of 0.05 of 1 percent per 24-hour period.

C. If the net drop in liquid level exceeds the maximum allowable, the liquid level test shall be extended to a total of 5 days. If at the end of 5 days, the average net drop in liquid level does not exceed the maximum allowable, the test shall be considered satisfactory. If the net liquid loss exceeds the maximum allowable, the test shall be considered unsuccessful, the source of leakage shall be corrected, and the tank shall be retested.

D. Damp spots on the exterior wall surface shall not be permitted. Damp spots are defined as spots where moisture can be picked up on a dry hand. The source of water movement through the wall shall be located and permanently sealed in an acceptable manner. No

leakage that includes visible flow through the wall-floor joint shall be permitted. Damp spots on the footing are permissible.

E. Water for the initial watertightness test shall be furnished to the tank by the Owner. Water for any subsequent tests which are required will be at the expense of the tank contractor.

3.7 TANK BACKFILL

A. Backfill shall not be placed against steel tank walls.
B. See Geotechnical Report.

END OF SECTION

SECTION 15060

PIPE AND PIPE FITTINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping complete with all fittings, jointing materials, expansion joints, hangers, supports anchors and necessary appurtenances for interior installations:
   1. Potable water tank inlet and outlet
   2. Potable water storage tank drain and overflow

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

B. Section 02616 – Site Piping

C. Section 02510 – Water Distribution System

D. Section 03300 – Cast-In-Place Concrete

E. Section 03610 – Non-Shrink Grout

F. Section 09900 – Coatings

1.3 REFERENCES

A. American National Standards Institute (ANSI)
   1. B1.1 – Unified Inch Screw Threads
   2. B16.1/B16.5 – Pipe Flanges and Fittings Package
   3. B16.24 – Cast Copper Alloy Pipe Flanges and Flanges Fittings
   4. B16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes
   5. B18.2 – Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
   6. B31.1/B31.3 – Power and Process Piping Package

B. American Society of Mechanical Engineers (ASME)
   1. B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings
   2. B16.22 – Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
   3. B16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes

C. American Society of Testing and Materials (ASTM)
   1. A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   2. A134 – Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
   3. A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe

4. A139 – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
5. A181 – Standard Specification for Carbon Steel Forgings for General-Purpose Piping
6. A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
7. A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
8. A234 – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
9. A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
10. A283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
11. A307 – Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
12. A312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
13. A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
14. A774 – Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fitting for General Corrosive Service at Low and Moderate Temperatures
15. A778 – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
16. A795 – Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
17. B32 – Standard Specification for Solder Metal
18. B75 – Standard Specification for Seamless Copper Tube
19. B88 – Standard Specification for Seamless Copper Water Tube
20. D1785 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
21. D2464 – Standard Specification for Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
22. D2466 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
23. D2467 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
24. D2996 – Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
25. D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR.) Based on Controlled Outside Diameter
26. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
27. D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
28. D3350 – Standard Specification for Polyethylene Plastics Pipe and Fitting Materials
29. F104 – Standard Classification System for Nonmetallic Gasket Materials
30. F412 – Standard Terminology Relating to Plastic Piping Systems
31. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

32. F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
33. F2164 – Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure

D. American Water Works Association (AWWA)
1. C110 – American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-Inch through 48-Inch, for Water
2. C111 – Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
3. C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
4. C150 – American National Standard for Thickness Design of Ductile-Iron Pipe
5. C151 – Standard for Ductile Iron Pipe, Centrifugally Cast, for Water
6. C153 – Standard for Ductile-Iron Compact Fittings
7. C200 – Standard for Steel Water Pipe 6 Inch and Larger
8. C203 – Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied
9. C206 – Standard for Field Welding of Steel Water Pipe
10. C207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 Inch Through 144 Inch
11. C209 – Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
12. C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe
13. C220 – Standard for Stainless Steel Pipe ½ Inch and Larger
14. C606 – Standard for Grooved and Shouldered Joints
15. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inch through 12 Inch, for Water Transmission and Distribution
16. C901 – Standard for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. through 3 In., for Water Service
17. C906 – Polyethylene (PE) Pressure Pipe and Fittings 4 Inch Through 63 Inch, for Water Distribution and Transmission
18. C907 – Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inch through 12 Inch, for Water, Wastewater, and Reclaimed Water Service
19. C950 – Standard for Fiberglass Pressure Pipe
20. M11 – Steel Pipe: A Guide for Design and Installation
21. M23 – PVC Pipe Design and Installation
22. M41 – Ductile-Iron Pipe and Fittings
23. M45 – Fiberglass Pipe Design

E. National Science Foundation (NSF)
1. 61 – Drinking Water System Components – Health Effects

F. International Plumbing Code (IPC)

G. Copper Development Association Inc. (CDA)
1. Copper Tube Handbook

H. Society for Protective Coatings (SSPC)

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Shop Drawings:
   1. Provide piping layout fabrication and assembly drawings with fittings dimensions. Provide sufficient information to verify compliance with specification including, but not limited to, the following:
      a. Layout of pipe drawings
      b. Pipe and joint details
      c. Specials, fittings, and coupling details
      d. Specification data sheets
      e. Certificates of compliance with applicable standard and specification and testing certificates
      f. For steel pipe show weld locations and installation of pipe, fittings, specials and connections
         i) Complete data of materials proposed
         ii) Do not manufacture until approved
         iii) Show where each numbered pipe fitting or special is to be installed
         iv) Numbers correspond to those painted on pipe
   2. Provide additional detailed information including elevations, fittings, specialty materials or fabrications for special or custom features, structures, junctions and/or pipes
   3. Specifications, data sheets and affidavits of compliance for coatings and linings
   4. Provide pipe-laying and installation schedule

C. Product Data: Provide sufficient data on features, pipe, joints, gasket material, lubricant and accessories to verify compliance with specifications

D. Manufacturers Certificate and affidavits:
   1. Furnish the following prior to fabrication
      a. Details: Pipe, joint, special, fitting and coupling
      b. Shop coating
      c. Shop coatings and linings: specifications, data sheets, and compliance affidavits
   2. Furnish the following prior to shipment
      a. Compliance affidavit for applicable standards
      b. Test certificates

E. Test Reports: Submit all shop and field test reports in accordance with Division 1 Specifications as Product Data

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 Specifications

B. Accurately record actual locations of piping, valves, connections, centerline of pressure pipe elevations, and top of gravity pipe elevations

C. Identify and describe unexpected variations to building conditions or discovery of unknown utilities

1.6 REGULATORY REQUIREMENTS

A. In accordance with all local City of Grand Junction codes and ordinances, laws and regulations of the State

B. In case of apparent conflict, State and local requirements govern over these specifications

C. In absence of State and local regulations, International Plumbing Code applies

1.7 DELIVERY, STORAGE AND HANDLING

A. For steel pipe with coal tar enamel or hot applied tape: comply with AWWA C203
   1. Handling and Storage:
      a. Use wide canvas slings and wide padded skids.
      b. Do not use bare cables, chains, hooks, metal bars, or narrow skids
      c. Do not store directly on ground, provide proper blocking
      d. Do not roll on enameled or taped surface
      e. Do not expose enameled pipe to temperature below 0 Degrees F
      f. Do not handle enameled pipe below 10 Degrees F
   2. Shipment
      a. Ship steel pipe supported on padded saddles not less than 12-inches wide, securely fasten load to prevent movement in transit. For pipes coated with fusion bonded epoxy use nylon straps
      b. Laterally support ends of pipe, fittings, special, to maintain shape during shipment
      c. Separate materials during shipment to prevent materials bearing against each other
   3. Delivery
      a. Products with dents, kinks, abrupt changes of curvature or other damages shall be rejected upon delivery
      b. Products dropped from truck or crane shall be rejected
      c. Rejected items shall be replaced or reconditioned at the expense of the contractor. Reconditioning shall only be permitted at approval of Engineer and with replacement coatings as originally specified on the reconditioned pipe

B. For all other pipe
   1. Deliver, store, protect and handle products to site under provisions of Division 1 Specifications
   2. Delivery
      a. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct sunlight
   3. Storage
      a. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: direct sunlight, mud, etc.
      b. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months

c. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
d. Do not stack pipe higher than 5 feet

4. Storage: Use the following precautions for valves, during storage:
   a. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      i) Protect valves from weather by storing indoors or support valves off ground and pavement in watertight enclosures when outdoor storage is necessary
5. Handling
   a. Handle so as to insure installation in sound undamaged condition
   b. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection
   c. Use hooks or straps with broad, well padded contact surfaces for lifting sections of pipe
6. Preparation for Transport:
   a. Prepare valves, for shipping as follows:
      i) Ensure that valves and pilotry are drained and dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends, flange faces, and weld ends. Set valves in best position for handling. Set valves closed to prevent rattling
7. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C500/C504/C509
8. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation
9. Seal pipe and fittings to prevent entry of foreign materials into pipe and fittings
10. During loading, transporting and unloading, exercise care to prevent damage to material
    a. Use nylon slings only
    b. Do not drop pipe or fittings
    c. Do not roll or skid against pipe already on ground
    d. Repair any damage done to coating or lining
    e. Handle per manufacturer's recommendations
    f. Store rubber gaskets in cool dark location
    g. Store all material on wood pallets or timbers
11. Adequately tag or otherwise mark all piping and fittings as to size

PART 2 PROCESS PIPING PRODUCTS

2.1 STEEL PIPE – 6-INCHES AND LARGER

A. Pipe: AWWA C200
   1. Fabricated or mill type
      a. ASTM A53 Type E or S, Grade B
      b. Or ASTM A134 made from:

i) Steel plate: ASTM A283, Grade C, with maximum carbon content of 0.30 percent and maximum manganese content of 1.2 percent, or ASTM A570, Grade 30

c. Or ASTM A139, Grade B

d. Or ASTM A135, Grade B

2. Wall thickness: 1/4 inch minimum continuous spiral seam welded on inside and outside of pipe
3. Specified pipe size:
   a. 12-inches or smaller, nominal inside diameter
4. Stab joint pipe specified diameter, nominal diameter
5. Reinforce or increase shell thickness of pipe, fittings and specials to maintain combined stress due to internal pressure and bending below 20,000 psi
6. Shop testing per AWWA C200
7. For pipe with mechanical couplings, the space between pipe ends shall be at least 1/2 inch, but not greater than the manufacturer's recommendations

B. Fittings and Specials: fabricated or wrought seamless
   1. AWWA C200 or ASTM A234, Grade A (WPA), unless otherwise required
      a. Steel plate: Same as for pipe specified above
   2. Wrought seamless: short or long radius, Contractor's option

C. End of Sections
   1. Field butt welding: outside be beveled to 37-1/2 degrees $\pm$ 1/32 inch
   2. Welded bell and spigot: AWWA C200
   3. For fitting with slip on flanges: AWWA C200
      a. Slip-on flanges may be used in lieu of weld neck flanges shown on Drawings, except on short radius fittings
   4. For mechanical couplings, plain end types per AWWA C200 shall be used
      a. Welds shall be ground flush on ends without pipe stops to permit slipping the coupling in at least one direction to clear pipe joint
      b. The outside diameter and out-of-round tolerances shall be within the limits of the coupling manufacturer
   5. For victaulic couplings, shall be grooved or collared type, per size and thickness of pipe, fitting, or special and maximum working pressure consistent with manufacturer's recommendations
      a. Grooving dimensions shall conform to rigid/standard grooving dimensions

D. Flanged Joints
   1. Shall be flanged where indicated on Drawings and in accordance with ANSI B16.1 /B16.5
      a. Flanges: Slip-on or welding neck, except where otherwise indicated
         i) Material: ASTM A181, Grade 1 or ASTM A283, Grade B or C
         ii) Dimensions and drilling: AWWA C207, Class D, Table 1 or 2
            a) Coordinate flange dimensiosn and drillings among piping, valves, and equipment
         iii) Bore weld neck flange to ID of pipe
         iv) Faces shall be finished to a plane surface within a maximum tolerance of 0.010 inch

v) Diameter shall have a maximum tolerance of 0.005 inch/foot for flange faces from the normal with respect to axis of pipe
vi) Flanges shall be tested for true plane after welding, reface if necessary
vii) Flange dimensions and drillings shall be coordinated between piping, valves and equipment

b. Blind Flanges
i) Conform in diameter, drilling and thickness with flanges where they attach
ii) Shall be reinforced as required

c. Flange bolting
i) Material: ASTM A307
ii) Type: Bolt and nut, bolt-stud and 2 nuts permitted for 1 inch and larger
iii) Bolts and bolt-studs
a) Length: Ends project ¼ inch to ½ inch beyond nuts
b) Ends: Chamfered or rounded
c) Threading: ANSI B1.1, coarse thread series, Class 2A fit. Bolt studs may be threaded full length. Studs for tapped holes threaded to match holes
iv) Bolt heads
a) Shape: Hexagonal or square
b) Dimensions: ANSI B18.2 heavy pattern for hexagonal, regular pattern for square
v) Nuts
a) Dimensions: ANSI B18.2 heavy, semi-finished pattern
b) Threading: ANSI B1.1 coarse thread series, Class 1B fit

E. Shop Welded Joints
1. Provided joints shall be water tight and sound and free from embedded scale and slag
2. Tensile strength across the weld shall not be less than that of the thinner of connected sections
3. Yield point of the welded joint shall be tested by independent laboratory at contractor's expense
4. Butt welds shall be used for all welded joints in line pipe assemblies and in fabrication of fittings and other specials
5. For slip-on flange attachments, fillet welds shall be used per AWWA C207
6. Back-up welding strips or rings shall not be allowed for shop welds

F. Coupled Joints
1. Mechanical couplings
a. Provide couplings with a middle ring length not less than 7-inches
b. Where couplings are used for closures or where union connections are required omit pipestop from inner surface of middle rings
c. Couplings shall be cleaned and shop primed with manufacturer's standard rust inhibitive primer. Couplings shall be coated with an NSF61 epoxy, fusion bonded, or powder coated.
d. Insulating
i) Dresser “Style 39”
ii) Rockwell “416”
iii) Romac IC501
iv) Smith-Blair

v) Or accepted substitution

e. Reducing
   i) Dresser “Style 62”
   ii) Rockwell “415”
   iii) Romac
   iv) Smith-Blair
   v) Or accepted substitution

f. Transition coupling
   i) Dresser “62”
   ii) Rockwell “413”
   iii) Romac
   iv) Smith-Blair
   v) Or accepted substitution

g. Others
   i) Dresser “Style 38”
   ii) Rockwell “411 Flexible Coupling”
   iii) Romac
   iv) Smith-Blair
   v) Or accepted substitution

2. Joint harness
   a. Bolts: ASTM A193, Grade B7, or Ryerson Stress-Proof, minimum yield point 100,000 psi
      i) Provide two (2), double nut bolts per harness
      ii) Design bolts based on 40,000 psi maximum stress at hydrostatic test pressure after installation
      iii) Threading: ANSI B1.1, Class 2A fit, coarse thread series for 1 inch and smaller and 8 thread series for 1-1/8 inch and larger
      iv) Ends: Chamfered or rounded
   b. Nuts: Hexagonal ASTM A194, Grade 2H or better
      i) Threading: As specified for bolts except Class 2B fit
      ii) Dimensions: ANSI B18.2 heavy, semi-finished pattern
   c. Washers: Hardened steel, ASTM A325
   d. Provide joint harnesses as indicated on the Drawings per Figure 13-17 of AWWA M11
   e. All lugs shall be shop welded to pipe, except where Drawings require a sleeve welded to the pipe and lugs welded to the sleeve
   f. Provide for coupling to be slipped clear of joint in at least one direction by placing harness lugs and bolts of sufficient length
      i) ” as required
      ii) Or accepted substitution

G. Gaskets
   1. Ring type, 1/8-inch rubber per AWWA C200
   2. Gasket compound
      a. Garlock “Compound No. 1”
      b. Titeseal T25
      c. Or accepted substitution

3. Rubber gaskets for bell and spigot pipe: Continuous O-ring, AWWA C200, except minimum tensile strength of 2100 psi and basic polymer of neoprene or other synthetic rubber. Do not use natural rubber.

H. Coatings
1. See Section 09900

2.2 DUCTILE IRON PIPE

A. Ductile Iron Process Piping: The following piping shall be ductile iron pipe as indicated on Drawings and provided for locations specified herein:
1. Drain and Overflow piping, as indicated on Drawings

B. Pipe:
1. AWWA C150 and C151: As listed below except as otherwise specified or indicated on Drawings.
a. Where fitted with push-on joints, mechanical joints or mechanical joints with joint restraint device, or restrained joints: Class 50
b. Where fitted with flanged, grooved or restrained joints: Class 53
c. 4-Inch to 12-Inch: Class 350
d. Thickness (minimum) for screw-on flanges shall be in accordance with AWWA C115
e. Pipe with grooved or shouldered joints for any restrained joint shall have wall thickness increased to provide the minimum wall thickness in accordance with AWWA C606

C. Fittings
1. Ductile iron: ANSI A21.10/AWWA C110, ASTM A536, Grade 80-60-03 or 70-50-05
a. 24-inch and below: 350 psi rating, mechanical joint or flanged
2. Ductile iron compact fittings: ANSI A21.53/AWWA C153
a. 16-inch and below: 350 psi rating, mechanical joint or flanged
3. Ductile iron grooved fittings: ANSI/AWWA C606, AWWA Fittings, conform to AWWA C110 for center-to-center dimensions and AWWA C153 for wall thickness,
a. 12-inch and below: 350 psi rating, grooved joint
4. Tapping Sleeve and Tapping Valve
a. Complete assembly, including tapping sleeve, tapping valve, and bolts and nuts. Use sleeve and valve compatible with tapping machine
b. Tapping Sleeve: Cast-iron or ductile-iron 2-piece bolted sleeve with flanged outlet for new branch connection. Sleeve may have mechanical joint ends with rubber gaskets or sealing rings in sleeve body. Use sleeves that mate with size and type of pipe material being tapped. Outlet flange shall be of a size required for branch connection
5. Provide all specials, taps, flanges, plugs and wall fittings as required
6. Provide openings for air valve, drain, sampling, testing, sensing and all other connections with threaded bosses sized and located as indicated and specified
a. Threaded connections:

i) Shall be in accordance with ANSI B2.1.NPT: provide boss or tapping saddle at all tapped connections

D. Joints
1. All joints shall be of restrained type unless otherwise indicated on Drawings
2. Mechanical and push-on joints
   a. Mechanical joints: ANSI A21.11/AWWA C111
      i) Bolts and nuts: High strength, low alloy steel, in accordance with ASTM A307 or accepted substitution
   b. Push-on joints: ANSI A21.11/AWWA C111, except gaskets shall be neoprene or other synthetic rubber. Natural rubber in not acceptable.Gaskets for air piping to be high temperature EPDM (Ethylene Propylenediene Monomer).
      i) Lubricant: Heavy vegetable soap solution suitable for potable water contact
      ii) Pressure rated 350 psi
3. Mechanical joints with tie rods
   a. Tie rods: ASTM A307, galvanized entire length
   b. Steel pipe spacers: ASTM A120, standard weight galvanized
   c. Washers: ANSI A27.2 plain steel, galvanized
4. Flanged joints
   a. Flanged joints shall be provided for all interior and exposed exterior pipe unless otherwise indicated or specified
   b. Flanges
      i) General use: ANSI A21.15/AWWA C115 and ANSI B16.1, Class 125
      ii) Where Class 250 indicated on Drawings or specified: ANSI B16.1, Class 250, flat faced
      iii) Effluent piping with ANSI Class 125 flanges rated for 250 psi
   c. Pipe with Victaulic-style couplings and rigid joints conforming to AWWA C606 may be substituted for Class 125 flanged pipe
   d. Hardware
      i) For locations within the tank
         a) Stainless steel, Type 316
      ii) All other locations
         a) Hot dipped zinc galvanized steel conforming to ASTM A307, grade B (Class B & D flanges), grade B7 (Class E & F flanges)
         b) Heads and dimensions per ANSI B1.1
         c) For mechanical couplings furnish ASTM A183 or A194 bolts and nuts
         d) Provide two nuts for one-inch diameter and larger bolt applications
5. Mechanical couplings:
   a. Dresser “Style 38”
   b. Rockwell “411”
   c. Or accepted substitution
6. Flanged coupling adapters 12 inch and under:
   a. Rockwell “Type 912”
   b. Dresser “Style 127”
   c. Or accepted substitution
7. Tapping saddles:
   a. Ductile iron with double stainless steel straps and rubber sealing gasket, 250 psi pressure rating

8. Wall castings: Mechanical and/or flanged joints, integral weep ring, sufficient space for bolting of connection piping to joint minimum 6 inches from embedded wall or with tapped holes for follower bolts and plastic plugs to prevent holes from filling with concrete

E. Dismantling Couplings/Joints:
   1. Consists of a mechanical joint fitting located between two pipe flanges with restraining rods across the mechanical joint section, providing a restrained system with integral space for removal of adjacent equipment
   2. Shall conform to AWWA C219
   3. Materials shall be steel.
   4. When connected to DIP system, install insulating flange kit

F. Fabrication
   1. Joints
      a. Except as indicated on Drawings
         i) Bells in wall pipe or casting: Mechanical with tapped holes for follower bolts or extended minimum 6 inches beyond wall
         ii) Exposed: Flanged or grooved
      b. 12 inch and smaller branch outlets where main line is at least twice the diameter of the branch, tee or a tapping saddle is acceptable
      c. Tie rods may be required as indicated on Drawings
      d. Mark the centerline of each flange and mechanical joint piece
      e. Screw flanges onto screwed-on flanged pipe so that pipe extends completely through and flush with the flange
      f. Finish machine pipe ends and flange faces flat and perpendicular to pipe centerline in a single operation
   2. Shop coating and lining
      a. See Section 09900

PART 3 EXECUTION

3.1 INSTALLATION

A. Install as specified and indicated on Drawings

B. Remove dirt, rocks, debris, and other foreign materials from all pipelines

C. Keep interior of pipe and fittings thoroughly clean before installation and until work is accepted

D. Take precautions to prevent entrance of foreign material during jointing, lining repair, and inspection operation

E. Seal open end of line with watertight plug if pipe laying stopped

F. Provide and install sufficient copper tubing to run instrument air to all pneumatic actuators

G. Provide a shutoff valve and union at the water and air supply connections to each fixture and unit of equipment, whether shown on the Drawings or not

H. Provide a union within 2 feet of each threaded end valve unless other means for easy removal of the valve are available

I. Provide unions where required for equipment removal, indicated on the Drawing or specified

J. Do not install piping to obstruct openings and passageways

K. Cut pipe to measurement taken at the site, not from the Drawings

L. Layout piping to provide for expansion and contraction

M. Provide taps for pressure gauge connections with a nipple, snubber, and gauge cock

N. Securely anchor piping at the midpoints between expansion joints

O. Provide air supply piping with sectionalizing valves and valved air inlet connections to isolate portions of system for periodic testing

P. Grade all air piping to points of drainage; provide driplegs on drain valves at drainage points

Q. Uniformly grade all piping serving metering equipment and provide complete venting to eliminate air traps

R. Pipe stuffing box leakage from water sealed pumps to nearest point of drainage

S. Provide insulating fittings and dielectric isolation in all piping except air and gas piping wherever copper tubing or fittings are connected to iron or steel pipe or fittings

3.2 CONNECTION TO EXISTING PIPELINES

A. Make connections between new and existing piping with suitable fittings

B. Schedule connection to minimize inconvenience to the Owner

C. Undertake connections in order to disturb the system as little as possible

D. Where connection involves potable water systems, provide disinfection methods as prescribed in these Specifications

E. Once tie in to existing system is initiated, continue Work continuously until tie-in is made and tested

3.3 STEEL PIPE

A. Flanged joints

1. During bolting avoid restraint on opposite end on opposite end that would prevent uniform pressure application on gasket
2. Pipe or fitting shall be free to move in any direction while bolting
3. Tighten bolts gradually, in turn, at uniform rate
4. Stresses shall not be transmitted during installation to equipment flanges by connecting pipe
5. Equipment shall be permanently supported to pipe to obtain accurate matching of bolt holes and uniform contact over surface of flange, before installing bolts
6. While bolts are tightened equipment connection piping shall be free to move longitudinally
7. To fit connecting pipe, level, align and wedge equipment into position
8. Equipment shall not be grouted until connecting piping is properly aligned
9. Equipment connections shall be tested by loosing flange bolts. No movement of piping relative to equipment or opening of equipment connection joints shall occur when flange bolts are loosened

B. Field welded joints:
1. Install per AWWA C206
2. Test specimens shall be furnished as requested by Engineer

C. Couplings
1. Prior to installation, remove dirt or foreign material from pipe ends and couplings.
2. Gaskets shall be kept clean during installation
3. Only use wrenches which have been recommended by coupling manufacturer
4. All bolts shall be tightened the same amount with parts square and symmetrical
5. Installed couplings shall be re-primed or touched up after installation

D. Anchorage shall be provided in exposed locations and where subject to internal pressure block, anchor or harness piping with mechanically coupled, push-on or similar joints to prevent separation of joints

E. Miter cutting
1. By cutting one end: up to 4-1/2 degrees
2. By cutting two adjacent ends: up to 22-1/2 degrees
3. Fabricated bends: greater than 22-1/2 degrees

3.4 JOINTS

A. Make pipe joints carefully and neatly

B. Connect piping in accordance with manufacturer recommendations

C. Threaded
1. ANSI B2.1, NPT fully and cleanly cut with sharp dies
2. No more than 3 threads exposed after installation
3. Ream pipe ends after threading to remove burrs
4. Apply Teflon thread tape to joints in all plastic and stainless steel piping
5. Apply thread tape or joint compound to joints in other piping

6. Apply Teflon thread tape or litharage and glycerine paste to joints on steel piping for chlorine service

D. Compression
   1. Cut pipe ends squarely, remove burrs
   2. Clean contact surfaces with steel wool

E. Flared
   1. Cut tubing ends squarely, remove burrs
   2. Scratches or grooves in flared ends are not allowed

F. Soldered and brazed
   1. Braze joints in 2 inch or larger copper tubing
   2. Solder or braze lines smaller than 2 inch where solder fittings are specified
   3. Thoroughly clean joint surfaces with flint paper and coat with thin film of flux
   4. Install tubing to full depth of socket
   5. Do not overheat metal or flux
   6. Uniformly heat joint to melt filler metal on contact
   7. Remove surplus filler metal and flux while joint is still hot

G. Solvent welded
   1. Cut PVC pipe ends square and smooth, wipe clean
   2. Remove all burrs and filings
   3. Using a small brush, apply cement primer to the outside of pipe and the inside of the fitting socket
   4. Using a small brush, apply solvent cement to outside of pipe and inside of the fitting socket
      a. Solvent cement to be specifically rated for use with chlorine or hypochlorite solutions for piping and fittings that will be used to convey these solutions
   5. To ensure uniform cement distribution, push the coated surface snugly together and rotate approximately 1/2 turn
   6. Remove excess cement by wiping

H. Grooved couplings
   1. Cut grooves with grooving tool
   2. Groove to rigid grooving dimensions
   3. Groove cleanly and sharply without burrs or check marks
   4. Form rounded bottom "radius grooves" in plastic piping

I. Welded: ANSI B31.1, and per applicable Standards for pressure piping

J. Push on
   1. Per recommendations of pipe manufacturer
   2. Bevel each spigot end to facilitate assembly
   3. Lubricate with a heavy vegetable soap solution immediately before joint is completed
   4. Store lubricant in closed containers, keep clean, suitable for use in potable water contact

K. Mechanical Joints
   1. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble

2. Do not over tighten bolts to compensate for poor installation
3. Carefully align holes in mechanical joints with restraint device to permit installation of the harness bolts
4. Install flange and mechanical joint pieces so the four mechanical joint holes, as well as the flange holes, straddle the top centerline for horizontal piping, or the side centerline for vertical piping

L. Flanged joints
1. Take care when bolting flanges to insure that there is no restraint on the opposite end of the pipe which would prevent gasket compression or cause unnecessary stress in flanges
2. Leave one flange free to move in any direction while tightening flange bolts
3. Do not pack or assemble bell and spigot joints until all flanges affected thereby have been tightened
4. Tighten bolts gradually at a uniform rate to compress gaskets uniformly

3.5 PIPE SLEEVES

A. Provide for pipes passing through concrete or masonry

B. Install before concrete is placed

C. Through ceramic or vinyl-tile floors, install sleeves flush with finished floor and provide nickel or chromium plated floor plates

D. Where passing through all other floors, install so the sleeve projects between 1 and 2 inches above the floor

E. Seal sleeves passing through slabs with 1 side against soil with a modular sealing element or a watertight pipe sleeve

F. If insulated, extend insulation through sleeves

G. For future pipe installation, provide sleeves and seal ends with plastic caps or plugs

H. For piping through interior walls and floors with special finish provide pipe sleeves or holes drilled with rotary drill

I. Make dust and gas tight through room walls and floor

J. Six inch or smaller; special dust-tight sleeves

K. Greater than 6 inches, seal with modular sealing elements or caulk with backer rod and seal both sides with non-sag silicone sealant
1. For pipe sleeves located in water bearing walls provide wall pipes or sleeves with dual modular sealing elements as shown on the Drawings

3.6 PROTECTIVE COATING

A. Paint exposed, threaded, or submerged galvanized steel piping with zinc-rich paint that have cut ends or are nicked or gouged

3.7 CLEANING

A. General
   1. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when erected
   2. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system
   3. Flush or blow all lines thoroughly before placing in service
   4. At completion of Work and prior to final acceptance, thoroughly clean Work installed under these specifications
      a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sand and dirt which may have accumulated by operation of system, from testing, of from other causes
      b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner

3.8 FIELD QUALITY CONTROL

A. General
   1. Utilize pressures, media, and pressure test durations as specified on Piping Schedules
   2. Isolate equipment which may be damaged by the specified pressure test conditions
   3. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge range. Notify Engineer 24 hours prior to each test
   4. Completely assemble and test new piping systems prior to connection to existing pipe systems
   5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance
   6. Provide all necessary equipment, materials, tools, appliances, devices, and perform all work required in connection with the tests and inspections
   7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination

B. Pipe leaks
   1. All joints and seams whether tested or not shall be watertight and airtight
   2. Inspect all exposed shop and field welded seams
   3. Leaks shall be clearly marked
   4. Welded joints (steel) shall be repaired by chipping out defective parts and rewelding. Welds shall not be hammered
   5. Leaks discovered by Owner within 2 years of final acceptance shall be repaired by the Contractor at no additional expense to the Owner

C. Test each line at the Contractor's expense in the presence and to the satisfaction of Engineer

D. General testing methods and criteria
   1. Types of pressure testing and inspection to be employed include hydrostatic pressure testing, cylinder water pumped compressed air or cylinder nitrogen testing, low pressure air testing and hydrostatic exfiltration/infiltration testing
   2. Air systems
      a. Utilize the following testing medium for air systems

Pipeline Size	Specified Test Pressure	Testing Medium
2 IN and smaller	Greater than 75 PSI	Water
Greater than 2 IN	3 PSI or less	Air or water
Greater than 2 IN	Greater than 3 PSI	Water

      b. The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include chlorine gas systems.
      c. The allowable leakage rate for systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, ensure air is at ambient temperature and specified test pressure
   3. Liquid systems
      a. The following liquid piping systems shall have zero allowable leakage at the specified test pressure throughout the specified duration of 2 hours: exposed piping and buried or exposed piping carrying liquid chemicals or water
      b. Hydrostatic pressure testing
         i) For exposed piping: Prepare each section for testing, using adequate bracing and protect system equipment susceptible to damage by test pressures. Do not paint or insulate exposed piping until successful performance of pressure test.

E. Dielectric Testing Methods and Criteria
   1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained
   2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition
   3. Check the integrity of each cad-welding connection using a light hammer blow at a 45 degree angle

3.9 DISINFECTION OF WATER PIPING SYSTEM

A. After favorable performance of pressure test and prior to final acceptance, thoroughly flush entire water piping system, including supply, source and any appurtenant devices and perform disinfection as prescribed

B. Flush and disinfect each segment of system in accordance with Section 02676

3.10 PIPING SCHEDULE

A. Install pipes as scheduled in the pipe schedule provided below

Description	Size (inches)	Material	Maximum Test Pressure (psi)
Tank Inlet Pipe	6	Steel	100
Tank Outlet Pipe	6	Steel	100
Tank Drain Pipe	8	DIP	15
Tank Overflow	8	DIP	15

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes basic electrical requirements for materials and methods applicable to electrical equipment specified under this section and other related sections.
   1. Conduit
   2. Boxes
   3. Duct Bank
   4. Wire and Cable
   5. Wiring Devices and Device Plates
   6. Maintenance Materials
   7. Grounding Materials

B. Related Sections:
   1. Section 01340 – Shop Drawings and Product Data
   2. Section 01500 – Construction Facilities and Temporary Controls
   3. Section 01730 – Operation & Maintenance Data
   4. Section 02300 – Earthwork
   5. Section 09900 – Coatings

1.2 REFERENCES

A. UL – All applicable standards

B. IEEE – All applicable standards

C. IPCEA – All applicable standards

D. NEMA – All applicable standards

E. ANSI/NFPA 70 – National Electrical Code

F. ANSI C2 – National Electrical Safety Code

G. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies

H. ANSI/NEMA OS 1 – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

I. ANSI/NEMA OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

J. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

1.3 SUBMITTALS

A. Information covering all material that is to be used on this project shall be submitted.

B. Each sheet of descriptive literature shall be clearly marked to identify the material or equipment for which it pertains.

C. Equipment on submitted sheets that is not for this project shall be crossed out.

D. As a minimum the following information shall be submitted:
   1. Equipment sheets shall identify what the equipment refers to by calling out the name of the equipment on the sheet.
   2. Schematics and connection diagrams for all electrical equipment shall be submitted.
   3. Submit all types of conduit and cables with manufacturer and sizes as well as all appurtenances.

1.4 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be designed, coordinated, and supplied by a qualified Electrical Contractor who is regularly engaged in the business of building electrical systems for water and wastewater projects. The Electrical Contractor shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.

B. Coordination
   1. The electrical equipment shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.
   2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
   3. The Contractor shall provide coordination with other contractors and supervision of installation as required during construction.
   4. Accurately record actual locations of conduit, duct banks, panels, and accessories.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable Building Code.

B. Electrical: Conform to latest version of NFPA 70.

C. Coordinate, obtain and pay for all permits, inspections and approvals of authority having jurisdiction.

D. Comply with local electrical codes in force or in the absence of local electrical code, the latest edition of the National Electrical Code, ANSI C1.

1.6 WARRANTY

A. The electrical contractor shall warrant the supplied equipment and labor for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment furnished under this Section shall be selected by the Contractor for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
   1. Conduit
      a. Minimum Size: 1 inch unless otherwise specified.
      b. Underground Installations:
         i) Use PVC conduit.
      c. Outdoor Locations, Above Grade:
         i) Use PVC Conduit.
      d. In Slab Above Grade:
         i) Use PVC conduit.
         ii) Maximum Size Conduit in Slab: 2-inch, 1-inch for conduits that cross over each other, or with structural engineer's approval.
         iii) Conduits shall not be spaced closer than 3 conduit widths on center.
         iv) Conduits shall not pass through a structural concrete beam without the structural engineer's approval.
      e. In or under slab on grade:
         i) Use PVC conduit.
      f. Wet and damp locations:
         i) Use PVC conduit.
      g. Dry locations:
         i) Use PVC conduit.
      h. Rigid Nonmetallic Conduit (PVC).
         i) PVC conduit shall be heavy wall, schedule 80, shall be UL labeled for aboveground and underground uses.
      i. Flexible connections
         i) Conduit: Moisture proof vinyl jacketed, liquid-tight, hot-dipped galvanized flexible steel and shall be UL labeled.
         ii) Connectors: Watertight, Appleton Type ST or STB, Crouse-Hinds Type LT or LTC, or equal.
   2. Outlet Boxes

a. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, Galvanized.
    i) Luminaries and equipment supporting boxes: rated for weight of equipment supported.
    ii) Concealed installations.
b. Nonmetallic outlet boxes: ANSI/NEMA OS 2.
c. Cast Boxes: NEMA FB 1, Type FD, Cast Ferroalloy.
    i) Provide gasketed cover by box manufacturer.
    ii) Provide threaded hubs.
    iii) Models VXF, GRFX as manufactured by Crouse-Hinds.
    iv) Models SEH, JBDX, with mounting lugs as manufactured by Appleton.

3. Pull and Junction
    a. Sheet Metal Boxes: NEMA OS 1, Galvanized Steel.
    b. Surface-Mounted Cast Metal Box: NEMA 250, Type 4 flat-flanged, surface-mounted junction box.
        i) Material: Galvanized cast iron Cast aluminum in corrosive areas.
        ii) Cover: Furnish with ground flange, neoprene gasket, and stainless-steel cover screws.
        iii) Model: WCB as manufactured by Crouse-Hinds.
    c. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting.
        i) Material: Galvanized cast iron.
        ii) Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
        iii) Cover Legend: ELECTRIC.
        iv) Model: WPD as manufactured by Crouse-Hinds.
    d. Surface-Mounted Fiberglass Boxes: NEMA 250, Type 4 flat-flanged, surface-mounted junction box.
        i) Optional sub-panel shall be marine grade aluminum.
4. Large Junction Boxes and Wiring Gutters
    a. Outdoors:
        i) Stainless steel or approved equal.
        ii) Weather-tight NEMA 4.
    b. Construction.
        i) Provide rigid handles for box covers larger than 9 sq. ft. or heavier than 25 lbs.
        ii) Provide split covers for covers larger than 12 sq. ft.
        iii) Aluminum boxes in concrete not allowed.
5. Seal Fittings
    a. Model ESU with Apelco sealing cement and fiber, as manufactured by Appleton.
    b. Model EZS with Chico X Fiber and Chico A compound as manufactured by Crouse-Hinds.
6. Deflection Fittings
    a. Locations:
        i) Underground conduit runs.
        ii) Runs between concrete sections subject to relative movement.
    b. Material:
        i) Ferroalloy hubs.

ii) Neoprene outer jacket.
iii) Stainless steel jacket clamps.
iv) Molded plastic inner sleeve.
v) Tinned copper braid grounding strap.

c. Model XD as Manufactured by Crouse-Hinds.

7. Expansion Fittings
   a. Locations:
      i) In long conduit runs, to permit linear movement caused by thermal expansion and contraction.
      ii) In long conduit runs to prevent conduit from buckling.
      iii) Indoors and outdoors, where conduit expansion occurs or where there is a wide temperature range.
      iv) At structural expansion joints.
   b. Material:
      i) End fittings: Ferroalloy.
      ii) Body: Steel conduit.
   c. Provide Bonding Strap When Used Outdoors.
   d. Model XJ, as Manufactured by Appleton and Crouse-Hinds.
8. Flexible Sealing Compound
   a. "Duxseal" as Manufactured by Johns-Manville.
   b. "Permagum" as Manufactured by In mount.
9. Coal Tar Epoxy Paint
10. Wire and Cable
    a. 600 Volt Power Cable
       i) General Use:
          a) Conductors: Single, copper, 12 AWG minimum.
          b) All conductors shall be stranded.
          c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
          d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
          e) Or as specified for service entrances.
       ii) Terminations
          a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap standard cable around screw type terminals
    b. Control circuits
       i) General Use:
          a) Conductors: Single, tinned copper, 14 AWG
          b) All conductors shall be stranded
          c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
       ii) Millivolt or Milliampere Instrumentation and Control.
          a) Conductors: 18 AWG stranded copper, 2 or 3 as required.
          b) Insulation: 15 mils, minimum, 90°C PVC.
          c) Shield: Mylar aluminum tape with 20 AWG copper drain wire, fully covering conductors.
          d) Jacket: 20 mils, minimum, 80°C PVC.
          e) Suitability: Wet or dry steel conduit.
       iii) Manufacturers: Belden "UL Instrumentation Cable – 1032A", Samuel Moore "Dekoron ICMX" No. 1852-686 and 1862-686, or equal.

iv) Arc-Proofing Tape: Irvington "77 Arc-Proofing Tape", Slipknot No. 50 or Slipknot No. 3, or approved equal.

11. Wiring Devices
    a. General:
        i) Industrial Specification grade.
        ii) White.
12. Device Plates
    a. General:
        i) Mounting hardware countersunk and finished to match plate.
        ii) Provide over-sized plates where standard plates do not cover wall opening.
        iii) Provide engraving as indicated on drawings.
    b. Indoors:
        i) Surface mounted devices: Galvanized or cadmium-plated steel.
        ii) Flush mounted devices in other finished areas: Phenolic plastic, white.
        iii) All other flush mounted devices: Type 302 stainless steel.
    c. Outdoors and Indoors when identified on Drawings as Weatherproof:
        i) Weatherproof with spring doors for receptacles and with provisions for padlocking switches on and off.
        ii) Provide an adaptor plate for flush mounted device plates, Crouse-Hinds FS031, or equal.
13. Grounding and Bonding
    a. Provide rod electrodes, exothermic connections and mechanical connections.
    b. Building perimeter ground cable shall be minimum of 4/0 AWG bare copper.
    c. Duct bank ground cable shall be minimum of 4/0 AWG bare copper.
    d. Other ground cable shall be as noted on the drawings.
14. Control Stations.
    a. Enclosures:
        i) Indoors: NEMA 4X.
        ii) Outdoors: NEMA 4X
    b. Pilot Devices:
        i) Refer to specification section 16900.
    c. Nameplates:
        i) Pilot devices: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
        ii) Control station: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
    d. Ratings:
        i) Maximum let through voltage shall be:

Mode	120/208	277/480
L-N or L-G	400V	800V
L-L	800V	1800V

        ii) Minimum total surge current capability:

Location	Per Phase	Per Mode
Switchgear	250 KA	125KA
MCC	160KA	80KA
Panelboards	120KA	60KA

2.2 SPARE PARTS

A. The Supplier shall furnish and deliver the following spare parts.

B. The following spare parts to be furnished as a minimum:
   1. 25% replacement lamps for lighting fixtures.
   2. 25% replacement lamps for pilot light.
   3. Two (2) sets of each type of fuse used in the project.
   4. Two (2) spare ballast of each type specified.

C. All the above parts shall be provided as spare parts and shall be packaged new in the original manufacturer's packaging. A list of spare parts shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements
   1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

B. Inspection
   1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
      a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation
   1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
      a. Separate sheet metal junction boxes, equipment enclosures, sheet metal raceways, etc., mounted on water or earth-bearing walls or wall-mounted outdoors ¼" from wall be corrosion resistant spacer.
      b. Seal the base of all outdoor switchgear, motor control center, and similar equipment with grout.
      c. Screen or seal with flexible sealing compound all openings into outdoor equipment to prevent the entrance of rodents, wasps, and mud-daubers.
      d. Electrical work shall conform to the construction schedule and progress of other trades.
      e. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
      f. Perform all work in accordance with manufacturer's instructions.

i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.

g. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.

D. Identification:
1. Conduit. All conduits shall be provided with identification tags. Tags shall be brass nameplates with 3/8" high lettering and attached to the conduits by means of stainless steel wire. Conduits shall be identified at both ends with the same identification number.
2. Cable. Except for lighting and receptacle circuits, each individual wire in power, control, indication, and instrumentation circuits shall be provided with identification markers at the point of termination. Power wires without individualized identification numbers shall be color coded with electrical tape or colored wire jacket. The wire markers shall be of the heat-shrinkable tube type.
3. Control Stations. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the drawings. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.
4. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.

E. Raceways:
1. General:
a. Except as otherwise indicated on drawings, conduit shall be concealed in finished areas and exposed in unfinished areas.
b. Rigid steel conduit and aluminum conduit connections and terminations shall be reamed, de-burred, threaded and provided with bushings.
c. Securely fasten conduit connections to sheet metal enclosures with locknuts inside and out. Conduit hubs outdoors and in wet locations.
d. Provide deflection fittings across structural joints where structural movement is allowed.
e. Keep conduit clear of structural openings and indicated future openings.
f. Provide flashing and seal watertight conduits through roofs and metal walls.
g. Neatly grout conduit into any opening cut into structure.
h. Cap or plug conduits during construction to prevent the entrance of trash, dirt and water.
i. Minimum conduit size shall be ¾", except ½" for luminaries pendants or as noted on drawings.
j. Seal conduits with flexible sealing compound forced to a minimum depth equal to the conduit diameter after cable is installed.
i) At handholes, manholes, and vaults.
ii) Building entrance junction boxes.

iii) One inch or larger connections to equipment.

k. Provide flexible conduit where flexible connections are necessary, including each motor without flexible cord.
   i) Keep length to a minimum, not to exceed 6’ maximum.
   ii) No sharp bends.

l. Provide suitable pull string in each empty or spare conduit.

2. Conduit exposed in structures:
   a. Install parallel to structural members and surface.
   b. Install conduits of the same general routing parallel with symmetrical bends.
   c. Arrange supports to prevent misalignment during wiring installation.
   d. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
   e. Group related conduits; support using conduit rack. Construct rack using steel channel provide space on each for 25 percent additional conduits.
   f. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
   g. Provide suitable pull string in each empty conduit except sleeves and nipples.
   h. Maintain 6” clearance to ducts, piping and flues.
   i. Support rigidly with galvanized or cadmium-plated hardware and framing materials, including nuts and bolts.
   j. Provide expansion fittings at 100’ centers outdoors, 200’ centers indoors; in each conduit run longer than 100’ outdoors, 200’ indoors.
   k. Provide galvanized pipe caps on conduit stubs for future use.
   l. Allow 7’ headroom for horizontal conduit runs, except along structures, piping equipment or where not possible.
   m. Except as otherwise indicated, do not install exposed conduit in water chambers.
   n. Where allowed, coat conduit exposed in water chambers with 2 coats of coal tar paint with paint injuries repaired or use PVC coated conduit.

3. Conduit concealed in structure:
   a. Install between reinforcing steel in slabs with reinforcing in both faces.
   b. Install under reinforcing steel in slabs where only a single layer is provided.
   c. Terminate conduit for future use in equipment or by galvanized couplings and conduit plugs flush with structural surfaces. Seal plugs with self-leveling caulk.
   d. Maximum of two conduits crossing each other in slab.

4. Underground:
   a. One inch minimum.
   b. Shall be direct burial.
   c. Two foot minimum bend radius at vertical risers, 3 foot elsewhere.
   d. Install underground conduit so that it does not drain to cable pulling access in buildings; where necessary, provide a handhole or manhole near or adjacent to building.
   e. Provide 3 foot minimum earth cover.
   f. Install underground conduits through buildings, manhole, handhole and vault walls in box outs as indicated on the drawings.
   g. All steel inside manholes, handholes and vaults shall be galvanized with bared spots treated with zinc rich paint.

h. Provide ¾" galvanized steel pulling eyes on opposite walls below the centerline of each duct bank.
i. Provide end bells at wall terminations and adapters for steel conduit continuations for non-metallic duct systems.
j. Isolate intercommunication and milliampere level instrumentation circuits from all power wiring raceways, conduits, boxes, vaults, manhole and handhole.
k. Provide a full-size extension for each underground conduit entering a building.
l. Rigid nonmetallic conduit (PVC) shall be fastened no less than every 4 feet.

5. Junction boxes and wiring gutters:
   a. Install electrical boxes as shown on drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
   b. Install pull boxes and junction boxes to maintain headroom and to present neat mechanical appearance.
   c. Install level and plumb.
   d. Where indicated, provide a removable side opposite underground duct banks.
   e. At least code size including space for full size continuation of any conduit not originally continued.
   f. Arrange conduit for maximum space for future conduits.
   g. Support boxes independently of conduit except cast box that is connected to rigid metal conduits both supported within 12 inches of box.

F. Wire and Cable
1. General:
   a. Protect the cable and avoid kinking conductors, cutting or puncturing jackets, contaminating by oil or grease or damaging in any manner.
   b. Terminate stranded cable with lugs, cup washers, or pressure type connectors; do not wrap stranded cable around screw type terminals.
   c. Splice stranded cable with pressure type connectors; do not use wire nut type connectors on stranded cable.
   d. Splice cables only at readily accessible locations.
   e. Do not pull cable tight against bushings or press heavily against enclosures.
   f. Use cable pulling lubricants as recommended by the cable manufacturer.
   g. Use swab to clean conduits and ducts before pulling cables.
   h. Install cable and accessories in accordance with manufacturer's instructions.
   i. Where necessary to prevent heavy loading of cable connectors due to cable weight, support cables in vertical risers with woven cable grips.
   j. Coil and tape spare cable ends.
   k. Support each 250 MCM or larger cable, and each conduit group of smaller cables from manholes, handholes or vault walls.
   l. Use Stranded conductor for feeders and branch circuits.
   m. Use stranded conductors for control circuits.
   n. Use conductor not smaller than 12 AWG for power and lighting circuits.
   o. Use conductor not smaller than 16 AWG for control circuits.
   p. Use 10 AWG conductors for 20 ampere, 120 Volt branch circuits longer than 100 feet.
   q. Pull all conductors into the raceway at same time.

r. Use suitable wire pulling lubricant for building wire 8 AWG and larger.
s. Protect exposed cable from damage.
t. Neatly train and lace wiring inside boxes, equipment, and panel boards.
u. Clean conductor surfaces before installing lugs and connectors.
v. Make splices, taps, and terminations to carry full ampacity of conductors.

2. Special cables:
   a. Isolate networking and milliampere level instrumentation cables from all power circuits.
   b. Isolate telephone cables from all other circuits.
3. Conductor identification:
   a. Color code all service, feeder, and branch circuit conductors, 277/480 VAC and above as follow:
      i) Phase A: Brown
      ii) Phase B: Orange
      iii) Phase C: Yellow
      iv) Neutral: White
      v) Ground: Bare or Green
   b. Color code all feeder, and branch circuit conductors, 120/208 VAC as follows:
      i) Phase A: Red.
      ii) Phase B: Black.
      iii) Phase C: Blue.
      iv) Neutral: White.
      v) Ground: Bare or Green.
   c. Identify single control conductors by color coding orange and by labeling each end of conductors by color coding orange and by labeling each end of conductor with heat shrink-tube type wire markers.
   d. Identify multi-conductor instrumentation and control cables with heat shrink-tube type wire markers.
   e. Contractor shall establish a control and instrumentation conductor and cable identification system acceptable to Engineer.

G. Wiring Devices:
1. Flush mount wiring devices in concealed conduit system.
2. Surface mount wiring devices in exposed conduit systems.
3. Provide extension rings to bring outlet boxes flush with finished surface.
4. Clean debris from outlet boxes.
5. Install products in accordance with manufacturer’s instructions.
6. Install devices plumb and level.
7. Install switches with OFF position down.
8. Install receptacles with grounding pole on bottom.
9. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
10. Connect wiring devices by wrapping conductor around screw terminal.
11. Use jumbo size plates for outlets installed in masonry walls.
12. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
13. Install wall switch 48 inches above finished floor.

14. Install convenience receptacle 24 inches above finished floor.
15. Inspect each wiring device for defects.
16. Operate each wall switch with circuit energized and verify proper operation.
17. Verify that each receptacle device is energized.
18. Test each receptacle device for proper polarity.
19. Test each GFCI receptacle device for proper operation.
20. Adjust devices and wall plates to be flush and level.

H. Grounding Materials:
   1. Coordinate installation with other disciplines.
   2. Verify that final backfill, and compaction has been completed before driving rod electrodes.
   3. Install Products in accordance with manufacturer's instructions.
   4. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
   5. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.
   6. Provide bonding to meet Regulatory Requirements.
   7. Install ground cable through building walls within 3' below finish grade and prepare a water stop.
   8. Install ground rods and cables as deep in earth as possible and as far from structure as possible, not closer than 6".
   9. All branch circuit and feeder circuits to include a copper ground conductor in addition to the conduit ground connection.
   10. Connect ground conductors to equipment by ground lugs or clamps.
      a. If no ground bus or terminal is provided and enclosure is not explosion-proof or submersible provide a clamp type lug under a permanent assembly bolt or by grounding locknuts or bushings.
      b. If an explosion-proof or submersible enclosure is not provided with grounding means, provide an adjacent junction box with a ground lug.
      c. Bond grounding system to station piping by connection to the first flange inside the building on either a suction or discharge pipe which will form a good ground connection:
         i) Drill and tap the flange.
         ii) Provide a bolted connection.
         iii) Bond with a copper bar or strap.
      d. Form ground conductors on equipment to the contours of the equipment.
      e. Install main ground cables with encased underground conduit banks in earth at least 3" below 1 corner of the duct bank.
      f. Bond ground cables in underground circuits to main ground cables at each manhole, handhole, and vault.

3.2 FIELD QUALITY CONTROL

A. Low Voltage Cable Testing
   1. Test 600 V power cables for continuity and freedom from short circuits and ground, except where grounding is intentional immediately after installation.

2. Test all circuits with a 500 V megger or its equivalent.
3. Replace conductors which read less than 1.5 Megohms between conductors and ground.

3.3 PROTECTION AND STORAGE

A. Protection of equipment during storage:
   1. During construction, all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously. Any means necessary shall be used to protect the equipment at the Contractor's expense.

END OF SECTION

SECTION 16100

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the design, furnishing, and installation of a complete lightning protection system for all new structures included in this contract. This shall include:
   1. Water Storage Tank

B. Lightning protection systems shall be furnished, installed, and tested as specified. Lightning protection equipment shall meet the requirements specified herein.

C. Lightning protections systems shall consist of, but not be limited to, air terminals; main, bonding, and down conductors; ground terminals; and all required connectors and fittings required for a complete system.

D. The lightning protection system shall include the bonding of all roof-mounted mechanical equipment, roof drains, roof mounted ladders, chimneys, antennas, and other roof mounted metal objects.

E. The lightning protection system shall include the below-grade ground grid system needed for the lightning protection system.

F. Related Sections:
   1. General provisions of the contract and drawings, including General and Supplementary Conditions and Division 01 Specification, apply to this section.

1.2 REFERENCES

A. UL96

B. NFPA 780 – Standard for Installation of Lightning Protection Systems

1.3 SUBMITTALS

A. Complete certification of design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming the system, shall be submitted in accordance with the submittals section of these specifications.

B. Shop drawings:
   1. Layout drawings for the entire system
   2. Installation information on how the equipment is to be installed.
      a. Include information on how the grounding cables are to be concealed.
      b. Mounting details.

3. UL Listing Information
4. Material certificates.

C. All information that may or will be required by the authority having jurisdiction shall be provided.

1.4 QUALITY ASSURANCE

A. The lightning protections system shall be inspected and tested after installation by conducting continuity and ground conductivity tests, as well as a visual inspection.

B. Inspection results and test data shall be submitted.

C. Upon completion of the installation, the Contractor shall apply for and deliver UL Master Label Certificate of Inspection for the structure/building.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable Building Code.

B. Electrical: Conform to latest version of NFPA 70 and NFPA 780.

C. Coordinate, obtain and pay for all permits, inspections and approvals of authority having jurisdiction.

D. Comply with local electrical codes in force or in the absence of local electrical code, the latest edition of the National Electrical Code, ANSI C1.

1.6 WARRANTY

A. The contractor shall warrant the supplied equipment and labor for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

2.2 MATERIALS AND EQUIPMENT

A. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed.

B. The system components shall be fabricated from the following metals:
1. Conductors Copper
2. Air Terminals Copper or bronze

3. Grounding electrodes — Copper clad steel
4. Fasteners — Copper or bronze
5. Bimetallic Fasteners — Bronze and aluminum

C. Aluminum conductors and air terminals shall be mounted on aluminum surfaces only.

D. Air terminals shall be OSHA-recognized impalement resistant.

E. All materials furnished for the lightning protection system shall bear the inspection label of UL.

2.3 PERFORMANCE CRITERIA

A. Materials shall be in compliance with the following standards:
1. UL96
2. NFPA 780

B. Roof and down conductors shall comply with ASTM B8

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building.

B. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

C. Air terminals shall have base supports designed for the surface on which they are to be used and shall be securely anchored.

D. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

E. The lightning protection system shall be bonded to the structure/building electrical ground rings wherever they are available.

3.2 FIELD QUALITY CONTROL

A. Notify Engineer at least 48 hours in advance of inspection before concealing the lightning protection components.
B. It is recommended that the lightning protection system be visually inspected at least once annually per NFPA by a Lightning Protection Contractor.

END OF SECTION

SECTION 16900

INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the furnishing and installation of metering which shall include the following principal items:
   1. Principal components of the metering and control systems shall be as listed on the "Instrument List" at the end of this section.
   2. Miscellaneous. One lot of test equipment, spare parts, and miscellaneous devices as set forth herein. Supplementing this section, the drawings indicate locations and arrangement of instruments, and provide functional diagrams and schematics regarding connection and interaction with other equipment.

B. Related Sections
   1. Section 16050 – Electrical

1.2 REFERENCES

A. Codes & Permits
   1. All work and materials shall comply with the National Electrical Code, the National Electrical Safety Code, and applicable local regulations and ordinances. All panels shall be listed by Underwriters Laboratories or other testing organizations acceptable to the governing authority. The Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

1.3 SUBMITTALS

A. Complete fabrication, assembly, and installation drawings: wiring and schematic diagrams: and details, specifications, and data covering the materials used and the parts, devices, and accessories forming a part of the equipment furnished shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in two separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Instrument tag numbers indicated on the contract drawings shall be referenced where applicable. Submittal data for multifunctional instruments shall include complete descriptions of the intended functions and configurations of the instruments.
   1. First-stage Submittal. The first-stage submittal shall include the following items.
      a. Product catalog cut sheets clearly marked to show the applicable model number, operational features, and intended service of the device.
      b. A detailed list of any exceptions, functional differences, or discrepancies between the Supplier's proposed system and the contract requirements.
      c. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall include overall dimensions, metal

thickness, door swing, mounting details, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

d. System wiring and installation drawings for all interconnecting wiring between components of the systems furnished and for all interconnecting wiring between the related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections.
e. If panel terminal designations, inter-device connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised drawings shall be resubmitted.
f. A total of seven (7) copies for the submittal shall be provided.

2. Second-stage Submittal. Complete system documentation, in the form of operation and maintenance manuals, shall be provided. Manuals shall include complete product instruction books for each item of equipment furnished.
   a. Where instruction booklets cover more than one specific model or range of instrument, product data sheets shall be included which indicate the instrument model number, calibrated range, and all other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings, calibration and startup sheets shall be included with the manuals.
   b. A copy of all final O&M manuals shall be provided in PDF format on a USB Thumb drive. All AutoCAD drawings shall be provided in PDF and DWG formats.
   c. A total of two (2) printed copies, and two (2) softcopies of final O&M manuals shall be provided.

1.4 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be designed, coordinated, and supplied by Filter Tech Systems who shall be referred to as the System Integrator.

B. Coordination.
   1. Instrument and control systems shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All instruments and control devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufactured and the manufacturer of related equipment.
   2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
   3. The Integrator shall provide coordination with other contractors and supervision of installation as required during construction.
   4. Coordination shall be provided between the Integrator and the process system supplier.
   5. Instrument and control systems shall be designed and coordinated for proper operation with other sections of these specifications. These shall include but not be

limited to Electrical – Section 16050 and Programmable Logic Controllers – Section 16950.

1.5 WARRANTY

A. All suppliers shall warrant their hardware for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
   1. Power and Instrument Signals. Unless specified otherwise, electrical power supply to the instrumentation equipment will be unregulated 120 VAC at the locations noted on the one-line and functional diagrams. All transmitted electronic analog instrument signals shall be 4-20 mA DC and shall be linear with the measured variable.
   2. Metering Accuracy. System metering accuracy, as compared to the actual process value, shall be determined from the value read at the principal readout device such as the recorder or totalizer. System requirements shall not preclude any requirements specified herein for individual devices.
      a. For systems where the primary measuring device, transmitter, and receiver are furnished under this section, the accuracies shall be within the following limits:
         i) Level: 1.0% of measured span.
         ii) Flow Rate: magnetic or transit time ultrasonic metering: 0.5% of full scale between 1.0 and 100% of scale.
   3. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation requirements shall be furnished and installed as required for proper performance of the equipment.
   4. Interchangeability and Appearance. Instruments used for the same types of functions and services shall be of the same brand and model line insofar as possible. Similar components of different instruments shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished. Recorders, process indicators, control stations, and similar panel-mounted instruments shall be of the same style and shall be products of the same major instrument manufacturer.
   5. Programming Devices. A programming or system configuring device shall be provided for systems that contain any equipment which required such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete and in like-new condition and shall be turned over to the Owner at completion of the startup.

6. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the instrument device schedules and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanels, and rack-mounted devices shall have laminated plastic identification tags securely fastened to the device. Hand lettered labels or tape labels will not be acceptable.
7. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
8. Provide sunshade for outdoor installations.
9. Provide stainless steel tags for each instrument.

2.2 PANEL FABRICATION

A. General Fabrication Requirements. All panels furnished hereunder shall conform to the requirements of NEMA ICS-6-1988. The following paragraphs describe general fabrication requirements for the instrument panels, consoles, enclosures, and subpanels:
   1. All completed panels shall be UL 508A or UL 698 listed (as appropriate).
   2. Wiring.
      a. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded tinned copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90°C.
      b. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 VAC. Surge protectors shall be of a non-faulting and non-interrupting design, with a response time of not more than 5 nanoseconds. Surge protectors shall be Cutler Hammer AEGIS Powerline Filters, or equal.
      c. Panels that are over 15 cubic feet in total volume shall have panel lighting above each door of the panel.
      d. Power distribution wiring on the line side of the panel's protective devices shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 16 AWG. Wiring for control circuits shall be minimum 16 AWG. Electronic analog circuits shall be 18 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, DC power distribution, and control circuits shall have different colors and shall agree with the color-coding legend on the system supplier's panel wiring diagrams.
      e. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with a marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 20% spare terminals shall be provided. Each control loop or system shall be individually fused, and all fused or

circuit breakers shall be clearly labeled and located for easy maintenance. Terminal block shall be Phoenix Contact UT 4-MTD series.

f. All wiring shall be grouped and firmly supported inside the panel. Wiring shall be routed in nonmetallic slotted wire duct or similar. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40% of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables. Wire duct shall be Thomas & Betts Ty Duct or approved equal.
g. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams.
h. All analog input signals coming from external from the building where the panel is located shall have surge protection.
i. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.
j. All wires in the panel shall be identified at both ends of the wire. These labels shall agree with the labels shown on the wiring diagrams. The wire labels shall be of the heat-shrink tube type of wire marker as manufactured by Brady thermal labels.
k. All instruments that require 120 VAC power that have the signal from the instrument going to a panel, shall be provided 120 VAC from that panel. The 120 VAC circuit to these instruments shall be individually fused.

3. Uninterruptable Power Supply (UPS)
   a. Any panels that have PLCs or are shown to have a UPS on the drawings shall have a UP
   b. The PLC and all associated equipment shall be powered by a UPS.
   c. The UPS shall be sized to provide power to all devices connected to it for a minimum of 30 minutes.
   d. The UPS shall be wired so that in the event of the UPS failure, the PLC panel will be powered by utility power and an alarm will be generated.
4. Nameplates. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends, as indicated on the drawings, letters approximately 3/16-inch-high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified herein under the Device Tag Numbering System paragraph.
5. Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils.
6. Factory test. Panels shall be factory tested electrically by the panel fabricator before shipment.

2.3 METERING & CONTROL SYSTEMS

A. Principal components for the metering and control systems are indicted on the "Instrument List" at the end of this specification.

2.4 CONTROL COMPONENTS

A. Panel Front-Mounted Devices
   1. SELECTOR SWITCHES. Selector switches shall be a minimum 30 mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 VAC. Contact configuration shall be as indicated on the drawings or as required for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton "Series 10250T", Square D "Class 9001", or approved equal.
   2. INDICATING LIGHTS. Indicating lights shall be a minimum 30 mm, heavy-duty, oil-tight type, Push-to-Test, which uses a low voltage lamp. A built-in transformer shall be used for AC service. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light. Indicating lights shall be Eaton "Series 10250T", Square D "Class 9001", or approved equal.
   3. PUSH BUTTONS. Push buttons shall be a minimum 30 mm, heavy-duty, oil-tight type. Legends shall be engraved on push button faceplate. Contacts shall be rated 10 amperes continuous at 120 VAC. Push buttons shall be Eaton "Series 10250T", Square D "Class 9001", or approved equal.
   4. TOTALIZERS. Totalizers shall have miniature, rectangular, semi-flush counters, designed for use in conjunction with miniature indicators and recorders, and shall be of such a design that only the counter is flush-mounted, and the associated integrating mechanism is located in the rear of the panel. The counter shall contain not less than seven digits; with a multiplier of a power of 10 plainly engrave on the face of the counter, or on a nameplate below the counter, so that a full range of 9,999,999 is reached before repeating. Totalizers actuated by DC powered coils shall be equipped with a reverse voltage protection device. Totalizers shall not reset upon power failure. Totalizers shall be as manufactured by Red Lion CUB7T series or Action Instruments.
   5. RUN TIME METERS. Run time meters shall have miniature, rectangular, semi-flush counters. The counter shall contain not less than seven digits, with a nameplate plainly engraved on the face of the counter, or below the counter identifying it as a run time meter. Run time meters shall not reset upon power failure. Run time meters shall be as manufactured by Red Lion "CUB7" series or Action Instruments.
   6. DIGITAL PANEL DISPLAYS. Digital panel displays shall be designed for semi-flush mounting in a panel. The display shall be a 3-1/2 digit LED or gas-discharged type, with digit height of not less than 0.5 inch. The display shall be easily read at a distance of 10 feet in varying control room lighting environments. Operating temperature range shall be 0 to 40 C. Accuracy shall be plus or minus 0.1%. The display shall be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The display shall have selectable decimal point and shall provide red indication. Digital displays shall be as manufactured by Red Lion "PAXP" series or Action Instruments.

B. Panel Interior-Mounted Devices

1. POWER SUPPLIES. Regulated DC power supplies for instrument loops shall be provided as needed. Power supplies shall be suitable for input voltage variation of plus or minus 10%. The DC power supplies shall be Idec “PS5R Slim line”, or Phoenix Contact “UNO”.
2. RELAYS. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL listed. Relays shall have a minimum rating of 10 amperes at 120 VAC. Time-delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of +/- 2.0% of setting. Latching and special purpose relays shall be as required for the specific application. Relays shall have a light to indicate when coil is energized. Relays shall be Idec “RH or RTE Series” or approved equal.
3. ELECTRONIC SIGNAL BOOSTERS AND ISOLATORS. Electronic Signal Boosters and Isolators shall have all solid-state circuitry and complete electrical isolation between the power supply and the input and output signals. Accuracy shall be +/-0.15% of span. Isolators shall be manufactured by Acromag, Moore, or Phoenix Contact.

2.5 INSTRUMENTATION

1. Radar Level Transmitters
   a. The transducer shall emit radar pulses via the transmitter, with a frequency range of 6.3 GHz to 26 GHz. The instrument measures the pulse travel time between transmitter, surface, and receiver to calculate the level. The antenna design shall be suitable for mounting in nozzle as indicated on drawings. The design shall be such that product condensation on the antenna shall not affect the performance. Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition. Must be able to measure up to 98FT. Shall operate in process temperatures -40 to 176ºF. Wetted parts shall be chemically compatible with process. Must have microprocessor-based signal transmitter. Power supply will be 4-wire 24VDC. Output signal shall be 4-20mA. Transmitter shall have backlit LCD display which can be remotely mounted if necessary. Transmitter shall be housed in NEMA 4X enclosure.
   b. Secure and encrypted Bluetooth wireless technology for commissioning, operation, and maintenance via iOS/Android app.
   c. The Radar level transmitter shall be Endress+Hauser “Micropilot FMR10”, or approved equal.

2. Weighted Float Level Switches
   a. Each level switch shall consist of a single-pole, double-throw switch, rated not less than 3 amperes AC, sealed, and housed in a chemical-resistant polypropylene casing. The switch assembly shall be weighted and suspended on its own cable. The flexible support cable shall be waterproof, three-conductor, synthetic covered cable with 18AWG conductors, and shall be of sufficient length so that no splice or junction box is required in the wet well. Switches shall be suitable for operation up to 150 volts within an ambient temperature range of 32° to 140°F. Switches shall be suitable for use in drinking water applications. Mercury

switches are not acceptable. Installation hardware shall be provided as shown on the drawings or as necessary for application.

b. Switches shall be Flygt “Type EMN-10”, MJK “7030” or approved equal.

B. Miscellaneous Instrumentation

1. Limit Switch

a. The limit switch shall be of the lever operated limit switch type and shall be enclosed in a NEMA 4 housing. The switch shall be furnished with one NO and one NC contacts and screw type wiring terminal. The switch shall be heavy duty, oil tight type. Limit switches shall be Square D model “9007C54B2” with adjustable type roller lever arm “9007HA1” or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements

1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers’ instructions. The services of the system Supplier’s technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

B. Inspection.

1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.

a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation.

1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.

a. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.

b. Perform all work in accordance with manufacturer's instructions.

i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.

ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.

c. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.

d. Field Piping. Field piping materials and installation shall conform to the requirements of the miscellaneous piping section.

e. Field-Mounted Instruments. Instruments shall be mounted so they may be easily read and serviced and all appurtenant devices are easily operated. Installation details for some instruments are indicated on the drawings. Unless otherwise

indicated on the drawings, instruments which include local indicators shall be mounted approximately 5 feet above the floor and shall be oriented for ease of viewing. Transmitters shall be mounted on corrosion-resistant pipe supports suitable for floor, wall, or bracket mounting.

D. Field Calibration. A technical representative of the system supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final tuning adjustment settings. The adjustment of each calibrated instrument shall be sealed or marked, insofar as possible, to discourage tampering. Instruments shall be calibrated before checkout of the operation of the system.

E. Systems Check. A technical representative of the system supplier shall participate in the checkout of metering and control systems. If interrelated devices furnished by other suppliers, such as valve actuators, motor controls, chemical feeders, or primary measuring devices, do not perform properly when placed in service, the technical representative shall use suitable test equipment to introduce simulated signals to verify or measure signals from such devices as required to locate the source of trouble or malfunction. A written report stating the results of such tests shall be furnished, if requested by the Engineer, to assign responsibility for corrective measures.
   1. Installation Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by the Contractor for the duration of the testing work. Unless specified otherwise, test equipment will remain the property of the Contractor or the system Supplier.

F. Adjustment and Cleaning
   1. Perform all required adjustments, tests, operational checks, cleaning and other start-up activities required.
   2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.

3.2 CUSTOMER TRAINING

A. The coordinating supplier shall provide a qualified representative at the job site to train the Owner's personnel in operating and maintenance of the equipment. The training session shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of one 4-hour session, and the schedule shall be arranged and coordinated with the Engineer.

3.3 INSTRUMENT LIST

Town of Grand Junction Kannah Creek Tank
Instrument List
(This list does not include instruments provided by the packaged systems)

Tag #	Description	Service	Scale	Provided Under Specification
LSHH-200	TANK LEVEL HIGH	WEIGHTED FLOAT SWITCH	N/A	16900
LSH-200	TANK PUMPS STOP	WEIGHTED FLOAT SWITCH	N/A	16900
LSL-200	TANK LEAD PUMP START	WEIGHTED FLOAT SWITCH	N/A	16900

LSLL-200	TANK LAG PUMP START	WEIGHTED FLOAT SWITCH	N/A	16900
LSLLL-200	TANK LEVEL LOW	WEIGHTED FLOAT SWITCH	N/A	16900
LIT-200	TANK LEVEL	RADAR LEVEL	0 – 25 FT	16900

END OF SECTION

SECTION 16950

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes the items listed below and all other components necessary for a complete system as noted herein and indicated on the drawings.
   1. Programmable Logic Controllers (PLCs)
   2. Communication equipment
   3. HMI software
   4. Programming
   5. Spare parts

B. Related Sections
   1. Section 16050 – Electrical
   2. Section 16900 – Instrumentation & Controls
   3. I/O list

1.2 REFERENCES

A. ISA 5.1 – Instrumentation Symbols and Identification

B. NEMA ICS 1 – General Requirements for Industrial Control and Systems

C. NEMA ICS 2 – Standards for Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated 600 Volts

D. DEMA ICS 3 – Industrial Control and Systems: Factory Built Assemblies

E. NEMA ICS 6 – Industrial Controls and Systems: Enclosures

1.3 DESIGN REQUIREMENTS

A. Discrete input/output signals shall all be 24VDC.

B. Analog input/output signals shall all be 4-20mA.

C. Analog signal isolators shall be independently powered units capable of driving two 4-20mA signals.

D. All required buffers, isolators, signal converter, and amplifiers for coordination with other equipment furnished under other sections, and between items of equipment needed for a complete system shall be furnished under this section of the specifications whether indicated on the Drawings or not or detailed in these specifications or not.

1.4 SYSTEM DESCRIPTION

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
   1. I/O List. An I/O list is attached at the end of this section.

1.5 SUBMITTALS

A. Submittals shall be required as noted in Section 16900.

1.6 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The radio system and associated tank site equipment shall be designed, coordinated, and supplied by Mountain Peak Controls.

B. Coordination
   1. The PLCs and PLC system shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.
   2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. A network diagram detailing the as-built radio network shall be prepared. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
   3. The Contractor shall provide coordination with other contractors and supervision of installation as required during construction.

1.7 WARRANTY

A. The Supplier shall warrant the hardware, software, and configuration related to the operational performance of the facility for a period of two years from the date of system acceptance. The Supplier shall provide a two-year software service agreement to correct any problems or "bugs" stemming from this project which prohibits the SCADA system from performing process operations in accordance with these specifications.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMNTS

A. All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the

supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.

1. Interchangeability. All PLC systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules shall be interchangeable among all I/O panels and systems.
2. Modules shall be added as needed to existing Plant PLC to provide for all the I/O required on the project plus the spares.
3. All Analog signals shall be logged in to the Historian Software as needed.
4. Autodialer alarms shall be selected and configured per the owner's requirements.

2.2 MATERIALS AND EQUIPMENT

A. Programmable Logic Controller (PLC)
   1. The additions to the Mountain Peak Controls "Radio PLC system" shall include what is necessary to add in new signals from Kannah Creek Tank site and forward signals via hardwire connection to Filter Tech Systems "WTP PLC system."

B. PLC Programming Software
   1. The PLC programming software shall be Allen Bradley RSLogix 500, Studio 5000, Scheider Electric EcoStruxure, Siemens TIA Portal, no equal.

C. Radio Equipment
   1. The existing Phoenix Contact RAD-900-IFS equipment shall be modified to encompass the new I/O and move any existing I/O from the obsolete radio system. This can include rewiring existing modules or adding additional modules. This includes one additional float switch signal for the new Tank.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements
   1. It shall be the Supplier's responsibility to ensure that the entire PLC system and HMI system is installed in a satisfactory condition per these specifications and the manufacturer's requirements.

B. Inspection
   1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
      a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation

1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
    a. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
    b. Perform all work in accordance with manufacturer's instructions.
        i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
        ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.

D. Adjustment and Cleaning
1. Perform all required adjustments, tests, operational checks, cleaning, and other start-up activities required.
2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.

E. PLC and HMI Programming.
1. Filter Tech Systems shall be responsible for all PLC and HMI programming as it is associated with the Main WTP PLC and HMI. Mountain Peak Controls shall be responsible for all PLC programming as it related to the WTP Radio PLC and radio system.

3.2 CUSTOMER TRAINING
1. The system supplier shall provide a qualified representative at the job site to train the Owner's personnel in operating and maintenance of the equipment. The training sessions shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of one 4-hour working day, and the schedule shall be arranged and coordinated with the Engineer.

3.3

I/O LIST TOWN OF GRAND JUNCTION KANNAH CREEK TANK
I/O List
(Only I/O points other than the packaged systems are shown here)

WTP PLC

Tag #	Description	DI	DO	AI	AO	Scale	Notes
LSHH-200	TANK LEVEL HIGH	1					Shared with existing LSHH-100. Local Selector Switch at Tank changes active tank. Signal then relayed to WTP PLC.
LSH-200	TANK PUMPS STOP	1					Shared with existing LSH-100. Local Selector Switch at Tank changes active tank. Signal then relayed to WTP PLC.

LSL-200	TANK LEAD PUMP START	1					Shared with existing LSL-100. Local Selector Switch at Tank changes active tank. Signal then relayed to WTP PLC.
LSLL-200	TANK LAG PUMP START	1					Shared with existing LSLL-100. Local Selector Switch at Tank changes active tank. Signal then relayed to WTP PLC.
LSLLL-200	TANK LEVEL LOW	1					Shared with existing LSLLL-100. Local Selector Switch at Tank changes active tank. Signal then relayed to WTP PLC.
LIT-200	TANK LEVEL			1			Signal then relayed to WTP PLC.
		5	0	1	0		

END OF SECTION

SECTION 16951

CONTROL DESCRIPTIONS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes the items listed below and all other components necessary for a complete system as noted herein and indicated on the drawings.
   1. General Programming Requirements
   2. PLC Programming
   3. HMI Programming

B. Related Sections
   1. Section 16900
   2. Section 16950
   3. I/O list

C. PLC & HMI programming shall be completed by Filter Tech Systems (System Integrator, SI) as associated with the Main Plant PLC and HMI below. Mountain Peak Controls shall complete programming as it associated with the radio system and WTP Radio PLC. SI shall utilize the existing SCADA system and will add new signals to existing screens as needed for the new tank site.

D. Scope of work shall also include, but is not limited to:
   1. Develop and test new PLC program based on control descriptions provided in this specification section.
   2. Develop and test HMI screens and add new screens to the existing SCADA system.
   3. Loop test all PLC input and output points for proper operation. The electrical contractor will terminate I/O points based on control panel drawings.
   4. Verify new instrument setup and calibration.
   5. Provide training to Town of Grand Junction personnel on the new system.

1.2 REFERENCES

A. ISA 5.1 – Instrumentation Symbols and Identification

B. NEMA ICS 1 – General Requirements for Industrial Control and Systems

C. NEMA ICS 2 – Standards for Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated 600 Volts

1.3 SYSTEM DESCRIPTION

A. All the programming performed under this section shall be done in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the software manufacturer, unless exceptions are noted by engineer.

1.4 SUBMITTALS

A. Submittals shall be required as noted in section 16900.

1.5 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be programmed under this agreement.
   2. These control descriptions are provided for informational purposes and for coordination between the system supplier and the programmer.

PART 2 EXECUTION

2.1 SYSTEM DESCRIPTION

A. The existing control panel shall communicate tank level transmitter signals & float switch signals via existing Phoenix Contact RAD-900-IFS I/O radio to the Plant Control Panel. Existing float switches will be re-terminated in the new Tank Level Control panel along with the new float switches and ultrasonic level transmitter. The Tank Level Control panel shall be provided with a selector switch to designate which tank is active. This changes which set of float switches are performing active control.

2.2 GENERAL PROGRAMMING REQUIREMENTS

A. Tag database structure and configuration.
   1. The process control system tag naming convention shall include the definition of all devices, derived and soft tags, and the required alarm processing and data logging definitions for each tag.
   2. Tag naming convention.
      a. The tag naming convention shall be:
         i) Tag numbers shall be grouped as follows:
            a) 100's – Existing Underground Tank Area
            b) 200's – New Above Ground Tank Area
         ii) Tag names shall minimally consist of two distinct components. The leading component shall be an abbreviated description of the associated process variable or the function of the tag it represents. The trailing component shall be the tag equipment number.
   3. All logic and control shall be done in Plant PLC.

B. PLC Programming standards.
   1. General Considerations
      a. Program Documentation
         i) Documentation for all PLC programs shall include comments, tag/register descriptions, or any other programming tags. All PLC programs shall be documented with comments provided for each subroutine, function and/or section. Use of abbreviations in comments and subroutine/section titles should be avoided. At the completion of the project, copies of the

programming, I/O list, memory map and communications map shall be provided in both printed and electronic format.

b. Analog signals
   i) All analog inputs shall be scaled in Engineering units to be used in the logic.
   ii) A low-level and high-level alarm shall be generated for each analog signal. Each alarm shall have separate alarm and reset set points that shall be operator programmable from the HMI screen.
c. All control to any devices will be stopped if there is a phase failure condition. After a time delay when the phase failure is normal, then normal operation shall proceed.

C. Human Machine Interface (HMI) standards.
1. General Considerations
   a. In general, when the term HMI is used it indicates the local operator terminal displays.
   b. All alarms will be displayed and logged on the HMI.
   c. All analog signals will be trended and logged and displayed on the HMI in engineering units.
   d. Alarming
      i) All alarms shall be displayed and logged on the HMI screens.
      ii) Selected alarms shall have a visual and audible alarm.

2.3 SPECIFIC DEVICE CONTROL CRITERIA

A. High Service Pumps
1. Existing High Service Pumps shall retain existing programming logic.
   a. Tank control panel shall be provided with a local selector switch to dictate which tank is designated for active control. This will change which set of floats are actively transmitting their signals back to the WTP Radio PLC. These floats will only be transmitted over the existing RAD-900-IFS Radioline signal. The hardwire signals running from the existing Tank Level Control Panel back to the plant shall be abandoned in place. If Radio connectivity is lost to the tank, the High Service pumps will shut down and float sequence shall be reset. The pumps will not start back up until connection is reestablished.

END SECTION