TECHNICAL SPECIFICATIONS

FOR

NEW AIRPORT RESERVOIR AND BOOSTER STATION

AUGUST 2021

VOLUME 2 OF 2

DIVISIONS 31 THROUGH 43
SUPPLEMENTARY INFORMATION

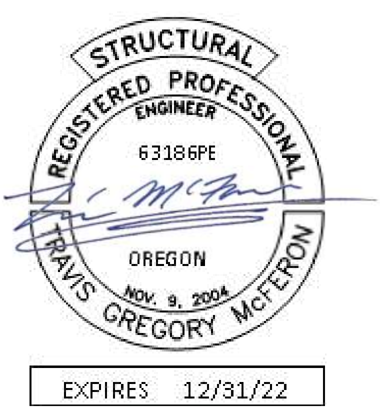
SECTION 000107

SEALS PAGE

See Table of Contents for author of each specification section, identified by author's initials as follows:

AUTHOR'S NAME = INITIALS

LAEL L. ALDERMAN = LLA
KRISTOFOR R. SNIDER = KRS
TRAVIS GREGORY McFERON = TGM
DAVID C. ROOT = DCR
MICHAEL E. WALLIS = MEW



TECHNICAL SPECIFICATIONS
FOR
NEW AIRPORT RESERVOIR AND BOOSTER STATION
FOR
CITY OF PENDLETON

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A. Geotechnical Engineering Evaluation, Proposed City of Pendleton Water and Sewer System Upgrades Project, Water Storage Reservoir, Pendelton, Oregon. (GeoEngineers, June 5, 2018)

B. Addendum Report, City of Pendleton Water and Sewer System Upgrades, Pendleton, Oregon, File No. 8946-003-03. (GeoEngineers, April 2, 2021)

C. Form: Explosives Near Gas Facilities, Cascade Natural Gas.

SECTION 31 05 13

SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.

B. Section includes:

1. Subsoil materials.
2. Topsoil materials.

1.2 RELATED SECTIONS

A. Section 31 05 16 - Aggregates for Earthwork.
B. Section 31 10 00 – Site Clearing.
C. Section 31 22 13 - Rough Grading.
D. Section 31 23 16 – Excavation.
E. Section 31 23 17 - Trenching.
F. Section 31 23 18 – Rock Removal.
G. Section 31 23 23 - Fill.
H. Section 31 37 00 - Riprap.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

2. ASTM D2487 - Standard Classification of Soils for Owner's Representativeing Purposes (Unified Soil Classification System).

3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Materials Source: Submit name of imported materials source.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish materials of each type from same source throughout the Work.

B. Soil Testing:

1. Soil sampling and testing to be completed by an independent laboratory approved by the Owner’s Representative.

2. Frequency of testing shall be determined by the Owner’s Representative.

3. All soil testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698 (AASHTO T99).

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1, Select Native Material:

1. Select earth obtained from on-site excavations approved for use by Owner’s Representative.

2. Graded.

3. Free of peat, humus, vegetative matter, organic matter and rocks larger than 6 inches in diameter.

4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

B. Subsoil Type S2, Imported Fill Material:

1. Imported earth approved for use by Owner's Representative.
2. Meeting the requirements of Subsoil Type S1.

2.2 TOPSOIL MATERIALS

A. Topsoil Type TS1, Select Native Topsoil Material:

1. Top 6 - 12 inches of existing soil containing organic matter.

2. Owner's Representative decision shall be final as to determination of what material is topsoil quality.

3. Graded.

4. Free of roots, rocks larger than 1/2-inch subsoil, debris, large weeds and foreign matter.

    a. Screening: Single screened.

B. Topsoil Type TS2, Imported Topsoil Material:

1. Imported borrow.

2. Friable loam.

3. Reasonably free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds, and foreign matter.

    a. Screening: Single screened.

4. Acidity range (pH) of 5.5 to 7.5.

5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

2.3 SPOILS

A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Owner's Representative.

B. Make arrangements for disposal of the material at no additional cost to the Owner.

C. Landfill permit to be obtained by the Contractor and provided to Owner's Representative prior to commencement of disposal.

2.4 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698 (AASHTO T99).

B. When tests indicate materials do not meet specified requirements, change material or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

C. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.

B. Site within clearing limits shall be stripped of topsoil as required to obtain additional topsoil necessary to complete Work indicated in the Drawings or as specified.

C. When practical, do not excavate wet top soil.

D. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

E. Remove excess excavated subsoil and topsoil not intended for reuse from Site.

F. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from Site.

3.2 STOCKPILING

A. Stockpile soils at locations shown in the Drawings or at locations as approved by Owner’s Representative for redistribution as specified.

1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.

2. No additional payments will be made for stockpiling excavated materials off-site.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16

AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes range of coarse and fine aggregate materials intended to be referenced by other Sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other Sections and in Drawing notes.

B. Section Includes:

1. Coarse aggregate materials.
2. Fine aggregate materials.

1.2 RELATED SECTIONS

A. Section 31 05 13 - Soils for Earthwork.
B. Section 31 22 13 - Rough Grading.
C. Section 31 23 17 - Trenching.
D. Section 31 23 19 - Dewatering.
E. Section 31 23 23 - Fill.
F. Section 31 37 00 - Riprap.
G. Section 32 11 23 - Aggregate Base Courses.
H. Section 33 11 16 - Site Water Utility Distribution Piping.
I. Section 33 41 00 - Storm Utility Drainage Piping.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.

2. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates.

3. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Aggregate Testing:

1. Aggregate sampling and testing to be completed by an independent laboratory approved by the Owner's Representative.

2. The frequency of testing shall be determined by the Owner's Representative.

3. All aggregate testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698 (AASHTO T99).

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Aggregate Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1, Dense-Graded Aggregate: Crushed rock with 3/4 inch-0, 1 inch-0, 1-1/2 inch-0, 2 inch-0 and 2-1/2 inch-0 gradation as shown in the Drawings and meeting the requirements provided below.

1. Grading - Dense-graded base aggregate shall be crushed rock, including sand. Uniformly grade the aggregates from coarse to fine.

2. Sieve analysis shall be determined according to AASHTO T27.

3. The aggregates shall conform to one of the grading requirements Table 310516-A below.

Table 310516-A
Grading Requirements for Dense-Graded Aggregate
Separated Sizes
Percent Passing (by weight)

Sieve Size	2-1/2" - 0	2" - 0	1-1/2" - 0	1" - 0	3/4" - 0
3”	100				
2-1/2”	95 - 100	100			
2”	-	95 - 100	100		
1-1/2"	-	-	95 - 100	100	
1-1/4”	55 - 75	-	-	-	
1”	-	55 - 75	-	90 - 100	100
3/4"	-	-	55 - 75	-	90 - 100
1/2"	-	-	-	55 - 75	-
3/8”	-	-	-	-	55 - 75
1/4"	30 - 45	30 - 45	35 - 50	40 - 55	40 - 60
No. 4*	-	-	-	-	-
No. 10	[1]	[1]	[1]	[1]	[1]

[1] Of the fraction passing the 1/4 inch sieve, 40% to 60% shall pass the No. 10 sieve.
* Report percent passing sieve when no grading requirements are listed.

4. Fracture of Rounded Rock:

a. Determined according to AASHTO TP61.

b. Provide at least one fractured face based on the following percentage of particles retained on the 1/4-inch sieve for the designated size:

Minimum Percent of Fractured Particles
by Weight of Material

Designated Size	Retained on 1/4-Inch Sieve
1 1/2" – 0 and larger	50
Smaller than 1 1/2" – 0	70

5. Durability:

   a. Crushed rock aggregate shall meet the following durability requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	35.0% maximum
Degradation (Coarse Aggregate)	ODOT TM 208	30.0% maximum
Passing No. 20 Sieve, Sediment Height	ODOT TM 208	3.0" maximum

6. Sand Equivalent -- Crushed rock aggregate will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 50.

B. Coarse Aggregate Type A2, Granular Drain Backfill Material: Crushed or uncrushed rock or gravel as shown in the Drawings.

1. Material shall be clean and free-draining.
2. Sieve analysis shall be according to AASHTO T27.
3. Grading: Meeting the gradation requirements provided in Table 310516-B below.

Table 310516-B
Grading Requirements for Granular Drain Backfill Material
Separated Sizes
Percent Passing (by weight)

Sieve Size	Separated Sizes 1 1/2" – 3/4"	Separated Sizes 3/4" – 1/2"
2"	100	
1-1/2"	90 - 100	
1"	20 - 55	100
3/4"	0 - 15	85 - 100
1/2"	-	0 - 15
3/8"	0 - 5	-

C. Coarse Aggregate Type A3, Select Native Granular Material:

1. Select aggregate and rock obtained from on-site excavations and controlled blasting approved for use by Owner's Representative.

2. Graded.

3. Free of peat, humus, vegetative matter, and organic matter.

4. Sorted as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

2.2 SAND

A. Sand: Sand material shall consist of granular material, naturally produced or produced from crushed gravel, or dredge sand that is reasonably free of organic material, mica, clay, fly ash and other deleterious material, meeting the gradations of Table 310516-C below.

Table 310516-C
Grading Requirements for Sand
Separated Sizes
Percent Passing (by weight)

Sieve Size	Coarse Sand	Medium Sand	Fine Sand
1"	100	100	100
3/8"	95 - 100	95 - 100	-
#4	80 - 100	70 - 95	90 - 100
#30	10 - 30	10 - 45	-
#100	-	2 - 10	2 - 10
#200	0 - 8	0 - 7	0 - 4
Sand Equivalent	50 min.	50 min.	50 in.

2.3 SOURCE QUALITY CONTROL

A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D698 (AASHTO T99).

B. Sand - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D698 (AASHTO T99).

C. When tests indicate materials do not meet specified requirements, change material and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials imported to site at shown in the Drawings or at locations as approved by Owner's Representative for redistribution as specified.

B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

C. Prevent intermixing of aggregate types or contamination.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes clearing site of incidental paving and curbs, debris, grass, trees, and other plant life in preparation for site or building excavation work.

1.2 RELATED SECTIONS:

A. Section 02 41 00 - Demolition.
B. Section 31 22 13 - Rough Grading.
C. Section 31 23 18 - Rock Removal.

1.3 DEFINITIONS

A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.

C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

D. Limits of Disturbance: Work area boundary as shown on the Plans.

E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.

F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Clearing, Grubbing and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing and stripping activities at Site.

C. Certification or disposal permit for landfill and/or waste disposal site.

D. A copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

1.5 QUALITY ASSURANCE

A. Existing Conditions: Determine the extent of Work required and limitations before proceeding with Work.

B. Obtain Owner's Representative's approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.

C. Conform to applicable local, state and federal codes for environmental requirements and disposal of debris,

1. Burning on project site will not be permitted.
2. Use of herbicides will not be permitted.

D. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.

E. Protection of Persons and Property: Meet all federal, state and local safety requirements for the protection of laborers, other persons, and property in the vicinity of the work and requirements of the General Provisions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Existing Materials: All materials, equipment, miscellaneous items and debris involved, occurring or resulting from demolition, clearing and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or specifications.

B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown in approved Clearing, Grubbing and Stripping Plan.

B. Remain within the property lines at all times.

C. Do not injure or deface vegetation or structures that are not designated for removal.

3.2 EXAMINATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify waste and salvage areas for placing removed materials.

3.3 PREPARATION

A. Carefully coordinate the work of this Section with all other work and construction.

B. Call Local Utility Line Information service at 1-800-332-2344, not less than three working days before performing Work.

C. Request underground utilities to be located and marked within and surrounding construction areas.

1. Disconnect or arrange for disconnection of utilities (if any) affected by required work.

2. Keep all active utilities intact and in continuous operations.

D. Prepare Site only after:

1. Erosion and sediment controls are in place.

    a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with COP Erosion and Sediment Control Manual and ESC Permits.

2. Tree and vegetation protection is installed.

    a. Protect existing site improvements, trees and shrubs to remain to preclude damage during construction.

3. Temporary fencing is installed along the project limits as shown in the Drawings.

4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

3.4 PROTECTION

A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.

B. Survey control: Protect bench marks, survey control points, and existing structures from damage or displacement.

C. Preservation and Trimming of Trees, Shrubs and Other Vegetation:

1. Avoid injury to trees, shrubs, vines, plants, grasses and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.

2. Protect existing trees and shrubs against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction materials, excavated materials, excess foot or vehicular traffic and parking of vehicles within drip line.

3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.

4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

5. Provide protection for roots and limbs over 1 1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.

6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Owner’s Representative. Cost shall be borne by the Contractor.

D. Landscaped Areas:

1. When any portion of the Work crosses private property or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.

2. Conduct Work in a manner that will restore original conditions as nearly as practicable.

3. Remove and replace any trees, shrubs, plants, sod or other vegetative material as needed to complete Work.

4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.

5. Wherever sod cannot be saved and restored, the ground must be reseeded and cared for until a stand of grass is reestablished.

6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.

7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.

E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, and curbs.

F. Repair and Replacement:

1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

3.5 LIMITS

A. As follows, but not to extend beyond Limits of Disturbance as shown on the Drawings:

1. Reservoir and Booster Station site: Extents shown in Drawings, extending 2 feet beyond permanent site perimeter fencing.

2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.

3. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling shall be permitted in area(s) shown in Drawings and as provided by the Owner.

3.6 CLEARING AND GRUBBING

A. Clear and grub areas within limits shown in approved Clearing, Grubbing and Stripping Plan.

B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.

C. Clearing:

1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds and other vegetative growth within the clearing limits shown in the Drawings, except

those trees and shrubs noted to remain in the Drawings or as directed by the Owner's Representative.

2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the project site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.

3. Clear undergrowth and deadwood, without disturbing subsoil.

D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to the following depths:

1. Future Structures and Building Areas	24 Inches
2. Roads and Parking Areas	18 Inches
3. All other Areas	12 Inches

3.7 TREE REMOVAL

A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.

B. Tree Salvage: As shown on the Plans.

C. No trees may be removed unless approved and permitted by the Owner's Representative.

D. Do not top trees unless otherwise specified or approved by Owner in writing.

3.8 REMOVAL AND DISPOSAL

A. Native vegetation may be mulched and used on Site.

B. Asphalt and Gravel Surfaces:

1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.

2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Owner's Representative.

3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.

C. Remove debris, rock, abandoned piping and extracted plant life from Site.

D. Remove from the Site all debris, materials, equipment and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.

1. All existing improvements designated on the Drawings or specified to be removed including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing and similar structures occurring above, at, or below existing ground surface shall be included in the Work.

2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on site. Leave site in clean condition.

G. Removal: All material resulting from demolition, clearing and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials and debris.

I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

3.9 CLEANUP

A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.

B. All refuse, broken pipe, excess fill material, cribbing and debris shall be removed as soon as practicable.

C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Owner's Representative.

D. The Work will not be considered complete or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Owner's Representative.

END OF SECTION

SECTION 31 22 13

ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes rough grading and filling associated with contouring of Site in preparation for building excavation and subsequent site work.

B. Section Includes:

1. Excavating topsoil.
2. Excavating subsoil.
3. Cutting, grading, filling, and rough contouring of Site.

1.2 RELATED SECTIONS:

A. Section 01 45 00 - Quality Control.
B. Section 31 05 13 - Soils for Earthwork.
C. Section 31 05 16 - Aggregates for Earthwork.
D. Section 31 10 00 - Site Clearing.
E. Section 31 23 16 - Excavation.
F. Section 31 23 17 - Trenching.
G. Section 31 23 18 - Rock Removal.
H. Section 31 23 23 - Fill.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).

5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Soils for Earthwork: As specified in Section 31 05 13, Soils for Earthwork.
C. Aggregates for Earthwork: As specified in Section 31 05 16, Aggregates for Earthwork.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 PRODUCTS

2.1 MATERIALS

A. Subsoil Fill: Type S1 and S2 as specified in Section 31 05 13, Soils for Earthwork.

B. Topsoil: As specified in Section 31 05 13, Soils for Earthwork.

1. Type TS1, Select Native Topsoil Material, as may be available.
2. TS2, Imported Topsoil Material, as may be required.

C. Structural Fill: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

D. Granular Fill:

1. Type A2, Granular Drain Backfill Material, as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

2. Type A3, Select Native Granular Material, as specified in Section 31 05 16, Aggregates for Earthwork. Material to be placed in fill area at north end of Old Airport Road right-of-way.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Notify Owner's Representative of any potential conflicts resulting from utility locations and the Drawings.

3. Notify utility company to remove and relocate utilities, as may be necessary.

B. Identify required lines, levels, contours, and datum.

C. See Section 31 10 00, Site Clearing, for additional requirements in protection of existing utilities, survey control, plant life and landscaped areas in coordination with the Work of this Section.

3.3 TOPSOIL EXCAVATION

A. Excavate and stockpile topsoil as specified in Section 31 15 13, Soils for Earthwork.

3.4 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded as shown in the Drawings.

B. When practical, do not excavate wet subsoil. When wet subsoil must be excavated and is to be reused on site for the Work, process wet material to obtain optimum moisture content.

C. Stockpile excavated material in area designated onsite in accordance with Section 31 05 13, Soils for Earthwork.

D. When excavating through roots, perform Work by hand and cut roots with sharp axe.

E. Benching Slopes: Horizontally bench existing slopes greater than 1:1 to key placed fill material to slope to provide firm bearing.

F. Stability: Replace damaged or displaced subsoil as specified for fill.

3.5 FILLING

A. General:

1. Grading and filling operations shall not take place when weather conditions and moisture content of fill materials prevent the attainment of specified density.

2. Vertical curves or roundings at abrupt changes in slope shall be established as approved by Owner's Representative.

3. Bring all graded areas to a relatively smooth, even grade and slope by blading or dragging. Remove high spots and fill depressions.

B. Fill areas to contours and elevations shown in the Drawings with unfrozen materials.

C. Topsoil Fill:

1. Scarify prepared subgrade to depth of 4 inches immediately prior to placing topsoil.

2. Place topsoil in areas to be seeded to depths indicated in the Drawings, minimum depth of 6 inches.

3. Place topsoil material loose; do not compact, do not place in wet or muddy conditions.

D. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 8 inches compacted depth.
2. Structural Fill: Maximum 12 inches compacted depth.
3. Granular Fill: Maximum 12 inches compacted depth.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise.

G. Make grade changes gradual. Blend slope into level areas.

H. Repair or replace items indicated in the Drawings to remain which are damaged by excavation or filling. All costs shall be borne by the Contractor.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 of a foot from required elevation.

3.7 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

B. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

C. Frequency and location of testing is dependent upon type of material placed. See Section 01 45 00, Quality Control, for testing requirements.

D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

END OF SECTION

SECTION 31 23 16

EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.

B. Section Includes:

1. Excavating for building foundations.
2. Excavating for paving, roads, and parking areas.
3. Excavating for slabs-on-grade.
4. Excavating for site structures.
5. Excavating for landscaping.

1.2 RELATED SECTIONS

A. Section 01 45 00 - Quality Control.
B. Section 02 41 00 - Demolition.
C. Section 31 05 13 - Soils for Earthwork.
D. Section 31 05 16 - Aggregates for Earthwork.
E. Section 31 10 00 - Site Clearing.
F. Section 31 22 13 - Rough Grading.
G. Section 31 23 17 - Trenching.
H. Section 31 23 18 - Rock Removal.
I. Section 31 23 18.20 - Controlled Blasting for Rock Removal.
J. Section 31 23 19 - Dewatering.
K. Section 31 23 23 - Fill.
L. Section 33 11 10 - Water Utility Distribution & Transmission Piping.

1.3 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition or condition of the material encountered. Common Excavation shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation, unless provided as Rock for under Section 31 23 18, Rock Removal.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.

C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.

D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.

E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.

F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory excavation, for the purposes of locating an underground utility and to investigate underground conditions.

G. Rock Removal: As defined in Section 31 23 18, Rock Removal.

H. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.

I. Unsuitable Materials: See Spoils.

1.4 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Excavation support plan and utility protection plan as specified in Section 31 50 10, Excavation Support Systems.

1.6 QUALITY ASSURANCE

A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

B. Provide adequate survey control to avoid unauthorized overexcavation.

C. Weather Limitations:

1. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit shall not be used as fill or backfill until material completely thaws.

2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.7 NOT USED

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Owner’s Representative as to the nature and extent of the differing conditions.

B. Call Local Utility Line Information service at 1-800-332-2344 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

C. Identify required lines, levels, contours, and datum.

D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life and landscaped areas in coordination with Work in this Section.

3.2 PROTECTION

A. Natural Gas Facilities:

1. Note where excavation activities are in the vicinity of existing natural gas lines activities may be restricted.

a. The Contractor shall notify the existing natural gas utility, Cascade Natural Gas (CNG), regarding planned excavation activities within 100 feet of their facilities.

b. The Contractor shall coordinate with CNG as may be required for staff presence during excavation activities near lines.

2. Controlled blasting within the vicinity of natural gas lines shall adhere to the requirements of Section 31 23 18.20, Controlled Blasting for Rock Removal.

3.3 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Owner's Representative to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.4 EXISTING UNDERGROUND UTILITIES

A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.

B. Remove inactive or abandoned utilities from within the project grading limits in accordance with Section 33 11 50, Existing Pipe Abandonment.

C. For sewer and other miscellaneous drainage facilities, fill and plug pipes as follows:

1. General:

a. Remove all structures to a minimum of 3 feet below subgrade, unless otherwise noted.

b. Cover top surface of all abandoned structures with two sheets of nonwoven geotextile, extended at least 1 foot beyond the outside walls of the abandoned manhole, sump, or basin.

c. Plug all abandoned pipes with permanent plugs as specified in Section 33 11 50, Existing Pipe Abandonment.

2. Sumps:

a. Remove existing sediment, soil, and water. Properly dispose of these materials in accordance with the requirements of these specifications.

b. Remove top cone and first solid concrete section to a depth of approximately 8 to 10 feet below ground.

c. Fill sump with CLSM.

d. Backfill remaining voids for facilities within existing or proposed roadways with approved materials meeting the requirements of Section 32 11 23, Aggregate Base Courses.

3. Salvaging Manhole Frames, Covers, and Grates:

a. Remove manhole frames, covers, and grates scheduled for salvage and store in approved location.

b. Frames, grates, and covers meeting Specifications may be salvaged from structures to be adjusted and may be reused in the Work if of suitable size and condition.

c. Replace, at no additional cost to the Owner, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.

d. Clean salvaged components to be reused of foreign material by methods that will not harm the components.

4. Existing Manhole Frames and Covers: Manhole frames and covers removed by the Contractor are the property of the Owner. Notify the Owner's Representative a minimum of 48 hours before removal to arrange for pickup of the removed frames and covers, if not reused.

3.5 PRESERVATION OF EXISTING IMPROVEMENTS

A. Protect adjacent existing structures which may be damaged by excavation work.

1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.

2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Owner's Representative.

3. Do not interfere with 45 degree bearing splay of foundations unless approved by the Owner's Representative.

4. Excavated material shall not be placed adjacent to existing or proposed structures.

3.6 EXCAVATION

A. General:

1. Method of excavation shall be the Contractor’s option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.

2. Excavation by means of controlled blasting shall strictly adhere to the requirements of Section 31 23 18.20, Controlled Blasting for Rock Removal, of these Contract Documents.

3. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Owner’s Representative at no additional cost to Owner.

4. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.

5. Provide all measures to ensure public safety.

B. Control of Water:

1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.

2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor’s expense and backfilled with compacted crushed rock at Contractor’s expense.

3. Grade top perimeter of excavation to prevent surface water from draining into excavation.

4. See additional requirements in Section 31 23 19, Dewatering.

C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.

D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.

1. Allow for forms, shoring, working space, granular base, topsoil and similar items, wherever applicable.

2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.

E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.

1. Fill:

    a. Subsoil Type S1, Select Native Fill, as approved for use by Owner's Representative.

2. Spoils:

    a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.

    b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.

    c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Owner's Representative.

F. Shoring:

1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state and federal laws, codes and ordinances.

2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain and remove such supports in accordance with applicable ordinances and safety requirements.

3. The design, planning, installation and removal of all sheeting, accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.

G. Slope existing banks with machine to angle of repose or less until shored.

1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

2. Protection of excavation side slopes:

    a. Use excavation methods that will not shatter or loosen excavation slopes.

    b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.

c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.

d. Excavation in rock or rocky cuts:

1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.

2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.

3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.

e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.

3. Construct slopes free of all exposed roots.

4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.

5. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

6. Trim all surfaces neatly and smoothly.

H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 17, Trenching and Section 31 23 23, Fill.

I. Notify Owner's Representative of unexpected subsurface conditions.

J. Overexcavation for Unsuitable Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Owner's Representative to secure foundations free from soft, weathered, shattered and loose material or other objectionable materials.

2. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2 inch – 0 gradation, as specified in Table 310516-A of

Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

3. Unsuitable materials shall be removed and replaced only as directed in writing by Owner’s Representative.

K. Rock Removal:

1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.

2. Remove larger boulders and rock material as specified in Section 31 23 18, Rock Removal.

3. Concrete removal, as defined herein, shall be treated as Rock Removal.

L. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

3.7 FIELD QUALITY CONTROL

A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.

B. Coordinate the visual inspection and approval of all bearing surfaces by Owner’s Representative before installing subsequent work.

3.8 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.

B. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17

TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for excavation and backfill of all utilities, including installation of pipe bedding, pipe zone backfill, and trench backfill, and related Work as shown on the Drawings and as specified.

B. Section includes:

1. Excavating trenches for pipe, utility vaults and other utilities.
2. Compacted fill from top of utility bedding to final grades.
3. Trench and utility vault backfilling and compaction.

1.2 RELATED SECTIONS

A. Section 01 45 00 - Quality Control.
B. Section 03 30 00 - Concrete Work.
C. Section 31 05 13 - Soils for Earthwork.
D. Section 31 05 16 - Aggregates for Earthwork.
E. Section 31 10 00 - Site Clearing.
F. Section 31 22 13 - Rough Grading.
G. Section 31 23 16 - Excavation.
H. Section 31 23 18 - Rock Removal.
I. Section 31 23 23 - Fill.
J. Section 31 23 24 - Flowable Fill.
K. Section 31 37 00 - Riprap.
L. Section 33 11 13 - Water Utility Distribution & Transmission Piping.
M. Section 33 41 10 - Storm Utility Drainage Piping.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International:

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

5. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill. Lean cement concrete fill. A self-compacting, cementitious material.

B. Flexible Pipe: For the purposes of these Specifications, tubing between 1/2-inch and 4-inch diameter constructed of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) are considered flexible pipes. HDPE piping 4 inches in diameter and larger is also considered flexible pipe.

C. Geosynthetics: Geotextiles, geogrids, geomembranes, and drainage composite materials.

D. Imported Material: Materials obtained from sources offsite, suitable for specified use.

E. Lift: Loose (uncompacted) layer of material.

F. Obstructions: Items which may be encountered during utility and vault trenching which do not require replacement.

G. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

H. Pipe Bedding: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 6 inches below the bottom outside surface of pipe, conduit, cable or duct bank to the trench foundation so as to uniformly support the barrel of the pipe.

I. Pipe Zone: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 12 inches above the top outside surface of pipe, conduit, cable or duct bank.

J. Pipe Bedding, Pipe Zone and Trench Backfill Classifications:

1. Class A: Backfill with suitable native or imported material that is approved to meet the characteristics required for the specific surface loading or other criteria of the backfill zone.

2. Class B: Backfill with imported granular material consisting of gravel or crushed rock meeting the requirements of this Section and Coarse Aggregate Type A1 as specified in Section 31 05 16, Aggregates for Earthwork; typical designated size shall be 1 inch-0 or 3/4 inch-0.

3. Class C: Backfill with Fine Sand, as specified in Section 31 05 16, Aggregates for Earthwork.

4. Class D: Backfill with approved pit run or bar run material, well-graded from coarse to fine; maximum dimension shall be 3 inches.

5. Class E: Backfill with CLSM. See Section 31 23 24, Flowable Fill.

K. Pothole Excavations: Removal and replacement of all materials via coring, vacuum extraction, or similar method for the purposes of locating an underground utility and to investigate underground conditions.

L. Prepared Trench Bottom: The bottom of the trench on which the pipe bedding is to lie and which provides support for the pipe.

M. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM Standards.

N. Rigid Pipe: For the purposes of these Specifications, pipe constructed of PVC, ductile iron, steel, concrete and clay pipes are considered rigid pipes.

O. Sewer, Pipes, and Mains: Conduits of circular or other geometric shapes, used to convey liquids or gases, or other material.

P. Trench Backfill: Trench backfill zone for full trench width extending from the top of the pipe zone to pavement base rock, ground surface or other surface material.

Q. Trench Stabilization: Removal of unsuitable material in the bottom of a trench and replacement with specified material for support of a pipe, main, conduit, structure, or appurtenances.

R. Utility: Any buried pipe, duct, conduit, or cable.

S. Well-Graded: A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.5 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.

2. Proposed on-site and off-site spoil disposal locations.

3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner’s access to Owner’s facilities impacted by excavation Work.

5. Proposed haul routes.

C. Product Data:

1. Geotextile fabric, indicating fabric and construction.
2. Tracer wire.
3. Connectors for tracer wire and/or marking tapes.
4. Tracer wire locate boxes.

D. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

E. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

F. Concrete: Mix designs in accordance with Submittal requirements of Section 03 11 00, Concrete Work.

1.6 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

1.7 NOT USED

1.8 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

B. Coordinate trenching and utility installation work with other work at utility construction location occurring near or adjacent to specified herein.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S1, Select Native Material as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 psi.

2. Structural concrete as specified in Section 03 30 00, Concrete Work, with compressive strength of 3,000 psi.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Sand: As specified in Section 31 05 16, Aggregates for Earthwork.

F. Trench Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2 inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 ELECTRONIC LOCATING MATERIALS

A. Tracer Wire:

1. Direct burial No. 12 AWG solid, annealed copper-clad steel (CCS) high strength tracer wire.

2. Tensile Breaking Load: 380-pound average.

3. Jacket:

    a. High molecular weight high-density polyethylene complying with ASTM D1248, 30-volt rating.

    b. Color: Provide in colors per Article 2.03 B above.

4. Manufacturer and Product: Copperhead Industries; LLC, 12 CCS high strength reinforced tracer wire, or approved equal.

B. Tracer Wire Connectors:

1. Waterproof, corrosion proof and suitable for No. 12 AWG solid core wire.

2. Prefilled with silicone and suitable for use with low-voltage tracer lines of less than 50 volts.

3. Lug Connectors:

    a. Waterproof plastic housing that encases the silicone prefilled lug terminals.
    b. Manufacturer and Product: King Innovations; DryConnTM Direct Bury Lug or approved equal.

4. Twist Connectors:

    a. Waterproof epoxy-filled packaging that encases the silicone prefilled twist connectors.

    b. Manufacturer and Product: 3M Division; DBY Direct Bury Splice Kit 09053 connectors or approved equal.

C. Ground Wire: No. 12 AWG bare solid copper wire.

PART 3 EXECUTION

3.1 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

3. Maintain and protect above and below grade utilities indicated to remain.

B. Identify required lines, levels, contours, and datum locations.

C. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

D. The site of an open cut excavation shall be first cleared of all obstructions preparatory to excavation in accordance with Section 31 10 00, Site Clearing.

E. See Section 31 10 00, Site Clearing, for additional requirements in protection of existing utilities, survey control, plant life and landscaped areas in coordination with Work in this Section.

1. Intent of Drawings and Specifications is that all streets, structures, and utilities be left in condition equal to or better than original condition.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material, which is satisfactory to Owner.

F. Potholing / Exploratory Test Pits: Dig such exploratory test pits and perform potholing as may be necessary in advance of trenching to determine the exact location and elevation of subsurface structures, pipelines, duct banks, conduits, and other obstructions which are likely to be encountered or need to be connected to and shall make acceptable provision for their protection, support, and maintenance of their continued operation.

G. Paved or Surfaced Streets:

1. Wherever paved or surfaced streets are cut, saw wheel or approved cutting devices shall be used.

2. Width of pavement cut shall be as shown in the Drawings.

3. Any cut or broken pavement shall be removed from site during excavation.

H. Traffic:

1. Maintain street traffic at all times as required by the Drawings and as specified herein.

2. Erect and maintain barricades, warning signs, traffic cones, and other safety devices during construction in accordance with the latest edition of Manual of Uniform Traffic Control Devices (MUTCD), Part 6, to protect the traveling public in any area applicable.

3. Provide flaggers as required during active work in roadway areas.

I. Operations shall be confined to rights-of-way and easements provided. Avoid encroachment on, or damage to, private property or existing utilities unless prior arrangements have been made with copy of said arrangement submitted to Owner's Representative.

3.2 EASEMENTS

A. Where portions of the Work are located on private property, easements and permits will be obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements.

B. Copies of these easements and permits will be available from the Owner for inspection by the Contractor. It shall be the Contractor's responsibility to determine the adequacy of the easement obtained in every case.

C. Confine construction operations to within the easement limits or street right-of-way limits or make special arrangements with the property owners for the additional area required and notify the Owner's Representative with a copy of the written approval from property owners of any such conditions.

D. Any damage to private property, either inside or outside the limits of right-of-way or easements provided by the Owner, resulting from Work shall be the responsibility of the Contractor. Before the Owner's Representative will authorize final payment, the Contractor will be required to furnish the Owner with written releases from property owners where the Contractor has obtained special agreements or easements or where the Contractor's operations, for any reason, have not been kept within the construction right-of-way obtained by the Owner.

3.3 PROTECTION

A. Existing Facilities:

1. It is the intent of these specifications that all streets, structure, and utilities be left in a condition equal to or better than original condition at the completion of the Project.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material to the satisfaction to the Owner's Representative.

3. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

B. Natural Gas Facilities:

1. Note where trenching activities are in the vicinity of existing high-pressure natural gas lines, trenching activities shall be completed with caution and in coordination with Cascade Natural Gas (CNG).

C. Removal of Water:

1. As specified in Section 31 23 19, Dewatering.

2. At all times during construction provide and maintain ample means and devices with which to remove promptly and dispose of properly all water entering the excavations or other parts of the Work.

3. Keep all excavations dry until the utilities or vaults to be placed therein are completed. In water bearing sand, well points and/or sheeting shall be supplied, together with pumps and other appurtenances of ample capacity to keep the excavation dry as specified.

4. Dispose of water from the Work in a suitable legal manner without damage to adjacent property or structures.

D. Trench Protection:

1. Provide the materials, labor, and equipment necessary to protect trenches at all times.

2. Trench protection shall provide safe working conditions in the trench and protect the Work, existing property, utilities, pavement, etc.

3. The method of protection shall be according to the Contractor's design.

4. The Contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided

the method meets the approval of all applicable local, state and federal safety codes.

5. Damages resulting from improper shoring, improper removal of shoring or from failure to shore shall be the sole responsibility of the Contractor.

3.4 LINES AND GRADES

A. Trench excavation for piping, utility vaults and other utilities shall be performed to the alignment and grade as indicated in the Drawings.

B. Where grades are not shown in the Drawings, utilities shall be laid to grade between control elevations shown.

C. Water mains shall be installed with a minimum cover of 48 inches.

D. The Owner's Representative reserves right to make changes in lines, grades and depths of utilities when changes are required for Project conditions.

E. Changes in the grade and horizontal alignment of the pipeline as shown in the Drawings or as provided elsewhere in the Specifications may be necessary due to unanticipated interferences or other reasons.

1. No additional compensation will be allowed the Contractor for changes in horizontal alignment.

2. No additional compensation will be allowed for changes in grade which require additional depth of trench excavation and backfill up to 2 feet from those shown in the Drawings.

F. Use laser-beam instrument with qualified operator to establish lines and grades.

3.5 OBSTRUCTIONS

A. Obstructions to the construction of the trench, such as tree roots, stumps, abandoned pilings, abandoned buildings and concrete structures, logs, rubbish, and debris of all types shall be removed without additional compensation from the Owner.

B. The Owner's Representative may, if requested by the Contractor or Owner, make changes in the trench alignment to avoid major obstructions if such alignment changes can be made within the perpetual easement and right-of-way and without adversely affecting the intended function of the facility or increasing costs to the Owner.

3.6 INTERFERING ROADWAYS AND STRUCTURES

A. Remove, replace and/or repair any damage done during trenching activities to fences, buildings, cultivated fields, drainage crossings, and any other properties without additional compensation from the Owner.

1. Replace or repair these structures to a condition as good as or better than their pre-construction condition prior to commencing work in the area.

B. Paved Roadways:

1. Where paved roadways are cut as part of trenching activities, Class D trench backfill will be required to the bottom of pavement base.

2. New pavement shall be equal to or better than the existing paved surface.

3. New surface shall not deviate by more than 1/4-inch from the existing finish elevation.

C. Existing Structures:

1. If existing structures are encountered as part of trenching activities which will prevent construction and are not adequately shown in the Drawings, the Contractor shall notify the Owner’s Representative before continuing with the Work.

2. The Owner’s Representative may make such field revisions to the utility alignment as necessary to avoid conflict with the existing conditions.

3. The cost of waiting or “down time” during such field revisions shall be borne by the Contractor without additional cost to the Owner or liability to the Owner’s Representative.

4. If the Contactor fails to so notify the Owner’s Representative when a conflict of this nature is encountered, but proceeds with construction despite this interference, the Contractor shall do so at the Contractor’s own risk with no additional payment.

3.7 TRENCHING

A. Excavate subsoil as required for construction of utilities to elevations shown in the Drawings.

B. Trenching within Rock:

1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section. Remove larger boulders and rock material as specified in Section 31 23 18, Rock Removal.

2. Rock removal for utility trenching purposes by means of controlled blasting is strictly prohibited.

C. Open Trench Limit:

1. Do not advance open trench beyond the distance which will be backfilled and compacted the same day.

2. A maximum length of open trench shall not exceed 100 feet at any one time.

3. Temporary resurfacing shall be completed within 300 feet of the associated open trench limit for each main pipe laying operation.

4. Cover or backfill excavations at the end of each day.

5. If the trench is not backfilled at the end of each working day:

   a. Provide means to prevent caving of excavation sides, as necessary, during non-working hours.

   b. Cover the excavation with a system as needed to provide public safety and prevention of entry during non-working hours.

   c. Provide signed and stamped submittal of caving prevention system and cover system.

6. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

D. Utility Crossings: Avoid horizontal and vertical conflicts with existing utilities.

1. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

2. Vertical clearance between the new pipe and existing utilities shall be 12 inches minimum, unless otherwise noted on the Drawings.

3. Where existing utility lines are damaged or broken during trenching activities, the utility shall be repaired or replaced. For water or sewer bearing lines, care being taken to insure a smooth flow line and absolutely no leakage at the new joints.

4. All expenses involved in the repair or replacement of leaking or broken utility lines that have occurred due to the Contractor's operations shall be borne by the Contractor, and the amount thereof shall be absorbed in the unit prices of its bid.

E. Water Lines Crossing Sewer Lines: Whenever water lines cross sewer lines, the Contractor shall comply with local Health Department requirements.

1. Wherever possible, the bottom of the water line shall be 18 inches or more above the top of sewer pipe. One full length of the water line pipe shall be centered at the crossing.

2. For clearances less than 1.5 feet, the Contractor shall replace the existing sewer pipe with ductile iron or PVC of equal size, centered at the utility crossing, or shall encase existing sewer pipe with concrete for a minimum of 10 feet on both sides of crossing, as directed by the Owner's Representative, at no additional cost to the Owner.

F. Excavate trenches to width and depth as indicated on Drawings. No additional payment will be provided for trenching activities beyond dimensions shown in the Drawings.

1. Excavation for trenches in which pipelines are to be installed shall provide adequate space for workers to place and joint the pipe properly and safely, but in every case the trench shall be kept to a minimum width.

2. The width of the pipe trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall not exceed 12 inches on either side of the pipe.

3. Excavation for utility vaults and other structures shall be wide enough to provide 18 inches between the structure surface and the sides of the excavation.

4. For pipe or utility vaults to have bedding material, excavate to a depth of 6 inches below the bottom of the pipe or utility vault. Care shall be taken not to excavate below depths required.

5. If over digging occurs, the trench bottom shall be filled to grade with compacted bedding material.

G. Remove water or materials that interfere with Work.

1. The trench at all times shall be kept free from water to facilitate fine grading, the proper laying and joining of pipe, and prevention of damage to completed joints.

2. Adequate pumping equipment shall be provided to handle and dispose of the water without damage to adjacent property.

3. Water in the trench shall not be allowed to flow through the pipe while construction work is in progress unless special permission to do so has been given by the Owner's Representative.

4. An adequate screen shall be provided to prevent the entrance of objectionable material into the pipe.

5. Remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the improvements.

   a. Where the excavation activities require the removal of portions of an abandoned pipeline, masonry plugs shall be installed in the open ends of the pipe, unless otherwise noted in the Drawings or by the Owner's Representative.

   b. Coordinate with Owner's Representative prior to plugging.

   c. For plugs less than 36 inches in diameter, 8-inch deep masonry units shall be used. For plugs in larger pipelines, 12-inch deep masonry units shall be used.

6. The costs associated with the removal of water and materials noted above will be considered incidental to trench excavation and backfill.

H. Do not interfere with 45 degree bearing splay of foundations.

I. Overexcavation for Unsuitable Trench Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Owner's Representative to secure foundations free from soft, weathered, shattered and loose material or other objectionable materials.

2. Unsuitable materials shall be removed and replaced only as directed in writing by Owner's Representative.

3. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2 inch – 0 gradation, as specified in Table 310516-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

4. Install nonwoven geotextile under trench stabilization material, over the soft or yielding excavated surface.

   a. Install the nonwoven geotextile ahead of placement of the trench stabilization material, continuously along the excavation bottom and centered on the pipe centerline.

b. Use nonwoven geotextile width equal to the pipe diameter plus 2 feet.

c. Place laps or splices in the geotextile in the direction of the pipe laying.

J. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

K. Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic or interfere with the function of existing drainage facilities or system operation.

L. Remove excess subsoil not intended for reuse from site.

M. Stockpile excavated material in area designated on site in accordance with Section 31 05 13, Soils for Earthwork.

3.8 TUNNELING

A. In lieu of open cut trenching as specified above, the Contractor may utilize tunnel methods for installation of pipe where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.

1. The Owner’s Representative must approve tunneling methods prior to utility installation.

2. Where tunneling is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks and other surface improvements whose replacement is avoided by the tunneling method.

3.9 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, new and existing structures, and adjacent and neighboring properties and to prevent caving, erosion, settlement, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

E. Design sheeting and shoring to be removed at completion of excavation work, unless shown otherwise in the Drawings.

F. Construction Sheeting Left in Place:

1. Furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.

2. Construction sheeting and bracing originally intended for temporary installation, placed by the Contractor to protect adjacent and neighboring structures, may be left in place if desired by the Contractor and approved by the Owner's Representative. All such sheeting and bracing left in place shall be included in the cost for excavation.

3. Any construction sheeting and bracing which the Contractor has placed to facilitate its work may be ordered in writing by the Owner's Representative to be left in place. The right of the Owner's Representative to order sheeting and bracing left in place shall not be construed as creating an obligation on its part to issue such orders. Failure of the Owner's Representative to order sheeting and bracing left in place shall not relieve the Contractor of its responsibility under the contract.

4. For sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.

3.10 COMPACTION

A. Testing will be required to show specified densities of compacted backfill are being achieved by the Contractor's compaction methods.

B. Moisture Control:

1. Moisture condition backfill material to within 2 percent of optimum moisture content required for compaction throughout each lift of the fill.

2. Add moisture to granular backfill by sprinkling during compaction operation.

3. Compaction by ponding or jetting is not permitted.

C. Compact all materials and areas that are not accessible for in-place density testing, as determined by the Owner's Representative, in place by whatever equipment and method is practicable or specified, and as approved by the Owner's Representative.

1. Perform compaction at such moisture content as is required to produce well-filled, dense, and firm material in place that will show no appreciable deflection or reaction under the compacting equipment.

3.11 BEDDING

A. All utility vaults, potable water pipe 4-inch nominal diameter and over, all steel pipe, all concrete sewer pipe, all plastic pipe, all pipe under existing or future structures or roadways, and any and all utilities at a depth greater than 6 feet shall be laid in pipe bedding material.

B. Unless otherwise noted in the Drawings, pipe or conduit of less than 4-inch diameter, outside structure lines and at a depth of less than 6 feet shall be bedded in native material properly shaped as specified below, all as detailed on the Drawings.

C. Compacted bedding material shall be placed the full width of the excavated trench to a depth as shown on the trench detail included in the Drawings.

1. In lieu of a detail, the depth shall be 6 inches.

D. Spread the bedding smoothly over entire width of trench to the proper grade so that the pipe is uniformly supported along the barrel.

E. Hand grade and compact each lift to provide a firm, unyielding surface along the entire pipe length. For rigid pipe, compact to at least 90 percent relative compaction.

F. Excavate bell holes at each joint to permit proper assembly and inspection of the joint.

G. Check grade and correct irregularities in bedding material.

H. Center pipes horizontally in trench width.

3.12 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Maintain optimum moisture content of fill materials to attain required compaction density.

D. Place fill material, with the exception of CLSM, in continuous layers and compact in 6 to 8-inch lifts.

1. Prevent pipe from moving either horizontally or vertically during placement and compaction of pipe zone material.

2. Where trenches are under existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on the Drawings or specified elsewhere in these specifications, the trench backfill shall be Class B or

Class E and pipe zone backfill shall be Class B or Class E. Class B backfill shall be compacted to 95 percent of maximum density at optimum moisture content.

3. Where trenches are outside existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on plans or specified elsewhere, the trench backfill shall be Class A and pipe zone backfill in these areas shall be Class B. For these locations, compaction of Class B backfill shall be to not less than 90 percent of maximum density at optimum moisture content. Class B backfill shall be compacted to not less than 95 percent of maximum density at optimum moisture content.

E. Employ placement method that does not disturb or damage nearby or adjacent foundation perimeter drainage or utilities in trench.

F. Do not use power-driven impact compactors to compact pipe zone material.

G. Backfill Immediately: All trenches and excavations shall be backfilled immediately after pipe or conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible, unless otherwise directed by the Owner's Representative.

H. Under no circumstances shall water be permitted to rise in open trenches after pipe has been placed.

I. Do not allow backfill material to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.

J. Use hand compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

K. Placement of Sand:

1. Place medium sand in lifts not exceeding 8 inches in uncompacted thickness.

2. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

L. Placement of CLSM:

1. Discharge from truck-mounted drum-type mixer into trench.

2. Place in lifts not exceeding 2 feet in thickness.

3. No compaction of CLSM is allowed.

4. Use steel plates to protect the CLSM from traffic a minimum of 24 hours. After 24 hours, the CLSM may be paved, or opened to traffic until permanent surface restoration is completed, if it has hardened sufficiently to prevent rutting.

M. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

N. Do not leave trench open at end of working day.

3.13 ELECTRONIC LOCATING FACILITY INSTALLATION

A. Tracer Wire and Terminal Appurtenances:

1. Tracer Wire:

a. Install as shown or directed directly over the pipe centerline and on top of the pipe zone in all sewer trenches, including mainline sewers, service laterals and storm sewer inlet leads.

b. Connect mainline and service lateral tracer wires using either an approved direct-bury lug connector or direct-bury twist connector.

c. Extend tracer wire to locator stations in manholes, locator boxes, storm inlets, or other visually identifiable terminal appurtenances, allowing for access with electronic locating equipment, as shown or directed and according to the following requirements:

2. Locator Stations:

a. Install locator stations as shown within manholes.

b. Mount locator station to manhole wall within 18 inches of manhole rim with two stainless steel expansion anchors.

c. Drill a minimum 3/8-inch diameter hole through the manhole wall within 18 inches of the finish grade of the manhole rim.

d. Extend the tracer wire from the pipe trench in one continuous piece up the outside of the manhole and through the hole and into a locator station and attach to one of the lugs in the locator station.

e. When multiple tracer wires are terminated in manhole install a multilead locator station.

f. Extend a ground wire from the locator station through a minimum 3/8-inch diameter hole in the manhole wall.

g. Install ground wire approximately 3 feet deep and extend from the outside manhole wall a minimum of 3 feet horizontally in any direction.

h. Seal all holes drilled in manhole walls with silicone sealant.

3. Storm Inlet Tracer Wire Termination: Terminate tracer wire inside inlet and directly over storm outlet pipe by placing tracer wire as follows:

   a. Drill a minimum 3/8-inch diameter hole through inlet wall to pass tracer wire through to inside inlet wall.

   b. Seal hole with silicon sealer or material approved by Owner's Representative.

   c. Leave 6 inches of coiled tracer wire along inside of inlet wall approximately 3 inches below the inlet frame and grate or as directed by Owner's Representative.

4. Service Lateral Tracer Wire Termination: Terminate tracer wire at ends of service laterals as shown or directed, as follows:

   a. Termination in Tracer Wire Locate Boxes: Extend the tracer wire in one continuous piece up vertically from the pipe trench and into the bottom of the locate box. Leave 18 inches of coiled tracer wire inside locate box.

   b. Termination at 2-inch by 4-inch Markers: Extend tracer wire in one continuous piece directly up service lateral 2-inch by 4-inch markers and leave 18 inches of tracer wire wrapped around the exposed top end of 2-inch by 4-inch marker.

3.14 VISUAL IDENTIFICATION FACILITIES

A. Tracer Wire Locate Boxes: Install tracer wire locate boxes directly over service laterals at property line, service boundary, or other location as shown or directed by the Owner's Representative.

3.15 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the Owner. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

C. In-place compaction testing of pipeline backfill materials shall be performed at 2-foot elevation increments, one test per 200 lineal feet of pipeline trench as measured along pipe centerline.

1. The Owner’s Representative may reduce the frequency when satisfied with method of compaction.

2. The Owner’s Representative may direct testing at a higher frequency at no additional cost to the Owner upon failure to obtain specified densities or if the Contractor changes compaction equipment or methods of compaction.

3. The Owner’s Representative shall determine all test locations.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

3.16 SURFACE RESTORATION AND CLEANUP

A. Open Trenches: At the end of each work day, all open trenches shall be backfilled and all trenches within streets shall be temporarily paved or covered to the satisfaction of the Owner’s Representative and the local permitting agency.

1. Temporary paving shall be replaced with permanent street paving at the completion of construction within street rights-of-way, or sooner, if deemed necessary by the Owner’s Representative.

2. No gravel-filled trenches shall be left open within the street right-of-way at the end of the workday.

B. Topsoil:

1. Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil to the specified depth and place the material in a stockpile.

2. Topsoil shall not be mixed with other excavated material.

3. After the trench has been backfilled, the topsoil shall be replaced.

C. Clean up and remove all excess materials, construction materials, debris from construction, etc. Replace or repair any fences, mailboxes, signs, landscaping, or other facilities removed or damaged during construction. Replace all lawns, topsoil, shrubbery, flowers, etc., damaged or removed during construction. The Contractor shall be responsible for seeing that lawns, shrubs, etc. remain alive and leave premises in condition equal to original condition before construction.

END OF SECTION

SECTION 31 23 18

ROCK REMOVAL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes removal of subsurface rock during excavation by mechanical method. The removal of subsurface rock by use of explosives to assist in removal is cover in Section 31 23 18.20, Controlled Blasting for Rock Removal.

B. Section Includes:

1. Removing identified and discovered rock during excavation.
2. Suitable Machinery and tools to assist rock removal.

1.2 RELATED SECTIONS:

A. Section 31 22 13 - Rough Grading.
B. Section 31 23 16 - Excavation.
C. Section 31 23 17 - Trenching.
D. Section 31 23 18.20 - Controlled Blasting for Rock Removal.
E. Section 31 23 23 - Fill.
F. Section 31 37 00 - Riprap.

1.3 NOT USED

1.4 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition or condition of the material encountered. All excavation shall be classified as Common Excavation, unless provided for under Rock Removal below.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.

C. Rock: Solid mineral material, including boulders, solid bedrock, or ledge rock, with volume in excess of 1/2 cubic yard or solid material which, by actual demonstration, cannot be reasonably excavated with suitable machinery as defined herein. The Owner’s Representative may waive the requirements for actual demonstration if the material encountered is well-defined rock.

D. Rock Removal: Removal of rock as defined herein by systematic and continuous drilling, hammering, breaking, splitting or other methods approved by the Owner's Representative.

E. Suitable Machinery:

1. A track-mounted hydraulic excavator of the 52,800 to 72,500-pound class equipped with a single shank ripper.

2. A track-mounted rocksaw trencher capable of a minimum trenching depth of 4 feet.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Equipment: Manufacturer information regarding pound class of machinery proposed for rock removal.

C. Survey Report: Submit survey report mapping extent and locations of rock encountered, to be used in calculating total volume of rock removal.

1.6 NOT USED

1.7 PROJECT CONDITIONS

A. Conduct survey of rock uncovered in excavation for structures or trenching for utilities prior to removal of material.

B. Conduct survey and document conditions of buildings near locations of rock removal, and photograph existing conditions identifying existing irregularities.

1.8 SCHEDULING

A. Schedule Work to avoid disruption to occupied buildings nearby.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting Work of this section.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Owner’s Representative Approval for Rock Removal:

1. Prior to commencement of rock removal, expose all material anticipated to be rock by removing the common material above it and then notify the Owner’s Representative.

2. The Owner’s Representative, in association with the Contactor or the Contractor’s representative, will measure the amount of material to be removed in an effort to reach a mutually agreeable volume for anticipated rock removal.

3. Prior to commencing the proposed rock removal, the Contractor must receive written approval by the Owner’s Representative stating the approximate volume of excepted rock removal to receive payment.

4. During rock removal activities, should it become apparent the previously agreed upon volume of rock removal will be exceeded, notify the Owner’s Representative immediately. Should the Contractor proceed with rock removal in excess of the previously agreed upon volume, the Contractor will do so at their own risk and expense.

3.3 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method.

1. Use single shank ripper to fracture rock.
2. Use rocksaw along utility trench limits.
3. Drill holes and use expansive tools and wedges to fracture rock.

B. Cut away rock at bottom of excavation to form level bearing.

C. Remove shaled layers to provide sound and unshattered base for footings and foundations.

D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

E. For vaults and other structures, excavate to the depth necessary to install the structure and to a maximum of 18 inches beyond the outside walls of the vault or structure.

F. Remove excavated materials from site.

G. Correct unauthorized rock removal associated with structural excavations in accordance with backfilling and compacting requirements of Section 31 23 16, Excavation, and as directed by Owner's Representative.

H. Correct unauthorized rock removal associated with utility work in accordance with backfilling and compacting requirements of Section 31 23 17, Trenching, and as directed by Owner's Representative.

I. If material which would be classified as rock as defined herein is mechanically removed with equipment of a larger size than specified as Suitable Machinery herein, it shall be understood that any added costs for the removal of rock by this method shall be included in the unit price for common excavation and not paid for under this pay item. If material which would be classified as rock as defined herein is mechanically removed without hammering, breaking, or splitting, it will be considered common excavation and not paid for under this pay item. If equipment larger than the Suitable Machinery as defined herein is brought on the project site for the sole purpose of rock removal without hammering, breaking or splitting, then such excavation will be considered rock removal.

3.4 ROCK REMOVAL BY CONTROLLED BLASTING

A. Rock removal by means of controlled blasting shall strictly adhere to the requirements of Section 31 23 18.20, Controlled Blasting for Rock Removal, of these Contract Documents.

B. Controlled blasting in rock removal for utility trenching purposes shall be strictly prohibited.

3.5 FIELD QUALITY CONTROL

A. Request visual inspection of foundation bearing surfaces by Owner's Representative before installing subsequent work.

END OF SECTION

SECTION 31 23 18.20

CONTROLLED BLASTING FOR ROCK REMOVAL

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the purchase, transportation, handling, storage, and use of explosives, blasting agents, and blasting accessories in drill-and-blast operations required for rock excavation.

B. The Work covered in this Section includes pre-blast inspections, blast design, evaluation of existing nearby structures, blast limitations, materials, equipment, labor, and supervision for the transportation and storage of explosives, drilling and loading of blast holes, protection of existing facilities, test blasts, blast-effects monitoring, post-blast inspections, and damage repairs.

1.2 RELATED SECTIONS

A. Section 01 45 00 - Quality Control.
B. Section 31 05 16 - Aggregates for Earthwork.
C. Section 31 23 16 - Excavation
D. Section 31 23 18 - Rock Removal.
E. Section 31 23 23 - Fill.

1.3 DEFINITIONS

A. Air Overpressure (also Airblast): Fluctuating changes in ambient air pressure caused by blasting. Airblast is expressed in units of pounds per square inch (psi) or decibels (dB).

B. ANFO: A blasting agent containing no essential ingredients other than prilled ammonium nitrate and fuel oil.

C. Buffer Holes: Holes with reduced energy charges drilled adjacent to smooth wall, trim or open line-drilled holes at the perimeter of the excavation. The explosive charge in buffer holes is generally between 50 and 75% of the charge used in normal production blast holes. Buffer holes are usually drilled parallel to adjacent holes at the excavation perimeter.

D. Backbreak (also Overbreak): Rock broken beyond the limits of the last row of holes. For slope cuts, this is typically the pre-split or trim blast line.

E. Bench: A horizontal ledge from which holes are drilled down into the material to be blasted.

F. Bench Height: The vertical distance from the top of the bench to the floor or the top of the next lower bench.

G. Blast Pattern: The plan of drill holes as laid out for blasting.

H. Blast Site (also Blast Area): The area where explosive material is handled during loading of blast holes.

I. Blasting Mat: A mat of woven steel wire rope, scrap tires, or other suitable material to cover blast holes for the purpose of preventing flyrock.

J. Blasting Supervisor (also Blasting Specialist, Blaster-in-Charge, Blaster): The qualified person in charge of and responsible for the loading and firing of a blast.

K. Blasting Vibration (or Vibration): The energy from a blast that manifests itself in vibrations which may be transmitted through the earth away from the immediate blast area.

L. Burden: The distance from the borehole to the nearest free face, or the distance between boreholes measured perpendicular to the spacing.

M. Cap Scatter: Deviation between the rated firing time and the actual firing time of a blasting cap. A deviation of between 1 and 15 percent of the rated cap period is typical for blasting caps in good condition.

N. Close-in Blasting (also Tight Blasting): Refers to drilling and rock excavation activities in proximity to existing structures, where the distance from the blast hole to the structure is less than or equal to the final excavation depth.

O. Controlled Blasting: Refers to the use of explosives and blasting accessories in carefully spaced and aligned drill holes to produce a free surface or shear plane in the rock along the specified excavation back slope. Controlled blasting techniques include, but are not limited to, pre-splitting, trim blasting, cushion blasting, and line drilling.

P. Cushion Blasting: See Trim Blasting

Q. Delay Interval: The nominal time between the detonation of delay detonators of adjacent periods in a delay series; the nominal time between successive detonations in a blast.

R. Flyrock: Rocks propelled from the blast area by the force of detonation.

S. Free Face: A rock surface exposed to air which provides room for expansion upon fragmentation.

T. Guide Hole: An unloaded hole that is drilled between normally spaced pre-split holes to facilitate controlled blasting by directing the pre-split crack.

U. Line Drilling: A method of controlling overbreak, in which a series of very closely spaced holes are drilled along the perimeter of the excavation. Line holes are generally not loaded with explosives.

V. Maximum Charge Weight per Delay: For purposes of vibration control, any charges firing within any 8-millisecond time period are considered to have a cumulative effect on vibration and airblast effects. Therefore, the maximum charge per delay equals the sum of the weight of all charges firing within any 8-millisecond time period. For instance, if two 10-1b charges fire at 100 ms and one 15-1b charge fires at 105 ms, the maximum charge per delay would be 35 lbs.

W. Misfire: A blast or specific borehole that failed to detonate as planned. Also, explosive materials that failed to detonate as planned.

X. Mudcapping: A mud-covered or unconfined charge fired in contact with a rock surface without the use of a borehole.

Y. Occupied Building: Structure on or off the construction limits that is occupied by humans or livestock.

Z. Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal, and transverse directions. Velocity units are expressed in inches per second (ips).

AA. Pre-Blast Survey: Documentation of existing conditions at structures near an area where blasting is to be conducted.

BB. Pre-Splitting: A controlled blasting technique in which the perimeter charges are detonated first in the firing sequence or as a separate blast ahead of production blasting. This technique is designed to generate a fracture in the plane of the pre-split holes drilled along the perimeter of the excavation.

CC. Precision Presplitting: A specialized method of pre-splitting described by Konya (2015) where the strength of the explosive is adjusted to fail the web of rock between holes with the minimum energy required so as not to damage the perimeter rock surface.

DD. Primary Initiation: The method whereby the blaster initiates the blasts from a remote and safe location.

EE. Production Holes: Blast holes in the main body of the rock mass that is being removed by drilling and blasting.

FF. Production Blasting: Refers to rock fragmentation blasts resulting from more widely spaced production holes, drilled throughout the main area adjacent to the perimeter line.

GG. Residential Building: Includes single and multi-family dwellings, hotels, motels, and any other structure containing sleeping quarters.

HH. Scaled Distance: The distance from a blast measured in feet, divided by the square root of the charge per delay period measured in pounds. These "square root" scaled distance values are used in calculations regarding ground vibration prediction and control. For airblast calculations, cube root scaling is used whereby distance is divided by the cube root of the maximum charge per delay.

II. Secondary Blasting: Blasting to reduce the size of boulders resulting from a primary blast.

JJ. Spacing: The distance between boreholes. In bench blasting, the distance is measured to the free face and perpendicular to the burden.

KK. Slurry: An explosive material that generally consists of an aqueous solution of inorganic oxidizer fuel, and a thickener. Slurry explosives can be packaged in cartridges or delivered in bulk. Also referred to as water gel or emulsion.

LL. Stemming: Crushed stone, tamped clay or some other inert earth material placed in the unloaded collar area of blast holes for the purpose of confining explosive charges and limiting rock movement and airblast.

MM. Sub-drilling: The portion of a blast hole that is drilled below or beyond the desired excavation depth or limit or final lines and grades. Subdrilling is typically utilized to prevent high or tight areas of unfractured rock between blast holes.

NN. Trim Blasting (also Cushion Blasting): A controlled blasting technique similar to pre-splitting, except that the trim blast is timed to fire after the production round. Trim blast holes are generally lightly loaded. The spacing of trim blast holes is commonly greater than is typical for pre-splitting.

OO. Precision Trim Blasting: A specialized method of pre-splitting described by Konya (2015) where the strength of the explosive is adjusted to fail the web of rock between holes with the minimum energy required so as not to damage the perimeter rock surface.

PP. USBM RI 8507 PPV Frequency Plot: A plot of measured peak particle velocity vs. measured frequency on logarithmic horizontal and vertical scales, examples of which are shown in Appendix A of "Structure Response and Damage Produced from Surface Mine Blasting", U.S. Bureau of Mines, Report of Investigation 8507, by D.E. Siskind, et al, dated 1980.

1.4 REFERENCES

A. General

1. Specific laws and regulations listed below are provided for general reference and shall not relieve the Contractor from the responsibility of knowing about and complying with all applicable regulations associated with the Work.

B. Laws and Regulations

1. United States Code (U.S.C.): 18 U.S.C. 40 – Importation, Manufacture, Distribution and Storage of Explosive Materials

2. U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF): 27 CFR 555 – Commerce in Explosives and ATF Explosives Rulings, Latest Revision.

3. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA): 29 CFR 1910.109 – Explosives and Blasting Agents and 29 CFR 1926 Subpart U – Blasting and the Use of Explosives.

4. U.S. Department of Transportation (USDOT): 49 CFR, Parts 146-149, 171-179, 383, 385, and 390-397.

5. Idaho Division of Building Safety, General Safety & Health Standards: Section 320 – Blasting and Use of Explosives.

6. International Society of Explosive Owner’s Representatives (ISEE), 2011, Blaster’s Handbook, 18th edition

7. Konya, C.J., 2015, Rock Blasting and Overbreak Control, 5th edition

1.5 SUBMITTALS

A. The following Preconstruction Submittals shall be provided for review by the Owner’s Representative at least 30 days prior to starting drilling and blasting operations, including test blasts.

1. Blasting Safety Plan

a. The Contractor shall prepare and submit a Blasting Safety Plan. The Blasting Safety Plan must be approved prior to conducting any blasting operations, and before any explosives, blasting agents, primers, or initiators are delivered to the job site.

b. The Blasting Safety Plan shall be specific, detailed and address all safety issues pertinent to the project site. Generic plans simply stating that "all regulations will be followed" will not be acceptable.

c. The Blasting Safety Plan shall include:

   1) A complete description of the warning, clearing and guarding procedures that will be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. This information will include details regarding visible warning signs or flags, audible warning signals, method of determining blast areas (all areas affected by potentially harmful blast effects), access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the blaster-in-charge will communicate with site security guards.

   2) Detailed description of how explosives will be stored, transported, and used at the project work site(s). Plans will explain how storage magazines and explosive transport vehicles will satisfy all applicable ATF, OSHA, federal, state, and local laws and regulations. This plan will also indicate how explosives will be inventoried, secured, and guarded to prevent theft or unauthorized use. This plan shall include a detailed description of how the Contractor shall provide 24-hour security for any explosive magazines located on the Right-of-Way or other Railroad property.

   3) Safety Data Sheets (SDSs) and specific details about hazard communication programs for employees.

   4) A description of the description equipment that will be used to monitor the presence of lightning and the approach of electrical storms, and in the event of such, evacuation and site security plans.

   5) Detailed contingency plans for handling of misfires caused by cutoffs or other causes.

   6) Fire prevention plan details, including, smoking policies, procedures and limitations for work involving any open flames or sparks, description and location of all firefighting equipment, and firefighting and evacuation plans.

   7) A description of the Contractor's initial and ongoing blasting and fire safety training programs.

   8) Description of the personal protective equipment that will be used by the Contractor's personnel, including but not limited to, safety glasses, hard-toe footwear, hard hats, and gloves.

9) Methods for preventing spills or losses of explosives, drilling fluids, oil, or any other pollutants to either ground or surface water during all handling and hole charging operations. Include details of all containment methods and contingency plans for quickly and effectively cleaning up any spilled materials.

10) A copy of all applicable federal, state, and local laws, codes, regulations, and ordinances pertaining to blasting and storage of explosives.

11) A copy of the approved Blasting Safety Plan shall be maintained on site at all times when blasting activities are ongoing and/or when explosives are stored on site.

2. Emergency Response Plan:

   a. The Contractor shall prepare and submit an Emergency Response Plan which shall be submitted and approved prior to bringing any explosive materials onto the project site. The Emergency Response Plan shall include the following:

      1) A description of specific actions to be taken by the Contractor in the event of spillage, loss, or theft of explosives.

      2) Types and quantities of explosive materials and storage locations on Railroad property or within the right-of-way.

      3) Points of contact and telephone numbers for local emergency response agencies.

3. General Blasting Plan

   a. The Contractor shall prepare and submit a General Blasting Plan that includes a description of intended storage, transportation, handling, placement, and usage of explosive materials.

   b. The Contractor's blasting consultant shall assist the Contractor in preparation of this plan and shall spend at least 24 hours in development and review of this plan.

   c. The General Blasting Plan shall be submitted under a signed letter from the blasting consultant stating that the Blasting Consultant has reviewed the plan.

   d. The General Blasting Plan shall be revised and reviewed by the Contractor’s Blasting Consultant anytime the Contractor significantly changes drilling and blasting methods.

e. The General Blasting Plan shall include:

1) Details of controlled blasting techniques. Include plan and cross-section section drawings showing hole locations, spacing, diameter and loading details for production blast holes, buffer holes, and pre-split, guide, or trim blast holes.

2) All blast plan drawings shall indicate explosive types, amounts, priming method, initiator types, delay periods, and locations, charge firing times, stemming type and quantities, and typical charge weights.

3) Methods of drilling, including equipment descriptions, hole alignment techniques and measures that will be used to prevent excessive deviation of drilled holes.

4) Method of surveying and establishing excavation limits, final grades, and tolerances.

5) Hole Charging Methods, including primer make-up, placement of charges and inert stemming and method of securing detonators until tie-in.

6) Initiation system hook-up and primary initiation methods.

7) Methods of safe and approved disposal of all explosive packaging materials.

8) Method of informing the Owner's Representative and Airport of the Contractor's blasting schedule.

9) Plans for preventing damage to nearby existing and newly constructed facilities, including but not limited to: utilities, bridges, piers, buildings and drainage structures. The Contractor's Blasting Consultant shall inspect, establish, and monitor Peak Particle Velocity and Airblast limits for each existing structure within the Right-of-Way and include appropriate measures to prevent damage to such structures.

10) A description of blast monitoring equipment and a listing of individuals who will operate such equipment. Submittal shall indicate that all equipment meets the requirements contained in this specification.

11) A description of specific measures taken to maintain good public relations with nearby residents and public agencies that own or use nearby property, and the measures that the Contractor shall take to respond to any complaints about drilling and blasting operations and effects.

12) Communications and coordinating all blasting operations with the Eastern Oregon Regional Airport and shall obtain permission from the Airport's Representative with regards to the timing of blasting operations.

f. Review of the blasting plan by the Owner's Representative shall not relieve the Contractor of his responsibility for the accuracy and adequacy of the plan when implemented in the field.

4. Personnel Qualifications

a. Blasting Supervisor (Blaster-in-Charge)

1) A detailed description of the education, training, and experience of all proposed persons that will be immediately in charge of drilling and blasting operations demonstrating compliance with the requirements of this Section.

2) A list of any lawsuits that were the result of property damage or personal injuries associated with blasting to which the Blaster-in-Charge has been a party, and the results of those suits. This shall include any suits which were settled out of court.

3) The Contractor's' submittal shall include names, addresses and telephone numbers of at least three persons who can verify prior successful experience for each Blasting Supervisor.

4) Separate qualifications shall be submitted for each Blasting Supervisor (Blaster-in-Charge).

b. Blasting Consultant

1) The qualifications of the recognized blasting consultant(s) whom the Contractor plans to retain to facilitate the development or review of all blasting designs and blast-effect control measures.

2) The Contractor's' submittal shall include names, addresses and telephone numbers of at least three persons who can verify prior successful experience for the Blasting Consultant(s).

5. Product Data

a. Safety Data Sheets and Manufacturer's Product Information (cut sheets) for all explosives, blasting agents, primers and initiator products, blasting devices, lightning detectors, seismographs, blasting mats, and all other blasting equipment. This information may be included in Blasting Safety Plan and/or General Blasting Plan submittals.

b. A description of the software to be used to interpret blast-induced vibration and air overpressure. If subsequently requested by the Owner's Representative, provide a copy of the software and/or user manual.

B. The following are to be submitted to the Owner's Representative at least 14 days prior to commencing blasting operations and do not require the Owner's Representative's approval:

1. Copies of licenses or certificates for each Blaster-in-Charge as required by federal, state or local laws, regulations, and ordinances.

2. Copies of letters to owners of nearby private and public utilities notifying them of the Contractor's intention to conduct drilling and blasting operations, if required by any federal, state, or local laws, regulations, and ordinances.

C. The following Progress Submittals shall be provided to the Owner's Representative for review within the timeframes listed.

1. Individual Blast (Shot) Plans:

a. The Contractor shall prepare and submit Individual Blast (Shot) Plans for each blast at least 24 hours prior to drilling any blast holes. No loading of any explosives shall be permitted until the individual blast plan has been approved by the Owner's Representative.

b. Individual Blast Plans for Test Blasts shall be prepared with the assistance of and submitted under a signed letter from the Contractor's Blasting Consultant. The Blasting Consultant is not required to sign the Individual Blast Plans for production shots, provided they are signed by an on-site blasting supervisor.

c. Acceptance by the Owner's Representative shall not relieve the Contractor of responsibility to produce satisfactory results as set forth in these specifications.

d. Individual Blast Plans shall be numbered in sequence and include the following information:

1) The proposed date and time of the blast.

2) Scaled plan view and cross section drawings showing the location, orientation, number, diameter, and length of blast holes relative to stations, slopes and elevations indicated.

3) The amount, type, diameter, weight, and linear loading density of explosives in all blast holes.

4) Maximum weight of explosive per hole or decked charge, total weight of explosives used, maximum charge weight per delay and powder factor.

5) Drawings or plan text shall clearly show detonator types, delays, quantities and charge firing times.

6) Proposed locations of seismographs to be used for monitoring blast effects.

7) Measures to control flyrock, vibration, and air-overpressure.

e. For steep slopes located near existing structures where blasted material may impact the structure, the Contractor shall include in the Individual Blast Plan any site- or location-specific measures required to avoid damage to the structure.

f. If the Contractor intends to blast within 100 feet of concrete aged less than 28 days, a plan prepared by the Contractor's Blasting Consultant indicating details of controlled blasting techniques that will be used to prevent damage to the concrete shall be submitted to the Owner's Representative.

1) These plans shall indicate the age of the concrete-at the time of blasting, and include calculations indicating levels of expected strain in the concrete.

2) Plans shall also indicate how concrete strain levels and peak particle velocities for such blasting will be monitored and reported to the Owner's Representative.

2. Post-Blast Reports

a. The post blast report is an as-built record of each blast. It shall be submitted within 24 hours of a blast and prior to loading of any subsequent holes. The reports shall be numbered in sequence and include the following information:

1) Printed air blast and ground vibration monitoring data from all seismographs. Upon request, the Contractor shall submit copies of digitally recorded blast monitoring files to the Owner's Representative.

2) A written description of any deviations between the information contained in the corresponding Individual Blast Plan as it was drilled, loaded, delayed, initiated, and fired.

3) Drilling logs of the blast holes, including the total footage of pre-split, guide, and trim blast holes.

4) A copy of the digital video recording of each the blast.

b. Post-Blast Reports shall be signed by the Blasting Supervisor.

3. Test Blast Evaluations

a. Within 7 days after each test blast, the Contractor shall submit to the Owner's Representative, a report prepared by the Blasting Consultant that contains the Blasting Consultant's evaluation of the test blast and any recommendations to improve the Contractor's drilling and blasting practices.

1.6 BLASTER QUALIFICATIONS

A. General

1. All blasters and supervising blasters-in-charge shall be properly qualified and licensed in accordance with applicable federal, state, and local government laws, regulations, and ordinances.

2. The Contractor shall not allow prohibited persons as defined by ATF (27 CFR 555) to transport, handle, or use explosive materials.

B. Blasting Supervisor (Blaster-in-Charge)

1. Blasting Supervisors (Blasters-in-Charge) shall have a minimum of 5 years of demonstrated experience, directly related to controlled blasting, non-electric surface blasting of similar nature and other demonstrated experience of satisfactory performance on previous jobs.

2. All blasting supervisors shall be able to document supervision of the completion of at least three projects with satisfactory results of similar scope and complexity.

3. Unless a variance is approved by the Owner's Representative, the blasting supervisor shall each have completed at least five 8-hour days of classroom training within the past 5 years related to controlled and production blasting methods, practices, and design.

1.7 QUALITY ASSURANCE

A. The Contractor shall retain the services of an experienced blasting consultant for the duration of the project. The blasting consultant shall be an independent consultant who derives his primary source of income from providing specialized blasting consulting services and shall not be an employee of the contractor nor an explosive distributor.

B. The Blasting Consultant shall have at least 10 years of experience in preparing controlled blasting designs, blast effects monitoring, and maintaining good public relations. This experience shall include specific experience with surface blasting using non-electric initiation on at least 5 projects of similar scope and complexity. Experience with blasting adjacent to natural gas facilities is highly desirable.

C. The blasting consultant shall have successfully completed at least two-years of college level courses in science or engineering or equivalent continuing education and training, and demonstrate an understanding of geology, controlled blasting methods, and blast effects monitoring.

D. The retained blasting consultant shall inspect the work site prior to blasting, assist the Contractor in development of the General Blast Plan, assist the Contractor in blast effects monitoring, and be on site during test blasts.

E. If requested by the Owner's Representative, the Contractor shall make the Blasting Consultant available to conduct a one-day, on-site visit during each month that blasting operations are being conducted.

1.8 PROJECT REQUIREMENTS

A. Blasting Operations

1. The Contractor shall comply with all laws, ordinances, applicable safety code requirements, and regulations concerning the handling, storage, loading, preparation, and usage of explosives and blasting agents and protection of life and property. The Contractor's safety manager shall ensure that ongoing blasting work complies with all applicable regulations.

2. The firing systems for the general blast holes shall be controlled using delay detonators. Explosives used for a single period of delay shall be the minimum required. Blast designs shall consider the potential for cap scatter when selecting the delay timing.

3. Blast designs shall include measures to prevent misfires and ensure complete detonation of all explosives. If any products or methods are causing excessive cutoffs or other forms of misfires, the Owner's Representative may require the Contractor to suspend the use of problematic products or methods. All associated costs of redesigned blasts or delays caused by this action will be at the Contractor's expense.

4. The methods of handling, storage, preparation, transportation, and usage of explosive shall be selected to minimize occurrences of spillage or loss of any explosives, oils or other pollutants.

5. Blasting operations, including the initial test blasts, shall be scheduled to minimize disturbance to ongoing nearby operations. The Contractor shall be responsible for coordinating all blasting operations with the Eastern Oregon Regional Airport and

shall obtain permission from the Airport's Representative with regards to the timing of blasting operations.

6. Close-in blasting is not anticipated for this project. Close-in blasting may require additional measures, evaluation of structures, and blasting methods not contained in these specifications. No close-in blasting will be allowed without the approval of the Owner's Representative.

7. The blasting methods and products selected and blast and shot patterns shall:

    a. Be sufficient to complete the excavation to the lines and grades shown on the plans to the specified tolerances without producing unacceptable overbreak and with the least disturbance to adjacent material.

    b. Limit the explosive charges to the minimum required for removal of material by excavating equipment.

    c. Minimize the production of fumes, dust, airblast, flyrock, and ground vibrations to not result in the annoyance of nearby residents.

8. Limit blasting vibrations (peak particle velocities) and airblast as follows:

    a. Vibration

        1) Unless a variance is approved by the Owner's Representative, the Peak Particle Velocity measured at the closest existing structures on the project site, including bridges, piers, drainage structures, buildings, and new construction shall not exceed 4 inches per second (ips).

        2) Unless a variance is approved by the Owner's Representative, the Peak Particle Velocity measured at adjacent exposed or buried structures (including groundwater wells), equipment, pipelines, buildings, and private, public, community, or institutional buildings located off the project site shall not exceed 0.75 inches per second (ips).

        3) Vibrations measured on the ground at 100 feet from the blast shall not exceed 4.0 inches per second.

    b. Airblast

        1) In no case shall blasting noise (air-overpressure or airblast), measured near the nearest occupied building located either on or off the project site exceed 133 dB.

9. Control flyrock so that it does not project past the guarded area of the shot or off the project site (either on the fly or by rolling after initial impact). Flyrock shall not result in personal injury or unacceptable damage to property or the Work.

B. Structure Protection and Inspection

1. Blasting shall not result in damage to buildings, structures, underground or overhead utilities, and highways due to blasting-induced ground vibrations, airblast, or flyrock.

2. Nearby structures shall be physically protected whenever the use of explosives has the potential to cause any material disturbed by blasting activities to come in contact with the structure. The method of protection shall be durable enough to prevent the structure from being damaged by flyrock or debris generated by the blast.

3. The Contractor shall also inspect any steep slopes located close to and above structures for loose material that may have been created by blasting that could fall and damage the structure. The Contractor shall remove any such material to the satisfaction of the Owner's Representative.

C. Production of Riprap and Aggregates

1. Consideration shall be given to designing blasts that will produce fractured rock suitable for use as riprap and/or suitable for processing to produce other aggregates, subject to the following:

    a. The rock meets the specified physical and durability requirements.

    b. Production of riprap and aggregates is technically, operationally, and economically practical within the limitations and requirements of this Section.

D. Natural Gas Facilities:

1. Note where controlled blasting activities are in the vicinity of existing natural gas lines activities may be restricted.

    a. It is anticipated no blasting of materials shall be allowed with 35 feet of existing natural gas mains. Be aware the owners of existing natural gas facilities reserve all rights to be more restrictive than this.

    b. The Contractor shall submit all data for planned blasting to Cascade Natural Gas (CNG) on CNG's Explosives Near Gas Facilities form. This form is included in the Supplemental Information section of the contract documents.

c. Controlled blasting in the vicinity of existing natural gas facilities shall be strictly prohibited without the signed authorization from CNG.

1.9 PUBLIC RELATIONS

A. At request of the Owner's Representative and prior to any blasting on site, the Contractor's representative shall meet with owners of private property located off the project site to inform them about anticipated drilling and blasting operations and answer any questions they may have with regards to blast effects such as vibration, air-blast overpressure, and flyrock. The Contractor shall make the blasting consultant available to attend this meeting.

1.10 PREPARATORY MEETING

A. Prior to commencing any blasting activities (including mobilization of magazines or delivery of explosives to the site), the Contractor, including the Blaster(s)-in-Charge and all field personnel to be involved in blasting activities shall meet with the Owner's Representative(s) to review the plans and specifications, work plans, and submittals. Drilling and blasting may commence upon approval of all required Submittals and after the completion of the Preparatory Meeting.

PART 2 PRODUCTS

2.1 EXPLOSIVE MATERIALS

A. Only fully non-electric blasting systems shall be used. Cap and fuse method shall not be allowed.

B. Only explosives in cartridges, prepared by the explosive's manufacturer shall be used. The use of bulk explosives will not be allowed for this project. Partial cartridges may be acceptable if approved by the Owner's Representative.

C. Explosives, blasting agents, primers, initiators, and ancillary blasting materials shall be kept in original packaging with clearly marked date codes. All explosives and initiating devices used shall be less than one year old. No blasting product shall be brought to the job site if the date code is missing or illegible.

D. If the Owner's Representative determines that a blasting product appears to be in a damaged or deteriorated condition, the suspect product shall not be used until its condition can be determined. Products found to be damaged or in a deteriorated condition shall be immediately returned to the supplier for safe disposal.

2.2 BLASTING MATS

A. Blasting mats shall be a commercially manufactured product specifically designed for control of flyrock, and may consist of steel wire rope, steel wire rope and rubber, sisal rope, or manila rope.

B. Blasting mats shall be in serviceable condition, as determined by the Owner's Representative.

2.3 BLASTING MONITORING EQUIPMENT

A. Equipment for on-site and off-site particle velocity and air overpressure monitoring shall be four channel (one overpressure and three seismic channels) units capable of digitally storing collected data. Equipment must be capable of printing ground motion time histories and summaries of peak motion intensities, frequencies, and USBM RI8507 PPV Frequency Plots. Printed report records must also include date, time of recording, operator name, instrument-number and date of last calibration. In addition, seismographs shall conform the following requirements:

   1. Instruments shall have a frequency response between 2 and 250 Hz for particle velocity and a flat frequency response from 2 to 200 Hz for air overpressure.

   2. The digitizing sampling rate for peak particle velocity and air overpressure measurements shall be least 1,024 samples per second.

   3. Seismographs shall be capable of performing a self-test of velocity transducers and printed event records shall indicate whether or not the sensor test was successful.

   4. Seismographs shall be capable of recording overpressure from 88 to 148 decibels (dB), and particle velocity from 0.005 to 5.0 in/sec.

   5. Seismographs shall have adequate memory to record events, on all measurement channels for a time period equal to maximum planned blast duration plus one second.

   6. All seismograph software systems shall be capable of saving or exporting back-up copies of all event files in a format supported by the software submitted by the Contractor for interpretation of blast-induced vibration and air overpressure.

B. Digital video camera equipment capable of recording in high-definition (minimum 1080p). The video camera shall have a field of view and zoom that will allow the entire blast area to be recorded.

2.4 LIGHTNING DETECTION EQUIPMENT

A. Lightning Detection equipment shall be capable of detecting lightning for a distance of at least 50 miles from the site.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. An Individual Blast Plan shall be submitted and approved by the Owner's Representative for each blast prior to commencing drilling of blast holes.

B. Prior to commencing drilling and blasting operations, the Contractor shall establish adequate survey control for the layout of all line drill, pre-split, trim blasting, and production holes. The horizontal and vertical control for all pre-split, smoothwall, and production holes shall be such to assure that all blast holes are drilled on the specified pattern and the location and to the depths as indicated on the Individual Blast Plan.

C. For all final rock slopes greater than 10 feet in height, rock excavation shall utilize controlled blasting techniques to prevent overbreak and minimize damage to the final rock face. Blast patterns shall be designed so that the explosive energy is directed toward the developed free face and not into the back or sidewalls of the excavation.

D. The Contractor may need to employ special measures to protect structures from flyrock and blasted rock. These measures are subject to approval by the Owner's Representative.

E. The Contractor shall perform blasting operations in a manner to minimize air-overpressure and ground motion near on-site structures. If blast-induced air overpressure or particle velocity exceeds the performance requirements specified herein, blasting shall be suspended until a re-designed blasting plan is submitted to and approved by the Owner's Representative.

F. Excavation Limits and Tolerances

1. Unless otherwise indicated, final rock faces created by pre-splitting or trim blasting shall not deviate by more than 1.0 foot from a plane passing through adjacent drill holes, except where the character of the rock is such that, as determined by the Owner's Representative, irregularities are unavoidable due to geologic conditions. The tolerance will be measured perpendicular to the plane of the slope.

G. Flyrock Control

1. Blasting mats shall be placed over faces or breakouts to be blasted as required to protect existing structures, new construction, personnel, and equipment from flyrock.

2. If flyrock projects outside of the guarded area of the blast, the Contractor shall file a report to the Owner's Representative explaining the cause of the flyrock and methods to be employed on the subsequent blasts to reduce the throw of flyrock. The Owner's Representative shall review the report and approve the proposed modifications before any subsequent blast holes are drilled.

3. If flyrock projects outside the project area or damages property, all blasting operations shall cease until the Contractor's Blasting Consultant reviews the incident. The Blasting Consultant shall submit a report to the Owner's Representative describing the cause of the incident and provide a recommended corrective solution. The Owner's Representative shall review the report and approve the proposed modifications before any subsequent blast holes are drilled.

H. Lightning Protection

1. The Contractor shall maintain and operate lightning detection equipment during the entire period of blasting operations or whenever explosives are present on the site.

2. When the detection equipment indicates a lightning strike within 50 miles of the site, the Blaster-in-Charge shall evaluate the hazard to blasting operations and be prepared to terminate the loading of blastholes, clear the area of all personnel, and guard the shot until the hazard has passed.

I. Misfires

1. After a blast has been fired, the Blasting Supervisor and one assistant under his direct supervision shall make a careful inspection of the blast area. The Owner's Representative's representative may be present for this inspection. Inspections shall determine whether there are any indications that a misfire might have occurred or whether the blast created any other imminent dangers (such as unstable ground conditions).

    a. If misfires or other dangerous conditions are found, the Blasting Supervisor shall secure the area and safely correct all hazards before any other work is allowed in the affected area.

    b. If the misfire poses a problem that cannot be safely corrected by the Blasting Supervisor, a consultant or explosive company representative skilled in the correction of misfires shall be called to rectify the problem.

c. The all clear signal, allowing other work to resume in the area, shall not be given until affected blast site is clear of all hazards.

J. Other Limitations:

1. Blasting shall not be permitted when in the opinion of the Owner’s Representative it may be detrimental to existing structures. The Owner’s Representative's decision will be final.

2. Whenever, in the opinion of the Owner’s Representative, proposed blasting may cause harm to persons, cause damage to structures, or create unacceptable rock instability, cease blasting immediately and review the blast design. The Contractor may resume excavation of the rock with an approved re-designed blast plan or by mechanical means.

3.2 BLASTING SCHEDULE

A. Blasting shall be performed only within the period of time occurring 30 minutes after dawn and 30 minutes before sunset. No nighttime blasting will be allowed, unless it is authorized under special circumstances with the express approval of the Owner’s Representative.

B. Placement and detonation of explosives shall, to the extent reasonably possible, take place during the same work shift. Explosives shall never be placed one day and left overnight for detonation on a subsequent day.

3.3 DELIVERY, STORAGE, AND HANDLING OF EXPLOSIVES

A. Comply with federal, state, and local laws, regulations, and ordinances, applying to the purchase, transportation, storage, handling, and use of all explosive materials.

B. Where explosives are transported on public roads, the carriage shall be in accordance with applicable federal, state, and local laws, regulations, and ordinances.

1. The Contractor shall be solely responsible for compliance with all applicable laws, regulations, and ordinances. If a conflict exists, the strictest requirement shall apply.

C. On-Site Storage:

1. The location, access, and construction of explosive storage magazines and day-use magazines shall be in accordance with ATF 27 CFR 555 and all other applicable federal, state, and local laws, ordinances, and regulations.

2. The location of the on-site storage facilities shall be no less than 100 feet away from any stream, body of water, or spring located on or off or adjacent to the site.

3. No more than a one-week supply of explosives shall be stored on site at any time.

4. All second-class magazines used for day storage shall be located at least 150 feet from active work areas.

5. Maintain inventory control of all blasting equipment and supplies. Copies of inventory logs shall be kept as required by ATF rules and be made available for review at the request of the Owner's Representative.

6. Storage places shall be identified with signs stating clearly and boldly, DANGEROUS EXPLOSIVES.

7. Signs shall be attached to poles in plain sight from all approaches to the magazine sites. Signs must not be attached directly to magazines. Signs shall also include the warning "Never Fight Explosive Fires."

D. Explosive Losses

1. The Contractor shall use care to prevent the loss of any explosives, oils or other pollutants to the ground, groundwater, or surface water as a result of spillage, misfires, or any other cause. If, in the Owner's Representative's judgment, poor handling practices or blasting malfunctions cause excessive losses of explosives, oils, or other pollutants, blasting activities shall cease until the Owner's Representative approves a revised explosive loss prevention plan.

2. If any explosives or other pollutants are spilled, immediately clean up the spilled explosives and dispose of them in accordance with the Contractor's Emergency Response Plan.

3. Spills of any amount shall be immediately reported to the Owner's Representative.

3.4 PREPARATION AND PROTECTION

A. Prior to commencing drilling and blasting operations, the Contractor shall provide written notice of planned blasting operations schedule and receive written approval for the following parties:

1. City of Pendleton Public Works Department

2. City of Pendleton Police Department

3. City of Pendleton Fire Department

4. Eastern Oregon Regional Airport at Pendleton

B. Prior to initiating blasting operations, the Contractor shall provide 48 hours' notice, and a 30 minutes' notice, to the City of Pendleton's Public Work Department and the Owner's Representative. The Owner's Representative shall coordinate notification of impending blasting operations to all parties noted in Paragraph 3.4(A).

C. Warning systems, procedures, and protection devices shall be established prior to blasting. Warning systems shall comply with applicable local, state, and federal requirements, and shall include, at a minimum:

1. A system of audible signals to warn of impending blasts. The following audible signals shall be sounded:

    a. A Warning Signal shall be sounded 5 minutes prior to the Blast Signal

    b. A Blast Signal shall be sounded 1 minute prior to initiating the blast

    c. An All-Clear Signal after the Blasting Supervisor has inspected the blast determined that the area is clear of all hazards.

2. Signboards and flags indicating areas where blasting operations are occurring.

    a. Signs shall be clearly visible and legible from all points of access to the area and shall clearly describe the audible signal system for warning of impending blasts including the length and nature of audible blast warning and all clear signals.

D. The blaster-in-charge shall determine when to sound the Warning Signal. Blasting will be performed only after ensuring that all people and equipment have been removed to a safe location.

E. Blasting shall occur only when a representative of the Owner's Representative is present to witness each blast.

F. The Contractor shall not complete the final hookup (connection of the initiation system to the shot) of the shot until permission is obtained from the Owner's Representative, Cascade Natural Gas (where applicable) and the Airport's Representative.

3.5 TEST BLASTS

A. Before any full-scale blasting is conducted, a series of test blasts shall be performed to demonstrate to the Owner's Representative that the Contractors proposed controlled blasting methods are satisfactory. These test blasts shall be designed by the Contractor's Blasting Consultant. The Contractor's Blasting Consultant shall be on site to facilitate test-blasting activities.

B. Test blasts shall accomplish the following:

1. Demonstrate that the proposed drilling and blasting methods, as described in the General Blasting Plan, will not produce ground vibrations and airblasts that exceed the limits specified herein, nor produce excessive flyrock that projects off the project area or results in damage to property.

2. Demonstrate that the results of pre-splitting, trim blasting, and other controlled blasting measures intended to minimize overbreak produce satisfactory results.

C. Following each test blast and prior to conducting additional drilling and blasting, the Contractor shall remove a sufficient amount of material from the test section so that the effects of any controlled blasting measures can be observed by the Owner's Representative.

D. After each test blast, the Contractor's Blasting Consultant shall review the test blast results and blast effects monitoring data. The Blasting Consultant shall prepare a written report containing his evaluation and recommendations for improving the Contractor's drilling and blasting operations.

E. Additional Test Blast Requirements

1. The test blasts shall be within the limits of the rock excavation, as shown on the Drawings.

   The Contractor shall initially perform up to three test blasts to demonstrate to the Owner's Representative that the Contractor's methods are sufficient to produce stable foundations and final slopes. Two test blasts will be required, and one test blast will be held in reserve and may be required at the direction of the Owner's Representative.

2. Test blasts shall conform to the following requirements:

   a. Test Blasts shall be typical of blasts performed throughout the project, not necessarily the first blast.

   b. Test blast sections shall be less than 50 feet in length.

   c. Once satisfactory rock slopes, grades, subgrades and foundation conditions, and suitable shot rock gradations are achieved during the test blasts, the Contractor shall hold to this design through the rest of the production blasting program.

3. The Owner's Representative may require the Contractor to perform additional test blasts if any of the following occur:

   a. The Contractor significantly changes either blasting patterns or blasting methods.

b. Production blasting results in damage to final slopes, grades, subgrades or foundations.

c. Production blast results fail to meet the performance requirements.

3.6 DRILLING

A. General

1. Before drilling pre-split holes, the Contractor shall completely remove all overburden and looser decomposed rock along the top of the excavation for a distance of at least 30 feet (laterally) beyond the limits of the production shot, or to the end of the cut.

2. In consultation with the Owner's Representative, potentially unstable boulders or other loose material uphill of the pre-split holes should be identified and removed prior to blasting.

3. Blast holes shall be drilled on the pattern submitted by the Contractor on the Individual Blast Plan, as approved by the Owner's Representative.

4. Drilling logs shall be kept for each blast hole and shall show the approximate depth of zones of soft or weathered rock, mud pockets, voids, and discontinuities, as well as the rate of penetration and the color and character of drill cuttings. This information should be used to properly load blast holes, including stemming decks across weak zones and voids. Copies of the logs should be included in the Post-Blast Report.

5. Immediately after drilling, blast holes shall be covered or otherwise protected to prevent overburden, drill cuttings, detonators, or other materials from falling into the holes before loading.

6. All blast holes shall be checked and measured before loading any explosives. If more than 5 percent of the blast holes are found to be short, either because they were not drilled to the full depth or because they have become plugged, the Owner's Representative may require the Contractor to deepen or clean out the holes.

B. Hole Diameter

1. Unless a variance is approved by the Owner's Representative, the maximum diameter of production blast holes shall be 4 inches.

2. Pre-split or trim blast holes shall be between 2.5 and 3 inches in diameter.

C. Drilling Equipment and Tolerances

1. Production blast holes shall be drilled within two blast hole diameters of the staked collar location.

2. Pre-split holes, trim blast, and guide holes shall be drilled within three inches of the staked collar location.

3. The Contractor shall control pre-split, trim blast, and guide hole drilling operations such that no hole deviates from the plane of the planned slope by more than 9 inches. If pre-split, trim blast, or guide holes routinely fail to meet this tolerance, the Owner’s Representative may require the Contractor to reduce the bench height.

4. Drilling equipment used to drill pre-split, trim blast, and guide holes shall have mechanical, electromechanical, or electronic devices affixed to the equipment to accurately determine the angle at which the drill steel enters the rock. Pre-split hole drilling will not be permitted if these devices are missing or inoperative.

5. If more than 5% of the holes are drilled outside of these tolerances, at the option of the Owner’s Representative, the Contractor may be required to fill out-of-tolerance holes with crushed stone and re-drill them at the proper locations.

3.7 PRE-SPLITTING

A. Length and Spacing of Holes

1. The center-to-center spacing of pre-split holes shall be between 12 and 30 inches. For the test blasts, it is expected (but not explicitly required) that the spacing will be 18 inches for 0.5H:1V slopes and 30 inches for 0.25H:1V slopes.

    a. A tighter spacing or the use of guide holes may be required if satisfactory results cannot be achieved, as determined by the Owner’s Representative.

    b. The spacing shall not exceed 30 inches, unless the Owner’s Representative approves a variance. Justification to increase hole spacing shall be based on the Owner’s Representative's opinion that test blasts have produced satisfactory results.

2. The length of pre-split holes shall not exceed 30 feet unless the Contractor can demonstrate to the Owner’s Representative that the specified excavation tolerances can be maintained, and a uniform slope can be produced.

3. Where the cut height requires multiple lifts, a 2-foot offset between lifts is permitted to allow for drilling equipment clearances, as shown on the Drawings.

4. The row of pre-split holes shall extend laterally a minimum of 30 feet beyond the limits of the production holes to be detonated, or to the end of the cut.

B. Explosives

1. Explosive materials shall be suitable and appropriate for the hole conditions (wet or dry).

2. Unless a variance is approved by the Owner’s Representative, the maximum diameter of explosive used in pre-split holes (except for a concentrated charge placed at the bottom of the hole) shall not be greater than one half the diameter of the pre-split hole.

3. Unless a variance is approved by the Owner’s Representative, only standard explosives manufactured specifically for pre-splitting shall be used.

    a. If fractional portions of standard explosive cartridges are used, they shall be firmly affixed to the detonating cord in such a manner that they will not slip or bridge across the hole. Spacing of fractional cartridges along the length of the detonating cord shall be as necessary to achieve the desired results but shall not exceed 36 inches without approval by the Owner’s Representative.

4. The top charge shall be placed far enough below the collar, and the weight reduced as necessary to avoid overbreak and heave.

5. The bottom charge shall not be large enough to cause overbreak.

C. Stemming

1. The upper portion of all pre-split holes, from the top of the uppermost charge to the collar of the hole shall be stemmed with dry, angular, granular material that passes a 3/8-inch sieve.

D. Firing Sequence

1. As long as equally satisfactory cut slopes are produced, the Contractor may either pre-split the face prior to drilling the production holes or pre-split the face and production blast at the same time, provided that the pre-split holes are fired first.

2. If required to reduce ground vibrations, pre-split holes may be delayed; however, the maximum hole-to-hole delay shall be 25 milliseconds.

E. Precision Pre-Splitting

1. The use of precision pre-splitting techniques, as described by Konya (2015), are not anticipated for this project.

3.8 TRIM (CUSHION) BLASTING

A. If the horizontal distance from the cut face to the existing free face is less than 15 feet, the Contractor may trim blast in lieu of pre-splitting.

B. The difference in delay time between the trim line and the nearest production row shall be at least 25 milliseconds but not more than 75 milliseconds.

C. All other specified requirements for pre-split holes shall apply to trim blast holes.

3.9 PRODUCTION BLASTING

A. General

1. Maintain a burden distance not more than one half the bench height and between 25 and 35 times the diameter of the explosive charge in the blast hole.

2. Production blast holes shall not be drilled closer than 6 feet to the controlled blast line unless specifically approved by the Owner's Representative.

3. The row of production blast holes immediately adjacent to the excavation line (pre-split face) shall be inclined approximately parallel to the excavation line.

4. The bottom of production blast holes (excluding subdrill depth) shall not be lower than the bottom of the pre-split holes.

5. Whenever practical, detonation of production blast holes shall be on a delay sequence toward a free face

B. Explosives

1. Explosive materials shall be suitable and appropriate for the hole conditions (wet or dry).

2. The maximum diameter of explosive cartridges that may be loaded into production blast holes shall be a function of the lift height (or individual hole length, if shorter than the design lift height).

   a. For lifts (or individual holes) up to 10 feet deep, explosive cartridges shall not exceed 1.25 inches in diameter.

   b. For lifts (or individual holes) between 10 and 15 feet deep, explosive cartridges shall not exceed 2 inches in diameter.

   c. For lifts (or individual holes) between greater than 15 feet deep, explosive cartridges shall not exceed 4 inches in diameter.

C. Stemming

1. All production holes shall be stemmed with dry, angular, granular material that passes a 3/8-inch sieve.

2. Unless otherwise approved by the Owner's Representative, the height of the stemming column shall be no less than 0.7 times the burden or 20 times the diameter of the explosive charge, whichever is greater.

D. Protection of Pre-Split Face

1. It is the Contractor's responsibility to take all necessary precautions to minimize blast damage to the pre-split face.

2. If the Owner's Representative determines that production blasting is causing excessive back-break the Contractor may be required to drill a line of buffer holes between the production blast holes and the pre-split face.

   a. If required, the row of buffer holes shall be located approximately 3 feet from the pre-split face in a plane parallel to the pre-split holes.

   b. Buffer holes shall be 3 inches in diameter and shall be spaced 36 inches center-to-center.

   c. The explosive load in buffer holes shall be 50 percent of the full load that could be placed in a 3-inch-diameter hole. Buffer holes shall be fired on a delay sequence toward a free face.

3.10 RIPRAP AND AGGREGATE PRODUCTION

A. If the Contractor determines that production of riprap and/or aggregate will be operationally practical and provide an economic benefit to the project, the Contractor shall test the rock to verify that it meets the specified physical and durability requirements. Refer to Section 31 05 16, Aggregates for Earthwork.

3.11 MONITORING

A. The Contractor shall provide seismographs conforming to the requirements of this Section.

B. The Contractor shall monitor each blast at locations determined by either the Owner's Representative or the Contractor's Blasting Consultant to demonstrate that the blasting induced ground vibrations and air blast overpressure at the closest structures are within the limitations specified by this Section.

C. Blast effects measurements shall be made in conformance to ISEE Seismograph Field Practice Guidelines.

D. The Owner's Representative may perform independent blast monitoring.

E. The Contractor shall record a high-definition digital video of each blast using a camera that conforms to the requirements of this Section. The video shall include coverage before, during, and after initiation of the shot that clearly depicts the layout of the shot, the behavior of the shot, and the resulting muck pile. The digital file of each shot shall be named to identify the project, date, and shot number.

3.12 SUSPENSION OF BLASTING

A. Blasting operations may be suspended by the Owner's Representative for any of the following reasons:

1. The Contractor's safety precautions are inadequate.
2. Air overpressure (airblast) or ground vibration (peak particle velocity) levels exceed specified limits contained in this Section.
3. Existing structural conditions are aggravated, or adjacent improvements are damaged by blasting.
4. Blasting endangers the stability of or causes damage to facilities outside the prescribed limits of excavation.
5. The results of the blasting, in the opinion of the Owner's Representative, are not satisfactory.
6. Excessive loss of explosives, oils, or other pollutants as a result of poor handling practices.
7. The Contractor's personnel are acting unsafely around the blast area immediately, before, during or after blasting operations.
8. Flyrock either projects outside the guarded area of the shot, projects outside the limits of the site, damages adjacent structures, or results in either a personal injury, damage to equipment, or damage to the Work.
9. The Contractor fails to submit Individual Blast Plans and Post Blast Reports.

B. Blasting operations shall not resume until the Owner's Representative has approved the Contractor's revised blasting plan with modifications correcting the conditions causing the suspension.

C. Delays or suspensions of blasting operations as a result of improper Contractor actions or inactions shall not be compensated, nor shall they form the basis for a claim.

3.13 PRE-BLAST/POST-BLAST INSPECTIONS

A. The Owner's Representative may make pre-blast inspections of structures located within the project limits and privately-owned residences, other structures, and water wells located off the project site. The Owner's Representative will notify the Contractor at least 7 days prior to the inspections. A representative of the Contractor may be present for these inspections.

3.14 DAMAGE REPAIR

A. When blasting operations damage existing structures, offsite properties, or a portion of the Work, or material surrounding or supporting the Work, the Contractor shall, at his expense, promptly repair or replace damaged items to the condition that existed prior to the damage, to the satisfaction of the Owner's Representative.

B. Any damage to structures shall be immediately reported to the Owner's Representative.

C. Nothing contained herein shall relieve the Contractor of his responsibility for claims arising from his construction operations. Failure to inspect any structure required by these contract documents, or inadequacy of the inspections shall not relieve the Contractor of his responsibility. The Contractor shall indemnify the Owner's Representative from such claims.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes temporary dewatering and surface water control systems for open excavations and utility trenches.

B. Section includes:

1. Dewatering systems.
2. Surface water control systems.
3. System operation and maintenance.
4. Water disposal.

1.2 RELATED SECTIONS

A. Section 02 30 00 - Subsurface Investigations.
B. Section 31 05 16 - Aggregates for Earthwork.
C. Section 31 23 16 - Excavation.
D. Section 31 23 17 - Trenching.

1.3 SUBMITTALS

A. Dewatering Plan:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply; pollution control facilities; discharge locations to be utilized; and provisions for immediate temporary water supply as required by this Section.

2. Plan to be reviewed by the Owner's Representative prior to the beginning of construction activities requiring dewatering. Review by the Owner's Representative of the design shall not be construed as a detailed analysis of the adequacy of the dewatering system, nor shall any provisions of the above requirements be construed as relieving the Contractor of its overall responsibility and liability for the work.

1.4 DEFINITIONS

A. Dewatering includes the following:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels, and /or shafts.

2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels, and /or shafts.

3. Disposing of removed water.

B. Surface Water Control: Removal of surface water within open excavations.

1.5 QUALITY CONTROL

A. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

B. Provide all labor, materials, and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents.

C. Secure all necessary permits to complete the requirements of this Section.

D. Control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

E. Where the critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop.

1. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor.

2. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 DEWATERING

A. Provide all equipment necessary for dewatering.

1. Have on hand, at all times, sufficient pumping equipment and machinery in good working condition.

2. Have available, at all times, competent workers for the operation of the pumping equipment.

3. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. Site Grading:

1. At all times, site grading shall promote drainage.

2. Surface runoff shall be diverted from excavations.

3. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

F. Maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

G. Flotation shall be prevented by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. Dispose of water from the work in a suitable manner without damage to the environment or adjacent property. No water shall be drained into work built or under construction without prior consent of the Owner's Representative. Water shall be filtered using an approved method to remove sand and fine sized soil particles before disposal into any drainage system.

J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

K. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the work and all costs thereof shall be included in the various contract prices in the bid forms.

END OF SECTION

SECTION 31 23 23

FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes backfilling required at building perimeter and site structures to subgrade elevations, fill under interior and exterior slabs-on-grade or pavement, and fill under landscaped areas. Backfilling for utilities within building proper is included within this section; backfilling for utilities outside building is included in Section 31 23 17, Trenching.

B. Section includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work.
B. Section 31 05 13 - Soils for Earthwork.
C. Section 31 05 16 - Aggregates for Earthwork.
D. Section 31 22 13 - Rough Grading.
E. Section 31 23 16 - Excavation.
F. Section 31 23 17 - Trenching.
G. Section 31 23 24 - Flowable Fill.
H. Section 31 37 00 - Riprap.
I. Section 33 11 10 - Water Utility Distribution Piping.
J. Section 33 41 10 - Storm Utility Drainage Piping.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-inch) Drop.

B. ASTM International:

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

5. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill elsewhere in these Specifications. A self-compacted, cementitious material.

B. Imported Material: Materials obtained from sources offsite, suitable for specified use.

C. Lift: Loose (uncompacted) layer of material.

D. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

C. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.6 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S2, Imported Fill Material, as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 psi.

2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete. Compressive strength as required by the application or as noted in the Drawings.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Foundation Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2” - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

F. Fill at north end of Old Airport Road right-of-way: Type A3, Select Native Granular Material, as specified in Section 31 05 16, Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to Work in this Section, become familiar with Site conditions. In the event discrepancies are found, notify Owner’s Representative as to the nature and extent of the differing conditions.

B. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.

C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Owner’s Representative to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

D. See provisions for Work in Section 31 25 00, Erosion and Sediment Controls.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Control of Water:

1. Excavated areas shall be kept free of water and frost.

2. Bearing surfaces which become softened by water or frost shall be re-excavated to solid bearing at Contractor’s expense and backfilled with compacted crushed rock at Contractor’s expense.

3. See Section 31 23 19, Dewatering for additional details.

C. Compact subgrade to density requirements for subsequent backfill materials.

D. Cut out soft areas of subgrade not capable of compaction in place and replace with specified granular fill material. See Article 3.5, Overexcavation for Unsuitable Foundation Conditions in Section 31 23 16, Excavation for additional details.

E. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

F. Subgrade to be approved by Owner's Representative prior to placement of structures and commencement of backfill activities.

G. Do not allow or cause any work performed or installed to be covered up or enclosed prior to required tests and approvals. Should any Work be enclosed or covered up, uncover at Contractor's expense.

3.4 BACKFILLING

A. Backfill areas to contours and elevations shown in the Drawings with unfrozen materials.

B. Do not place materials when weather conditions and/or moisture content prevent attainment of specified density.

C. Maintain optimum moisture content of backfill materials to attain required compaction density.

D. Employ placement method that does not disturb or damage other work.

E. Mechanical tampers permitted in confined areas.

F. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

G. Foundation Base for Structures:

1. Bring excavation to required subgrade elevation shown in the Drawings.

2. Place foundation base material to required grade shown in the Drawings.

3. Place foundation base material in 6-inch lifts and compact to 95 percent maximum dry density.

4. Reservoir Foundation:

   a. Concrete Footings: Place a 6-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, ¾-inch-0 gradation to required grade under all concrete footings.

b. Concrete Slabs: Place a 6-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate,3/4-inch-0 gradation under all concrete slabs.

5. Pump Station:

a. Concrete Footings: Place a 6-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4 inch-0 gradation to required grade under all concrete footings.

b. Concrete Slabs: Place an 8-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4 inch-0 gradation under all concrete slabs.

6. Foundations established near finished site grades:

a. Place a 3-inch thick layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in the bottom of footing excavations to minimize disturbance of silty foundation soils during wet weather.

b. Lightly compact material with a light-weight hand-operated vibratory plate compactor.

c. To provide uniform support, slabs should be underlain by a minimum 8-inch thick granular base course consisting of 1-1/2- or 3/4-inch - 0 gradation.

d. The base course material should be installed in a single lift and compacted to at least 95 percent of the maximum dry density. See Drawings for details.

H. Backfill for Structures:

1. Prior to placing backfill, remove forms, temporary construction and debris below grade.

2. Backfill shall not be placed against poured concrete until 28 days have passed from completion of original concrete pour, unless otherwise approved by Owner's Representative.

3. Heavy compactors and large pieces of construction equipment shall be kept away from any embedded wall a distance of a least 5 feet in order to avoid the build-up of excessive lateral pressures.

a. Over-compaction of fill near walls should be avoided.

4. Compaction within 5 feet of the walls shall be accomplished using hand-operated vibratory plate compactors or tamping units.

5. The maximum particle size of granular material placed against buried structures shall be limited to no greater than 1 1/2-inch diameter.

6. Structural fill backfill material shall be brought up on all sides of the walls and footings in such a manner as to avoid adverse differential lateral earth pressures on the vertical surfaces.

7. Appropriate lift thickness will depend on the type of compaction equipment used and the type of material being placed. All material shall be compacted to at least 95 percent of the standard maximum dry density.

   a. For moderate- to heavy-weight compactors, a maximum loose lift thickness of 12 inches shall be used.

   b. For hand-operated or small compactors, a maximum loose lift thickness of 8 inches shall be used.

8. Particular care must be taken to avoid damage to the pipe connections to the structure.

9. Utility trench backfill within 10 feet of all structural perimeters shall meet the requirements for structural fill.

I. For areas receiving surface structures or existing paved areas to be constructed or replaced, such as roadways, driveways, and parking lots:

1. Place Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in 6-inch lifts.

2. Compact with vibratory equipment to 95 percent maximum density, unless otherwise specified or shown in the Drawings.

J. Slope grade away from building minimum 2 percent slope for minimum distance of 5 feet, unless noted otherwise in the Drawings.

K. Make gradual grade changes. Blend slope into level areas.

L. Remove surplus backfill materials from Site in accordance with Section 31 23 16, Excavation.

3.5 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the Owner. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

C. In-place compaction testing for structural fill material shall be performed at 2-foot elevation increments in the fill material with at a minimum of one test per each 2,500 square feet of material placed. The Owner's Representative shall be provided with the results of each compaction test at the time of testing.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

F. When testing of subgrade is not possible or feasible as detailed above, proof roll compacted fill surfaces under slabs-on-grade, pavers, paving, and as may be otherwise required by the Owner's Representative.

3.6 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

SECTION 31 23 24

FLOWABLE FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes flowable lean concrete mix used for structure backfill, utility bedding and backfill and other subgrade Site Work. Applications also include filling abandoned structures and utilities that remain in place.

B. Section Includes:

1. Structure backfill.
2. Utility bedding.
3. Utility backfill.
4. Filling abandoned utilities.

1.2 RELATED SECTIONS

A. Section 31 23 16 - Excavation.
B. Section 31 23 17 - Trenching.
C. Section 31 23 23 - Fill.
D. Section 33 11 10 - Water Utility Distribution Piping.
E. Section 33 11 50 - Existing Pipe Abandonment.
F. Section 33 41 10 - Storm Utility Drainage Piping.

1.3 DEFINITIONS

A. Flowable Fill: Also referred to as Controlled Low Strength Material (CLSM) elsewhere in the Specifications. Lean cement concrete fill.

B. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

1.4 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

3. ASTM C150 - Standard Specification for Portland Cement.

4. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

5. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.

6. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

7. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

8. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

9. ASTM C1040 - Standard Test Methods for Density of Unhardened and Hardened Concrete in Place By Nuclear Methods.

10. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Field Quality-Control Submittals:

1. Mix Design:

a. Furnish flowable fill mix design for each specified strength.

b. Furnish separate mix designs when admixtures are required for the following:

1) Flowable fill Work during hot and cold weather.
2) Air entrained flowable fill Work.

c. Identify design mix ingredients, proportions, properties, admixtures, and tests.

2. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements.

D. Delivery Tickets:

1. Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.

1.6 QUALITY ASSURANCE

A. In-place testing of Flowable Fill: In accordance with ASTM C403.
B. Compressive testing of Flowable Fill: In accordance with ASTM D4832.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Minimum Conditions: The following minimum conditions shall be met at time of flowable fill placement.

1. Do not install flowable fill during inclement weather.

2. Ambient temperature must be at least 34 degrees Fahrenheit (4 degrees Celsius) and rising.

3. Flowable fill shall be at 40 degrees Fahrenheit (4 degrees Celsius).

4. Subgrade on which flowable fill is to be placed shall be free of disturbed or soft material, debris and water.

1.8 FIELD MEASUREMENTS

A. Verify field measurements before installing flowable fill to establish quantities required to complete the Work.

PART 2 PRODUCTS

2.1 FLOWABLE FILL

A. Flowable Fill:

1. Composed of cement, pozzolans, fine aggregate, water, and admixtures.

2. Low cement content.

3. Non-segregating, self-consolidating, free-flowing and excavatable material which will result in a hardened, dense, non-settling fill.

4. Compressive strength at 28 days of 100 to 200 psi, if not otherwise shown in Drawings or specified.

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type I – Normal.
B. Fine Aggregates: ASTM C33.
C. Water: Clean and not detrimental to concrete.

2.3 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical Admixture: ASTM C494.

C. Fly Ash: ASTM C618 Class C or F, obtained from residue of electric generating plant using ground or powdered coal.

D. Plasticizing: ASTM C1017 Type I, plasticizing.

2.4 MIXES

A. Mix and deliver flowable fill according to ASTM C94, Option C.

B. Flowable Fill Design Mix:

ITEM	PROPERTIES
Cement Content	75 to 100 lb/cu yd
Fly Ash Content	None
Water Content	As specified
Air Entrainment	5 to 35 percent
28-Day Compressive Strength	Maximum 200 psi.
Unit Mass (Wet)	80 to 110 pcf
Temperature, Minimum at Point of Delivery	50 degrees F (10 degrees C)

C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.

D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.5 SOURCE QUALITY CONTROL

A. Test and analyze properties of flowable fill design mix and certify results for the following:

1. Design mix proportions by weight of each material.

2. Aggregate: ASTM C33 for material properties and gradation.

3. Properties of plastic flowable fill design mix including:

   a. Temperature.
   b. Slump.
   c. Air entrainment.
   d. Wet unit mass.
   e. Yield.
   f. Cement factor.

4. Properties of hardened flowable fill design mix including:

   a. Compressive strength at 1 day, 7 days, and 28 days. Report compressive strength of each specimen and average specimen compressive strength.

b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.

B. Prepare delivery tickets containing the following information:

1. Project designation.
2. Date.
3. Time.
4. Class and quantity of flowable fill.
5. Actual batch proportions.
6. Free moisture content of aggregate.
7. Quantity of water withheld.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavation specified in Section 31 23 16, Excavation and trenching specified in Section 31 23 17, Trenching is complete.

B. Verify utility installation as specified in elsewhere in the specifications is complete and tested before placing flowable fill.

C. Verify excavation is dry and dewatering system is operating, as may be required, prior to placement of flowable fill.

3.2 PREPARATION

A. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.

B. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.

C. Protect utilities and foundation drains to prevent intrusion of flowable fill.

3.3 INSTALLATION - FILL, BEDDING, AND BACKFILL

A. Place flowable fill by chute, pumping or other methods as approved by Owner's Representative.

B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.

C. Place flowable fill evenly on both sides of utilities to maintain alignment.

D. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

3.4 INSTALLATION - FILLING ABANDONED UTILITIES

A. As specified in Section 33 11 50, Existing Pipe Abandonment.

3.5 FIELD QUALITY CONTROL

A. Perform inspection and testing according to ASTM C94.

1. Take samples for tests for every 100 cubic yards of flowable fill, or fraction thereof, installed each day.

2. Sample, prepare and test four compressive strength test cylinders according to ASTM D4832. Test one specimen at 3 days, one at 7 days, and two at 28 days.

3. Measure temperature at point of delivery when samples are prepared.

B. Further construction proceeding upon placed flowable fill will be permitted only after initial set is attained, as measured by ASTM C 403.

1. Perform in place penetration (density) tests using hand held penetrometer to measure penetration resistance of hardened flowable fill.

2. Perform tests at locations as directed by Owner's Representative.

C. Defective Flowable Fill: The Owner's Representative reserves the right to reject all flowable fill failing to meet the following test requirements or flowable fill delivered without the following documentation.

1. Test Requirements:

a. Minimum temperature at point of delivery.
b. Compressive strength requirements for each type of fill.

2. Documentation: Duplicate delivery tickets.

D. No traffic or construction equipment shall be allowed on flowable fill for a least 24 hours after placement.

3.6 CLEANING

A. Remove spilled and excess flowable fill from Project Site.

B. Restore facilities and Site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION

SECTION 31 37 00

RIP RAP

PART 1 GENERAL

1.1 SCOPE

This Section consists of furnishing and placing an erosion-resistant cover material for protecting slopes and basins at locations shown or as directed.

1.2 RELATED SECTIONS

A. Section 31 22 13, Rough Grading.
B. Section 31 23 18, Rock Removal.

1.3 DEFINITIONS

A. Filter Blanket - A layer of graded granular material placed between the area prepared for it and the riprap.

B. Grouted Riprap - Loose riprap with all or part of the spaces filled with Portland cement mortar.

C. Keyed Riprap - Loose riprap placed on prepared slope, riprap geotextile or filter blanket, as specified, and keyed in place by slapping the surface with a piece of armor plating.

D. Loose Riprap - Specified classes of graded rock placed on prepared slope, riprap geotextile or filter blanket, as specified.

E. Riprap Backing - An option of using either riprap geotextile or a filter blanket placed between the area prepared for it and the riprap.

F. Riprap Basin - Energy dissipater consisting of loose riprap placed at pipe outlets as specified.

G. Riprap Geotextile - A geotextile placed between the area prepared for it and the riprap.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

PART 2 MATERIALS

2.1 RIPRAP GEOTEXTILE

A. Furnish riprap geotextile as shown in the Drawings.

2.2 RIPRAP REQUIREMENTS

A. General - Furnish rock for loose riprap meeting the following requirements:

1. Meet the test requirements of provided herein.

2. Be angular in shape. Thickness of a single rock shall not be less than 1/3 its length. Rounded rock will not be accepted unless authorized by the OWNER'S REPRESENTATIVE.

3. Meet the gradation requirements for the class specified.

4. Be free from overburden, spoil, shale and organic material. Non-durable rock, shale or rock with shale seams is not acceptable.

B. Test Requirements - Furnish the rock meeting the following test requirements:

Material Test	Requirement
Apparent Specific Gravity (AASHTO T 85)	2.50 Min.
% Absorption (AASHTO T 85)	6.0 Max.
Degradation (ODOT TM 208A)	
Passing No. 20 Sieve	35.0% Max.
Sediment Height	8.0" Max.
Soundness (AASHTO T 104)	
Average Loss of 2 1/2" - 1 1/2" and 1 1/2" - 3/4" fraction after 5 alternations	16.0% Max.

C. Gradation Requirements - Grade loose riprap by class and weight of rock according to the following:

Class 50	Class 100	Class 200	Class 700	Class 2000	Percent (by Weight)
Weight of Rock (pounds)					
50 - 30	100 - 60	200 -	700 -	2000 -	20.0
30 - 15	60 - 25	140	500	1400	30.0
15 - 2	25 - 2	140 - 80	500 -	1400 -	40.0
2 - 0	2 - 0	80 - 8	200	700	10.0 - 0
		8 - 0	200 - 20	700 - 40	
			20 - 0	40 - 0	

Uniformly grade each load of riprap from the smallest to the largest weight specified. Control of gradation will be by visual inspection.

1. Control Sample - If directed, provide, at a satisfactory location near the project site, a rock sample of at least 5 tons meeting the gradation for the class specified. This sample will be used as a frequent visual reference for judging the gradation of the riprap supplied.

2. Sampling and Testing Assistance - Any difference of opinion between the OWNER'S REPRESENTATIVE and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truck loads of rock. Mechanical equipment, a sorting site and labor needed to assist in checking gradation shall be provided by the CONTRACTOR at no additional cost to the OWNER.

D. Grouted Riprap

1. Furnish rock for grouted rip rap meeting the requirements of stated herein for class and size specified.

2. Furnish non-shrink Portland cement grout meeting the requirements of Section 03 60 00, Grouting.

E. Filter Blanket - Furnish filter blanket material meeting the following requirements according to riprap class:

Riprap Class	Filter Blanket
Class 2000	16-inch layer of Class 50 riprap conforming to the requirements of this section
Class 700	9-inch layer of 6-inch- 0 stone embankment meeting the test requirements of this section
Class 200	6-inch layer of 4-inch- 0 stone embankment meeting the test requirements of this section
Class 100	No filter blanket required
Class 50	No filter blanket required

PART 3 EXECUTION

3.1 PREPARATION

A. Remove brush, trees, stumps and other organic material from slopes to be protected by riprap and dress to a smooth surface.

B. Remove all unsuitable material to the depth shown or directed and replace with approved material.

C. Compact filled areas as specified in Section 31 23 23, Fill.

D. Provide riprap protection as early as the structure foundation construction permits. Prepare the surfaces to be protected as shown.

E. Maintain the trench slopes, riprap geotextile or filter blanket until the riprap is placed.

3.2 RIPRAP GEOTEXTILE

A. Install riprap geotextile as shown in the Drawings or as directed by the OWNER'S REPRESENTATIVE.

3.3 FILTER BLANKET CONSTRUCTION

A. If required, place the filter blanket on the prepared area to the full specified thickness in one operation, using methods which will not cause segregation.

B. The surface of the finished layer shall be reasonably even.

3.4 RIPRAP BACKING

A. When indicated on the Drawings, the CONTRACTOR shall have the option of placing either riprap geotextile or a filter blanket behind the riprap.

B. Install the backing per these specifications or as shown in the Drawings.

3.5 RIPRAP

A. General - Unless otherwise directed, place the riprap protection as the embankment is constructed. Its placement shall lag behind embankment construction only as necessary to allow proper embankment construction and prevent mixture of embankment and riprap material.

B. Loose Riprap - Place riprap on the prepared area:

1. With a clam-shell, orange-peel bucket, skip or similar approved device which will contain the riprap material to its final destination. Do not open the bucket until it has been lowered to the slope on which the material is being placed

2. To its full course thickness in one operation

3. According to the compaction requirements of Section 31 23 23, Fill if riprap is placed on geotextile

4. By methods that do not cause segregation of riprap or displace the underlying material

5. To produce a compact riprap protection in which all sizes of material are placed in their proper proportion

6. With some hand placing, or rearranging of individual stones by mechanical equipment, or some other approved means to provide a smooth finished surface

Where filter material and/or riprap are placed under water, increase their thicknesses as shown or as directed.

C. Keyed Riprap - After placing loose riprap material, key the riprap into place by slapping the surface with a piece of armor plating (approximately 4 feet x 5 feet in size with a weight of approximately 5,000 pounds) or other approved means which will produce a nearly smooth surface.

D. Grouted Riprap - Place loose riprap material. If the depth specified for grouting is more than 12 inches, place the riprap in lifts of 12 inches or less and grout each lift before placing the next lift. Construct and grout the succeeding lifts before the grout in the previous lift has hardened.

Thoroughly moisten the stones and sluice any excess fines to the underside of the riprap before grouting. Deliver the grout to the place of final deposit by any means that will ensure uniformity and prevent segregation of the grout. Spade or rod the grout into the spaces to completely fill the voids in the riprap. Control pressure grouting and do not unseat the stones. Penetration of the grout shall be to the depth shown on the plans. If a rough surface is specified, brush the stone until 25% to 50% of the depth of surface stone is exposed. For a smooth surface, grout the crevices to within 5/8-inch of the surface.

Provide weep holes through the riprap as shown or as directed.

E. Riprap Basins - Excavate, backfill and construct riprap basins, without a riprap geotextile or filter blanket, at pipe outlets with Class 50 riprap as shown or as directed.

3.6 Maintenance

A. Maintain the riprap protection until accepted. Replace any material displaced by any cause at no additional cost to the owner.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes construction of an aggregate subbase and base course for placement under asphalt or concrete paving, unit paving, or placed and left exposed.

B. Section Includes:

1. Aggregate subbase.
2. Aggregate base course.

1.2 RELATED REQUIREMENTS:

A. Section 31 05 16 - Aggregates for Earthwork.
B. Section 31 22 13 - Rough Grading.
C. Section 31 23 17 - Trenching.
D. Section 31 23 23 - Fill.
E. Section 32 12 16 - Asphalt Concrete Pavement.

1.3 REFERENCE STANDARDS

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

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.

2. T11, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.

3. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.

4. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

2. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D2940 - Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.

5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities and standing water, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Keystone: Fine aggregate used to aid in binding of loose surface stone.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit data for geotextile fabric and herbicide.

C. Materials Source: Submit name of aggregate materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

PART 2 PRODUCTS

2.1 SHOULDER AGGREGATE

A. 1 1/2-inch - 0.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.2 DENSE-GRADED BASE AGGREGATES

A. 3/4-inch - 0.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.3 OPEN-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A2, Granular Drain Backfill Material as specified in Section 32 05 16, Aggregates for Earthwork.

2.4 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

2.5 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

2.6 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Obtain Owner’s Representative’s acceptance of subgrade before placing base course or surfacing material.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.

1. Proof roll substrate with equipment approved by the Owner’s Representative in minimum two perpendicular passes to identify soft spots.

2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23, Fill.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.3 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material on prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.
4. Maintain consistent gradation of material. Widely varying gradation will be cause for rejection.

3.4 CONSTRUCTION OF COURSES

A. Untreated Aggregate Base Course:

1. If the required compacted depth of the base course exceeds 6 inches, construct it in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.
2. Completed Course Total Thickness: As shown on the Drawings.
3. Spread lift on preceding course to required cross-section. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.
4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:

    a. Use 3/4-inch leveling course or surfacing material as keystone.

    b. Spread evenly on top of base course, using spreader boxes or chip spreaders.

    c. Roll surface until keystone is worked into interstices of base course without excessive displacement.

    d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.

6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing and Leveling Course:

1. Place shoulder aggregates in a single layer, or two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 9 inches.

2. Spread on preceding course in accordance with cross-section shown.

3. Blade lightly and roll surface until material is thoroughly compacted.

4. Complete Total Thickness: As shown on the Plans, 8-inch minimum.

3.5 ROLLING AND COMPACTION

A. Commence compaction of each layer of base immediately after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by AASHTO T99.

B. Roll each layer of material until there is no appreciable reaction or yielding under the compactor before succeeding layer is applied.

C. Shape and maintain the surface of each layer during compaction operations. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to the required density before succeeding lift is placed.

F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Overall Average: Within plus or minus 0.04 foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

A. Quality control testing shall be performed by an independent testing laboratory provided by the Owner.

B. Refer to table below for minimum sampling and testing requirements for aggregate base course and surfacing. The OWNER reserves the right to complete additional testing.

Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T99	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	AASHTO T99	One for each 500 ton but at least every 5,000 square feet of area	In-place completed, compacted area

3.8 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate. Restore per Specifications as applicable.

END OF SECTION

SECTION 32 12 16

ASPHALT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SCOPE

This section includes the construction of asphalt concrete pavement.

1.2 REFERENCE STANDARDS

A. References herein to “AASHTO” shall mean Association of American State Highway Transportation Officials.

B. Standard Specifications: Where the term “Standard Specifications” is used, such reference shall mean the current edition of the Oregon Department of Transportation (ODOT) Standard Specifications for Highway Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.3 DEFINITIONS

A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041 (Rice), by 62.4 pounds per cubic foot.

1.4 SUBMITTALS

A. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00640 for aggregate used in aggregate base.

B. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00745 for aggregate used in asphalt concrete.

C. Job mix formula shall be an approved job mix formula. Submit formula, supplier, and product identification to the Owner’s Representative 30 days prior to start.

1. Definite percentage for:

a. Each sieve fraction.
b. New asphalt cement.
c. Recycled asphalt pavement.

2. Temperature of completed mix when discharged from mixer.

3. Character and quantity of anti-strip and recycling agents.

1.5 QUALITY ASSURANCE

A. All testing to determine compliance with the specifications shall be performed by an independent testing laboratory contracted by the Contractor and approved by the Owner's Representative. All testing costs shall be borne by the Contractor.

B. A minimum of five (5) nuclear densometer readings shall be taken in random locations within every test area. Each test area shall not exceed 200 tons of asphalt; however, smaller areas may be designated by the Owner's Representative.

C. The surface smoothness of the new asphalt concrete pavement shall be such that when a 10-foot straightedge is laid longitudinally across the paved area in any direction, the new pavement shall not deviate from the straightedge more than 1/8 inch. Surface drainage shall be maintained. Additionally, paving must conform to the design grade and crown and contain no abrupt edges, low or high areas or any other imperfections as determined by the Owner's Representative. Pavement construction not meeting these requirements will be repaired by grinding the existing pavement to a 1 1/2-inch depth and replacing with Level 3, 1/2-inch dense graded Asphaltic Concrete the full width at no cost to Owner.

1.6 PRE-PAVING CONFERENCE

A. Any supervisory personnel of the Contractor and any subcontractors who are to be involved in the paving work shall meet with the Owner's Representative, at a time mutually agreed upon, to discuss methods of accomplishing all phases of the paving work.

B. The Contractor shall be prepared to review the size and type of equipment to be used and the anticipated rate of placement to determine equipment needs.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIAL

A. Aggregate Base for Dense Graded Asphalt Concrete: The aggregate material shall be a clean, well-graded crushed base aggregate conforming to the Standard Specifications. Base course and leveling course shall be 3/4-inch minus aggregate.

2.2 ASPHALT CONCRETE PAVEMENT

A. Dense Graded Hot Mix Asphalt Concrete

1. Use Level 3, 1/2-inch-dense graded, PG 70-22 HMAC. Conform to the requirements as specified in Section 00745 of the Standard Specifications. Conform to the requirements as specified in Section 00745 of the Standard Specification.

2. Asphaltic concrete pavement delivered to the site shall be accompanied by a ticket with the approved "job mix formula" number shown. Loads without tickets identifying the job mix formula will not be accepted.

3. Percent of recycled asphalt pavement used in new asphalt pavement shall not exceed 30 percent. Recycled asphalt pavement may not be used in top wearing course unless otherwise approved by the Owner's Representative.

B. Tack Coat

In accordance with Standard Specifications. Use AR 4000, AC-20 asphalt or CSS-1 emulsified asphalt C.

C. Seal and Cover Coat

Asphalt material shall be CRS-2 cationic emulsified asphalt. Cover stone shall conform to size 1/4-inch -#10 aggregate in the Standard Specifications.

D. Subgrade Geotextile

1. Dense Graded AC Mix-For subgrade separation using dense graded asphalt concrete, use subgrade geotextile with Certification Level B as specified in Section 02320 of the Standard Specifications.

E. Subgrade Stabilization

1. In the event that unstable materials are encountered during excavation, the additional excavation and installation of geotextile fabric and twelve (12) inches of rock substructure will be required, as directed. Conform to the requirements as specified in Section 00331 of the Standard Specifications. For subgrade separation, use subgrade geotextile with Certification Level B as specified in Section 02320 of the Standard Specifications.

PART 3 EXECUTION

3.1 AGGREGATE PAVEMENT BASE

A. Place pavement base to the depth shown on the plans or as specified in all cases, pavement base shall be compacted to a minimum depth of 6 inches. Bring the top of the pavement base to a smooth, even grade at a distance below finished grade equivalent to the required pavement depth.

B. Compact the pavement base with mechanical vibratory or impact tampers to a density of not less than 95 percent of the maximum density, as determined by AASHTO T-99.

C. Obtain the Owner’s Representative’s acceptance of the subgrade before beginning construction of the aggregate base course.

D. When, in the judgment of the Owner’s Representative, the weather is such that satisfactory results cannot be secured, suspend operations. Place no aggregate base course in snow or in soft, muddy, or frozen subgrade.

E. If the required compacted depth of aggregate base course exceeds six (6) inches, construct in two or more lifts of approximately equal thickness. Maximum compacted thickness of any one lift shall not exceed six (6) inches. Compact each layer to the specified density before a succeeding lift is placed.

3.2 ASPHALT CONCRETE PAVEMENT

A. Construct asphalt concrete pavement in accordance with Section 00745 of the Standard Specifications.

B. Conform to the requirements for prime coat and tack coat in the Standard Specifications. Tack coat all edges of existing pavement, manhole and clean out frames, inlet boxes and like items. When rate is not specified, asphalt will be applied at the rate of 0.1 gallon per square yard.

C. Obtain the Owner’s Representative's acceptance of the aggregate base course before beginning construction of the asphalt concrete wearing course.

D. Hot mix asphalt shall be placed on dry, prepared surfaces, when air temperature in the shade of 40 degrees Fahrenheit or warmer, unless otherwise authorized by the Owner’s Representative.

E. Placing asphalt pavement during rain or other adverse weather conditions will not be permitted unless otherwise authorized by the Owner’s Representative, except that asphalt mix in transit at the time these adverse conditions occur may be placed provided it is of proper temperature, the mix has been covered during transit, and it is placed on a foundation free from mud or free-standing water.

F. Correct any defects in material and workmanship, as directed, when determined detrimental by the Owner’s Representative. These include segregation of materials, non-uniform texture, and fouled surfaces preventing full bond between successive spreads of mixture. The corrections or replacement of defective material or workmanship shall be at the Contractor's expense.

G. Compact the bituminous mixture to at least 92 percent of the Theoretical Maximum Density.

H. The finished surface of each course of layer of mixture shall be of uniform texture, smooth, and free of defects and shall closely parallel that specified for the top surface finished grade. Remove and replace boils and slicks immediately with suitable materials.

I. The surface of each layer when tested with a Contractor-furnished 10-foot straightedge shall not vary from the testing edge by more than 0.02-foot for underlying courses of pavements and 0.015-foot for finished top courses or wearing courses of pavements. At no point shall the finished top of the wearing course vary more than 0.03-foot from the specified finished grade.

J. Lift thickness shall be as shown on the drawings or specified, but not to exceed 3 inches.

K. Do not place asphalt concrete pavement on emulsified asphalt (tack coat) until the asphalt separates from the water (breaks) but before it loses its tackiness.

L. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 FIELD QUALITY CONTROL

A. Job mix will be sampled immediately behind the paving machine.

B. Temperature of the mix will be measured immediately behind the paver.

C. The theoretical maximum specific gravity of the bituminous mixture will be determined in accordance with ASTM D2041.

D. Properties of the job mix will be measured using ASTM D2041.

E. Density of the compacted job mix will be measured in accordance with ASTM D2922.

3.4 ADJUSTMENT OF EXISTING MANHOLE COVERS AND VALVE BOXES

A. Prior to placing asphalt concrete pavement, the Contractor shall make all necessary adjustments to existing manhole frames and covers and valve box covers to ensure that the tops of the manhole covers or valve box lids are flush with the finished grade of the adjoining pavement or ground surface, and that valve boxes and PVC pipes are centered and plumb over operating nut valve.

END OF SECTION

SECTION 32 12 16.39

ASPHALT PAVING FOR STEEL TANK BASE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers the requirements for placing asphalt concrete pavement under the reservoir.

B. See Section 32 12 16, Asphalt Concrete Paving, for required Submittals and Pre-Paving Conference.

PART 2 MATERIALS

2.1 Materials

A. Comply with the requirements described in Section 32 12 16, Asphalt Concrete Paving except as modified herein.

B. Asphalt Cement for the reservoir base shall be PBA-2.

PART 3 EXECUTION

3.1 Execution shall comply with the requirements described in Section 32 12 16, Asphalt Concrete Paving, except as modified herein.

A. A 2-inch thick lift of asphalt concrete Class C shall be placed over a prepared aggregate base and compacted according to OSHD specifications for light duty asphalt concrete as shown on the plans.

B. When tested with a CONTRACTOR-furnished 10-foot straightedge the finished surface shall not vary from the testing edge by more than .015 foot and shall be free of all roller marks.

C. The finished asphalt concrete surface shall be flush with the top of the concrete ringwall and sloped at a 2 percent grade to the center point of the tank resulting in a 0.4-foot crown at tank center.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes chain link steel fencing and gates as shown on the Drawings or specified elsewhere. All fences and gates shall be furnished with top rails and knuckled periphery edges.

B. Section includes:

1. Chain link fabric.
2. Posts.
3. Rails.
4. Tension wires.
5. Braces.
6. Fittings.
7. Gates.
8. Lock assemblies and gate stops.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Chain Link Fence Manufacturer's Institute:

1. Galvanized Steel Chain Link Fence Fabric.
2. Industrial Steel Specifications for Fence-Posts, Gates and Accessories.

B. ASTM International (ASTM):

1. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

2. A313, Standard Specification for Stainless Steel Spring Wire.

3. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

4. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.

5. A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

6. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

7. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.

8. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.

9. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

10. C94, Standard Specification for Ready-Mixed Concrete.

11. C150, Standard Specification for Portland Cement.

12. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.

13. F552, Standard Terminology Relating to Chain Link Fencing.

14. F567, Standard Practice for Installation of Chain-Link Fence.

15. F626, Standard Specification for Fence Fittings.

16. F900, Standard Specification for Industrial and Commercial Swing Gates.

17. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

18. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

19. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.

20. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.

21. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

C. Conflicts in requirements shall use this Section to take precedence.

1.3 SUBMITTALS

A. Section 01 30 00, Submittal Procedures: Requirements for submittals.

B. Shop Drawings:

1. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.

2. Fence, gate posts, rails, and fittings.

3. Chain link fabric.

4. Gates and hardware.

C. Manufacturer's recommended installation instructions.

D. Evidence of Supplier and installer qualifications.

1.4 QUALITY ASSURANCE

A. Use skilled workers thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Provide each type of steel fence and gate as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition.

B. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fabric

1. Continuous chain link fence.

2. Height: As shown on the Drawings.

3. Mesh: 2-inch. All mesh shall have knuckled periphery to eliminate sharp appendages.

4. #9 gauge steel core wire.

5. Top and bottom selvage: Knuckled finish.

6. Galvanized after weaving.

7. Zinc coating shall not be less than 0.9 ounces per square foot.

B. Line Posts

Line posts shall be hot dipped galvanized 2.375-inch O.D. hot dipped galvanized pipe, weighing 3.12 pounds per lineal foot.

C. Terminal Posts

End, corner and pull posts shall be hot dipped galvanized pipe 2.875 inches O.D. and weighing not less than 4.64 pounds per lineal foot.

D. Top Rail

1. Top rail shall be hot dipped galvanized 1.660-inch O.D. pipe, weighing 1.83 pounds per lineal foot.

2. Furnish in random lengths of approximately 20 feet.

3. Jointed using a pressed steel or malleable sleeve, not only allowing for expansion and contraction, but also providing a continuous brace from end to end of each stretch of fence.

E. Tension Wire

Bottom tension wire shall be #6 gauge heavy galvanized high carbon steel coil spring wire, securely fixed to the fabric, line posts and terminal posts.

F. Braces

1. All terminal posts shall be braced with 1.660-inch O.D. horizontal pipe bracing of the same material as the top rail, securely attached to the terminal and first line post with malleable iron fittings.

2. Braces shall be truss-braced from the first line post to the bottom of the terminal post, with a 3/8-inch galvanized truss rod assembly.

3. Corner posts shall be braced in both directions.

G. Fittings

1. Malleable, cast iron or pressed steel.
2. Hot dip galvanized.

H. Fabric Ties

1. #11 gauge galvanized wire ties shall be used to tie the fabric to the line posts and rails.

I. Chain Link Gates

1. Frames:

   a. Made of heavy galvanized 2.875-inch O.D. pipe, weighing 4.64 pounds per lineal foot.

   b. Welded or assembled with corner fittings.

2. Corner fittings, ball and socket hinges, catch stops and center rest to be heavy galvanized malleable iron.

3. Hinges as required.

4. Provide diagonal cross-bracing.

J. Gate Posts

Posts shall be hot dipped galvanized pipe 2.875-inch O.D. weighing 4.64 pounds per lineal foot.

K. Framework Material

All posts, rails and braces to be heavy galvanized.

L. Lock Assembly and Gate Stop

1. Provide for each gate one (1) double-hasp drive gate drop rod lock assembly set in concrete and one (1) gate stop set in concrete.

2. All lock assemblies and gate stops shall be fabricated from heavy galvanized malleable iron.

3. Provide one vandal-proof keyed lock and 3 keys for each gate assembly.

M. Sliding Gate Operator (located at Booster Station entrance driveway)

1. Furnish and install an electric gate operator as specified. Gate operators that cannot be configured to leave the gate in the open position shall not be permitted.

2. L-3 Slide Gate Operator, as manufactured by Viking Access Systems.

    a. Provide with a 1/2-horsepower motor, continuous duty cycle, operating speed of 12 inches per second at a 1,600-pound maximum gate capacity.

    b. Provide with battery backup system capable of 100 fully continuous cycles at the specified maximum gate capacity.

    c. Provide with integrated heater unit capable of operation to temperatures of minus 20-degrees Fahrenheit.

3. Gate to include chain drive operation with single continuous length of chain, attached to gate securely with fasteners. Properly align chain drive system with gate operator and gate.

4. Operational voltage shall be 24 VDC. Manufacturer shall provide control power transformer that mounts inside their enclosure and is properly sized to provide power for all low-voltage equipment, sensors, etc. for a completely operable system.

5. Main Power Source: 120 VAC, single phase, out to gate’s controller cabinet.

6. The gate shall be provided with a minimum of five wireless remote-control operators that can be used from vehicles.

7. The gate shall also be equipped with a control station for use by emergency services personnel such as the fire department.

8. The gate operator shall be a pre-wired, self-contained, slide gate operator for horizontal sliding gates, including all selected attachments and accessory equipment.

9. Operators shall be built to UL 325 standards and be listed by a testing laboratory. Complete all electrical work according to local codes and National Electrical Code. All fieldwork shall be performed in a neat and professional manner, completed to journeyman standards.

10. Gate operator shall be sufficient to operate the specified gate. The gate operator shall be furnished as a complete system including the operator, support system, anti-entrapment components, input devices such as end sensors, controls, etc. including all interconnecting wiring and electrical conduits. The design drawings include the power to the operator, but do not provide details of the wiring between the gate operator and the various sensors and electrical components. This wiring shall be of the Contractor's design and shall be in accordance with the operator manufacturer's instructions and all the NEC.

11. All wiring shall be installed in conduits sized in accordance with NEC requirements. Direct bury wiring shall not be permitted.

12. The gate operating system shall be furnished with photo eyes such that it can reverse in either direction upon sensing an obstruction. All sensors and controls to provide anti-entrapment.

13. The gate operator shall be furnished with a five-year warranty against all defects in materials or workmanship. Defective materials shall be replaced with comparable materials furnished by the manufacturer, at no cost to the Owner.

14. Operation.

    a. Operation of the gate operator:

        1) By command with an activation from transmitter devices.
        2) By command with push-button operation (open-close-stop).

    b. Gate shall require command or signal for open operation.

    c. Operator's self-close features shall be activated for this project.

        1) If gate is open for 20 seconds and if electronic sensor eye is not tripped, gate's self-closed feature is activated.

15. Ancillary Equipment (*for use with Sliding Gate Operator*) shall be provided as follows.

    a. Wireless Receiver and Transmitters

        1) The Contractor shall provide a fully operational system with compatible wireless receiver and transmitter and push-button operator.

        2) Wireless Receiver: Multi-Code 1090 Receiver, manufactured by Linear Research.

            a) Access controls to include long range receiver with coax antenna kit.

            b) Mount antenna on top of one of the gate posts.

    b. Wireless Transmitter: Multi-Code 3089 One-Button / One-Channel Remote Control Transmitter (MUL-3089), manufactured by Linear Research.

c. Post-Mounted Push-Button Operator

1) As a part of complete sliding gate installation, the Contractor shall provide a post-mounted push-button operator compatible with the system components specified within this Section.

d. Photo Eye

1) As a part of complete sliding gate installation, the Contractor shall provide a photo eye sensor compatible with the system components specified within this Section.

2) Include one photo eye install on gate posts and providing infrared eye safety across the gate opening. Provide the required low volt conduit installed across the gate opening for hard wire connections from send and receive eye contacts.

16. Emergency Vehicle Access.

a. Emergency vehicle access shall be provided by installation of a Knox Master Key safety lock box modified to include gate open switch inside secured box (City of Pendleton Fire Marshal requirement).

PART 3 EXECUTION

3.1 INSTALLATION

A. All materials and workmanship shall be first class in all respects and shall be done in a neat and workmanlike manner.

B. Installation shall be conducted in accordance with the requirements of the Chain Link Fence Manufacturers Institute and these Drawings & Specifications.

C. All line, terminal, gate stops, gate drop, and gate posts shall be fixed with a minimum of 3-foot embedment in concrete poured into a 1-foot diameter hole and plumb upon curing of the concrete.

D. Line posts shall be spaced not further than 10-foot on-center.

E. Gates shall have 3-inch clearance above ground surface and sized for the application shown.

F. Space ties at 14 inches on-center (O.C.).

END OF SECTION

SECTION 33 01 30.13

STORM AND MANHOLE TESTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes methods for testing of gravity storm piping and manholes.

B. Section includes:

1. Testing of Gravity Storm Piping:

    a. Low pressure air testing.

2. Deflection testing of plastic storm piping.

3. Testing of Manholes:

    a. Vacuum testing.
    b. Exfiltration testing.

1.2 RELATED SECTIONS

A. Section 33 05 13 - Manholes.
B. Section 33 13 00 - Testing and Disinfection of Water Utility Piping.
C. Section 33 41 10 - Storm Utility Drainage Piping.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

B. American Water Works Association:

1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances.

2. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gage calibration.
6. Deflection mandrel drawings and calculations.

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.1 VACUUM TESTING

A. Equipment:

1. Vacuum pump.

2. Vacuum line.

3. Vacuum Tester Base:

   a. Compression band seal.
   b. Outlet port.

4. Shutoff valve.

5. Stopwatch.

6. Plugs.

7. Vacuum Gage: Calibrated to 0.1 in. Hg (0.34 kPa).

2.2 EXFILTRATION TESTING

A. Equipment:

1. Plugs.
2. Pump.
3. Measuring device.

2.3 AIR TESTING

A. Equipment:

1. Air compressor.
2. Air supply line.
3. Shutoff valves.
4. Pressure regulator.
5. Pressure relief valve.
6. Stopwatch.
7. Plugs.
8. Pressure Gage: Calibrated to 0.1 psi.

2.4 HYDROSTATIC TESTING

A. Equipment:

1. Hydro pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi.

2.5 DEFLECTION TESTING

A. Equipment:

1. "Go, no go" mandrels.
2. Pull/retrieval ropes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify manholes and piping are ready for testing.
B. Verify trenches are backfilled.
C. Verify pressure piping thrust restraint system is installed, as may be required.

3.2 PREPARATION

A. Obstructions:

1. After backfilling and restoration of surfaces, gravity pipelines shall be inspected for obstructions and shall be cleaned.

2. Pipes less than 24 inches in diameter shall be cleaned using the sewer ball method.

3. Lines larger than 36 inches in diameter may be cleaned by flushing as long as they are first visually inspected to assure that no physical obstructions exist.

    a. Flushing shall be such that velocities are at least 2.5 feet per second.

B. Lamping:

1. Lamp gravity piping after flushing and cleaning of lines, checking manholes for unfinished work.

2. Perform lamping operation by shining light at one end of each pipe section between manholes.

3. Observe light at other end.

4. Pipe not installed with uniform line and grade will be rejected.

5. Remove and reinstall rejected pipe sections.

6. Reclean and lamp until pipe section is installed to uniform line and grade.

C. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Testing of Gravity Sewer Piping:

1. Low Pressure Air Testing:

    a. Test each reach of gravity storm piping between manholes.

    b. Introduce air pressure slowly to approximately 4 psig.

        1) Determine ground water elevation above spring line of piping.

        2) For every foot of ground water above spring line of piping, increase starting air test pressure by approximately 0.4 psi.

        3) Do not increase pressure above 10 psig.

    c. Allow pressure to stabilize for at least five minutes.

d. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.

e. Testing:

1) Determine test duration for reach of storm with single pipe size from following table; do not make allowance for laterals.

Table 33 01 30.13 -1
Air Testing Duration for Gravity Sewer Piping

NOMINAL PIPE SIZE, INCHES	MINIMUM TESTING TIME, MIN/100 FEET
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4

2) Record drop in pressure during testing period.

3) If air pressure drops more than 1.0 psi during testing period, piping has failed.

4) If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.

5) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

B. Testing of Pressure Piping:

1. Test system according to AWWA C600 and the requirements of Section 33 13 00, Testing and Disinfection of Water Utility Piping.

C. Deflection Testing of Plastic Storm Piping:

1. Perform vertical ring deflection testing on PVC storm piping after backfilling has been in place for at least 30 days but not longer than 12 months.

2. Allowable maximum deflection for installed plastic storm pipe is no greater than five percent of original vertical internal diameter.

3. Perform deflection testing using properly sized rigid ball or "go, no go" mandrel.

4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured; measure pipe diameter in compliance with ASTM D2122.

5. Perform testing without mechanical pulling devices.

6. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

D. Testing of Manholes:

1. Description:

   a. Option of air testing or exfiltration testing.

   b. If air testing, test whenever possible prior to backfilling in order to more easily locate leaks.

   c. Repair both outside and inside of joint to ensure permanent seal.

   d. Test manholes with manhole frame set in place.

2. Vacuum test according to ASTM C1244 and following:

   a. Plug pipe openings; securely brace plugs and pipe.

   b. Inflate compression band to create seal between vacuum base and structure.

   c. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 in. Hg .

   d. Close valve.

   e. Testing:

      1) Determine manhole testing duration using following table:

MANHOLE DIAMETER (feet)	TEST PERIOD
4	60 seconds
5	75 seconds
6	90 seconds

      2) Record vacuum drop during test period.

      3) If vacuum drop is greater than 1 in. Hg during testing period, repair and retest manhole.

4) If vacuum drop of 1 in. Hg does not occur during test period, manhole is acceptable; discontinue testing.

5) If vacuum test fails to meet 1 in. Hg drop in specified time after repair, repair and retest manhole.

3. Exfiltration Testing:

   a. Plug pipes in manhole.

   b. Remove water from manhole.

   c. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole.

   d. Determine ground water level outside manhole.

   e. Fill manhole with water to its rim at the start of the test.

   f. Prior to testing, allow manhole to soak from minimum of four hours to maximum of 72 hours.

   g. After soak period, adjust water level to rim of manhole.

   h. Leakage in the manhole shall not exceed 0.2 gallons per foot of head above the highest invert after a one-hour test period.

4. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.

5. Repair visible leaks regardless of quantity of leakage.

END OF SECTION

SECTION 33 05 13

MANHOLES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes cast-in-place and precast concrete manholes and covers for access to subsurface drainage piping or utilities.

B. Section Includes:

1. Cast-in-place concrete manholes with transition to cover frame, covers, anchorage, and accessories.

2. Modular precast concrete manhole with tongue-and-groove joints with precast transition to cover frame, covers, anchorage, and accessories.

3. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work.
B. Section 03 21 00 - Reinforcing Steel.
C. Section 31 05 13 - Soils for Earthwork.
D. Section 31 05 16 - Aggregates for Earthwork.
E. Section 31 23 16 - Excavation.
F. Section 31 23 23 - Fill.
G. Section 33 01 30 - Storm and Manhole Testing.
H. Section 33 41 10 - Storm Utility Drainage Piping.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M-198B – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. American Concrete Institute:

1. ACI 301 – Building Code Requirements for Structural Concrete.
2. ACI 315 – Details and Detailing of Concrete Reinforcement.
3. ACI 318 – Building Code Requirements for Structural Concrete.

C. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. ASTM C55 - Standard Specification for Concrete Building Brick.
5. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
6. ASTM C150 - Specifications for Portland Cement.
7. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar.
8. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
12. ASTM C913 - Standard Specification for Precast Concrete Stormwater and Wastewater Structures.
13. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
14. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

D. Federal Specifications:

1. SS-S-00210 (210-A) – Specification for Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

E. US Army Corp of Owner’s Representatives:

1. CRD-C 621 – Specifications for Non-Shrink Grout.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Pre-cast concrete manholes:

   a. Design criteria and calculations.
   b. Details of reinforcement.

2. Steps.

3. Cover and frame construction, features, configuration, dimensions and material specifications.

4. Rubber gaskets.

5. Grout and mortar.

C. Shop Drawings:

1. Indicate manhole by location.

2. Provide dimensions, elevations, joints, location and type of lifting inserts.

3. Indicate connecting piping material, piping size, piping connection angles and offsets, and sizes of penetrations.

D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

C. Storage:

1. Store precast concrete manholes as to prevent damage to Owner's property or other public or private property.

2. Repair property damaged from materials storage.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA FOR MANHOLES

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: According to ASTM C913.

C. Design of Joints for Precast Components:

1. According to ASTM C913.
2. Lipped male/female joints.
3. Maximum Leakage: 0.025 gal. per hour per foot of joint at 3 feet of head.

D. Shaft Construction:

1. Reinforced concrete.
2. Concentric with eccentric cone top section
3. Sleeved to receive pipe connections.

E. Wall Thickness:

1. Minimum wall thickness shall be 5 inches.
2. Cones shall have the same wall thickness and reinforcement as riser sections.

F. Shape: Cylindrical.

G. Clear Inside Dimensions:

1. As indicated on Drawings.

2. Sections shall consist of circular sections in standard nominal inside diameters of 42, 48, 54, 60, 72, 84, 96, 108, 120, 132, or 144 inches.

H. Design Depth:

1. As indicated on Drawings.

I. Clear Cover Opening: As indicated on Drawings, minimum of 30 inches.

J. Pipe Entry: Furnish openings as required and as indicated on the Drawings.

K. Steps:

1. Rungs:

   a. Material: Formed polypropylene with 1/2-inch diameter, Grade 60 reinforcing bar.

   b. Comply with ASTM C478.

   c. Reinforcing bar to comply with ASTM A615.

2. Formed integral with manhole sections.

3. Width: Minimum 12 inches.

4. Spacing: 12 inches o.c. vertically.

2.2 MANHOLES

A. Precast Concrete Manholes:

1. Sections:

   a. Description: Reinforced precast concrete according to ASTM C478.
   b. Gaskets: According to ASTM C923.
   c. Heights: Multiples of 6 inches.

2. Bases:

   a. Base slab integral with sidewalls.
   b. Monolithic construction, conforming to ASTM C478.

B. Cast-in-Place Concrete Manholes:

1. Sections: Reinforced cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.

2. Concrete forming in accordance with Section 03 10 00, Concrete Work.

C. Joint Materials:

1. Mortar:

   a. Conform to ASTM C387.

   b. Admixtures

      1) Allowable, not exceeding the following percentages of weight of cement:

         a) Hydrated lime, 10 percent;
         b) Diatomaceous earth or other inert materials, five (5) percent;

   c. Consistency: Shall be such that it will readily adhere to the precast concrete if using the standard tongue and groove type joint.

   d. Mortar not used within 30 minutes of initial mixing shall be discarded and not be used.

2. Non-Shrink Grout:

   a. Description: Non-metallic, cementitious, commercial grout exhibiting zero shrinkage per ASTM C827 and CRD-C-621.

   b. Manufacturers:

      1) Preco-Patch;
      2) Sika 212;
      3) Euco N-S;
      4) Five-Star;
      5) Approved equal;

3. Grout shall not be amended with water after initial mixing.

4. Grout not used within 20 minutes of initial mixing shall be discarded and not be used.

5. Commercial Concrete Bonding Agent:

   a. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted.

   b. Bonding agent shall be compatible with the brand of grout used.

   c. Water shall not be used as a substitute for the commercial bonding agent.

D. Preformed mastic gaskets for manhole joints shall meet Federal Specifications SS-S-00210 (210-A), AASHTO M-198B and ASTM C990.

E. Reinforcement:

1. Formed steel wire.

2.3 FRAMES AND COVERS

A. Description:

1. Construction: ASTM A48, Class 30B cast iron.

2. Lid:

   a. Machined flat bearing surface.
   b. Removable.
   c. Boltable at locations shown on the Drawings.

3. Cover Design: Closed.

4. Live Load Rating: AASHTO H20 loading.

5. Cover: Molded with “S” cast in.

6. Coefficient of Friction on Outside Face: Minimum of 0.60.

2.4 RISER RINGS

A. Description:

1. 4 Inches to 6 Inches Thick:

   a. Material: Precast concrete.
   b. Comply with ASTM C478.

2. Less than 4 Inches Thick:

   a. Material: Cast iron.
   b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

   a. Wraps and Band Widths: Conform to ASTM C877, Type III.
   b. Cone/Riser Ring Joint: Minimum 3 inches overlap.
   c. Frame/Riser Ring Joint: 2 inches overlap.
   d. Additional Bands: Overlap upper band by 2 inches.

2.5 MATERIALS

A. Bedding and Cover:

1. Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Backfill Around Structure: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Soil Backfill from Above Pipe to Finish Grade:

a. In existing or future roadways, right-of-way:

1) Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

b. In non-paved areas outside of footprint of existing or future structures, outside of right-of-way:

1) Soil Type S1, as specified in Section 31 05 13, Soils for Earthwork.
2) Subsoil: No rocks over 6 inches in diameter, frozen earth, or foreign matter.

2.6 FINISHES

A. Steel:

1. Galvanizing:

a. ASTM A123.
b. Hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items provided by other Sections of Work are properly sized and located.
B. Verify built-in items are in proper location and ready for roughing into Work.
C. Verify correct size of manhole excavation.

3.2 PREPARATION

A. Design the method of placement for all precast items and add all reinforcing steel, embeds, bracing and other items necessary for placement. All portions of embeds which remain embedded in the concrete shall be made of stainless steel.

B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

D. Do not install manholes where site conditions induce loads exceeding structural capacity of manhole components.

E. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage; remove and replace damaged units.

F. Subgrade

1. Subgrade shall be compacted to 95 percent of maximum density.

2. Compacted subgrade shall be covered with a minimum of six (6) inches of aggregate base compacted to 95 percent of maximum density, extending a minimum of six (6) inches beyond the outside limits of the manhole, unless otherwise indicated on Drawings.

3. Grade the aggregate base to a uniform, level surface which will fully support the structure and to an elevation that will ensure proper positioning of the top slab or lid.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate manholes as specified in Section 31 23 16, Excavation in location and to indicated depth.

2. Provide 12 inches of clearance around sidewalls of structure for construction operations.

3. When groundwater is encountered, prevent accumulation of water in excavations; place manholes in dry trench.

B. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation as approved by Owner’s Representative.

C. Base Pad:

1. Place base pad.
2. Trowel top surface level.

D. Backfill excavations for manholes as specified in Section 31 23 23, Fill.

E. Form and place manhole cylinder plumb and level and to correct dimensions and elevations.

F. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.

G. Set cover frames and covers level without tipping and to correct elevations.

H. Coordinate with other Sections of Work to provide correct size, shape, and location.

I. Precast Concrete Manholes:

1. Assembly:

a. Install precast structures in accordance with the manufacturer's recommendations unless otherwise required by the Contract Documents.

b. Verify installed manholes meet required alignment and grade.

c. Lift precast components at lifting points designated by manufacturer.

d. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.

e. Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified in Section 31 23 23, Fill or on other support system as indicated on Drawings.

f. Assemble multi-section structures by lowering each section into excavation; set level and firmly position base section before placing additional sections.

g. Place manhole sections plumb and level, trim to correct elevations, and anchor to base pad.

h. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.

i. Maintain alignment between sections by using guide devices affixed to lower section.

2. Joints:

    a. Sealing materials may be installed onsite or at manufacturers plant.

    b. All joints shall be sealed watertight by the use of rubber gaskets or other approved preformed sealant.

    c. All joints shall then be filled with non-shrink grout on both the inside and outside surfaces to produce smooth interior and exterior surfaces.

3. Concrete Base Installation:

    a. Bases shall be set at the proper grade to allow pipe openings to match the grades for connecting pipes.

    b. Invert shall be constructed to a section identical with that of the storm pipe.

    c. Where the size of storm pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces.

    d. Prevent water from contacting the new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

    e. Manhole bases shall be set level so base gravel fully and uniformly supports them in true alignment with uniform bearing throughout full circumference.

    f. Do not level the base sections by wedging gravel, or other material, under the edges.

    g. Flexible connectors shall be installed in the base section to form a permanently watertight seal.

4. Manhole Riser Sections:

    a. Precast manhole components may be used to construct standard, drop and carry-through manholes. Manholes less than four (4) feet in depth measured from the spring line of the pipe to the bottom of the lower riser ring shall be flat-top manholes.

    b. Install manhole riser sections at the location shown on the plans. All joints shall be watertight and shall use rubber gaskets or a preformed sealant. All joints shall then be filled with non-shrink grout inside and out so as to produce smooth interior and exterior surfaces. All manhole penetrations shall be watertight. Complete manholes shall be rigid. Compact backfill in accordance with the provisions stated elsewhere in this document.

c. All lift holes shall be thoroughly wetted, completely filled with mortar, and smoothed and pointed both inside and out to ensure watertightness.

d. The shortest length of riser section to be incorporated into the manhole shall be installed immediately below the flat slab top or cone.

e. Properly locate and plumb each manhole riser section.

f. Install manhole extensions and top slabs in accordance with manufacturer's specifications and as shown on the plans. Lay section risers with the sides plumb and the tops level. Make joints and penetrations watertight.

g. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.

5. Entrances / Exits:

   a. Cut pipe flush with interior of structure.

   b. Shape inverts through manhole as indicated on Drawings.

   c. All rigid non-reinforced pipe entering or leaving the manhole (new or existing manhole) shall be provided with flexible joints within one (1) foot of the structure and shall be placed on compacted bedding.

   d. Ribbed HDPE pipe connections shall be grouted watertight with non-shrink grout.

   e. PVC pipe shall be connected to manholes using an approved adapter specifically manufactured for the intended service.

      1) Adapters shall be Fernco, Kor-N-Seal, or approved equal.

6. Grates, Frames, and Covers:

   a. Manhole frames, grates and covers shall be installed in such a manner as to prevent infiltration of surface or groundwater between the frame and the concrete of the manhole section. Use preformed rubber ring to form a watertight seal.

   b. Manhole frames and covers shall be installed to grades shown on the drawings or as directed.

   c. Adjustment of manhole castings shall be made using specified precast grade rings and approved rubber ring joints.

d. The maximum depth of adjustment below any manhole casting shall be 16 inches, and a minimum depth of adjustment shall be four (4) inches.

J. Cast-in-Place Concrete Manholes:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.

2. Erect and brace forms against movement as specified in Section 03 10 00, Concrete Work.

3. Install reinforcing steel as indicated on Drawings and as specified in Section 03 10 00, Concrete Work.

4. Place and cure concrete as specified in Section 03 10 00, Concrete Work.

5. Frames and Covers:

a. Set frames using mortar and masonry.

b. Install radially-laid concrete brick with 1/4-inch thick vertical joints at inside perimeter.

c. Lay concrete brick in full bed of mortar and completely fill joints.

d. If more than one course of concrete brick is required, stagger vertical joints.

e. Set frame and cover as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

A. Test concrete manhole and structure sections according to ASTM C497.
B. Perform manhole testing according to Section 33 01 30, Storm and Manhole Testing.
C. Test cast-in-place concrete as specified in Section 03 11 00, Concrete Work.
D. Vertical Adjustment of Existing Manholes:

1. If required, adjust top elevation of existing manholes to finished grades as indicated on Drawings.

2. Reset existing frames, grates, and covers that were carefully removed and cleaned of mortar fragments to required elevation according to requirements specified for installation of castings.

3. When removal of existing concrete wall is required, remove concrete without damaging existing vertical reinforcing bars, clean concrete from vertical bars, and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 11 00, Concrete Work.

END OF SECTION

SECTION 33 05 17

PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete valve vaults.
2. Precast concrete meter boxes.

1.2 RELATED SECTIONS

A. Section 05 50 00, Metal Fabrications.
B. Section 31 05 16, Aggregates for Earthwork.
C. Section 31 23 16, Excavation.
D. Section 31 23 23, Fill.
E. Section 33 11 10, Water Utility Distribution Piping.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

3. ASTM A536 - Standard Specification for Ductile Iron Castings.

4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

6. ASTM C33 - Standard Specification for Concrete Aggregates.

7. ASTM C150 - Standard Specification for Portland Cement.

8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.

10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).
15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
16. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests).
17. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 COORDINATION

A. Coordinate Work with utilities within construction area.

B. The drawings identify precast vaults and meter boxes by manufacturer and model number. This information is provided for dimensional information only. Provide precast items in accordance with the requirements of this Section.

1.5 PREINSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section to confirm finished floor and finished grade elevations.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on valve vaults and meter boxes.

C. Shop Drawings for Precast Concrete Valve Vaults:

1. Indicate plan, location, and inverts of connecting piping.
2. All interior and exterior dimensions.

3. Location and type of lifting inserts, connection embeds and joints.
4. Details of reinforcement.
5. Covers or hatches.
6. Ladders and grating.

D. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and specified requirements.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.8 QUALITY ASSURANCE

A. Perform Work according to standards identified in Article 1.2 herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Transport and handle precast concrete units with equipment designed to protect units from damage.

C. Storage:

1. Store precast concrete valve vaults and meter boxes according to manufacturer instructions.

2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Performance and Design Criteria:

1. Watertight, Precast, Reinforced, Air-Entrained Concrete Structures:

   a. Manufactured to conform to ASTM C913.

2. Loading:

   a. Design to ASTM C890-A16 / AASHTO HS20 live loading and installation conditions.

   b. Where vaults are below grade, a dead load of 125 pounds per cubic foot shall be added for the soil.

   c. Lateral loads:

      1) Static: 105 x Depth of fill (psf) triangular equivalent fluid pressure plus a surcharge of an additional three (3) feet of soil depth in areas subject to vehicular traffic (assume traffic load in all areas, unless indicated otherwise by the Contract Documents).

      2) Seismic acceleration: UBC Zone 3 requirements (I = 1.25) where I = importance factor, I = 1.25, but not less than 0.20 g acting on structure mass. Seismic loading need not be considered simultaneously with traffic surcharge.

3. Minimum 28-Day Compressive Strength: 3,000 psi.

4. Honeycombed or re-tempered concrete is not permitted.

5. No knockouts shall be cast into vault walls. All pipe penetrations shall be pre-formed or core-drilled at the required locations.

6. Accessories: Accessories such as ladders, floor grates at sumps, and other features shall be provided as shown on the Drawings.

7. Size: Vault dimensions shall be as required by the Drawings.

2.2 PRECAST CONCRETE VALVES AND METER BOXES

A. Manufacturers:

   1. Furnish materials according to Owner standards as shown in the details of the Drawings.

B. Valve Vault and Meter Box Frames and Covers:

   1. Cast Iron Castings:

      a. ASTM A48, Class 30 or better.
      b. Free of bubbles, sand, air holes, and other imperfections.

C. Access Steps:

1. Steel reinforced formed polypropylene:

   a. ASTM C478.
   b. Reinforced rod: ASTM A615, Grade 60, 1/2-inch diameter.

2. Aluminum: ASTM B221, Alloy 6061-T6.

3. Width: Minimum 12 inches.

4. Spacing: 12 inches o.c. vertically.

2.3 ACCESS HATCHES AND LIDS

A. Unless noted otherwise elsewhere in the Contract Documents, vaults shall have concrete top slabs with access openings as shown on the Drawings.

B. Hatches

1. Frame opening length x width = As shown in Drawings.

2. Flush grip handle.

3. Comp. spring lifting mechanism assembly.

4. Heavy duty forged brass hinges with stainless steel pins.

5. Heavy duty automatic lock open arm with red vinyl release grip.

6. Heavy duty check chain.

7. Plate cover reinforced for 300 #/S.F. live load.

8. Stainless steel slam-lock with brass spoon handle.

9. All steel plate, sheeting and hardware galvanized or cadmium plated except as noted above.

10. Shop finish of cover and frame: Mill finish.

11. Recessed hasp for pad lock.

12. Aluminum in contact with concrete or grout shall be coated with epoxy as specified herein.

C. Lids shall have lifting holes.

D. When leveling bolts are used to set the vault top sections, ensure the load from the top slab is transferred through grout to the vault walls so that the load is not carried by the leveling bolts.

2.4 MATERIALS

A. Portland Cement:

1. ASTM C150, Type II.

B. Coarse Aggregates:

1. ASTM C33.
2. Graded 1 inch to No. 4 sieve.

C. Sand:

1. ASTM C33.
2. Fineness Modulus: 2.35.

D. Water:

1. Potable.

2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.

E. Air-Entraining Admixtures: ASTM C260.

F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 40 minimum.
2. Welded Wire Fabric: ASTM A185.

G. Gaskets:

1. Rubber gaskets: ASTM C443.

H. Joint Sealant:

1. ASTM C990.

I. Bedding:

1. Aggregate Bedding Material: Fill Type A1 as specified in Section 31 05 16, Aggregates for Earthwork. Size as shown in the Drawings.

2.5 FABRICATION

A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

B. Vaults may be formed with separate top and bottom slabs.

C. Walls shall be cast so that all sides are continuous at corners and their full length with no block-outs or knockouts.

D. Horizontal joints may be provided so that walls can be placed in horizontal segments.

E. All horizontal joints shall be keyed to prevent offsets and shall be provided with a watertight gasket.

F. Finish:

1. Formed surfaces shall be smooth and uniform with no fins, bulges, or other irregularities.
2. Any void greater in width than 1/2-inch or deeper than 3/8-inch shall be repaired.
3. Unformed interior slab surfaces shall have a smooth steel trowel finish.
4. Unformed exterior slab surfaces shall have a light broom finish applied to a steel trowel finish.

2.6 MIXES

A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

A. Ream pipe ends and remove burrs.

B. Remove scale and dirt from components before assembly.

C. Establish invert elevations for each component in system.

D. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

A. Vaults/Meter and Bedding:

1. Excavate as specified in Section 31 23 16, Excavation for Work of this Section.
2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.
3. Place bedding material level in one continuous layer to a minimum compacted depth of 6 inches.
4. Compact bedding material to 95 percent maximum density.
5. Bases for precast concrete structures shall be set level so that bedding material fully and uniformly supports them in true alignment with uniform bearing throughout full perimeter. Do not level bases by wedging gravel under the edges.
6. Backfill around sides of vaults and meter boxes as required by the Drawings.

B. Connect piping.

3.4 FIELD QUALITY CONTROL

A. Request examination of subgrade by Owner’s Representative prior to placing aggregate base under precast materials.

B. Compaction Testing: In accordance with Field Quality Control requirements of Section 31 23 23, Fill.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

D. Frequency of Compaction Tests: In accordance with Section 01 45 00, Quality Control.

END OF SECTION

SECTION 33 11 10

WATER UTILITY DISTRIBUTION & TRANSMISSION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section applies to furnishing and installation of buried pipe materials, fittings and appurtenances normally encountered with water distribution and transmission systems, including potable water and fire water systems. Work for in-plant piping for pump stations and vaults, see Section 40 05 13, Common Work Results for Process Piping.

B. Section includes:

1. Pipe and fittings.
2. Flexible couplings.
3. Flanged coupling adapters.
4. Insulating flanged joints.
5. Tapping sleeves and valves.
6. Flexible expansion joints.
7. Bedding and cover materials.

C. Related Requirements:

1. General

a. Furnish and install all piping systems shown and specified in accordance with the requirements of the Contract Documents.

b. Each buried piping system shall be complete, with all necessary fittings, valves, accessories, lining and coating, testing, excavation, backfill and encasement, to provide a functional installation.

c. Piping layouts shown in the Drawings are intended to define the general layout, configuration, and routing for pipe, as well as the size and type of piping to be installed. The piping plans are not pipe construction or fabrication drawings.

d. The Contractor shall cause the Supplier of pipes, valves, fittings and appurtenances to coordinate piping installation such that all equipment is compatible and is capable of achieving the performance requirements specified in the Contract Documents.

e. It is the Contractor’s responsibility to develop the details necessary to construct all piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, valves, gaskets, fittings, appurtenances etc., for a complete and functional system.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work.
B. Section 31 05 13 - Soils for Earthwork.
C. Section 31 05 16 - Aggregates for Earthwork.
D. Section 31 23 16 - Excavation.
E. Section 31 23 17 - Trenching.
F. Section 31 23 23 - Fill.
G. Section 31 23 24 - Flowable Fill.
H. Section 33 05 17 - Precast Concrete Valve Vaults and Meter Boxes.
I. Section 33 12 13 - Water Service Connections.
J. Section 33 12 16 - Water Utility Distribution and Transmission Valves.
K. Section 33 12 19 - Fire Hydrants.
L. Section 33 13 00 - Testing & Disinfecting of Water Utility Piping.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kilogram (5.5-pound) Rammer and a 305-millimeter (12-inch) Drop.

B. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.

3. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.

4. ASME B31.10 - Standards of Pressure Piping.

C. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

4. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

5. ASTM A536, Standard Specification for Ductile Iron Castings.

6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

7. ASTM D1598 - Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.

8. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

9. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

10. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

D. American Water Works Association:

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

7. AWWA C153 - Ductile-Iron Compact Fittings.

8. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe

9. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

10. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

11. AWWA C606 - Grooved and Shouldered Joints.

12. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch Through 12 inch (100 millimeter Through 300 millimeter), for Water Transmission and Distribution.

13. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inch Through 48 inch (350 millimeter Through 1,200 millimeter) for Water Transmission and Distribution.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves.

F. National Sanitation Foundation:

1. NSF Standard 61 - Drinking Water System Components – Health Effects.
2. NSF Standard 372 - Drinking Water System Components – Lead Content.

G. SUBMITTALS

H. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

I. Product Data: Submit data on pipe materials, pipe fittings, restrained joint systems, and accessories.

J. Shop Drawings: Indicate piping layout, including piping specialties.

1. Layout Schedule for applicable segments of proposed transmission main alignment. Schedule shall include layout plan and dimensions, schedule of pipe fittings and specials, materials and class for each size and type of pipe, joint details, pipe supports, and any special provisions required for assembly.

K. Lining and coating data.

L. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

M. Manufacturer’s handling, delivery, storage and installation requirements.

N. Field Quality-Control Submittals:

1. Pipeline hydrostatic testing plan.

2. Indicate results of Contractor-furnished tests and inspections.

O. Preconstruction Photographs:

1. Submit digital files of colored photographs of Work areas and material storage areas.

1.4 CLOSEOUT SUBMITTALS

A. As-Built Drawings:

1. Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Materials:

1. Unless otherwise noted, all water works materials provided for the project shall be new, of first-class quality and shall be made by reputable manufacturers.
2. All material of a like kind shall be provided from a single manufacturer unless otherwise approved by the Owner's Representative.
3. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage and handling.

B. Markings:

1. Pipes and Fittings: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, inside diameter of pipe, dimension ratio as applicable, pipe class as applicable, pipe number for laying purposes as applicable, and other information required for type of pipe.
2. Bolting materials (washers, nuts, and bolts) shall be marked with material type.

C. Testing:

1. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards.

1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's written recommendations and as specified in these Contract Documents.

B. Pipe, specials, and fittings delivered to Project Site in damaged condition will not be accepted.

C. Storage:

1. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

2. Pipe and fittings shall not be stored on rocks, gravel or other hard material that might damage pipe. This includes storage area and along pipe trench.

3. Do not store materials in direct sunlight.

4. Gaskets: Do not allow contact with oils, fuels, petroleum, or solvents.

D. Handling:

1. Pipe and appurtenances shall be handled in accordance with manufacturer's recommendations or requirements contained in this section or subsequent sections dealing with the specific pipe material, whichever is more stringent.

2. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.

3. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.

4. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

PART 2 PRODUCTS

2.1 WATER PIPING

A. General

1. All piping materials and specials shall meet the specifications of this Section and of the appropriate AWWA Standard Specifications. In the case of conflict, the more stringent specifications shall apply.

2. All coatings and materials specified herein which may come in contact with potable water shall conform to National Sanitation Foundation (NSF) Standard 61 and 372.

3. Minimum Pressure Ratings: Unless otherwise specified herein or shown in the Drawings, the minimum working pressure rating of all water works materials specified herein shall be 1.5 times the operating pressure or 150 psi minimum.

4. Gaskets:

    a. Material: Styrene Butadiene Rubber (SBR) composition.

B. Ductile Iron Pipe:

1. Centrifugally cast, conforming to AWWA Standard C151.

2. Coating: Asphaltic exterior coating in accordance with AWWA Standard C151.

3. Pipe Mortar Lining: Shop-applied NSF 61 cement mortar lining, smoothed finish, complying with AWWA C104.

4. Pipe Thickness Class:

    a. Comply with AWWA C151.

    b. Class 52, unless shown to be greater in the Plans.

        1) The Contractor shall be aware ductile iron piping with thickness class greater than Class 52 may have long fabrication and supplier lead times. The Contractor shall be responsible for coordinating product submittal and delivery times accordingly such as not to delay construction.

5. Gauged Pipe:

    a. All ductile iron pipe 24-inch diameter or greater to be cut in the field shall be gauged full length and, along the full length, shall meet the outside diameter standard dimensions and tolerances required for spigot ends along the full length of pipe to within 2 feet of the bell end.

    b. In addition to pipe supplied for anticipated cutting, a minimum of 5 percent of each size of piping 24-inch diameter or greater shall be provided gauged full length as described above.

    c. Pipe shall be externally marked, in manufacturer’s color, indicating gauged pipe.

6. Polyethylene Encasement:

    a. Comply with AWWA C105.

b. Polyethylene film shall be minimum 8-mil thick virgin linear low-density polyethylene (LLDPE).

7. Joints:

   a. Joint types shall be provided as identified in the Drawings and as required for the application.

   b. Mechanical Joints:

      1) Comply with AWWA C111.

   c. Push-on Joints:

      1) Comply with AWWA C111.

      2) Manufacturers, without exception:

         a) Tyton Joint by American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, McWane, and Pacific States Cast Iron Pipe.

         b) Fastite Joint by American Cast Iron Pipe Company.

   d. Restrained Joints:

      1) Joint restraint for pipe shall be accomplished with an integral lock mechanism, except as may be otherwise specified.

         a) Any such system shall be a manufacturer's standard proprietary design, shall be as recommended by the manufacturer for the application, and shall be performance proven.

      2) Restraining components:

         a) Ductile iron complying with AWWA C110 and/or C153, with the exception of a manufacturer's proprietary design dimensions.

         b) Push-on joints for such fittings shall comply with AWWA C111.

      3) Deflection:

         a) The maximum pipe deflection shall not exceed one half of the manufacturer's stated joint deflection allowance.

      4) Manufacturers:

         a) "TR Flex", United States Pipe and Foundry Company.

b) “Field-Lok”, United States Pipe and Foundry Company.

c) “MJ-TJ” pipe with “MEGALUGs”, Pacific States Cast Iron Pipe Company.

d) “MEGALUG”, EBAA Iron, Inc.

(1) Where any restrained joint system requires the use of a wedge-type mechanical restraint gland for restraint, the glands shall be provided in quantities as may be required and shall be considered incidental to the joint restraint system.

(2) Wedge-type mechanical restraining glands shall not be used to restrain the plain end of plain end ductile iron or cast iron fittings.

e. Flanged Joints:

1) Flat faced, complying with AWWA C115.

2) Bolt hole drilling according to ASME/ANSI B16.1, Class 125. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.

3) The Contractor shall coordinate with pipe, valve and fitting suppliers to make certain mating pipe, valve and fitting flanges match in bolt pattern.

4) Flange class:

a) Where design pressure is 150 psi or less, flanges shall conform to either AWWA C207 Class D or ASME B16.5 150-pound class.

b) Where design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either AWWA C207 Class E or ASME B16.5 300-pound class.

5) AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity.

6) Threaded flanges:

a) Ductile iron pipe spools with threaded flanges shall conform to AWWA C115.

b) Installed only on pipe with a minimum Class 53 wall thickness.

7) Buried flanges:

a) Flanged connections shall not be buried unless shown as such on the Drawings.

b) Buried flanges shall be wrapped with 2 layers of 10 mil tape along edges of flanges.

8) Gaskets:

a) Full faced, composed of synthetic rubber and 1/8-inch thick conforming to ASME B21.1 and AWWA C111.

b) Ring gaskets will be permitted only where specifically noted in the Drawings and Specifications.

c) Gaskets for flanged joints shall be as follows:

(1) Pipe sizes between 6-inch and 24-inch diameter, service pressures of 150 psi or greater shall be Garlock 3760-U or equal.

(2) Pipe sizes 4-inch diameter and under, service pressures of 150 psi or greater shall be Garlock 3505 or equal.

(3) All pipe sizes with service pressures of 150 psi or less shall be Garlock 98206 or equal.

d) Insulating flanged joints:

(1) Full faced, conform to ANSI 16.21.

(2) Material: Non-asbestos.

(3) Suitable for operating and test pressures of the pipe system.

(4) Manufacturer:

(a) Garlock GYLON Style 3505 or equal.

C. PVC:

1. All PVC pressure pipe shall be manufactured with an integral bell design capable of receiving an elastomeric gasket.

2. All PVC pressure pipe shall be dimensionally compatible with standard cast/ductile iron fittings produced according to AWWA C110 or AWWA C153, as applicable.

3. Deflection:

    a. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly.

    b. Deflection by bending of the pipe rather than at the joints is not allowed.

    c. The maximum pipe deflection shall not exceed one half of the manufacturer's stated joint deflection allowance.

4. Joints:

    a. Solvent-cement couplings are not permitted.

5. Gaskets: Comply with ASTM F477.

6. Size: 4-inch through 12-inch diameter

    a. Comply with AWWA C900, DR 14, Class 305, unless shown otherwise in the Drawings or specified elsewhere.

7. Size: 14-inch through 48-inch diameter

    a. Comply with AWWA C905, DR 18, Class 235, unless shown otherwise in the Drawings or specified elsewhere.

8. Restrained Joints:

    a. For push-on pipe joint at pipe bells:

        1) Material:

            a) Body: Ductile iron. Comply with ASTM A536.
            b) Bell Restraint Systems: Corten steel tie rods.

        2) Coatings: Shop-applied liquid epoxy.

        3) Construction:

            a) A split serrated ring shall be used behind the pipe bell. A split serrated ring shall also be used to grip the pipe and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring.

            b) System shall be designed for a minimum 2 to 1 safety factor.

4) Manufacturers:

a) 4-inch through 12-inch diameter: EBAA Iron, Inc. - Series 1900 Bell Restraint Harness.

b) 14-inch through 48-inch diameter: EBAA Iron, Inc. - Series 2800 Bell Restraint Harness.

b. At mechanical joint fittings:

1) Material: Ductile iron. Comply with ASTM A536.

2) Coatings: Shop-applied liquid epoxy.

3) Construction:

a) Restraint accomplished by a restraint device consisting of a follower gland utilizing multiple gripping wedges.

b) The restraint system shall have a sufficient number of fastening bolts to connect the ring to the mechanical joint.

c) System shall be designed for a minimum 2 to 1 safety factor.

4) Fasteners:

a) T-bolts and nuts: High strength, low alloy steel.
b) Comply with AWWA C111.

5) Manufacturers:

a) EBAA Iron, Inc. - MEGALUG, Series 2000PV
b) Romac Industries, Inc. – 470 Series Pipe Restraining System

2.2 FITTINGS:

A. Material: Ductile iron, complying with AWWA Standard C110.

1. Fittings conforming to AWWA C153 may be substituted in lieu of AWWA C110 fittings.

B. Fittings used for joining ductile iron and PVC pipe shall be of the type, size and strength designated on the Plans, elsewhere in the specifications.

1. Fittings shall be mechanical joint, push-on type, flanged or plain-end as required and shown on the Drawings.

2. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

C. Pressure ratings: As specified for joining pipe above and as shown on the Drawings.

D. Coating and Lining:

1. Asphaltic exterior coating in accordance with AWWA Standard C110.
2. Cement Mortar Lining: Comply with AWWA C104.

E. Following information cast upon fittings:

1. Manufacturer's identification.
2. Country of manufacture.
3. Pressure rating.
4. For bends, number of degrees and/or fractions of a circle.

F. Owner may require additional metallurgical documentation or other certifications.

2.3 NUTS, BOLTS AND WASHERS:

A. All bolts shall have heavy hex head with heavy hex nuts.

B. For operating pressures greater than 150 psi:

1. Bolts: Steel alloy composition. Comply with ASTM A193.
2. Nuts: Comply with ASTM A194, Grade 2H.
3. Washers: Comply with ASTM F436.

C. For operation pressures of 150 psi or less:

1. Bolts: Low-carbon steel composition. Comply with ASTM A307, Grade B.
2. Nuts: Comply with ASTM A563A, Heavy Hex.
3. Washers: Comply with ASTM F844.

2.4 FLEXIBLE COUPLINGS

A. General

1. All flexible couplings shall be constructed to inside diameters that properly fit the connecting pipes.

2. The Contractor shall be responsible for selecting sleeve lengths appropriate to the application, subject to review and approval of the Owner's Representative, recognizing that longer sleeves allow for larger deflections and may ease installation.

B. Flexible Couplings:

1. Description:

   a. Comply with AWWA C219.

   b. Type: Bolted, sleeved.

   c. Configuration: Straight, transition, or reducing as shown in the Drawings.

   d. Center rings and end rings: Ductile iron. Comply with ASTM A536.

   e. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

   f. Bolts and nuts: High strength low alloy steel. Comply with AWWA C111.

   g. Lining and coating: Factory-applied fusion bonded epoxy.

   h. Working pressure: Up to 260 psi.

2. Manufacturers:

   a. For 2-inch to 24-inch diameter:

      1) Romac Industries, Inc. – Style 501 or equal.

   b. For 12-inch diameter and larger:

      1) Romac Industries, Inc. – 400 Series or equal.

C. Insulating Flexible Couplings:

1. The Contractor shall be responsible for selecting couplings appropriate to the application, subject to review and approval of the Owner’s Representative, recognizing that different pipe materials will require specific sizing and material selection for couplings.

2. Description:

   a. Comply with Flexible Coupling specifications above.

   b. Insulating Boot: Ethylene propylene diene monomer (EPDM) compounded for water service. Comply with ASTM D2000.

3. Manufacturers:

   a. For 4-inch to 14-inch diameter:

      1) Romac Industries, Inc. – Style IC501 or equal.

   b. For 12-inch to 96-inch diameter:

      1) Romac Industries, Inc. – Style IC400 or equal.

D. Restrained Flexible Couplings:

1. Description:

   a. Body: Steel. Comply with ASTM A36.

   b. Restrained gland: Ductile iron. Comply with ASTM A536, Grade 65-45-12.

   c. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

   d. Bolts and nuts: All-thread rod, at a minimum complying with ASTM A193 Grade B7. Nuts per ASTM A194 Grade 2H.

   e. Lining and coating: Factory-applied fusion bonded epoxy.

   f. Working pressure: 350 psi. Test pressure: 500 psi.

2. Manufacturers:

   a. Romac Industries, Inc. – Style 400RG
   b. EBAA Iron – 3800 MEGA-COUPLING

2.5 FLANGED COUPLING ADAPTERS

A. Flanged Coupling Adapters:

1. All flanged coupling adapters shall be constructed to diameters that properly fit the connecting plain end pipe and the flanged fitting.

2. Description:

   a. Comply with AWWA C219.

   b. Flange: AWWA Class E Steel Ring Flange, compatible with ANSI Class 125 & 150 bolt circles.

c. End ring and body:

   1) Steel. Comply with ASTM A36.
   2) Ductile iron. Comply with ASTM A536, Grade 65-45-12.

d. Flange: Compatible with ANSI Class 125 & 150 bolt circles.

e. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

f. Bolts and nuts: High strength low alloy steel bolts and nuts. Comply with AWWA C111 composition requirements.

g. Lining and coating: Factory-applied fusion bonded epoxy.

h. Working pressure rating: Equal to the maximum rating of the flange.

3. Manufacturers:

   a. Romac Industries, Inc.

      1) Style FCA501

         a) For 3-inch to 16-inch diameter.

      2) Style FC400.

         a) For 12-inch to 96-inch diameter.

B. Restrained Flanged Coupling Adapters:

1. Description:

   a. Gland and flange body: Ductile iron. Comply with ASTM A536.

   b. Flange: Compatible with ANSI Class 125 & 150 bolt circles.

   c. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

   d. Restraining bolts and lugs: Ductile iron. Comply with ASTM A536.

   e. T-bolts Bolts and nuts: High strength low alloy steel. Comply with AWWA C111 composition requirements.

   f. Lining and coating: Factory-applied fusion bonded epoxy.

2. Manufacturers:

   a. Romac Industries, Inc. – RFCA Restrained Flanged Coupling Adapters.
   b. EBAA Iron – MEGAFLANGE Restrained Flange Adapter.

2.6 TAPPING SLEEVES AND VALVES

A. Tapping Sleeves:

1. Description:

   a. Type: Dual compression.

   b. Material:

      1) Body: Stainless steel, Type 304.
      2) Flanged outlet: Stainless steel, Type 304.

   c. Outlet Flange Dimensions and Drilling: Comply with ASME B16.1, Class 150 and MSS SP-60.

   d. Outlet Gasket:

   e. Provide with Type 304 stainless steel test plug.

   f. Nuts, bolts and washers: Stainless steel, Type 304.

2. Manufacturers:

   a. Romac Industries, Inc. – Model STS 420
   b. JMC Industries, Inc.

B. Tapping Valves:

1. Resilient wedge gate valves specified in Section 40 05 23.15, Gate Valves.

2.7 FLEXIBLE EXPANSION JOINTS

A. Description

1. Installed at locations indicated in the Drawings.

2. End connections: As shown in the Drawings.

3. Material: Ductile iron, AWWA C153.

4. Working pressure: 350 psi, minimum.

5. Construction:

    a. An expansion joint designed and cast as an integral part of a double ball and socket type flexible joint.

    b. Manufactured of ductile iron, conforming to requirements of AWWA C153 and ASTM A536.

    c. Deflection: Minimum of 15 degrees deflection per ball.

    d. Expansion:

        1) 12-inch diameter and under: 8 inches.
        2) Greater than 12-inch diameter: 16 inches.

    e. Each flexible expansion joint shall be hydrostatically tested to the manufacturer's published pressure rating prior to shipment.

    f. Lining: All interior "wetted" parts shall be shop-lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213 and shall be holiday tested with a 1500-volt spark test conforming to said specification.

    g. Coating: Coal tar epoxy.

6. Quality Assurance: Hydrostatically tested to manufacturer's published pressure rating prior to shipment.

7. Appropriately sized polyethylene sleeves, meeting AWWA C105 requirements, shall be included for direct bury applications.

B. Manufacturers

1. EBAA Iron, Inc. – Flex-Tend or equal.

2.8 UNDERGROUND PIPE MARKERS

A. As specified in Section 31 23 17, Trenching.

2.9 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 33 00 - Concrete Work.
2. Type: reinforced, air entrained as shown in the Drawings.
3. Compressive Strength: Minimum 3,000 psi at 28 days.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 33 00 - Concrete Work.

2.10 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2.11 ACCESSORIES

A. Concrete for Thrust Restraints: As specified in Section 03 33 00 - Concrete Work.

B. Manhole and Cover: As specified in Section 33 05 13 - Manholes.

C. Miscellaneous Steel Rods, Bolt, Lugs, and Brackets:

1. Comply with ASTM A36 or ASTM A307.
2. Grade A carbon steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Preconstruction Site Photos:

1. Take photographs along centerline of proposed pipe trench; minimum one photograph for each 50 feet of pipe trench.

2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.

3. Include Project name, date taken, and sequential number of each photograph in physical log or CD.

B. Inspection:

1. All pipe sections, specials and jointing materials shall be carefully examined for defects.

2. No piping or related materials shall be laid that is known to be defective. Any defective piece installed shall be removed and replaced with a new pipe section in a manner satisfactory to the Owner's Representative at the Contractor's expense.

3. Defective material shall be marked and removed from the job site before the end of the day.

C. Pipe Cutting:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.

3. Grind edges smooth with beveled end for push-on connections.

4. Prior to assembly of field cut pipe, the reference mark shall be re-established with a pencil or crayon. The location of the reference mark at the proper distance from the bevel end shall be in accordance with the manufacturer's recommendations.

D. Remove scale and dirt on inside and outside before assembly. Cleaning of each pipe or fitting shall be accomplished by swabbing out, brushing out, blowing out with compressed air, or washing to remove all foreign matter.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Bedding:

1. Excavation:

a. Excavate pipe trench as specified in Section 31 23 17, Trenching for Work of this Section.

b. All pipe trenches shall be excavated below the proposed pipe invert as required to accommodate the depths of pipe bedding material as scheduled on the Drawings.

c. Remove large stones or other hard matter which could damage pipe or impede consistent pipe bedding backfilling or compaction.

d. Trench base shall be inspected prior to placement of pipe.

e. Hand trim excavation for accurate placement of pipe to elevations as indicated on Drawings.

2. Dewater excavation as specified in Section 31 23 19, Dewatering to maintain dry conditions and to preserve final grades at bottom of excavation.

3. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

4. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth, and compact to 95 percent of maximum density.

B. Piping:

1. Install pipe according to AWWA C600 and AWWA C605.

2. Handle and assemble pipe according to manufacturer instructions and as indicated on Drawings.

3. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

4. Steel Rods, Bolt, Lugs, and Brackets: Coat buried steel with one coat of coal tar coating before backfilling.

5. Sanitary Sewer Separation:

a. Install new water lines and appurtenances in compliance with local and state regulations governing the horizontal and vertical separations between water and sewer facilities.

b. Variance:

1) If a variance is proposed due to requested design revisions or if an existing facility has been installed at a different location or elevation than indicated on the Plans, submit written proposal for review and approval by the Owner’s Representative.

2) Include the reason for the variance, type of material and condition of the sewer line, location of the water and sewer facilities, horizontal and vertical skin-to-skin clearances and corrective measures proposed.

3) Each variance will be considered on a case-by-case basis.

4) Review Time: Allow a minimum of 5 working days review and response to each proposal.

6. Install ductile iron fittings according to AWWA C600.

7. Joints:

   a. Pipe jointing surfaces shall be clean and dry when preparing surfaces for joining.

   b. Lubricants, primers, adhesives, etc. shall be used as recommended by the pipe or joint manufacturer's specifications.

   c. The jointing materials or factory-fabricated joints shall then be placed, fitted, joined, and adjusted in such a manner as to obtain a watertight joint.

   d. Trenches shall be kept water-free and as dry as possible during bedding, laying and jointing.

   e. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of the pipe from any cause.

8. Flanged Joints: Not to be used in underground installations except within structures, unless shown otherwise in the Drawings.

9. Deflection:

   a. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly.

   b. Deflection by bending of the pipe rather than at the joints is not allowed.

   c. The maximum pipe deflection shall not exceed one-half of the manufacturer's stated joint deflection allowance.

   d. Set a laser, string line or other approved alignment guide along the centerline of previously installed pipe to the point where pipe joint deflection is required. The approved alignment guide shall extend to the end of the proposed subsequent pipe length. A measurement will be taken from the alignment guide to the centerline of the subsequent pipe length to determine the amount of pipe joint deflection proposed. Measured deflection shall not exceed the specified allowable deflection for the purposes of aligning the pipe.

10. Install pipe and fittings to the line and grade specified on the Drawings, with joints centered, pipe properly supported and restrained against movement, and all valve stems plumb. Re-lay pipe that is out of alignment or grade.

11. High Points:

    a. Install pipe with no high points, unless otherwise shown in the Drawings.

    b. If unforeseen field conditions arise that necessitate high points, install air release valves as directed by Owner's Representative.

12. Bearing:

    a. Install pipe to have bearing along entire length of pipe.

    b. Excavate bell holes to permit proper joint installation where necessary or as directed by Owner's Representative.

    c. Do not lay pipe in wet or frozen trench.

13. Prevent foreign material from entering pipe during placement.

14. Install pipe to allow for expansion and contraction without stressing pipe or joints.

15. Close pipe openings with watertight plugs during Work stoppages.

16. All pipe ends which are to be permanently closed shall be plugged or capped and restrained against internal pressure.

17. Install access fittings to permit disinfection of water system performed under Section 33 13 00 - Disinfecting of Water Utility Piping.

18. Cover:

    a. Establish elevations of buried piping with not less than 36 inches of cover.
    b. Measure depth of cover from final surface grade to top of pipe barrel.

19. Pipe Markers:

    a. Install as specified in Section 31 23 17, Trenching.

C. Tapping Sleeves and Valves:

1. As indicated on Drawings and according to manufacturer instructions.

D. Polyethylene Encasement:

1. Encase piping in polyethylene when within 10 feet horizontally of steel natural gas mains or any other facilities within impressed current cathodic protection systems installed.

2. Comply with AWWA C105.

E. Thrust Restraints:

1. Provide valves, tees, bends, caps, and plugs with concrete thrust blocks at locations shown in the Drawings and as required to facilitate testing of lines.

2. Pour concrete thrust blocks against undisturbed earth.

3. Locate thrust blocks to ensure that pipe and fitting joints will be accessible for repair.

4. Provide thrust restraint bearing area on subsoil as shown in details within the Drawings.

5. Install tie rods, clamps, setscrew retainer glands, or restrained joints.

6. Protect metal-restrained joint components against corrosion with polyethylene film as specified herein.

7. Do not encase pipe and fitting joints to flanges.

F. Backfilling:

1. Backfill of piping systems shall be as specified in Section 31 23 17, Trenching.

G. Testing and Disinfection of Potable Water Piping System:

1. In accordance with AWWA C600 and AWWA C605, AWWA C651 and as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

2. All chlorinated water used in disinfection of the water main shall either be discharged through an approved connection to a public sanitary sewer system or shall be dechlorinated to limits acceptable by the Oregon State Department of Environmental Quality (DEQ) prior to discharge into any storm drainage system or open drainage way.

3. No chlorinated water shall be discharged into a storm drainage system or open drainage way without a dechlorination under a plan meeting DEQ's requirements.

3.4 FIELD QUALITY CONTROL

A. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

END OF SECTION

SECTION 33 11 50

EXISTING PIPE ABANDONMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the removal of existing buried piping and abandonment in place of existing buried piping.

B. Section includes:

1. Pipe removal.
2. In-place abandonment of pipe.

1.2 RELATED SECTIONS

A. Section 31 23 16, Excavation.
B. Section 31 23 17, Trenching.
C. Section 31 23 19, Dewatering.
D. Section 31 23 23, Fill.
E. Section 31 23 24, Flowable Fill.

1.3 SUBMITTALS

A. Provide all submittals in accordance with Section 01 33 00, Submittal Procedures.

B. Piping Abandonment Plan:

1. Identify locations specified for pipe abandonment.
2. Provide method to be utilized to abandon the pipe, including whether the pipe will be left in place or removed in its entirety.

C. Non-Shrink Grout: Product data.

D. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the work described herein.

B. Protection of Persons and Property: Meet all federal, state and local safety requirements for the protection of workmen, other persons, and property in the vicinity of the work and requirements of the General Provisions.

1.5 PROTECTION OF EXISTING WORK

A. Carefully examine the Contract Documents to determine the extent of the work of this Section.

B. Carefully coordinate the work of this Section with all other work and construction.

C. Take all necessary precautions to prevent damage to existing facilities or utilities which are to remain in place and be responsible for any damages to existing facilities or utilities, which are caused by the operations.

1.6 REPAIR OF DAMAGE

A. Work procedures shall provide for safe conduct of the work; careful removal and disposition of materials and equipment; protection of facilities, utilities and property which are to remain undisturbed; coordination with existing facilities and utilities to remain in service.

B. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired to acceptance of Owner's Representative.

C. Damaged items shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

1.7 EXISTING CONDITIONS

A. If the pipe material contains any hazardous materials, such as asbestos, requiring special handling upon removal, it is the responsibility of the Contractor to remove and dispose of the material in accordance with all applicable federal, state and local regulations.

PART 2 PRODUCTS

2.1 OWNERSHIP OF EXISTING MATERIALS

A. All materials, equipment, miscellaneous items and debris involved, occurring or resulting from pipe removal work shall become the property of the Contractor at the place of origin, unless otherwise specified in the Drawings or by the Owner's Representative.

2.2 CONTROLLED LOW STRENGTH MATERIAL

A. As specified in Section 31 23 24, Flowable Fill.

PART 3 EXECUTION

3.1 PIPE REMOVAL

A. Where identified on the Drawings, remove and dispose of all pipe material and associated appurtenances.

1. All fire hydrants, air release valves service lines and appurtenances being abandoned shall be removed to 36 inches below finished grade.

2. Existing service line appurtenances, including valve and meter boxes, shall be removed to 36 inches below finished grade.

B. All exposed ends of pipes and fittings to remain in service shall be capped or plugged with an appropriate ductile iron blind flange, cap or plug and restrained.

1. A pipe shall be considered in service if it is possible to flood the pipe with water by opening valves in the water system.

C. All excavation and backfilling associated with pipe removal shall be performed in accordance with Section 31 23 17, Trenching.

3.2 IN-PLACE ABANDONMENT OF PIPING

A. Where identified on the Drawings, abandon pipe in place.

B. All exposed ends of pipes being abandoned in place shall be cut and plugged with a minimum of two (2) feet of non-shrink grout.

C. Prior to placing grout, roughen interior pipe surface and apply epoxy bonding agent.

3.3 FILLING PIPE WITH CLSM

A. Where identified on the Plans, pipes greater than 12 inches in diameter to be abandoned-in-place shall be filled with CLSM.

B. CLSM shall be placed in a manner to ensure complete filling of the pipe, leaving no cavities or voids.

C. Install hot taps, saddles, fill lines and appurtenances as necessary for pumping CLSM from the surface into the pipe being filled.

D. CLSM shall be pumped up grade from fill lines rigidly connected to the pipes being filled.

E. Placement of CLSM by free-flowing (non-pumped) methods will not be acceptable.

F. Fill lines shall be located at elevations lower than the pipe being filled.

G. As the CLSM is being placed, use other fill lines as view ports to ensure complete filling of the pipes.

H. Relocate pumping equipment as necessary to complete filling of the pipes.

I. Excavate and cut access holes in the pipes as necessary to complete filling operations.

J. Perform pipe filling operations in a manner to eliminate all air pockets.

K. Submit volume calculations for CLSM placed in each filled segment of piping to verify that pipelines have been completely filled.

3.4 CLEANUP

A. During and upon completion of work of this Section, promptly remove all unused tools and equipment, surplus materials and debris.

B. Adjacent areas shall be returned to their existing condition prior to the start of work.

END OF SECTION

SECTION 33 12 16

WATER UTILITY DISTRIBUTION & TRANSMISSION VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes valves and valve boxes for installation with buried water distribution and transmission main, including fire hydrants and tapping sleeves.

B. Section Includes:

1. Valves.
2. Valve boxes.
3. Valve operator extensions.

C. Related Requirements:

1. Section 03 11 00 - Concrete Work.
2. Section 33 11 10 - Water Utility Distribution & Transmission Piping.
3. Section 33 12 19 - Fire Hydrants.
4. Section 33 13 00 - Testing and Disinfecting of Water Utility Piping.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Owner's Representatives:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.
3. ASME 1.20.1 - General Purpose Pipe Threads (Inch)

B. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 Inch Through 72 Inch.
2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
3. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.
4. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

5. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

C. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

D. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. The Contractor shall cause the Supplier of valves to coordinate installation such that all pipes, valves, fittings, appurtenances and equipment are compatible and capable of achieving the performance requirements specified in the Contract Documents.

B. Coordinate Work of this Section with City of Pendleton standards and utilities within construction area.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling: Schedule of valves to be labeled indicating in each case the valve location and the proposed labeling for the valve.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.
B. Operation and Maintenance Data: Submit information for valves.

1.6 NOT USED

1.7 QUALITY ASSURANCE

A. Cast manufacturer's name, maximum working pressure, size of valve and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Unless otherwise noted, all water works materials provided for the Project shall be new, of first class quality and shall be made by reputable manufacturers.

E. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Owner’s Representative.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves and accessories for shipment according to applicable AWWA standards.

B. Seal valve and ends to prevent entry of foreign matter.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Storage:

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

E. Handle products carefully to prevent damage to interior or exterior surfaces.

F. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT WEDGE GATE VALVES

A. As specified in Section 40 05 23.15, Gate Valves.

B. Connecting Hardware:

1. As specified in Article 2.3, Nuts, Bolts and Washers of Section 33 11 10, Water Utility Distribution & Transmission Piping.

C. Gaskets:

1. As required for the end connection types specified in Section 33 11 10, Water Utility Distribution & Transmission Piping.

2.3 NOT USED

2.4 NOT USED

2.5 RUBBER-SEATED BUTTERFLY VALVES -- NOT USED

2.6 ACTUATORS

A. Unless otherwise indicated, all valves shall be furnished with manual actuators.

B. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

C. All gear-assisted valves that are buried and submerged shall have the actuators hermetically-sealed and grease-packed.

D. All valves 6 inches to 30 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

2.7 VALVE BOXES

A. Provide all buried valves with valve boxes, covers and risers.

B. Valve Boxes:

1. Materials: Cast iron.

2. Construction:

   a. Walls not less than 3/16-inch thick at any point.
   b. Internal diameter not less than 5 inches.

3. Type: Two-piece extension.

4. Manufacturers:

   a. Olympic Foundry.
   b. Brooks Products.

C. Covers:

1. Construction:

   a. Prevents dislodging and rotation from traffic.
   b. Allows a hand-held pry bar to be applied for easy removal.

2. Materials: Cast iron.

3. Lid Inscription: WATER.

4. Manufacturers: Matching that of valve box.

D. Riser:

1. PVC Pipe:

   a. ASTM D3034, SDR 35 PVC.
   b. White, Schedule 40, 8-inch diameter.
   c. Length as shown on details in the Drawings.

2.8 VALVE OPERATOR EXTENSIONS

A. As shown in the Drawings.

B. Provide operator extensions to a maximum of 12 inches below grade where depth to valve exceeds 36 inches.

2.9 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 03 11 00, Concrete Work.

PART 3 EXECUTION

3.1 PREPARATION

A. Conduct operations to not interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures, utilities, and landscape in immediate or adjacent areas.

B. Identify required lines, levels, contours, and datum locations.

C. Locate, identify, and protect from damage utilities to remain.

D. Access:

1. All valves shall be installed to provide easy access for operation, removal, and maintenance.

2. Avoid conflicts between valve operators and above grade construction such as structural members or handrails.

E. Valve Accessories:

1. Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly.

2. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.2 INSTALLATION

A. General:

1. All valves, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer’s written instructions and as shown in the Drawings and as specified herein.

2. Valves shall be firmly supported to avoid undue stresses on the pipe.

3. Stem extensions shall be braced at no greater than 10 feet intervals and be provided with double universal joints to allow for misalignment, where applicable.

B. Perform trench excavation, backfilling, and compaction as specified in Section 33 11 10, Water Utility Distribution & Transmission Piping.

C. Install valves in conjunction with pipe laying.

D. Set valves plumb.

E. Provide buried valves with valve boxes installed flush with finished grade.

1. Valves installed out of paved or otherwise hard-surfaced areas shall be set in a concrete pad at finished grade.

2. Concrete valve box pads shall be 18 inches square and be not less than 6 inches thick.

F. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

3.3 FIELD QUALITY CONTROL

A. Pressure test valving for water distribution system according to AWWA C600 and in accordance with Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

B. Field Testing of Valves:

1. All valves 18-inch diameter or larger, and all in-line transmission main valves, shall be pressure and leakage tested at the Site and shall pass the field testing prior to installation.

2. Valves shall be tested at 1.5 times normal operating pressure, 200 psi minimum.

3. No valve shall be accepted for installation that fails to pass the field pressure test. Any valves failing field pressure tests shall be replaced by the Contractor at no additional cost to the Owner.

4. Owner’s Representative shall witness field testing.

END OF SECTION

SECTION 33 12 19

FIRE HYDRANTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section addresses dry-barrel fire hydrants used in water supply service.

B. Section includes:

1. Fire hydrants used in water main installations.

1.2 RELATED SECTIONS:

A. Section 03 11 00 - Concrete Work.
B. Section 31 05 16 - Aggregates for Earthwork.
C. Section 31 23 17 - Trenching.
D. Section 33 13 00 - Testing and Disinfecting of Water Utility Piping.

1.3 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C502 - Dry-Barrel Fire Hydrants.
2. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

B. National Fire Protection Association:

1. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants.

1.4 COORDINATION

A. All hydrants supplied for the Project shall be of like kind from a single manufacturer.

1.5 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's latest published literature, including illustrations, installation and maintenance instructions, and parts lists.

C. Shop Drawings: Submit description of proposed installation.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of fire hydrants and service valves.
B. Operation and Maintenance Data: Submit data for hydrants.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare hydrants and accessories for shipment according to AWWA standards.

B. Seal hydrant and ends to prevent entry of foreign matter.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Storage:

1. Store materials in areas protected from weather, moisture, or potential damage.
2. Do not store materials directly on ground.

E. Handle materials in a way that prevents damage to interior and exterior surfaces.

PART 2 PRODUCTS

2.1 FIRE HYDRANTS

A. Manufacturers:

1. M & H, No. 129.
2. Mueller, Super Centurion, Model No. A423.
3. Clow, No. F-2500.
4. Waterous, No. WB-67.
5. Kennedy, No. K-11 or K81A.
6. US Pipe, Metropolitan@ or Pacific States

B. Dry-Barrel Breakaway Type:

1. Comply with AWWA C502.

2. Body: Cast iron.
3. Valve: Compression type.
4. Burial Depth: As indicated on Drawings.
5. Inlet Connection Size: 6 inches (150 mm).
6. Valve Opening: 5-1/4 inches (133 mm) in diameter.
7. End Connections: Mechanical joint or bell end.
8. Bolts and Nuts: Galvanized steel.
9. Interior Coating: Comply with AWWA C550.
10. Direction of Opening: Counterclockwise unless otherwise indicated.

C. Hose Connections:

1. One 4-1/2-inch diameter pumper, two 2-1/2 inch diameter hose nozzles.
2. Obtain thread type and size from local fire department.
3. Attach nozzle caps by separate chains.

D. Finishes:

1. Primer and two coats of enamel.
2. Color: As designed by City of Pendleton standards.

2.2 NSF REQUIREMENTS

A. All fire hydrants must be NSF/ANSI Standard 61 certified and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.

2.3 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 03 11 00, Concrete Work.

B. Aggregate: Aggregate for hydrant drainage as specified in Section 31 05 16, Aggregates for Earthwork.

2.4 OUT OF SERVICE COVERS/OUT OF SERVICE RINGS

A. Provide orange plastic bag with reflective tape, or red plastic hydrant out of service rings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify location and size of hydrants from Drawings. Final location of hydrants to be determined by Owner’s Representative in the field.

B. Obtain clarification and directions from Owner’s Representative prior to execution of Work.

C. If installing a hydrant on an existing water system, verify invert elevation of existing piping is as indicated on Drawings prior to excavation and installation of fire hydrant.

3.2 PREPARATION

A. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures, utilities, and landscape in immediate or adjacent areas.

B. Identify required lines, levels, contours, and datum locations.

C. Locate, identify, and protect from damage utilities to remain.

D. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.

1. Notify Owner & Owner’s Representative not less than 48 hours in advance of proposed utility interruption.

2. Do not proceed without written permission from Owner’s Representative.

3. Only District staff shall operate valves in existing system.

3.3 INSTALLATION

A. Perform trench excavation, backfilling, and compaction as specified in Section 31 23 17, Trenching.

B. Install pier support block and drainage gravel for fire hydrants; do not block drain hole.

1. Place drainage gravel around the pier block and bottom of hydrant to 6 inches above the hydrant drain opening.

2. Place textile fabric to cover drain rock prior to placement of backfill.

3. Setting shall allow the hydrant barrel to drain into drainage gravel at base of hydrant.

C. Set fire hydrants plumb with pumper nozzle facing roadway.

D. Set fire hydrants with centerline of pumper nozzle 18 inches (450 mm) above finished grade, and with safety flange not more than 6 inches (150 mm) nor less than 2 inches (50 mm) above grade. Install hydrant extensions where required and as approved.

E. Paint hydrants according to color scheme of local authorities having jurisdiction. Touch up paint after hydrant installation and testing.

F. After hydrostatic testing, flush hydrants and check for proper drainage.

G. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Disinfecting of Water Utility Piping.

3.4 FIELD QUALITY CONTROL

A. Pressure test water distribution system according to AWWA C600 and Section 33 11 10, Water Utility Distribution & Transmission Piping, Field Quality Control.

3.5 CONCRETE HYDRANT PADS

A. When hydrant is placed within sidewalks, form and pour-in-place 36-inch x 36-inch x 6-inch, 4,000 psi concrete pad around the hydrant after the hydrant has been installed and set to grade.

B. Center hydrant pad on the hydrant. Set hydrant pad so top of pad is flush with surrounding surface, or as directed by the Owner’s Representative.

C. Hydrant pads may be adjusted to reach the back of curb if the hydrant pad is no less than one foot in any one direction.

3.6 OUT-OF-SERVICE HYDRANTS

A. To indicate that the fire hydrant is NOT operational, secure reflective tape, an orange plastic bag over the entire hydrant assembly or an approved out-of-service cover.

B. An out-of-service ring may also be used in addition to the bag or cover in case of removal of the cover.

C. Maintain the plastic bag up until the waterline is accepted by the Owner.

END OF SECTION

SECTION 33 13 00

TESTING & DISINFECTING OF WATER UTILITY PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hydrostatic pressure testing, disinfection and purity testing of potable water systems piping, fittings, valves, and domestic water services.

B. Section Includes:

1. Pressure testing and disinfection of potable water distribution and transmission piping systems and appurtenances.

2. Testing and reporting of results.

1.2 RELATED REQUIREMENTS:

A. Section 33 11 10 - Water Utility Distribution & Transmission Piping.
B. Section 33 12 16 - Water Utility Distribution & Transmission Valves.
C. Section 33 12 19 - Fire Hydrants.
D. Section 33 12 13 - Water Service Connections.

1.3 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA B300 - Hypochlorites.

2. AWWA B301 - Liquid Chlorine.

3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

4. AWWA C605 - Underground Installation of PVC and PVCO Pressure Pipe and Fittings.

5. AWWA C651 - Disinfecting Water Mains.

6. AWWA C655 - Field Dechlorination.

1.4 SUBMITTALS

A. Section 01 33 00 – Contractor Submittals: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Pipeline Testing & Disinfection Plan: To be submitted for review and approval by the Owner's Representative a minimum of one month before testing is to start. As a minimum, the plan shall include the following:

1. Testing schedule.

2. Hydrostatic Testing Plan:

   a. Narrative of the proposed process.
   b. Proposed equipment to be used.
   c. Disposal location for excess water used to fill mains.

3. Disinfection Plan:

   a. Narrative of the proposed process.

   b. Proposed chemicals and equipment (including list of all pumps and meters) to be used.

   c. Calculations for the amount of chlorine required to achieve required chlorine residual levels.

   d. Proposed method of mixing, injecting and distributing of chlorine solution throughout all portions of the new water system facilities.

   e. Proposed plan for testing chlorine levels throughout the length of pipeline.

4. Proposed testing locations.

5. Proposed plan for water conveyance, including flow rates.

6. Proposed plan for water control.

7. Proposed plan for water disposal, including flow rates. Include proposed plan for dechlorination of disinfection water, including discharge points.

8. Proposed measures to be incorporated in the project to minimize erosion while discharging water from the pipeline.

1.5 CLOSEOUT SUBMITTALS

A. Disinfection Report:

1. Type and form of disinfectant used.

2. Date and time of disinfectant injection start and time of completion.

3. Test locations.

4. Name of person collecting samples.

5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.

6. Date and time of flushing start and completion.

7. Disinfectant residual after flushing in ppm for each outlet tested.

1.6 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Owner's Representative's review. No materials shall be used which would be injurious to the construction or its future functions.

B. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.

C. As a minimum, furnish the following equipment and materials for the testing:

Amount	Description
2	Graduated containers approved by the Owner's Representative.
1	Hydraulic pump approved by the Owner's Representative with hoses, valves and fittings as needed and required for the testing and disinfection of the facilities.
1	High range chlorine test kit, as approved by Owner's Representative, with digital readout. Range of detection shall be between 5 & 200 ppm. Accuracy of 3 percent.
2	Pressure gauges with pressure range at least 120 percent greater than the required maximum test pressure with graduations in two (2) psi increments. Gauges shall have been calibrated with 90 days of pressure testing.

2.2 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Liquid chlorine: Comply with AWWA B301.

2.3 DECHLORINATION CHEMICALS

A. Chemicals:

1. Comply with AWWA C655.

PART 3 EXECUTION

3.1 HYDROSTATIC TESTING OF WATER PIPING

A. Make all necessary provisions for conveying water to the points of use and for the disposal of test water.

B. No section of the pipeline shall be hydrostatically tested until backfill has been placed, compacted and passed required density testing and all field-placed concrete or mortar has attained full strength.

1. At the Contractor's option, early strength concrete may be used when the full-strength requirements conflict with schedule requirements.

2. All such substitutions and installations shall be approved by the Owner's Representative prior to installation.

C. Provide 72-hour notification to the Owner's Representative and Owner prior to conducting hydrostatic testing.

1. Provide coordination and scheduling required for the Owner and Owner's Representative to witness and provide necessary labor for operating Owner's existing system during hydrostatic testing and disinfecting procedures.

2. The Contractor shall not operate any part of the existing water systems.

D. Pipe Filling:

1. Fill pipes slowly from the lowest elevation to highest point along test section with potable water.

2. Take all required precautions to prevent entrapping air in the pipes.

3. Allow for natural absorption of water by the lining of the pipe to occur.

4. Apply specified test pressure by pumping.

E. Testing of Mains:

1. Ductile Iron: In accordance with AWWA C600.

2. PVC: In accordance with AWWA C605.

3. General:

   a. Tests shall be conducted under a hydrostatic test pressure not less than 1.25 times the stated anticipated maximum sustained working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section**, minimum 200 psi**, unless otherwise shown in the Drawings.

   b. In no case shall the test pressure exceed the rated working pressure for any joint, thrust restraint, valve, fitting, or other connected appurtenance of the test section.

   c. Testing shall be performed by applying the specified test pressure by pumping.

   d. Once the test pressure has been attained, the pump shall be valved off.

   e. The test will be conducted for a two-hour period with the allowable leakage not to exceed the value as calculated per the Allowable Leakage formula below.

   f. During the test period, there shall be no appreciable or abrupt loss in pressure.

4. Allowable Leakage:

   a. Flanged Joints: Pipe, fittings and valves with flanged joints shall be completely watertight. No leakage allowed.

   b. Mechanical or Push-on Joints: Pipe, fittings and valves with rubber gasketed joints shall have a measured loss not to exceed the rate given in the following Allowable Leakage formula:

$$AL = \frac{ND(P)^2}{11{,}000}$$

In the above formula:

AL = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe line tested
D = Nominal diameter of pipe, in inches
P = Average test pressure during the leakage test, in pounds per square inch.

5. Maintaining Pressure:

   a. During the test period, operate the pump as required to maintain pressure in the pipe within 5 psi of the specified test pressure at all times.

   b. At the end of test period, operate the pump until the specified test pressure is again obtained.

      1) The pump suction shall be in a clean, graduated barrel or similar device or metered so that the amount of water required to restore the test pressure may be accurately measured.

      2) Sterilize this makeup water by adding chlorine to a concentration of 25 mg/L.

   c. The Owner's Representative will determine the quantity of water required to maintain and restore the required pressure at the end of the test period.

   d. Each hour's loss stands on its own and will not be averaged.

6. Defects, Leakage, Failure:

   a. If the test reveals any defects, leakage in excess of the allowable, or failure, furnish all labor, equipment and materials required to locate and make necessary repairs.

   b. Correct any visible leakage regardless of the allowable leakage specified above.

   c. All leaks shall be repaired in a manner acceptable to the Owner's Representative.

   d. The testing of the line shall be repeated until a test satisfactory to the Owner's Representative has been achieved.

3.2 DISINFECTION OF WATER PIPING

A. Disinfection shall be in accordance with the latest version of AWWA C651 following Owner's Representative's acceptance of hydrostatic testing.

B. Chlorination by means of tablets or powders (calcium hypochlorite) placed in each length of pipe during installation is specifically prohibited.

C. Flush all foreign matter from the pipeline, branches and services.

   1. Provide at no additional cost to the Owner, hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties.

2. Flushing velocities shall be at least 2.5 feet per second (fps).

3. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipe in place from the inside by brushing and sweeping, then flush the line at a lower velocity.

D. Chlorine Application:

1. Fill the test section of main from the lowest elevation and maintain a steady flow rate while injecting the water main with chlorinated water.

2. Flow (bleed) a blow-off, standpipe or hydrant at the water main’s high point(s) to allow air to escape and ensure all interior pipe surfaces are wetted.

E. Chlorine Residual:

1. Measure chlorine residual with a high-range chlorine test kit at a point near to the injection point while filling the main.

2. Adjust the dose rate as necessary to maintain the target dose rate.

F. Potable water piping shall be disinfected with a solution containing a minimum 25 parts per million (ppm) and a maximum 50 ppm chlorine.

1. Once the main is completely filled with super-chlorinated water, measure the chlorine residual a minimum of once every 200 feet of main and once for each main branch, 2-inch service or as directed by the Owner’s Representative.

2. The chlorine solution shall remain in the piping system for a period of 24 hours, after which time the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.

3. If check samples fail to produce acceptable results, the disinfection procedure shall be repeated at the expense of the Contractor until satisfactory results are obtained.

G. Flush piping, branches and services with municipal potable water until the chlorine residual is below 1.5 ppm and approximately the same as the source water.

1. There is no minimum flushing velocity for this step.

H. Disposal of any water containing chlorine shall be performed in accordance with the latest edition of AWWA C651 and C655, and all state or local requirements.

1. Disposal may be made into existing sanitary sewer systems providing approvals are obtained from the respective system owners.

2. Any chlorinated water discharged to open stream channels must be dechlorinated prior to discharge to levels acceptable by Oregon State Department of Environmental Quality (DEQ).

3.3 DISINFECTION & TESTING OF WATER MAIN END CONNECTIONS AND TIE-INS

A. Disinfection of potable water piping and appurtenances at end connections and tie-ins to the existing system which are required to remain in service due to restrictions in allowable shutdown time shall be disinfected as described below.

B. Prior to connecting new potable water piping and appurtenances with existing piping and appurtenances, the interior of all new pipe, fittings, valves and appurtenances shall be swabbed or sprayed with a 1% to 5% percent calcium hypochlorite solution.

C. In accordance with AWWA C651, swabbing or spraying of connection piping is allowed only if the total length of piping is equal to or less than one pipe length (18 feet). All runs of new piping over 18 feet in total length will require hydrostatic pressure testing, flushing and disinfection as detailed elsewhere in this Section.

D. Following the disinfection procedures described above, connection of the new piping and appurtenances to the existing water system shall be made.

1. During the system startup, the Owner's Representative and Contractor shall visually inspect all new fittings, piping, valves and appurtenances for evidence of leakage.

2. Any leakage observed during this period shall be promptly repaired by the Contractor, at Contractor's expense, as required by the Owner's Representative.

3.4 FIELD QUALITY CONTROL

A. Bacteriological Sampling and Testing:

1. The Owner will collect samples after the line is flushed in accordance with the latest edition of AWWA C651.

a. The locations for sample collection shall be at the sole discretion of the Owner and Owner's Representative.

b. The chlorine residual must be below 1.5 ppm or restored to the level maintained in the Owner's distribution system, when the sample is taken.

2. Bacterial Testing: After completing the chlorination procedure, test the main according to the following:

   a. Bacterial Sampling

      1) Option A:

         a) Take an initial set of samples using sampling site procedures outlined herein.

         b) Resample after a minimum of 24 hours' time has elapsed using sampling site procedures outlined herein.

         c) Both sets of successive samples must pass for the main to be approved for service.

      2) Option B:

         a) Allow main to sit for a minimum of 24 hours without any water use.

         b) Using sampling site procedures outlined herein, collect two sets of samples a minimum of 15 minutes apart while the sampling taps are left running.

         c) Both sets of samples must pass for the main to be approved for service.

      3) Allow 24 hours for the test results for each sample set.

   b. Sampling Locations

      1) The Owner will take one bacteriological sample from the end of the main and on each branch.

      2) For long runs of main, at least one sample will be taken for every 1,200 feet of new main and as directed.

   c. Sample Testing

      1) The Owner will test the sample set for coliform bacteria and publish the test results within 24 hours.

   d. Evaluating the Test Results

      1) If one or more of the sample set tests positive for coliforms (fails), repeat chlorination and sampling processes specified herein after correcting the cause of the failure and as directed by the Owner's Representative.

2) When two consecutive sample sets test negative (passing) for coliform bacteria, the bacterial testing is complete.

e. Completion of Bacterial Testing

1) Upon completion of bacterial testing, notify the Owner shall notify the Owner’s Representative and Contractor in writing that the testing is complete and the main is ready for tie-in.

f. Multiple Positive (Failing) Test Results

1) If sample sets continue to test positive for coliforms, the Owner’s Representative will determine how to proceed, up to and including repeating the chlorination procedure or rejecting the pipe.

3. Results of the bacteriological testing shall be satisfactory with the Oregon Health Authority and/or other appropriate regulatory agencies, or disinfection shall be repeated by the Contractor.

B. Optional Sampling and Testing

1. If a pipeline is not promptly returned to service, the situation will be evaluated by the Owner to determine if the water quality may have been impacted and if additional testing as specified herein is warranted.

END OF SECTION

SECTION 33 13 13

DISINFECTION OF WATER UTILITY STORAGE TANKS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes methods of disinfecting water storage tanks for potable water.

B. Section includes:

1. Water storage tank disinfection.
2. Bacteriological testing.

1.2 RELATED SECTIONS

A. Section 09 97 14 - Steel Water Storage Tank Painting.
B. Section 33 16 13 - Steel Aboveground Water Utility Storage Tanks.

1.3 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C652 - Disinfection of Water Storage Facilities.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Disinfection Procedure:

1. Submit description of procedure, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.

2. Comply with Sections 3 and 4 of AWWA C652.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Certify that disinfectants meet or exceed AWWA C652 requirements.

E. Test and Evaluation Reports: Indicate results of bacteriological and residual chlorine laboratory test reports.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 QUALITY ASSURANCE

A. Perform Work in compliance with AWWA C652.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store disinfectants according to manufacturer's recommendations and in a cool, dry place away from combustibles such as wood, rags, oils, and greases.

C. Handle disinfectants according to manufacturer's safety precautions.

PART 2 PRODUCTS

2.1 DISINFECTANTS

A. Chlorine Forms: According to AWWA C652, Section 4.

1. Liquid chlorine.
2. Sodium hypochlorite.
3. Calcium hypochlorite.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspection:

1. Conduct inspection of tank interior before beginning disinfection.

2. Verify tank is clean and free of polluting materials.

3. Verify tank piping and vent connections are properly made and clear of obstructions.

4. Verify all interior paint is thoroughly cured according to paint manufacturer's instructions.

3.2 PREPARATION

A. Furnish personnel working inside tank during disinfection with equipment to comply with Federal and State regulations for Work conducted in a hazardous atmosphere.

B. Coordinate with the Owner's Representative and Owner for scheduling of disinfection activities.

1. The Owner may require up to one weeks' time following notice to supply water for filling of reservoir.

3.3 APPLICATION

A. Use Chlorination Method 2 for disinfecting tank in Section 4 of AWWA C652, generally detailed as followed:

1. Spray or brush a solution of 200 mg/L available chlorine directly on the surfaces of all parts of the storage facility that will be in contact with water when the storage facility is full to the overflow elevation.

2. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping and shall be applied to any separate drain piping such that it will have available chlorine of not less than 10 mg/L when filled with water.

3. Disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30 min.

4. Following the completion of the chlorination procedure, potable water shall be admitted, the drain piping purged of the 10 mg/L chlorinated water, and the storage facility filled to its overflow level.

B. A sample shall be taken by the Owner for microbiological analysis according to State Health Standards for potable water.

1. Contact the Owner's Representative and/or Owner to arrange for samples to be taken for microbiological analysis.

2. Microbiological analysis must indicate that the water is free of coliform organisms before the facility can be put into service.

3. It will not be necessary to flush the reservoir or tank after the chlorine solution is applied by spraying or brushing providing a passing microbiological test is achieved.

C. When water samples fail to meet State Health Standards for potable water, perform corrective measures until water quality conforms to State Health Standards.

D. Any superchlorinated water shall be discharged through an approved connection to the public sanitary sewer system or shall be dechlorinated to limits acceptable by the Oregon State Department of Environmental Quality (DEQ) for discharge into the existing storm drainage system. If superchlorinated water is to be discharged into the public sanitary sewer system, notify the sewage treatment plant notifying the planned time, location, and quantity of discharge. No superchlorinated water shall be discharged into the storm drainage system or natural drainage way prior to approved dechlorination treatment.

END OF SECTION

SECTION 33 16 23

GROUND-LEVEL STEEL WATER STORAGE TANK

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

This Section defines the work required for design, fabrication, and erection of the 2,000,000-gallon ground supported welded steel reservoir. Hatches, ladders, piping, and other appurtenances and accessories for the reservoir, earthwork, foundation construction, electrical, mechanical and yard piping, landscaping and provisions for other related project work is covered elsewhere in the specifications.

1.2 QUALIFICATION OF RESEVOIR CONTRACTOR

The Contractor's attention is directed to Section 4, Prequalification, of the Contract Documents for a list of Prequalified Reservoir Contractors. See Section 00 20 10, Reservoir Contractor Statement of Qualifications Form for instructions on submitting a Statement of Qualifications during bidding in order to become prequalified to perform reservoir construction work for this Project.

1.3 DESIGN

A. General

The ground supported steel reservoir and all appurtenances shall be designed in accordance with the latest edition of the American Water Works Association (AWWA) Standard for Welded Steel Tanks for Water Storage, ANSI/AWWA D100-11 except as herein modified by these specifications. The basis for design of this welded steel reservoir shall be in accordance with AWWA D100-11 Sec. 3. The reservoir shall be a ground supported welded steel reservoir with a self-supported dome roof as shown on the drawings.

B. Design Loads

1. Hydrostatic and Hydrodynamic Loads

The reservoir shall be designed for hydrostatic stresses and resultant loads resulting from the overflow operating level. Additionally, hydrodynamic seismic loads and stresses, freeboard requirements, slosh loads, and anchorage shall also be based on the overflow operating level.

2. Seismic Loads

The ground supported steel reservoir and all related components shall be designed and constructed to resist all seismic forces under both full (at overflow) and empty conditions. Per AWWA D100-11 Sec. 3 for Seismic Site Class D, the seismic design factors shall be applied as noted in Sheet S-1 of the Drawings.

The reservoir manufacturer's Design Engineer shall also utilize site specific response spectra prepared for this project by GeoEngineers Inc. to replace the seismic coefficient in accordance with AWWA D100- 11 Sec. 13.2.8. The final reservoir design shall be based upon the most conservative value of the site specific response spectra or the seismic coefficient.

3. Wind Loads

The reservoir shall be designed to resist wind loading under both full (at overflow) and empty conditions. The design method shall be in accordance with the 2019 OSSC or AWWA D100-11 with the following factors applied]:

Wind Speed = 100 mph (AWWA) or 112 mph (IBC OR OSSC); Exposure C; Importance Factor, Iw = 1.15 (AWWA) or N/A (IBC OR OSSC). Minimum wind load shall not be less than 18 pounds per square feet in accordance with AWWA D100.

4. Snow Loads

Snow loads are per 2019 OSSC and County Minimums. For the site the uniform ground snow load is 20 pounds per square feet for a site elevation of approximately 1347 feet. The design snow load, for the reservoir roof is 25 pound per square feet based on design minimums.

C. Codes and Standards

In addition to compliance with the provisions of ANSI/AWWA D100-11, the reservoir and all associated accessories and appurtenances shall be designed and constructed in accordance with all applicable local requirements including the following Codes, Standards:

1. State of Oregon Structural Specialty Code, 2019.
2. Oregon Occupational Safety and Health Code.
3. Oregon Administrative Rules Chapter 333 for Public Water System published by the Oregon Health Division.

D. Physical Requirements

The reservoir shape shall be a ground supported welded steel reservoir with a dome roof as shown on the plans, with the following dimensional criteria:

1. Capacity	2,000,000 gallons (below Overflow Elevation level)
2. Normal High Water Level (NHWL)	30.00 Feet (above floor at wall)*
3. Overflow Elevation	30.00 Feet (above floor at wall)*
4. Wall Height	32.00 Feet
5. Floor Slope	2.0% (high point at reservoir center)
6. Dome Roof Radius	86.0 Feet
7. Reservoir Diameter	107.0 Feet

Details of design and construction shall be such as to allow access to all surfaces for maintenance, cleaning and coating and to eliminate all moisture pockets. All welds shall be "seal" welds. There shall be no open crevices caused by overlap of steel plate on a supporting member.

*Where the NHWL and overflow levels differ, the overflow operating level shall govern design.

E. Reservoir Design by Supplier

It is anticipated that the reservoir supplier will bid based on the details and requirements provided in the construction documents. The supplied reservoir shall conform to the details shown and described unless OWNER'S REPRESENTATIVE approvals are made otherwise during the shop drawing review process.

F. Acceptable Reservoir Contractors

The Reservoir Contractor shall be as determined through the Prequalification process as described in Section 4, Prequalification, of the Contract Documents and other relevant Sections of these Specifications. The Reservoir Contractor shall be a supplier normally involved in the design and manufacture of the type of reservoir structure specified. Submittal Requirements

Where revisions to the design represented in the construction documents are approved by the OWNER'S REPRESENTATIVE, the reservoir supplier shall provide any and all design drawings required by the OWNER'S REPRESENTATIVE to clearly delineate all proposed details of construction. These shall include as a minimum, but not be limited to, plan, section, and elevation views for the basic structure and shall include detail drawings for all proposed revised accessories and attachments. Detailed structural design calculations shall also be provided, signed by an Oregon licensed Structural Engineer.

In addition, shop drawings shall be provided which illustrate the steel plate sizes and layout, and which distinguish all sizes and types of both shop and field welds. All components, which will be shop fabricated, shall be clearly identified. Shop drawings shall also be provided for all proposed accessories.

The Contractor shall provide a letter from the Reservoir Supplier who certifies conformance of the (STRUCTURAL ENGINEER OF RECORD approved) design and any changes and/or supplier designed additions with requirements of these specifications (unless otherwise approved) and all applicable codes and standards of the State of Oregon. That letter shall include a summary of design data, which identifies live, snow, and dead loads and design base loads for wind and seismic loading. The calculated lateral force coefficient shall also be identified. If any Contractor initiated changes and/or additions are made to the original design, that letter, and the above-described design drawings and structural calculations, shall have affixed thereto the current and valid Structural Engineer's seal of an Engineer licensed to practice in the State of Oregon. The OWNER'S REPRESENTATIVE reserves the rights to review and reject with proper cause all or portions of the submittal.

PART 2 MATERIALS

2.1 RESEVOIR AND ACCESSORIES

Reservoir and accessories shall be welded steel unless otherwise noted and approved in accordance with ANSI/AWWA D100-11. All reservoir steel shall be of sand blast quality and shall be free of surface pitting. Mill test certificates shall be provided for all steel components.

A Certificate of Compliance shall be provided with each lot of steel delivered to the project site, which certifies that all steel included in the delivery meets all requirements of the Specifications. Each certificate shall include the delivery date and shall clearly identify the material for which it applies, and the Contractor's representative responsible for checking the material. All materials proposed to be used may be required by the OWNER'S REPRESENTATIVE to be sampled and tested at any time. Any materials found to be in nonconformance with the Specifications will be rejected. The form of the Certificate of Compliance shall be as approved by the OWNER'S REPRESENTATIVE. Mill test certificates for corresponding steel components shall be attached to each Certification of Compliance.

2.2 RESEVOIR ACCESSORIES

The completed reservoir shall include all accessories shown on the drawings and described herein. All accessories shall be designed and constructed in accordance with all applicable Federal, State and local codes and standards.

PART 3 EXECUTION

3.1 GENERAL

All workmanship required for the fabrication and erection of the steel reservoir structure and all accessories shall be of the highest quality. All work shall conform to the standards set forth in AWWA D100-11 except as modified herein. The steel reservoir structure and all integral accessories and components shall be the end product of one manufacturer. The structure shall be constructed to true, plumb and concentric lines and dimensions.

3.2 STANDARDS

All construction shall be in full conformance with all applicable Federal, State, and Local codes, standards and specifications including those set forth by the American Water Works Association (AWWA), International Building Code (IBC) OR Oregon Structural Specialty Code (OSSC), American Welding Society (AWS), the American Institute of Steel Construction (AISC), American Society of Testing Materials, (ASTM) and the Occupational Safety and Health Administration (OSHA).

3.3 FABRICATION AND ERECTION

A. Reservoir Foundation – A concrete foundation shall be constructed beneath the reservoir in accordance the provisions stated elsewhere in these specifications.

B. Perimeter Seal – A continuous perimeter seal of 1-inch thick non-shrink grout shall be provided between the top of the concrete foundation and the underside of the reservoir in accordance with Section 12.6.1 of AWWA D100-11.

C. Plate Forming – All single radius plates shall be cold rolled to the appropriate design diameter resulting in a continuous smooth radius. Double curved plates shall be press formed. Mortar and pestle dishing will not be allowed. Field hammering or any other method of plate adjustment which may cause marring or unsightly deformation will not be allowed. Any plates which do not meet the tolerance requirements set forth in AWWA D100-11 and as further described herein shall be rejected and replaced.

D. Welding – All welds shall be “seal” welds. All circumferential and longitudinal steel plate shell welds shall be full penetration butt welds except as described as follows. Circumferential lap welds will be allowed only on the roof portion of the reservoir. Any overlap of plates shall be seal welded to prevent moisture pockets. All exposed sharp edges, burrs and corners shall be ground smooth. All weld splatter shall be removed by grinding. Any and all welds not uniform and continuous shall be ground smooth.

E. Matching Plates – In addition to the requirements of the AWWA D100-11 Sec. 10.7, deviations at welded joints shall not exceed 1/8 of an inch from the true curve shape. The Contractor shall provide any and all field jigs as may be required for checking joint tolerances. Any plates or sections of plates not meeting these requirements shall be rejected and replaced.

F. Inspection and Testing – Inspection of shop forming, surface preparation and welding procedures may be conducted by the STRUCTURAL ENGINEER OF RECORD or the OWNER'S REPRESENTATIVE'S agent. The Contractor shall provide the OWNER'S REPRESENTATIVE with a schedule identifying all planned shop fabrication activities. The quality of welded joints shall be determined by the radiograph method as specified in AWWA D100- 11 Sec. 11. The Contractor shall provide all necessary radiographic testing equipment and shall perform any and all tests as may be required by the OWNER'S REPRESENTATIVE. All radiographic films shall become the property of the OWNER. Initial field-testing will be conducted immediately following the beginning of field welding operations and inspection of radiographs will be made to establish the acceptable quality of work.

The Contractor shall conduct regular weld inspections after the completion of every three (3) shell courses or per every 600 linear feet of weld, whichever comes first. Weld inspection shall occur at a frequency as described in AWWA D100-11 Sec. 11.5 and ensure all areas of the reservoir shell are subject to inspection. Weld inspection results shall be provided on a Weld Testing Location form which uses weld identification notation consistent with the Welder Identification tracking form. The Contractor shall provide and submit a written report as per the requirements of AWWA D100-11 Sec. 11.2. Updated copies of the Weld Testing Location and Welder Identification tracking documents shall accompany the written report. Radiographic methods shall be used for testing of all welds where possible. The Contractor shall notify the OWNER'S REPRESENTATIVE24 hours in advance of any scaffolding relocation and shall provide ample opportunity for any and all testing and inspections as may be required by the OWNER'S REPRESENTATIVE.

Individual weld inspection reports shall show a pass rate of 80% of the welds inspected on a minimum of six (6) tests per inspection. For an 80% pass rate, non-passing welds can be ground out, repaired, and re-tested to determine if they pass. For pass rates lower than 80% the OWNER or OWNER'S REPRESENTATIVE can opt to ask for additional testing to determine if issues are systemic. Upon the direction of the OWNER or OWNER'S REPRESENTATIVE additional testing shall be performed at a rate of one (1) additional test per failed test.

1. Example for a pass rate of 50% on six (6) tests, the three (3) original tests would need to be repaired and retested and an additional three (3) tests performed in locations as directed by the OWNER or OWNER'S REPRESENTATIVE.

Following completion of reservoir erection, and prior to reservoir coating, the reservoir shall be leakage tested in accordance with the requirements of AWWA D100-11 Sec. 11.10. The OWNER shall provide water for initial testing of the reservoir. Water as may be required for subsequent tests shall be purchased by the Contractor. Disposal of water shall be through the overflow and drain piping system constructed as part of this project.

G. Painting and Disinfection – Painting and disinfection shall be accomplished in accordance with requirements included elsewhere in these specifications.

H. Post Fabrication & Erection Cut-Outs – Special cut-outs within a fabricated steel panel for the temporary purpose of moving equipment into, out of, or off of the steel reservoir structure will not be allowed. Any requirements shall be accommodated by either postponing installation of a particular panel or by cutting out and rewelding an entire fabricated steel panel section at pattern layout seams. The intent of this specification is to preserve the aesthetic appearance of symmetrical and uniform fabricated panel layouts and weld seams. It is not the intent of this specification to restrict the Contractor's use of external crane equipment for purposes of removing or installing equipment from or into the structure.

3.4 SUBMITTALS

The Contractor shall submit information provided by the Reservoir Contractor as identified below. The submittal shall be presented in the form of a bound portfolio. All items shall be included in this single submittal package of which six copies shall be provided.

A. Letter Certifying Design Compliance for all elements (approved by the OWNER'S REPRESENTATIVE) varying from the details included in the construction documents and/or not included in the construction document.

B. Design drawings for varying details and/or details not included in the construction documents – Plan, sections, elevations and details, including all accessories shall be stamped by an Oregon State licensed Structural Engineer unless otherwise approved. Supporting calculations stamped by an Oregon State licensed Structural Engineer are also required.

C. Shop Drawings – Include plate layout and steel thicknesses for basic structure indicating which sections are to be shop fabricated and which are to be field fabricated. Shop drawings shall include: weld locations, types and sizes, fabrication details of all required components and accessories, support details for all pipes and conduits, and any other information as may be required by the OWNER'S REPRESENTATIVE.

D. Joint Tolerance Jigs – As per Paragraph 3.3 “Fabrication and Erection”, Subparagraph E “Matching Plates” -- provide shop drawings.

E. Radiographic Weld Testing Equipment

1. Submit manufacturer and model of equipment proposed to be used for testing of weld joints; include detailed outline description of equipment operation and testing evaluation methods.

2. Submit form for tracking Weld Testing Locations.

    a. The Weld Testing Location form shall match any Welder Identification tracking form being used so that both forms shall have consistent weld identifications information.

END OF SECTION

SECTION 33 16 23.10

GROUND-LEVEL STEEL WATER STORAGE TANK ACCESSORIES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

This Section defines the work required for design, fabrication, and construction of steel reservoir hatches, ladders, piping, and other appurtenances and accessories associated with the 2,000,000-gallon (2.00 MG) ground supported welded steel reservoir. Construction of the reservoir, earthwork, foundation construction, electrical, mechanical and yard piping, landscaping, structural elements, and provisions for other related project work is covered elsewhere in the specifications.

1.2 QUALIFICATION OF RESERVOIR CONTRACTOR

The Contractor's attention is directed to Section 4, Prequalification, of the Contract Documents for a list of Prequalified Reservoir Contractors. See Section 00 20 10, Reservoir Contractor Statement of Qualifications Form, for instructions on submitting a Statement of Qualifications during bidding in order to become prequalified to perform reservoir construction work for this Project.

1.3 DESIGN

A. General

The ground supported steel reservoir accessories shall be designed in accordance with the latest edition of the American Water Works Association (AWWA) Standard for Welded Steel Tanks for Water Storage, ANSI/AWWA D100-11 except as herein modified by these specifications. The basis for design of this welded steel reservoir shall be in accordance with AWWA D100-11 Sec. 3.

Details of design and construction shall be such as to allow access to all surfaces for maintenance, cleaning, and coating and to eliminate all moisture pockets. All welds shall be "seal" welds. There shall be no open crevices caused by overlap of steel plate on a supporting member.

B. Design by Supplier

It is anticipated that the reservoir supplier will bid based on the details and requirements provided in the construction documents. The supplied accessories shall conform to the details shown and described unless OWNER'S REPRESENTATIVE approvals are made otherwise during the shop drawing review process.

C. Submittal Requirements

Where revisions to the design represented in the construction documents are approved by the OWNER'S REPRESENTATIVE, the reservoir supplier shall provide any and all design drawings required by the OWNER'S REPRESENTATIVE to clearly delineate all proposed details of construction. These shall include as a minimum, but not be limited to, plan, section, elevation views, and detail drawings for all proposed revised accessories and attachments. Detailed structural design calculations stamped by a Structural Engineer licensed in the State of Oregon shall also be provided.

In addition, shop drawings shall be provided which illustrate the proposed steel sizes and layout, and which distinguish all sizes and types of both shop and field welds. All components, which will be shop fabricated, shall be clearly identified. Shop drawings shall also be provided for all proposed accessories.

The Contractor shall provide a letter from the reservoir supplier who certifies conformance of the (STRUCTURAL ENGINEER OF RECORD approved) design changes and supplier designed additions with requirements of these specifications (unless otherwise approved) and all applicable codes and standards of the State of Oregon. That letter shall include a summary of design data, which identifies live, snow, and dead loads and design base loads for wind and seismic loading. The calculated lateral force coefficient shall also be identified. That letter, and the above-described design drawings and structural calculations, shall have affixed thereto the current and valid Structural Engineer's seal of an Engineer licensed to practice in the State of Oregon. The OWNER'S REPRESENTATIVE reserves the rights to review and reject with proper cause all or portions of the submittal.

PART 2 MATERIALS

2.1 TANK AND ACCESSORIES

Tank and accessories shall be welded steel unless otherwise noted and approved in accordance with ANSI/AWWA D100-11. All tank steel shall be of sand blast quality and shall be free of surface pitting. Mill test certificates shall be provided for all steel components.

A Certificate of Compliance shall be provided with each lot of steel delivered to the project site, which certifies that all steel included in the delivery meets all requirements of the Specifications. Each certificate shall include the delivery date and shall clearly identify the material for which it applies, and the Contractor's representative responsible for checking the material. All materials proposed to be used may be required by the OWNER'S REPRESENTATIVE to be sampled and tested at any time. Any materials found to be in nonconformance with the Specifications will be rejected. The form of the Certificate of Compliance shall be as approved by the OWNER'S REPRESENTATIVE. Mill test certificates for corresponding steel components shall be attached to each Certification of Compliance.

2.2 TANK ACCESSORIES

The completed tank shall include all accessories shown on the drawings and described herein. All accessories shall be designed and constructed in accordance with all applicable Federal, State, and local codes and standards.

A. Ladders – Fixed internal and external ladders shall be included, providing access from the ground level along the tank shell to the roof, and from the access hatch at the roof edge inside the tank to the reservoir floor. The interior ladder shall be of steel fabrication and coated with an NSF 61 approved material and all other ladders shall be of steel fabrication as shown on the drawings. Internal and external ladders shall include a fall prevention system as per Section
11 81 29, Facility Fall Protection, of the specifications. Ladders may be constructed in section lengths as determined by the Contractor. See Section 05 50 00, Metal Fabrications, for additional ladder layout and detailing information.

B. Tank Bottom Access Hatches – Two 36-inch diameter hinged access hatches shall be provided through the tank shell to the tank bottom. Hatches shall be of watertight design and construction and shall be oriented as shown on the plans. Hatches shall be designed to resist the reservoir water head and shall be operable from the outside of the tank shell and open outward.

C. Roof Hatch – A rectangular aluminum hinged access hatch shall be provided on the roof as shown on the plans to allow access into the reservoir. The hatch shall be designed and constructed in accordance with AWWA D100- 11 provisions. Hatch construction shall be of weatherproof design and in compliance with State Health regulations. A steel collar from which the hatch shall be hinged shall be welded to the reservoir roof and extend vertically 4-inches above the landing surface. The hatch shall have sides which overlap the collar by 2 inches. OWNER will provide locks. Provide a single-leaf door with spring assist. Hinge design shall be such as to hold the hatch at approximately 90 degrees above the roof level when opened, providing easy closing, and preventing damage to the tank exterior coating during opening. The access hatch opening shall have a clear opening of 36 inches by 48 inches. Hatch shall be constructed so as to operate smoothly without binding. All sharp edges and corners shall be ground to a smooth chamfer. The hatch shall be equipped with an open position locking mechanism. See Section 05 50 00, Metal Fabrications, for additional roof hatch information.

D. Roof Exhaust Manhole – A 30-inch diameter flanged steel exhaust manhole shall be provided on the tank roof as shown on the plans. The exhaust manhole shall be watertight and designed and constructed in accordance with AWWA D100-11 provisions. A 6-inch high steel flanged collar shall be welded to the reservoir to which the manhole cover can be bolted. The manhole cover shall be equipped with two handles welded on the outside of the cover. All sharp edges and corners shall be ground to a smooth chamfer.

E. Tank Vent – The reservoir shall be vented through a vent mounted on the tank roof at the center peak of the roof as shown on the plans.

1. Vent shall include integral vacuum and pressure relief in the event of frost or other clogging of the screen.

2. Vent shall include tamper-resistant hardware and means of keyed locking of the hood to the vent body.

3. The vent shall be sized for adequate airflow at extreme tank fill/empty flow rates. Vent sizing shall be based on a minimum fill rate of 15,800 gpm and an empty flow rate of 62,000 gpm.

4. Vent shall be fitted with No. 24 stainless steel screening for insect and pest obstruction and shall be secured continuously around all edges. Screen securing system shall be such as to allow maintenance replacement of screen.

5. Vent shall include a minimum 48-inch diameter, aluminum rainproof hood and shall be removable by means of a bolting system accessible and operable from the tank roof without the need for entry into the tank wet well.

6. Vent shall include flange isolation hardware to eliminate dissimilar metals in contact where the aluminum vent is mounted to the steel flange.

7. Vent shall meet all recommendations of the Oregon Health Authority Drinking Water Program.

8. The tank vent shall be designed by the Manufacturer and approved by the OWNER'S REPRESENTATIVE.

F. Hand Rails – Permanently mounted OSHA approved handrails shall be provided as shown on the plans. See provisions of other sections of these specifications relating to handrails.

G. Overflow, Drain, Outlet and Inlet Pipes – Overflow, drain, outlet and inlet pipes shall be provided as shown on the plans. Water inlet and outlet piping shall be 18 inches and 24 inches in diameter, respectively. Reservoir overflow and drain piping shall be 16 inches and 8 inches in diameter, respectively. All steel piping shall be of extra strong pipe thickness with either flanged ends as per AWWA C207- 18 or plain ends as shown on the plans. The steel overflow, drain, and outlet pipes shall be shop fabricated and coated inside and out according to the provisions of this document. The steel portion of the inlet pipe shall be shop fabricated and coated inside and out according to the provisions of this document. No field welding of pipe sections will be allowed except near ends where pipe can be readily prepared, primed, coated, and inspected without remote equipment. Where field welds must be made to connect the piping to the tank, the primer and paint shall be held back a minimum of 6-inches with the hold back distances being staggered for each layer of primer/paint. Upon completion of the pipe connecting welds, the unpainted sections of pipe shall be primed and painted inside and out according to the provisions of this document. All pipe supports and/or other attachments shall be fabricated and welded to pipe sections prior to interior pipe coating. Overflow piping shall be fully supported as shown on the drawings. Provisions covered elsewhere in these specifications for piping shall apply to this section.

H. Painter’s Plugs and Painter’s Lugs – Painters plugs and lugs shall be provided as generally shown on the plans. Design and construction may be of Manufacturer’s standard design. All painters’ accessories shown are minimum requirements. The Contractor shall satisfy themselves as to the adequacy of shown accessories for specific construction operations. No representation is made as to the structural capacity of these accessories. The Contractor may propose, under the discretion of the OWNER’S REPRESENTATIVE, alternate accessories to facilitate specific construction operations as may be deemed necessary.

I. Drip Eave/Overhang – Perimeter drip eave and overhang shall be provided around roof edge as shown on the plans.

J. Lightning Grounding – Provide lightning grounding of steel reservoir structure as required by National Electrical Code (NEC) and City of Pendleton electrical permit requirements.

K. Identification Plate – A tank identification plate shall be mounted near the north tank bottom access hatch. The identification plate shall be corrosion resistant and contain the following information:

- Tank Contractor
- Tank Contractor’s project or file number
- Tank capacity
- Height to High Water Level
- Date erected

PART 3 EXECUTION

3.1 GENERAL

All workmanship required for the fabrication and erection of the steel tank structure and all accessories shall be of the highest quality. All work shall conform to the standards set forth in AWWA D100-11 except as modified herein. The steel tank structure and all integral accessories and components shall be the end product of one manufacturer. The structure shall be constructed to true, plumb, and concentric lines and dimensions.

3.2 STANDARDS

All construction shall be in full conformance with all applicable Federal, State, and Local codes, standards and specifications including those set forth by the American Water Works Association (AWWA), International Building Code (IBC), American Welding Society (AWS), the American Institute of Steel Construction (AISC), American Society for Testing and Materials International (ASTM International) and the Occupational Safety and Health Administration (OSHA).

3.3 FABRICATION AND ERECTION

A. Welding – All welds shall be “seal” welds. All circumferential and longitudinal steel plate shell welds shall be full penetration butt welds except as described as follows. Circumferential lap welds will be allowed only on the roof portion of the tank. Any overlap of plates shall be seal welded to prevent moisture pockets. All exposed sharp edges, burrs and corners shall be ground smooth. All weld splatter shall be removed by grinding. Any and all welds not uniform and continuous shall be ground smooth.

B. Inspection and Testing – Inspection of shop forming, surface preparation and welding procedures may be conducted by the OWNER’S REPRESENTATIVE. The Contractor shall provide the OWNER’S REPRESENTATIVE with a schedule identifying all planned shop fabrication activities. The quality of welded joints shall be determined by the radiograph method as specified in AWWA D100-11, Sec. 11. The Contractor shall provide all necessary radiographic testing equipment and shall perform any and all tests as may be required by the OWNER’S REPRESENTATIVE. All radiographic films shall become the property of the OWNER. Initial field-testing will be conducted immediately following the beginning of field welding operations and inspection of radiographs will be made to establish the acceptable quality of work.

   The Contractor shall provide and submit a written report as per the requirements of AWWA D100-11 Sec. 11.2 Radiographic methods shall be used for testing of all welds where possible. The Contractor shall notify the OWNER’S REPRESENTATIVE24 hours in advance of any scaffolding relocation and shall provide ample opportunity for any and all testing and inspections as may be required by the OWNER’S REPRESENTATIVE.

   Following completion of tank erection, and prior to tank coating, the reservoir shall be leakage tested in accordance with the requirements of AWWA D100-11 Sec. 11.10. The OWNER shall provide water for initial testing of the reservoir. Water as may be required for subsequent tests shall be purchased by the Contractor. Disposal of water shall be through the overflow and drain piping system constructed as part of this project.

C. Painting and Disinfection – Painting and disinfection shall be accomplished in accordance with requirements included elsewhere in these specifications.

3.4 SUBMITTALS

The Contractor shall submit information provided by the tank supplier as identified below. The submittal shall be presented in the form of a bound portfolio. All items shall be included in this single submittal package of which six copies shall be provided.

A. Letter Certifying Design Compliance for all elements (approved by the OWNER'S REPRESENTATIVE) varying from the details included in the construction documents and/or not included in the construction document.

B. Design drawings for varying details and/or details not included in the construction documents – Plan, sections, elevations, and details, including all accessories shall be stamped by an Oregon State licensed Structural Engineer unless otherwise approved (See Part 1., of this section). Design calculations shall also be required.

C. Shop Drawings – Include weld locations, types and sizes, fabrication details of all required components and accessories, support details for all pipes and conduits, and any other information as may be required by the OWNER'S REPRESENTATIVE.

END OF SECTION

SECTION 33 41 10

STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials and accessories normally used with gravity storm drainage sewers.

B. Section includes:

1. Storm drainage piping.
2. Piping accessories
3. Connection to existing manholes.
4. Catch basins and area drains.
5. Cleanouts.
6. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work.
B. Section 31 05 13 - Soils for Earthwork.
C. Section 31 05 16 - Aggregates for Earthwork.
D. Section 31 23 16 - Excavation.
E. Section 31 23 17 - Trenching.
F. Section 31 23 23 - Fill.
G. Section 33 01 30.13 - Storm and Manhole Testing.
H. Section 33 05 13 - Manholes.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-pound) Rammer and a 305-mm (12-inch.) Drop.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
7. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
8. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
10. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
11. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
13. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
14. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
15. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
16. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
17. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
18. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association:

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inch Through 12 Inch (100 mm Through 300 mm), for Water Transmission and Distribution.

1.4 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.
2. Submit detailed description of procedures for connecting new storm sewer to existing storm sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Polyvinyl Chloride (PVC) Pipe:

1. Material:

    a. Manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.

    b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.

2. Pipe and fittings 4 inches to 15 inches in diameter, non-pressurized:

    a. Comply with ASTM D3034, SDR 35.

3. Pipe and fittings 18 inches and larger in diameter, non-pressurized:

    a. Comply with ASTM F679, PS46.
    b. Pipe shall have a minimum stiffness of 46 psi.

4. AWWA C900 Pipe:

    a. At locations shown in the Drawings.
    b. 4 inches to 12 inches in diameter.
    c. DR 25.
    d. Pipe shall have minimum stiffness of 149 psi.

5. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.

6. Joints:

    a. Integral bell push-on type, comply with ASTM D3212.
    b. For use with AWWA C900 pipe: Integral bell push-on type comply with ASTM D3139.

7. Gaskets:

    a. Factory installed.
    b. Elastomeric gaskets, comply with ASTM F477.

B. Ductile Iron Pipe: NOT USED

C. High Density Polyethylene (HDPE) Pipe: NOT USED

D. Acrylonitrile-Butadiene-Styrene (ABS) Pipe: NOT USED

E. Reinforced Concrete Pipe: NOT USED

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two Series 300 stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 11 00, Concrete Work.

2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 11 00, Concrete Work.

2.5 MANHOLES

A. Description:

1. As specified in Section 33 05 13 - Manholes.
2. Material: Reinforced precast or cast-in-place concrete.
3. Diameter: As shown in the Drawings.
4. Top: Eccentric cone.
5. Frames and Covers: Watertight cast iron.
6. Cover Inscription: “S”.

2.6 CATCH BASINS AND AREA DRAINS

A. Construction:

1. Material: Reinforced precast concrete pipe sections.

    a. Minimum compressive strength of 3,000 psi at 28 days.
    b. Precast concrete inlets shall conform to ASTM C913.

2. Joints: Lipped male/female.

3. Nominal Interior Dimensions: As shown in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron.

2. Lid:

    a. Removable.
    b. Design: Linear grill.

3. Nominal Lid and Frame Size: As shown in the Drawings.

2.7 CLEANOUTS

A. Construction:

1. Per details provided in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron. Meet H20 load requirement.

2.8 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.
b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2.9 MIXES

A. Grout: As specified in Section 03 60 00, Grouting.

2.10 ACCESSORIES

A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut or excavation base is ready to receive Work.
B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Owner's Representative if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Owner’s Representative prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

6. Placement:

   a. Place bedding material at trench bottom.
   b. Level materials in continuous layer not exceeding 6 inches compacted depth.
   c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

   a. PVC, HDPE, ABS: Comply with ASTM D2321.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated on Drawings.

4. Variations:

   a. Maximum Variation from Indicated Line: 1/32 inch per inch of pipe diameter, but no more than 1/2 inch, providing that such variation does not result in a level or reverse-sloping invert.

   b. Maximum Variation from Indicated Grade: 1/32 inch per inch of pipe diameter, but no more than1/4-inch.

   c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64 inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer’s instructions, except as may be modified on Drawings or by Owner’s Representative.
7. Make straight field cuts without chipping or cracking pipe.
8. Keep pipe and fittings clean until Work has been completed and accepted by Owner’s Representative.
9. Assemble pipe joints in accordance with manufacturer’s recommendations / specifications.
10. Cap open ends during periods of Work stoppage.
11. Lay bell and spigot pipe with bells upstream.
12. Backfill and compact as specified in Section 31 23 17, Trenching.
13. Do not displace or damage pipe when compacting.
14. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.
2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.
3. Before the joint is fully “home,” the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.
4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.
5. The pipe is then forced “home” firmly and fully.
6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Manholes:

1. Install manholes as specified in Section 33 05 13, Manholes.

E. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

F. Catch Basins

1. Form bottom of excavation clean and smooth, and to indicated elevation.

2. Mount lid and frame level in grout, secured to top cone section to indicated elevation.

G. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Owner’s Representative prior to and immediately after placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Pipe Testing: As specified in Section 33 01 30.13, Storm and Manhole Testing.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 40 05 13

COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section applies to the furnishing and installation of piping inside a building, structure, enclosure piping and miscellaneous yard piping.

1.2 RELATED SECTIONS

A. Section 05 50 00, Metal Fabrications.
B. Section 09 90 00, Painting and Coating.
C. Section 31 23 17, Trenching.
D. Section 33 11 10, Water Utility Distribution Piping.
E. Section 33 05 17, Precast Concrete Valve Vaults and Meter Boxes.
F. Section 33 13 00, Disinfecting of Water Utility Distribution.
G. Section 40 05 23, Common Work Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Owner's Representatives:

1. ASME B1.20.1 Pipe Threads, General Purpose (inch)

2. ASME A13.1 - Scheme for the Identification of Piping Systems.

3. ASME B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys

4. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250.

5. ASME B31.3 - Process Piping.

6. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile.

3. ASTM A325 - Specification for High-Strength Bolts for Structural Steel Joints.

4. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.

5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

7. ASTM D792 - Test Methods for Specific Gravity and Density of Plastics by Displacement.

8. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

10. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

11. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.

12. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

C. American Water Works Association:

1. AWWA C200 - Steel Water Pipe - 6 In. (150 mm) and Larger.

2. AWWA C207 - Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.

3. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

5. AWWA C510 - Double Check Valve Backflow Prevention Assembly.

6. AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly.

7. AWWA C606 - Grooved and Shouldered Joints.

8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Coordinate installation of specified items with installation of valves and equipment.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer catalog information for each product specified.

C. Shop Drawings:

1. Identification:

   a. Submit list of wording, symbols, letter size, and color coding for pipe identification.

   b. Comply with ASME A13.1.

2. Provide all necessary dimensions and details on pipe joints, restraints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists.

3. Provide detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, couplings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.

D. Manufacturer's Statement: Certifying pipe fabrication and products meet or exceed specified requirements.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS and ASME qualification within previous 12 months.

F. Manufacturer Instructions: Submit special procedures and setting dimensions.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping appurtenances.

B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Drawings:

1. Piping layouts shown in the Drawings are intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

B. Inspection:

1. All pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture of the pipe, the Owner's Representative shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Welding:

1. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1.

2. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring

attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welders:

1. Skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used shall do all welding.

2. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local approved testing agency prior to commencing work on the pipeline.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. The Contractor shall furnish all material and bear the expense of qualifying welders.

E. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

1.8 MATERIAL DELIVERY, STORAGE AND INSPECTION

A. Inspection:

1. Accept materials on Site in manufacturer's original packaging and inspect for damage.

2. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition.

B. Storage:

1. Store materials according to manufacturer instructions.

2. Store materials off the ground, to provide protection against oxidation caused by ground contact.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.

3. Provide additional protection according to manufacturer instructions.

D. All defective or damaged materials shall be replaced with new materials.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

B. Unless specified otherwise or indicated differently in the Drawings, all piping systems and process piping materials shall be as listed in the table below or as shown on the Drawings:

Service	Material
Drainage	See Division 33.
Exposed ≥ 4"	Class 52 Ductile Iron or Standard Weight Welded Steel, unless indicated otherwise on Drawings
Buried ≥ 4"	Class 52 Ductile Iron
Exposed < 4"	Brass - ASTM B 43, Fittings - Bronze - ASTM B 62 Threaded - ANSI/ASME B 16.15
Buried < 4"	Copper Tubing - ASTM B88 Type K Soft / Fittings - Wrought Copper - ANSI B16.22, Joints-Soldered
Miscellaneous Pipelines	As shown in the Drawings

2.2 DUCTILE IRON PIPE AND FITTINGS

2.3 FLANGED DUCTILE IRON PIPE AND FITTINGS

A. Centrifugally cast, conforming to AWWA C151 and AWWA Standard C115.

B. Coating: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer. Field coating shall be in accordance with the requirements of Section 09 90 00 – Painting and Coatings.

C. Pipe Mortar Lining: Shop-applied NSF 61 cement mortar lining, smoothed finish, complying with AWWA C104.

D. Pipe Thickness Class:

1. Comply with AWWA C115.

2. Class 52, unless shown to be greater in the Plans.

3. Flanged Joints:

   a. Flat faced, complying with AWWA C111 and C115, unless otherwise specified.

   b. Bolt hole drilling according to ASME/ANSI B16.1, Class 125, or ASME/ANSI B16.1, Class 250, where specified. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.

   c. The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain mating pipe, valve, and fitting flanges match in bolt pattern.

   d. Flange joint connections shall not be exposed to test pressures greater than 1-1/2 times their rated working pressure.

   e. Gaskets:

      1) Full faced, composed of synthetic rubber and 1/8-inch thick conforming to ASME B21.1 and AWWA C111.

      2) Ring gaskets will be permitted only where specifically noted in the Drawings and Specifications.

      3) Gaskets for flanged joints shall be as follows:

         a) Pipe sizes between 6-inch and 24-inch diameter, service pressures of 150 psi or greater shall be Garlock 3760-U or equal.

         b) Pipe sizes 4-inch diameter and under, service pressures of 150 psi or greater shall be Garlock 3505 or equal.

         c) All pipe sizes with service pressures of 150 psi or less shall be Garlock 98206 or equal.

      4) Insulating flanged joints:

         a) Full faced, conform to ANSI 16.21.

b) Material: Non-asbestos.

c) Suitable for operating and test pressures of the pipe system.

d) Manufacturer:

(1) Garlock GYLON Style 3505 or equal.

2.4 FITTINGS:

A. Material: Ductile iron, complying with AWWA Standard C110.

1. Fittings conforming to AWWA C153 may be substituted in lieu of AWWA C110 fittings.

2. Fittings shall be flanged as required and shown on the Drawings.

3. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

B. Coating and Lining:

1. Coating: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer. Field coating shall be in accordance with the requirements of Section 09 90 00 – Painting and Coatings

2. Cement Mortar Lining: Comply with AWWA C104,

C. Following information cast upon fittings:

1. Manufacturer's identification.
2. Country of manufacture.
3. Pressure rating.
4. For bends, number of degrees and/or fractions of a circle.

2.5 NUTS, BOLTS, AND WASHERS:

A. All bolts shall have heavy hex head with heavy hex nuts.

B. For operating pressures greater than 150 psi:

1. Bolts: Steel alloy composition. Comply with ASTM A193.
2. Nuts: Comply with ASTM A194, Grade 2H.
3. Washers: Comply with ASTM F436.

C. For operation pressures of 150 psi or less:

1. Bolts: Low-carbon steel composition. Comply with ASTM A307, Grade B.
2. Nuts: Comply with ASTM A563A, Heavy Hex.
3. Washers: Comply with ASTM F844.

D. Higher-strength bolts with higher torque values as specified above for operation pressures greater than 150 psi shall not be used for assembly of flange joints including gray-iron flanges.

2.6 COPPER PIPE AND FITTINGS

A. Description:

1. Seamless; ASTM B88.

2. Type:

a. Type L, hard drawn.
b. For pipe under floor slabs, underground or cast in concrete: Type K, annealed, seamless.

B. Joints:

1. Compression.
2. Manufacturer: Mueller Model 110 or approved equal

C. Dissimilar Metals: See Dielectric Unions specified herein.

2.7 BRASS PIPE AND FITTINGS

A. Pipe: ASTM B43, chrome plated.

B. Fittings:

1. ASTM B584, brass.
2. ASTM B16.15.

C. Joints:

1. Mechanical compression.
2. Threaded: Tapered and smooth threads, ASME B1.20.1 and ASTM B43.

D. Dissimilar Metals: See Dielectric Unions specified herein.

2.8 POLYVINYL CHLORIDE (PVC) WATER PIPE AND FITTINGS

A. PVC Pipe and Fittings:

1. 4-inch diameter and smaller:

    a. Pipe: ASTM D1785, Schedule 40.
    b. Fittings: ASTM D2466, Schedule 40.
    c. Joints: Socket, solvent-welded, ASTM D2855.
    d. Materials: ASTM D1784, minimum cell classification 12545-C.

2. 6-inch diameter and larger:

    a. Pipe: AWWA C900, Class 235.
    b. Fittings: AWWA C111, cast iron.
    c. Joints: ASTM D3139, compression gasket ring.
    d. Materials: ASTM D1784, minimum cell classification 12545-C.

2.9 FLEXIBLE TUBING

A. PVC Braided Flexible Tubing:

1. Compatible with 12% Sodium Hypochlorite.
2. Open mesh polyester braiding permanently encapsulated in wall of clear, flexible PVC tubing.

2.10 GALVANIZED STEEL PIPE AND FITTINGS

A. Pipe: Seamless, or electric resistance welded, ASTM A53, Schedule 40.

B. Joints: Threaded.

C. Fittings:

1. Threaded, 150 lb. malleable iron, galvanized, ASTM A197 or ASTM A47, dimensions conforming to ANSI B16.3.

2. Unions, 300 lb. malleable iron, galvanized with dimensions conforming to ANSI B16.3, brass to iron seat.

3. Thread lubricant shall be Teflon tape or joint compound that is insoluble in water.

2.11 FLEXIBLE COUPLINGS

A. Description:

1. Sleeve-type, couplings. Comply with AWWA C219.

2. Minimum design pressure rating: 150 psi.

3. Middle Ring: As required for coupling based upon connecting pipe materials, steel or ASTM A536, ductile iron.

4. Followers: As required for coupling based upon connecting pipe materials, steel or ASTM A536, ductile iron.

5. Gaskets:

   a. Material: Buna-N.
   b. Comply with ASTM D2000.

6. Bolts:

   a. Buried: Steel.
   b. Submerged: Stainless steel.

7. Center Pipe Stop: Required where shown on the Drawings.

B. Finishes:

1. Buried Couplings, Bolts: Factory epoxy coated.

C. Manufacturers:

1. For ductile iron and steel pipe:

   a. Dresser, Style 38.
   b. Romac, Model 501.
   c. Smith-Blair.

2. For PVC pipe:

   a. Romac, Model 501 or approved equal.

3. For flanged steel and ductile pipe:

   a. Dresser, Style 128 or approved equal.

2.12 RESTRAINED FLANGE ADAPTERS FOR DUCTILE IRON PIPE

A. Description:

1. ASTM A536, ductile iron.

2. Flange bolt circles compatible with ANSI/AWWA C115/A21.15.

3. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges.

4. Capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

5. Safety factor of 2:1 minimum.

6. Manufacturer:

   a. EBAA Iron, Series 2100 Megaflange or approved equal.

2.13 FLANGED INSULATING JOINTS

A. Set shall include a full faced gasket, a full length insulating sleeve for each flange bolt, and two insulating washers and two steel washers for each bolt.

1. Gaskets:

   a. Full face comply with ASME 16.21.

   b. Non-asbestos and non-phenolic compressed sheet packing with nitrile rubber binder.

   c. Manufacturer: Garlock, Style 3505, or equal.

2. Insulating sleeves:

   a. G-10 glass epoxy.

   b. Extend the full width of both flanges, except where one flange hole is threaded where the sleeve shall extend through one flange and the gasket.

3. Insulating washers:

   a. G-10 glass epoxy.
   b. 1/8-inch thickness.

4. Washers:

   a. Buried: Cadmium plated steel.
   b. Submerged: Stainless steel.

B. The complete assembly shall have an ANSI/AWWA pressure rating equal to or greater than that of the flanges between which is installed.

C. After assembly, the joint shall be tested for continuity. Electrical resistance between flanges and between each bolt and each flange shall be not less than 100,000 ohms.

2.14 INSULATING UNION

A. Description:

1. Material: Galvanized malleable iron with a ground joint.

2. Iron pipe threads: Conform to ANSI B2.1.

3. Insulations: Nylon, bonded and molded onto the metal body.

4. Union: Rated for the operating and test pressures of the pipe system.

5. Joint connections to copper alloy pipe and tube shall be copper solder or threaded brass ground joints.

6. Isolation Barrier: Impervious to water.

2.15 BACKFLOW PREVENTERS

A. Manufacturers:

1. Nibco.
2. Watts.

B. Double Check Valve Backflow Preventer Assemblies:

1. Size: 1/2 inch to 3 inches.

2. Comply with AWWA C510.

3. Materials:

a. Body: Bronze.
b. Internal Parts: Corrosion resistant.
c. Springs: Stainless steel.

4. Check Valves:

a. Quantity: Two, operating independently.
b. Intermediate atmospheric vent.

5. Ball Valves:

a. Type: Full port, resilient seated.
b. Quantity: Two.
c. Operation: Quarter turn.

d. Material: Bronze.

6. Accessories: Strainer and test cocks.

2.16 DISMANTLING JOINT

A. Description:

1. Comply with AWWA C219, where applicable.

2. Self-contained flanged restrained joint fitting, including both flanged components and sufficient harness bars to withstand the imposed thrust.

3. Design: No part of the restraint system extends outside the flange diameter. The internal bore shall match that of the pipe system.

4. Dismantling joints will allow for a minimum of 2 inches of longitudinal adjustment.

5. Furnish as a complete assembly consisting of spigot piece, flange adaptor, tie bars and gasket.

6. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system. Tie Rod diameter shall be compatible with the corresponding bolt diameter of the mating flange. The Tie Rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50% of the yield strength of tie rod material.

7. Pressure Rating:

a. Determined by the flange configuration, and all commonly used flanges shall be available.

b. Design pressure rating shall be equal to or greater than the mating flanges.

c. Dismantling joints will be specially fabricated to accommodate pressure requirements with ANSI B16.5 or ANSI B16.47 300-pound class flanges, depending on size of dismantling joint.

8. Lining and Coating:

a. Shop-applied fusion bonded epoxy coating applied by fluidized bed method, complying with the requirements of NSF 61 and AWWA C550 as applicable.

b. As an alternative, a shop-coat primer suitable for field applied coatings can be supplied.

9. Flanges: Flat-faced, rated to pressure requirements as shown on the Drawings.

   a. Where design pressure is greater than 300 psi, flanges shall conform to ASME B16.5 and ASME B16.47 300-pound class.

B. Materials:

1. Spigot piece: Steel, ASTM A283 Grade C.

2. Flange adaptor:

   a. Up to 12-inch diameter: Ductile iron, ASTM A536 Grade 65-45-12.
   b. Above 12-inch diameter: Steel, ASTM A283 Grade C.

3. Tie bars: ASTM A193 Grade B7 threaded rod with rolled threads.

4. Gasket: EPDM Grade E.

5. Nuts, Bolts and Washers: Type 304 stainless steel.

C. Manufacturer:

1. Romac or approved equal.

2.17 PIPE SUPPORTS

A. Floor Support for Pipe:

1. Flanged Pipe Support:

   a. Construction:

      1) Adjustable vertical pipe support, flange plate, extension pipe from base cup to top collar cup with threaded stud.

      2) Bolts directly to flange.

      3) Anchorable base plate.

   b. Material: Steel, comply with ASTM A36.

   c. Finish: Corrosion resistant, electro-galvanized or prime coated.

   d. Manufacturers:

      1) Standon - Model S89.

2. Cradle Pipe Support:

    a. Construction:

        1) Adjustable vertical pipe support with saddle strap, extension pipe from base cup to top collar cup with threaded stud.

        2) Anchorable base plate.

    b. Material: Steel, comply with ASTM A36.

    c. Finish: Corrosion resistant, electro-galvanized or prime coated.

    d. Manufacturers:

        1) Standon - Model S92.

2.18 PIPE PENETRATIONS

A. Sleeves for Pipes through Walls and Floors:

1. Material: Galvanized steel.
2. Thickness: Schedule 40.
3. Inside surface of all wall sleeves shall be coated with coal-tar.
4. Annular space between penetrating pipe and wall sleeve shall be filled with an approved permanently flexible sealant.
5. Diameter of wall sleeve shall be as shown in the Drawings.

B. Mechanical Sleeve Seals:

1. Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
2. Manufacturer: Link-Seal or approved equal.

C. Pipes Cast-In Walls and Floors:

1. Material: Ductile iron or steel pipe, as required by the Drawings and the intended service.
2. Diameter: As shown in the Drawings.
3. End Type: As shown in the Drawings.

D. Seep Rings:

1. Material: 3/8-inch thick steel plate conforming to ASTM A36, unless otherwise noted.

2. Inside diameter: Equal to the outside diameter of the pipe or sleeve to which it is attached plus 1/4-inch.

3. Outside diameter: As shown in the Drawings.

4. Attach to the pipe or sleeve by means of a continuous seal weld located on both sides of the ring.

2.19 PIPE COATINGS

A. See Section 09 90 00, Painting and Coatings.

PART 3 EXECUTION

3.1 GENERAL

A. Furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. Pipe shall be installed in accordance with good trade practice. The methods employed in handling and placing of pipe, fittings, and equipment shall be such as to insure that after installation and testing they are in good condition. Should damage occur to the pipe, fitting or equipment, repairs satisfactory to the Owner’s Representative shall be made.

3.2 INSTALLATION

A. Buried Piping Systems:

1. Establish elevations of buried piping with not less than 3 feet of cover.

2. Remove scale and dirt from inside of piping before assembly, as may be required.

3. Excavate pipe trench as specified in Section 31 23 17, Trenching.

4. Install pipe to accurate lines, elevations, and grades as shown on the Drawings.

5. Where grades are not shown, pipe shall be laid to grade between control elevations shown on the Drawings.

6. Place bedding material at trench bottom to provide uniform bedding for piping.

7. Level bedding material in one continuous layer not exceeding 6 inches compacted depth.

8. Install pipe on prepared bedding.

9. Route pipe in straight line.

10. Install pipe to allow for expansion and contraction without stressing of pipe or joints.

11. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

12. Pipe Cover and Backfilling:

    a. Backfill trench as specified in Section 31 23 17, Trenching.

13. All buried non-ferrous piping shall be installed with detectable tracer tape.

    a. Tape shall be buried 12 inches above the top of the pipe or as recommended by manufacturer.

    b. Tape shall be continuous and labeled the same as the piping system.

B. Interior Piping Systems:

1. Install non-conducting dielectric connections wherever joining dissimilar metals.

2. Establish elevations of buried piping outside valve vault to obtain not less than 3 feet of cover.

3. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting as specified in Section 09 90 00, Painting and Coating.

4. Install water piping according to ASME B31.9.

5. Install unions downstream of valves and at equipment or apparatus connections.

6. Install brass male adapters each side of valves in copper piped system; solder adapters to pipe.

C. Backflow Preventer Assemblies:

1. Install backflow preventers of type, size, and capacity indicated.
2. Comply with applicable code and authority having jurisdiction.
3. Install air-gap fitting on units with atmospheric vent connection.

4. Pipe relief outlet drain to nearest floor drain.
5. Do not install bypasses around backflow preventers.

D. Pipe Supports and Hangers

1. Install pipe supports according to MSS SP-58 & ASME B31.10.

2. All pipe shall be secured in place by use of blocking, hangers, brackets, clamps or other approved methods, and the weight thereof shall be carried independently of pump casings or equipment.

3. Special hangers and supports are shown on the Drawings.

4. The Contractor shall be responsible for determining the location of and providing all additional supports.

5. Hanger supports shall be as noted below with at least one support adjacent to the joint for each length of pipe, at each change in direction and at each branch connection. Sufficient hangers shall be provided to maintain proper slope without sagging. Support spacing shall not exceed manufacturer's recommendations, nor as listed below.

Pipe	Maximum Support Spacing (Feet)
Steel Pipe	
Under 3 inches	6
3 inches and Over	12
Cast or Ductile Iron	
Under 4 inches	6
4 inches and Over	12
Stainless Steel and Galvanized Iron	
Under 1-1/2 inches	4
1-1/2 inches to 4 inches	6
Over 4 inches	12
Copper Pipe	6
PVC Pipe	
Under 2-1/2 inches	4
2-1/2 inches and Over	6

6. Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment as well as to support the weight of the piping and contents unless other vertical support is shown, but in no case shall be more than 12 feet.

7. Provide adjustable hangers for all pipes, complete with adjusters, swivels, rods, etc. Size hangers to clear insulation and guide where required, as well as support piping.

All rigid hangers shall provide a means of vertical adjustment after erection. Hanger rods shall be machine-threaded. Continuous threaded rods will not be allowed.

8. Clevis or band-type hangers (B-Line FIG B3100) or approved equal shall be provided as required. Strap hangers not permitted.

9. Provide floor stands, wall bracing, concrete piers, etc., for all lines running near the floors or near walls and which cannot be properly supported or suspended by the walls or floors. Pipe lines near concrete or masonry walls may also be hung by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.

10. Equipment shall be positioned and aligned so that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

11. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

E. Pipe Penetrations:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals or grout, as shown in the Drawings.

2. Whenever a pipe line of any material terminates at or through a structural wall or floor, install piping or sleeve in advance of pouring of concrete required for the particular installation.

3. Plastic pipe shall not be cast in concrete or masonry walls.

4. Set sleeves in position in forms and provide reinforcing around sleeves.

5. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.

6. Extend sleeves through floors 1 inch above finished floor level and caulk sleeves.

7. Pipe other than concrete, to be cast in water-bearing walls or more than four feet below grade shall have seep rings.

8. All buried piping entering structures shall have a flexible connection installed less than two feet outside the structure line or as close to the wall as practical.

3.3 CLEANING, TESTING AND DISINFECTION

A. Testing and Disinfection: Piping shall be hydrostatically tested, flushed and disinfected as specified in Section 33 13 00, Testing and Disinfection Water Utility Pipelines.

END OF SECTION

SECTION 40 05 23

COMMON WORK RESULTS FOR PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes basic materials and methods related to valves commonly used for process systems, including pump stations, utility vaults and water & wastewater treatment.

B. Section Includes:

1. Valves.
2. Valve actuators.

1.2 RELATED SECTIONS

A. Section 03 11 00, Concrete Work.
B. Section 05 50 00, Metal Fabrications.
C. Section 09 90 00, Painting and Coating.
D. Section 33 11 10, Water Utility Distribution Piping.
E. Section 40 05 13. Common Work Results for Process Piping.
F. Section 40 05 23.15, Gate Valves.
G. Section 40 05 23.18, Butterfly Valves.
H. Section 40 05 23.24, Check Valves.
I. Section 40 05 23.72, Miscellaneous Valves.

1.3 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

3. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.

4. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

5. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Fire Protection Association:

1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling Schedule: Indicate valve locations and nametag text.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

J. CLOSEOUT SUBMITTALS

1. Project Record Documents: Record actual locations of valves and actuators.

2. Operation and Maintenance Data: Submit information for valves.

K. MAINTENANCE MATERIAL SUBMITTALS

1. Spare Parts:

   a. Furnish one set of manufacturer's recommended spare parts.

2. Tools:

   a. Furnish special wrenches and other devices required for Owner to maintain equipment.

   b. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.6 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required and shown in the Drawings.

B. Operation:

1. Open by turning counterclockwise; close by turning clockwise.

2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

C. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.

D. Connecting Nuts and Bolts: Stainless steel.

2.3 RESILENT-SEATED GATE VALVES

A. As specified in Section 40 05 23.15, Gate Valves.

2.4 RUBBER-SEATED BUTTERFLY VALVES

A. As specified in Section 40 05 23.18, Butterfly Valves.

2.5 VALVE ACTUATORS

A. All valves shall be furnished with manual actuators, unless otherwise indicated in the Drawings.

B. Valves in sizes up to and including four inches in diameter shall have direct acting lever or handwheel actuators of the manufacturer’s best standard design.

C. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

D. Provide actuators with position indicators for shutoff valves 6 inches and larger.

E. Comply with AWWA C541 and C542, where applicable.

F. Furnish gear operators for valves 8 inches and larger, and chainwheel operators for valves mounted over 7 feet above floor.

G. Provide gear and power actuators with position indicators.

H. Gear-Assisted Manual Actuators:

1. Provide totally enclosed gears.
2. Maximum Operating Force: 60 lbf.
3. Bearings: Permanently lubricated bronze.
4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

I. Handwheel:

1. Furnish permanently attached handwheel for emergency manual operation.
2. Rotation: None during powered operation.
3. Permanently affix directional arrow and cast OPEN or CLOSE on handwheel to indicate appropriate direction to turn handwheel.
4. Maximum Operating Force: 60 lbf.

J. Electric Motor Actuators

1. General

   a. All electric motor actuators shall be non-intrusive, intelligent quarter-turn type, suitable for use on a nominal 120 VAC, single phase, 60 Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.

   b. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.

   c. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without opening or removing any electrical compartment covers.

   d. Diagnostic information shall be available from both an integrally mounted display window and through non-intrusive means of reading and writing data to the actuator.

   e. Two-way communication must be possible to facilitate downloading actuator setup.

f. During loss of electric power supply, fail in valve open position. Actuator shall have an onboard battery for failsafe operation of the valve failing in the open position.

g. Operate from Full Closed to Full Open position or the reverse so that stem travel speed is 1 foot per minute.

2. Actuator Sizing

a. The electronic actuators shall be sized to operate the valve from full open to full close with an 150 psi max line pressure with the actuator torque output being sized for 1.5 times this pressure.

b. All actuators shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.

3. Temperature

a. The actuator shall be capable of functioning in an ambient temperature ranging from minus 13 F (-25° C) to plus 160° F (+ 70° C).

4. Torque Controller

a. The motor control PCB shall monitor and control the amount of torque output produced by the motor. Motor current shall be measured via a sensing resistor mounted on the PCB, which is digitally filtered and then temperature compensated to produce the final calibrated output torque of the actuator. Torque setting shall be able to be set between 40% and 100% of rated torque and shall be adjustable via a non-intrusive setting tool using Infrared Data Access (IrDA) technology.

5. Motor

a. Motors shall be sized for a minimum 25 percent duty and a rated running torque equal to 35 percent of the operator capacity at a rated running time of 15 minutes, without exceeding the allowable NEMA temperature rise for class F insulation.

b. Motors shall be totally-enclosed, non-ventilated motor with squirrel cage.

c. The electric motor shall be a low inertia motor. The motor shall be controlled by a toroidal transformer unit, which shall also include a thermostat for motor circuit protection. Motors shall be specifically designed and built by the actuator manufactured for electric actuator service.

d. If three phase-powered actuators are provided, the actuator shall include automatic detection and correction of 3-phase power supply to assure proper open/close directions.

e. The motor control PCB shall restrict the amount of current to prevent damage to the motor, integral switching devices or toroid transformer. A 20A fuse in the transformer secondary circuit and anti-surge fuse in the primary circuit shall provide further protection.

f. Motor removal shall be possible without loss of lubricant.

6. Gearing and Gearbox

a. The actuator gearing shall be totally enclosed in a lubricant filled gearcase suitable for operation at any angle. Food grade lubricants approved by the manufacturer shall be used to lubricate the gearcase. Special or exotic lubricants shall not be used as they may be expensive or difficult to source in some locations.

b. Gearbox shall house and operate an appropriate coupling as follows:

1) Coupling of operator to a multi-turn threaded rising stem valve shall be by means of threaded high tensile bronze top entry stem nut installed in a declutchable thrust base. Stem nut shall be keyed to mate with the internal bore and keyway of the operator sleeve.

2) Coupling of operator to a multi-turn non-rising stem shaft shall be by a high-tensile aluminum/bonze drive bushing that is easily replaceable.

c. Final stage of the operator gear train shall consist of a steel worm and a bronze alloy worm gear. Other gears shall be heated treated alloy steel or high tensile bronze. Gear train shall be supported throughout by antifriction ball or roller bearings. The operator shall be self-locking in either motor or handwheel mode.

7. Hand Operation

a. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor. The handwheel declutch mechanism shall include an output contact to indicate actuator manual operation. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.

b. Handwheel shall be disengaged by motor operation.

c. Actuator shall incorporate a mechanism to track valve position while operated with the handwheel when electric power is off.

8. Position Setting Range

a. An intelligent micro controller on the motor PCB shall monitor and control two Hall Effect position sensors. Incremental encoders requiring batteries to retain settings upon loss of power shall not be accepted. The sensors shall employ a magnetic pulse system to measure the accuracy of the actuator's stroke. Position limits shall be factory set to 90° degrees stop bolt position, with a limit setting range of 10° to 1800°, and maximum angular resolution to 0.1°.

9. Controls

a. Control power shall be provided from an integral 24 VDC or 120 VAC supply unless a separate power source is shown on the electrical drawings. The transformer shall be sized to operate at not more than 80 percent of rating with the connected load shown. The transformer shall have protective secondary fusing. Operators shall be provided with a control station; refer to drawings for integral or remote type. The control station shall include "LOCAL/OFF/REMOTE" and "OPEN/STOP/CLOSE" switches. Open and Close positions shall be configurable for momentary or maintained-operation. Open, Close, and Stop.

b. All external communication signals are 24 VDC. The following signals need to be provided unless explicitly not shown in contract drawings:

1) Status:

a) REMOTE

(1) OPENED
(2) CLOSED

b) Control:

(1) OPEN
(2) CLOSE

c. Connections for external remote controls shall be suitable for any one or more of the following methods of control:

1) Open and Close

2) Overriding Emergency, Shutdown to Close (or Open) Valve from a "Make" Contact

3) Two-Wire Control, Energize to Close (or Open), De-Energize to Open (or Close)

10. Set Up, Monitoring and Diagnostics

a. Facilities shall be provided for monitoring actuator operation and availability as follows:

1) Monitor (availability) relay, having one change-over contact, the relay being energized from the control transformer only when the Local/Off/Remote selector is in the "Remote" position and thermostat is not “tripped” to indicate that the actuator is available for remote (control room) operation.

2) Where required, it shall be possible to provide indication of thermostat trip and "Remote" selected as discrete signals.

3) A non-intrusive hand-held computer must be available, capable of two-way communication for uploading and downloading all variables for the actuator as well as performing detailed diagnostics.

4) Actuators shall include a diagnostic data logger module, which will store and enable download of historical actuator data logger information to permit analysis of changes in actuator or valve performance. It shall be possible for customer to access data via non-intrusive infrared means using either a notebook PC or hand-held windows CE based ‘Personal Digital Assistant (PDA)’ capable of duplex IrDA communications. Appropriate diagnostic software shall be provided to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured.

5) Provision shall be made to display valve torque demand as a percent of rated actuator torque and position simultaneously, so as to facilitate valve troubleshooting and diagnostics. The data logger shall also enable the retrieval of all configurable actuator date and time-stamped events, including the ability to search for occurrences of any particular event. Valve torque profiles shall be available in 1° positional increments. The diagnostics shall also enable retrieval of at least three types of alarms – actuator alarms, valve alarms and control system alarms.

6) A Setting Tool shall be provided and used for non-intrusive calibration and interrogation of the actuator. This Setting Tool will provide speedy interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing. The Setting Tool shall enable the user to extract and store actuator configuration and data logger files within the Tool. The Setting Tool shall store up to ten (10) configuration and four (4) data logger files. Stored configuration and data logger files shall also be able to be

uploaded to both the actuators and to diagnostic software provided by the actuator manufacturer.

11. Enclosure

    a. Double-sealed ‘O’ Ring design shall provide a termination chamber that is separate and sealed from the control chamber. Control components shall remain sealed and protected when the termination cover is removed. Actuators shall be sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof 'O' ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.

    b. Enclosure must allow for temporary site storage without the need for electrical supply connection.

    c. All external fasteners shall be stainless steel.

        1) Actuators for explosion/hazardous applications shall in addition be certified flameproof for Zones 1 and 2 (Divisions 1 and 2) Group C, D, E, F, G hazardous areas.

        2) Double-sealed design shall provide a termination chamber that is separate and sealed from the control chamber. Control components shall remain sealed and protected when the termination cover is removed.

12. Remote Valve Position

    a. In the event of a (main) power (supply) loss or failure, the position contacts must continue to be able to supply remote position feedback and maintain interlock capabilities.

    b. A backup power source must be provided in the actuator to ensure correct remote indication should the actuator be moved manually when the power supply is interrupted.

    c. The position of the actuator and valve must be updated contemporaneously, even when the power supply is not present.

    d. Four contacts shall be provided which can be selected to indicate any position of the valve with each contact selectable as normally open or normally closed. The contacts shall be rated at 5A, 250V AC, 30V DC.

e. As an alternative to providing valve position, any of the four above contacts shall be selectable to signal one of the following:

1) Valve Opening or Closing
2) Valve Moving (Continuous or Pulsing)
3) Motor Tripped on Torque in Mid-Travel
4) Motor Stalled
5) Actuator Being Operated by Handwheel
6) Open or Close Interlock Active
7) ESD Active
8) Motor Tripped on Torque in Mid-Travel
9) Motor Tripped on Torque Going Open
10) Motor Tripped on Torque Going Closed
11) Pre-Set Torque Exceeded
12) Valve Jammed
13) Actuator Being Operated by Handwheel
14) Lost Main Power Phase
15) Customer 24V DC or 24V AC Supply Lost
16) Battery Low
17) Internal Failure Detected
18) Thermostat Tripped

13. Local Position Indication

a. The actuator must provide a local display of the position of the valve, even when the power supply is not present. The display shall be able to be rotated in 90 degree increments in order to provide easy viewing regardless of actuator mounting position.

b. The local display should be large enough to be readable from a distance of six feet (6') when the actuator is powered up. In addition to valve position, the local display shall also display torque in percent of rated value as well as customer-configurable multilingual text.

c. The actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.

14. Integral Push Button And Selector

    a. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector switch padlockable in any one of the following three positions:

        1) Local Control Only
        2) Off (No Electrical Operation)
        3) Remote Control plus Local Stop Only

    b. It shall be possible to select maintained or non-maintained local control.

    c. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator. It shall be possible to program the actuator without removal of any covers.

15. Actuator Networking

    a. Provisions shall be made for connectivity with field bus control systems via a plug-in card. The following interfaces shall be available:

        1) Modbus

16. Special Features

    a. An LCD indicator panel shall provide continuous position and torque information as well as valve status, alarm, and diagnostic information.

    b. Actuators shall include a diagnostic data logger module, which will store and enable download of historical actuator data logger information to permit analysis of changes in actuator or valve performance. It shall be possible for customer to setup, calibrate and access actuator data via non-intrusive infrared means using any of three methods: Setting Tool, Laptop PC or hand-held Windows CE-based 'Personal Digital Assistant (PDA)' capable of duplex IrDA communications. Appropriate diagnostic software shall be provided by the actuator manufacturer to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured. One hand-held programming setting tool shall be provided for every 10 actuators shipped. Data download shall be carried out without removing any actuator covers.

    c. Actuator calibration, setup, and communications settings shall be stored in non-volatile memory and shall be retained in the event of loss of power. In addition, battery power shall ensure that local indication of valve position is provided under power-failure conditions.

d. Non-intrusive local control switches shall communicate switch position to the microprocessor without penetrations in the actuator housing.

e. Actuator’s microprocessor shall continuously accept control signals (when in Remote) and communicate position, torque, status, alarm, and diagnostic data to the plant process control system via a data network connection.

17. Performance Test Certificate

a. Each actuator must be performance tested and individual test certificates shall be supplied free-of-charge. The test equipment should simulate a typical valve load and the following parameters should be recorded:

1) Current at maximum torque setting

2) Torque sensing tripping points in both the open and closed directions of travel

3) Actuator Output Speed or Operating Time

b. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

18. Warranty

a. Each actuator shall be warranted for a minimum of 12 months of operation up to a maximum of 24 months from shipment. This warranty shall be held in effect regardless of pre-commissioning conditions in a typical indoor or outdoor environment as long as the actuator is not abused or disassembled. This warranty shall not require the use of special storage procedures (such as the use of indoor storage, plastic bags, desiccants, and the energization of heater(s) in order to be maintained.

19. Manufacturers, or equal

a. Rotork IQ Series
b. AUMA
c. Or Approved Equal

2.6 SOURCE QUALITY CONTROL

A. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

3.2 PREPARATION

A. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.

B. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 INSTALLATION

A. Install valves, actuators, extensions, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Clean field welds of slag and splatter to provide a smooth surface.

E. Install valves with stems upright or horizontal, not inverted.

F. Install valves with clearance for installation of insulation and allowing access.

G. Provide access where valves and fittings are not accessible.

H. Comply with Division 40 - Process Integration for piping materials applying to various system types.

I. Valve Applications:

1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

2. Install shutoff and isolation valves.

3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.

4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.

J. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

3.4 FIELD QUALITY CONTROL

A. Valve Field Testing:

1. Test for proper alignment.

2. If specified by valve Section, field test equipment to demonstrate operation without undue leakage, noise, vibration, or overheating.

3. Owner’s Representative shall witness all field testing.

END OF SECTION

SECTION 40 05 23.15

GATE VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes gate valves for use in buried service, pump stations, and utility vaults. Coordinate with Section 33 12 16, Water Utility Distribution & Transmission Valves & Section 40 05 23, Common Work Results for Process Valves.

B. Section Includes:

1. Resilient-seated gate valves.

1.2 RELATED SECTIONS

A. Section 33 12 16, Water Utility Distribution & Transmission Valves.
B. Section 33 11 10, Water Utility Distribution & Transmission Piping.
C. Section 40 05 13, Common Work Results for Process Piping.
D. Section 40 05 23, Common Work Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Owner's Representatives:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association:

1. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.

D. National Sanitation Foundation International:

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. As required by Section 33 12 16 - Water Utility Distribution & Transmission Valves and Section 40 05 23, Common Work Results for Process Valves.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT-SEATED GATE VALVES

A. Description:

1. Comply with AWWA C509.

2. Minimum Pressure Rating:

   a. 12-inch Diameter and Smaller: 200 psig.
   b. 16-inch Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

   a. Standard mechanical joint ends comply with ANSI/AWWA C111.

b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125. Comply with AWWA C115 & ASME 16.5.

   1) The Contractor shall coordinate with pipe, valve and fitting suppliers to make certain pipe, valve and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C509 for manual valves.

5. Linings and Coatings:

   a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

   b. All internal and external ferrous surfaces.

   c. Do not coat flange faces of valves.

6. Bi-directional flow.

B. Operation:

1. Non-rising stem.

2. Open counterclockwise when viewing the valve from above, unless otherwise indicated in the Drawings.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators, unless otherwise specified in Section 40 05 23, Common Work Results for Process Valves.

C. Materials:

1. Wedge:

   a. ASTM A126, cast iron or ASTM A536, ductile iron.
   b. Fully encapsulated with molded rubber.

2. Body and Bonnet:

   a. ASTM A126, cast iron or ASTM A536, ductile iron.

3. Stem, Stem Nuts, Glands, and Bushings: ASTM B584, bronze.

4. Valve Body Bolting: Stainless steel.

D. Manufacturers:

1. Clow Valve Company.
2. M&H Valve.
3. U.S. Pipe.
4. American Flow Control.
5. Mueller Company.

2.3 SOURCE QUALITY CONTROL

A. Testing: Test gate valves according to AWWA C509.

PART 3 EXECUTION

3.1 INSTALLATION

A. As required by Section 33 12 16, Water Utility Distribution & Transmission Valves, and Section 40 05 23, Common Work Results for Process Valves.

B. Install according to manufacturer's instructions.

C. Support valves in plastic piping to prevent undue stresses on piping.

END OF SECTION

SECTION 40 05 23.18

BUTTERFLY VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes butterfly valves for use in buried service, pump stations, and utility vaults. Coordinate with Section 33 12 16, Water Utility Distribution & Transmission Valves & Section 40 05 23, Common Work Results for Process Valves.

B. Section Includes:

1. Rubber-seated butterfly valves.

1.2 RELATED SECTIONS

A. Section 33 12 16, Water Utility Distribution & Transmission Valves.
B. Section 33 11 10, Water Utility Distribution & Transmission Piping.
C. Section 40 05 13, Common Work Results for Process Piping.
D. Section 40 05 23, Common Work Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Owner's Representatives:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

B. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

4. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).

2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.

D. National Sanitation Foundation International:

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. As required by Section 33 12 16, Water Utility Distribution & Transmission Valves and Section 40 05 23, Common Work Results for Process Valves.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RUBBER-SEATED BUTTERFLY VALVES

A. Description:

1. Comply with AWWA C504, Class 150B and 250B as indicated in the Drawings.

2. Minimum Pressure Rating:

a. 12-inch Diameter and Smaller: 200 psig.
b. 16-inch Diameter and Larger: 2000 psig.

3. End Connections: As shown in the Drawings.

a. Standard mechanical joint ends comply with ANSI/AWWA C111.

b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1 and AWWA C110, class 125, unless shown otherwise. Comply with AWWA C115 & ASME 16.5.

1) The Contractor shall coordinate with pipe, valve and fitting suppliers to make certain pipe, valve and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C504 for manual valves.

5. Linings and Coatings:

a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

b. All internal and external ferrous surfaces.

c. Do not coat flange faces of valves.

6. Bubble-tight at the rated pressure for bi-directional flow.

7. Style: Wafer.

8. Shaft: Self-lubricating, sleeve-type bearings. One-piece, through-shaft construction.

a. Valve shafts shall be full size for that portion of the shaft extending through the valve bearings, valve disc and shaft seal.

b. Any portion of the shaft turned down for any reason shall have fillets with radii equal to the offset to minimize stress concentrations at the junction of the different shaft diameters. The turned down portion of the shaft shall be capable of transmitting the maximum operator torque without exceeding a torsional steel stress of 11,500 psi.

9. Seats: Mounted on body for valves 24 inches and smaller; field replaceable (mechanically retained in a machined groove) for valves larger than 24 inches.

10. Packing: Replaceable without dismantling valve.

B. Operation:

1. Open counterclockwise, unless otherwise indicated in the Drawings.

2. Operators shall be of the traveling nut, self- locking type and shall be designed to hold the valve in any intermediate position between full open and fully closed without creeping or fluttering.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. Valves for exposed service shall be furnished with an operator as specified on the valve schedule, unless otherwise specified in Section 40 05 23, Common Work Results for Process Valves.

C. Materials:

1. Body: ASTM A126, cast iron or ASTM A536, ductile iron. Integrally cast flanged or mechanical end joints.

2. Shaft: Stainless steel.

3. Disc: ASTM A126, cast iron or ASTM A536, ductile iron.

4. Seats: Resilient, replaceable, Buna-N.

5. Seating Surfaces: Type 316 stainless steel.

6. Bearings:

   a. Sleeve: Corrosion-resistant and self-lubricating.

D. Manufacturers:

1. M&H Valve.
2. Henry Pratt Company.
3. Mueller Company.
4. Kennedy Valve Company.
5. Dezurik.
6. Val-Matic Valve & Manufacturing Corporation.

2.3 SOURCE QUALITY CONTROL

A. Testing: Test butterfly valves according to AWWA C504.

PART 3 EXECUTION

3.1 INSTALLATION

A. As required by Section 33 12 16, Water Utility Distribution & Transmission Valves and Section 40 05 23 - Common Work Results for Process Valves.

B. Install according to manufacturer's instructions.

END OF SECTION

SECTION 40 05 23.24

CHECK VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Work in this Section includes check valves for use in water and wastewater facilities. Work includes the furnish and install of all swing and silent check valves, complete, as shown on the Drawings and specified herein, including coating and lining, appurtenances, operators, and accessories.

B. Section includes:

1. Swing check valves, 1-inch through 4-inch diameter.
2. Swing check valves, 4-inch diameter and larger
3. Silent check valves.

1.2 RELATED SECTIONS:

A. Section 40 05 23 - Common Work Results for Process Valves

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Owner's Representatives:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings.

B. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.
5. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

6. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

7. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.

8. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

C. American Water Works Association:

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

D. National Sanitation Foundation International:

1. NSF 61 - Drinking Water System Components - Health Effects.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. As required by Section 40 05 23, Common Work Results for Process Valves.

PART 2 PRODUCTS

2.1 SWING CHECK VALVES, 1-INCH THROUGH 4-INCH DIAMETER

A. Description:

1. Horizontal T-pattern style.
2. 200# WOG.
3. Capable of functioning in the vertical position.
4. Connections shall be standard threaded or threaded for fire hose connections where shown on plans

B. Materials:

1. Body Cap and Disc: Brass conforming to ASTM B584 C85400.

C. Manufacturer:

1. Figure 246 as manufactured by Red White Valve.

2.2 SWING CHECK VALVES, 4-INCH DIAMETER AND LARGER

A. Description:

1. Meeting requirements of AWWA C508.
2. Type: Swing, resilient-seated, with outside lever and adjustable spring.
3. Flow Area: Full open.
4. Mounting: Horizontal or vertical.
5. Shall close tightly when the pressure downstream of the valve disc exceeds the upstream pressure.
6. Working Pressure: 150 psi or 250 psi as indicated on the Drawings.
7. Tight sealing, shockless in operation and absolutely prevent the return of water back through the valve.
8. The disc shall be attached to the sic arm by means of a center pin, disc nut and washer providing 360-degree angular articulation but not rotation.
9. Pin Shaft:
    a. Discs shall be suspended from a non-corrosive hinge pin shaft that shall rotate freely without the need for external lubrication.
    b. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing.
10. End Connections: As shown on Drawings. End connections shall be rated to the working pressure requirements specified above.

B. Materials:

1. Body and Disc: Constructed of heavy cast iron conforming to ASTM A126 class B, or ductile iron conforming to ASTM A536.
2. Cover: Steel conforming to ASTM A36 or Ductile iron conforming to ASTM A536.
3. Disc Arm: Ductile iron conforming to ASTM A536.
4. Body Seat: Type 316 stainless steel or Bronze ASTM B62.
5. Disc Seat: Field-replaceable, NBR or Buna-N.

6. Hinge Pin and Key: Stainless steel.

7. Rubber Components: NBR or Buna-N.

8. Connecting Hardware: Stainless steel.

C. Finishes:

1. Epoxy lining and coating conforming to AWWA C210.

2. For potable water service, epoxy lining and coating shall meet be provided with NSF 61 certification.

D. Manufacturer:

1. GA Industries, Figure No. 220-D.
2. Cla-Val, 585 Series.
3. Approved equal.

2.3 SILENT CHECK VALVES

A. Description:

1. Type: Globe-style, silent operating type that begins to close as the forward velocity diminishes and be fully closed at zero velocity, preventing flow reversal and resultant water hammer or shock.

2. Valve design shall incorporate a center-guided, spring-loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe.

3. Valve Interior: Contoured and unrestricted to achieve maximum flow capacity along with minimum pressure drop.

4. Installation: Operation of the valve shall not be affected by the position of installation. It shall be capable of operating in the horizontal or vertical position with the flow op or down.

5. Valve Disc: Concave to the flow direction providing for disc stabilization, maximum strength and minimal flow velocity to fully open the valve.

6. All component parts shall be field replaceable without the need of special tools.

7. A replaceable guide bushing shall be provided and held in position by the valve's spring.

8. Spring: Designed to withstand 100,000 cycles without failure and exert a force which allows the valve to start opening at a differential pressure of .5 PSI (.04 KG/CM2) and to fully open at a flow velocity of 4 FPS (1.22 meters per second).

9. The valve disc and seat shall be field replaceable and have a seating surface finish of 32 micro-inch or better to insure positive seating at all pressures.

10. Valve shall be hydrostatically tested at 1.5 times the rated working pressure.

11. Working Pressure: or 250 psi or as indicated on Drawings.

12. End Connections: As shown on Drawings. End connections shall be rated to the working pressure requirements specified above.

B. Materials:

1. Body: ASTM A536, ductile iron.
2. Trim: Stainless steel.
3. Spring: Stainless steel.
4. Resilient Seat: Buna-N

C. Finishes:

1. Epoxy lining and coating conforming to AWWA C210.

2. For potable water service, epoxy lining and coating shall meet be provided with NSF 61 certification.

D. Manufacturer:

1. Val-Matic.
2. Cla-Val,
3. Dezuirk
4. Approved equal.

2.4 SOURCE QUALITY CONTROL

A. Testing:

1. Hydrostatically test check valves at twice rated pressure, in conformance with requirements of AWWA C508.

2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install check valves according to AWWA C508, Section 40 05 23 Common Work Results for Process Valve, and as recommended by manufacturer.

3.2 SERVICES PROVIDED BY MANUFACTURER’S REPRESENTATIVES

A. Provide the services of the valve manufacturer's representative to verify proper installation of the valves and to adjust the valves when construction is complete.

END OF SECTION

SECTION 40 05 23.72

MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes miscellaneous valves not included in other Sections for use in buried service, pump stations, and utility vaults.

B. Section Includes:

1. Air release valves.
2. Combination air/vacuum valves.
3. Blow-off hydrant assemblies.
4. Flap valves.
5. Ball valves, 2 inches and under.
6. Pressure relief and surge anticipator valve.

1.2 RELATED SECTION

A. Section 05 50 00, Metal Fabrications.
B. Section 09 90 00, Painting and Coating.
C. Section 33 11 10, Water Utility Distribution & Transmission Piping.
D. Section 40 05 13, Common Work Results for Process Piping.
E. Section 40 05 23, Common Work Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.

4. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

5. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

1.4 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling Schedule: Indicate valve locations and nametag text.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and actuators.
B. Operation and Maintenance Data: Submit information for valves.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

B. Tools:

1. Furnish special wrenches and other devices required for Owner to maintain equipment.
2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.8 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Owner’s Representative.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.
2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 AIR RELEASE VALVES

A. Description:

1. Inlet Size: 2-inch diameter and smaller.
2. Cast-iron body & cover. Comply with ASTM A126, Class B.
3. Stainless steel orifice and float. Comply with ASTM A240.
4. Design test pressure: 450 psig.

B. Manufacturers:

1. DeZurik - APCO Series 200A or approved equal.

2.3 COMBINATION AIR/VACUUM VALVES

A. Description:

1. Construction: Two independent valves: (1) air/vacuum valve, (1) air release valve.

2. Inlet Size: Greater than 2-inch diameter.
3. Cast iron body & cover. Comply with ASTM A126, Class B.
4. Stainless steel orifice and float. Comply with ASTM A240.
5. Valves seats: Buna-N.

B. Manufacturers:

1. DeZurik - APCO Series 1700 or approved equal.

2.4 BLOW-OFF HYDRANT ASSEMBLIES

A. Description:

1. Material: 100% low-lead brass.

2. Inlet: 2-inch diameter FIP vertical straight inlet.

3. Outlet: 2-inch diameter MIP.

4. Operation:

    a. By turning a top-mounted square operating nut.
    b. Operation must seal drain outlet in all positions from 1/4-open to fully open.

5. Hydrant shall be non-freezing, self-draining.

6. Accessories: Provide Owner with (1) operating wrench.

B. Manufacturers:

1. Kupferle – Truflo #TF500 or approved equal.

2.5 FLAP VALVES

A. Description:

1. Material: ASTM A126, cast iron.
2. Seat and hinge pin: Bronze.
3. End connection: 125-pound flange, unless otherwise noted on the Drawings.
4. Two pivot points.
5. Valves 14-inches and smaller shall have the hinge pin secured with cotter pins.
6. Valves 16-inches and larger shall have the hinge pin secured with nuts.

B. Manufacturers:

1. M & H, Style 47 or approved equal.

2.6 BALL VALVES, 2 INCHES AND UNDER

A. Description:

1. 400 lb. WOG with bronze body and trim, unless otherwise shown on the Drawings.
2. Seat ring: TFE.
3. O-ring seals: Fluorocarbon.
4. Three-piece construction so that maintenance can be performed without distributing the valve body after installation.

B. Manufacturer:

1. Nibco, T-590-Y or equal.

2.7 SOURCE QUALITY CONTROL

A. Testing Pressure-Reducing and Pressure-Sustaining Valves:

1. Leakage Testing:

   a. Test each assembled valve hydrostatically at 1-1/2 times rated working pressure for minimum five minutes.

   b. Test each valve for leakage at rated working pressure against closed valve.

   c. Permitted Leakage: None.

2. Functional Testing:

   a. Test each valve to verify specified performance.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves per manufacturer requirements and recommendations.

B. Install all valves with valve seats level.

C. Install protective strainers upstream of solenoid valves, pressure-reducing valves, and pressure-sustaining valves.

END OF SECTION

SECTION 40 05 23.74

PRESSURE RELIEF AND SURGE ANTICIPATOR VALVES

PART 1 GENERAL

1.1 DESCRIPTION

A. The Pressure Relief / Surge Anticipator Control Valve shall control high pressures and power failure surges by bypassing system pressure that exceeds the high-pressure control setting and also by opening a preset amount when sensed pressure decreases below a preset minimum in anticipation of a surge.

1. System Pressure ranged from 120 to 150 psi.

2. Valve has a back pressure of 15 psi.

1.2 SUBMITTALS

A. The following information shall be provided:

1. Control Valve manufacturer’s technical product data.

2. Control Valve manufacturer’s Installation, Operation and Maintenance manual (IOM).

3. Provide specific information on all optional features specified above and confirm that these items are provided

PART 2 PRODUCTS

2.1 GENERAL

A. Main Valve:

1. The main valve shall be hydraulically operated, single diaphragm actuated, globe or angle pattern. The valve shall consist of three major components; the body with seat installed, the cover with bearing installed and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from line pressure. Packing glands, stuffing boxes and/or rolling diaphragm technology will not be permitted and there shall be no pistons operating the main valve or pilot controls. No fabrication or welding shall be used in the manufacturing process. Y-pattern valves shall not be permitted. Main valve shall comply with NSF/ANSI

Standard 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component. Main Valve Body:

a. Material Specification Main Valve as follows:
b. Body & Cover Ductile Iron-ASTM A536
c. Main Valve Trim Stainless Steel
d. Disc Retainer Cast Iron
e. Diaphragm Washer Cast Iron
f. Seat Stainless Steel
g. Stem, Nut and Spring Stainless Steel
h. Seal Disc Buna-N® Rubber
i. Diaphragm Nylon Reinforced Buna-N® Rubber
j. Internal Trim Parts Stainless Steel:
k. Pressure Rating Class 150 lb. (250psi Max.)
l. Any other wetted metallic parts Stainless Steel
m. Coating Fusion Bonded Epoxy Coating (Interior and Exterior); ANSI / NSF 61 Approved / AWWA coating specifications C116-03.

2. No separate chamber(s) below the diaphragm shall be allowed between the main valve cover and body. No fabrication or welding shall be used in the manufacturing process.

3. The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the discs firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hours-glass shaped disc retainers shall be permitted and no V-type or slotted-type disc guides shall be used.

4. The diaphragm assembly containing a non-magnetic stainless steel stem; of sufficient diameter to withstand high hydraulic pressures and shall be fully guided at both ends by a bearing in the main valve cover and an integral bearing in the valve seat. The valve seat shall be a solid, one-piece design and shall have a minimum five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from the line pressure. No bolts or cap screws shall be permitted for use in the construction of the diaphragm assembly

5. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm's center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 X per layer of nylon fabric and shall be cycled tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

6. The main valve seat and stem bearing in the valve cover shall be removable. The cover bearing and seat in the 6" and smaller size valve shall be threaded into the cover and body. The valve seat in the 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc guide and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. The valve shall be designed such that both the cover assembly and internal diaphragm assembly can be disassembled and lifted vertically straight up from the top of a narrow opening/vault. Y-pattern valves shall not be permitted. The seat shall be of the solid one piece design. Two piece seats or seat inserts shall not be permitted. Packing glands and/or stuffing boxes shall not be permitted.

B. Pilot Control System:

1. Pressure Relief and Surge Anticipator Valve

   a. High Pressure Surge Relief Pilot: The pressure relief/sustaining pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. The pressure relief pilot control is normally held closed by the force of the compression in the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. Pressure relief pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

   b. Low Pressure Pilot: The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to open when the sensed pressure falls below the control setting and close when pressures are normal. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall include a fixed orifice. The pilot control shall have a second downstream sensing port which can be utilized to install a pressure gauge. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

c. Flow Limiter: The pilot system shall contain an adjustable flow limiter to limit main valve travel during low pressure opening without affecting high pressure relief valve travel. This unique hydraulically operated flow limiter has two calibrated orifices, each positioned proportional to valve position, to vary main valve cover control chamber operating pressure. The hydraulically operated flow limiter regulates flow through main valve pilot systems based on valve position to prevent main valve exceeding predetermined flow. A manually adjustable orifice provides reference valve position. Valve position is linked to an integral sensor orifice. When valve position is below reference set-point of the hydraulically operated flow limiter, it allows unhindered pilot system flow. As valve position rises and approaches the reference control setting, the hydraulic flow limiter limits pilot system outward flow to build pressure in the main valve control chamber. Pressure continues to build until flow equals and hydraulically locks the valve at the flow limiters valve position set-point. Mechanical flow limiters shall not be permitted.

d. The pilot controls shall be hard piped, or bracket mounted to the main valve.

e. The pilot control system shall include a strainer, an adjustable closing speed and all required control accessories, equipment, control tubing and fittings. The pilot system shall include isolation ball valves on sizes as standard equipment. A full range of spring settings shall be available in ranges of 0 to 400 psi. Pilots to be manufactured by control valve manufacturer.

f. The Pressure Relief / Surge Anticipating Control Valve shall include a visual position indicator assembly on all sizes, as standard equipment.

2. Pressure Relief Valve (Well Pump to Waste)

a. The pressure relief pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. The pressure relief pilot control is normally held closed by the force of the compression in the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. Pressure relief pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

b. The pilot control system shall include a strainer, a fixed orifice closing speed and all required control accessories, equipment, control tubing and fittings. No variable orifices shall be permitted. The pilot system shall include an opening speed control on all valves sizes 3” and smaller as standard equipment. The pilot system shall include isolation ball valves on sizes 4” and larger as standard equipment. A full range of spring settings shall be available in ranges of 0 to 400 psi. Pilots to be manufactured by control valve manufacturer.

C. Ancillary Equipment

1. Each valve shall include an electric limit switch assembly to indicate that the valve is opening.

   a. A stainless steel actuating stem with a swivel adapter fastened directly to the main valve stem moves through an adapter and gland with two O-Ring seals allowing the stop collar to actuate the micro switch bracket mounted on the exterior of the adapter which is attached to the cover of the main valve.

   b. The single pole, double-throw micro switch can be connected either to open or to close the circuit when actuated. It is easily adjusted to operate at any point of the valve’s travel simply by loosening the Allen screw and raising or lowering the collar on the actuating stem. The electrical switch shall be in weatherproof enclosure (NEMA rated).

D. Factory Assembly:

1. Each control valve shall be factory assembled.

2. The Quality Management System of the factory shall be certified in accordance with ISO 9001: 2008.

3. For all control valves, the factory assembly shall include the complete main valve, pilot valve(s), and all associated accessories and control equipment.

4. During factory assembly the control valve manufacture shall make all necessary adjustments and correct any defects.

E. Nameplates:

1. Each Control Valve and associated pilot(s) shall be provided with an identifying nameplate.

2. Nameplates, depending on type and size of control valve, shall be mounted in the most practical position possible, typically on the inlet side of the valve body.

3. Nameplates shall be brass and a minimum of 3/32” thick, ¾” high and 2-3/4” long.

4. Pertinent control valve data shall be etched or stamped into the nameplate. Data shall include control valve Catalog number, function, size, material, pressure rating, end-connection details, type of pilot controls used and control adjustment range.

F. Factory Testing:

1. Each control valve shall be factory tested.

2. Tests shall conform to approved test procedures.

3. Shell Test: Control valves and pilot valves in the partially open position with both ends closed off with blind flanges (valves) and pipe plugs (pilots) shall be subject to a hydrostatic test. The applied pressure shall be 200 psi minimum. The pressure shall be applied for a minimum of 15 minutes. No visible leakage is permitted through the pressure boundary walls of the valve or pilot body or valve cover or the body-cover joint.

4. Seat Test: Control valves and pilot valves shall be subjected to an air pressure seat test and held for a minimum of 15 minutes. Pressure Rating -- Valve shall be suitable for a working water pressure of 250 psig.

G. Manufacturer

1. Cla-Val Co., Pressure Relief and Surge Anticipator Valve 52-03KC w/X105LCW.

PART 3 EXECUTION

3.1 GENERAL

Valve installation shall be in accordance with manufacturer's requirements.

3.2 SERVICES PROVIDED BY MANUFACTURER'S REPRESENTATIVES

The CONTRACTOR shall provide the services of the valve manufacturer's representative to verify proper installation of the valves and to adjust the valves when construction is complete.

END OF SECTION

SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.1 DESCRIPTION

A. This section specifies Contractor and Systems Integrator performance in testing and documentation of process instrumentation and control system materials and equipment.

B. The term instrumentation covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

C. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all testing with other sections:

1. Pre-Operational Performance Testing Sequence:

    a. Wiring Testing
    b. Installation Inspection
    c. Loop Testing

2. Functional Acceptance Testing (FAT) Sequence:

    a. Process Control Strategy Testing
    b. Control System Closed Loop Testing
    c. Functional Checkout

3. Operational Testing:

    a. System Acceptance Testing (SAT)

1.2 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents with additional references as specified.

    a. All references shall be to the current edition of the document unless specifically stated otherwise. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

b. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no bids). If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

c. Where document dates are given in the following listing, reference to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ISA S51.1	Process Instrumentation Terminology

B. Project Labeling:

1. The items specifying project labeling herein shall include the following as a minimum: Owner’s name, facility name, project name, and project number.

1.3 SUBMITTALS

A. Submittal material shall consist of the following:

1. Qualification Submittal:

a. Provide the following submittal documentation:

1) Example test forms per paragraph 3.1.D, Field Test Procedure Documentation, revised to show Project Labeling per paragraph 1.2.B, Project Labeling.

2) Example I/O interface summary.

2. Definition Submittal: Provide the following submittal after review of the Qualification Submittal.

a. Control descriptions.

b. I/O Interface Summaries.

c. Testing status spreadsheets.

d. Test procedures per paragraph 3.1.D, Field Test Procedure Documentation.

e. Proposed test forms per paragraph 3.1.D of this Section, detailed for each test for this project.

f. Certified Factory Calibration Reports.

g. Provide a copy of this specification and the referenced and applicable sections with addenda updates included with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

h. Provide a copy of all Addenda updates marked to indicate requested deviations from specified requirements.

i. Provide a copy of all referenced and applicable Instrumentation Drawings with addenda updates included, marked to indicate requested deviations from specified requirements.

j. Provide a copy of all referenced and applicable City of as-built Electrical Drawing's, Control Diagrams with any applicable addenda updates included, marked to indicate requested deviations from specified requirements.

k. Failure to include a copy of the specifications and proposed drawings with the submittal shall be cause for rejection of the entire submittal with no further consideration.

PART 2 PRODUCTS

2.1 PRODUCT DATA

A. Provide the following product data submittal after completion of testing as part of the Operations and Maintenance Submittal.

B. The following information shall be provided:

1. Completed test forms per paragraph 3.1.D.

2. List of factory calibrated items and calibration certificates.

3. Final Test Report assembled in a three-ring binder and submitted at the completion of the inspection and testing activities.

a. The binder cover and spine shall be labeled to identify the project name. Test report shall include the applicable test procedures and the completed inspection and test report forms associated with the equipment and systems.

b. Test results shall be organized by equipment item or system with individual, labeled tab dividers. System deficiencies and non-compliant test results identified in the final test report shall be acknowledged by the responsible testing entity as corrected.

PART 3 EXECUTION

3.1 GENERAL

A. General Requirements:

1. Materials, equipment, and construction included under this specification shall be inspected in accordance with this Section and subsequent Sections of this Division. Testing shall be performed by the Contractor in accordance with this and subsequent Sections.

2. No required test shall be applied without prior notice to the Owner. At least two weeks before the commencement of any testing activity, the Contractor shall provide a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

B. Technician Qualifications:

1. Field instruments and analyzers shall be calibrated and set up by a certified instrument technician qualified to calibrate the instrumentation.

2. Technicians shall be qualified by completion and certification from training courses in accordance with the requirements of paragraph 40 90 00 1.2C.

C. Field Test Procedure Submittal:

1. Test procedures submitted for approval within 30 days from the date of Notice to Proceed. Field Test Procedure Submittal may be included with the Definitions Submittal specified in paragraph 1.3A.2 above.

2. Test procedures for each analog and discrete loop in the process control system shall be organized and assembled a single volume. Final test records shall be submitted in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

3. Test procedure documentation shall include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

4. Test report forms for each loop, including forms for wiring, piping, and individual component tests, shall be included with the test procedure documentation. The actual test results shall be recorded on these forms and a final test report assembled and submitted for final approval.

5. Test report forms shall be preprinted and completed to the extent possible prior to commencing testing. Test report forms that document the field test procedures shall include the following information:

    a. Project name

    b. Equipment under test.

    c. Instrument loop description.

    d. Instrument loop identification number.

    e. Instrument nameplate data.

    f. Instrument setup and configuration parameters.

    g. Time and date of proposed test.

    h. Inspection checklist with results column.

    i. Reference to applicable test procedure.

    j. Expected and actual test results fields for each test point in the loop to include programmable controller data table or register values.

    k. Test equipment used.

    l. Space for remarks regarding test procedure or results, observations, etc.

    m. Name, date, and signature of testing personnel.

    n. Test witness' name and signature.

D. Performance Deviation Tolerances:

1. Tolerances shall be as specified. Where tolerances are not specified, refer to the manufacturer's published performance specifications.

2. Overall accuracy requirements for loops consisting of two or more components shall be the root-summation-square (RSS) of the component accuracy specifications. Tolerances for each required calibration point shall be calculated and recorded on the associated test report form.

E. Installed Tests:

1. Contractor shall test equipment, system performance and operations of the PLC Control systems. The Contractor's Quality Assurance Manager shall coordinate, manage, and supervise the quality assurance program that includes:

   a. Testing plan with the sequence for the test work.
   b. Documentation program that records tests results.
   c. Performance testing program systems.

F. Witnessing:

1. The Owner reserves the right to observe factory and field instrumentation testing and calibration procedures. The Owner shall be notified prior to testing, as specified herein.

3.2 PRE-OPERATIONAL PERFORMANCE TESTING

A. General Requirements:

1. In general, tests shall be performed in the following order:

B. Wiring Tests:

1. Electrical power and signal cable ring-out and resistance testing. Wiring tests shall not be conducted until cables have been properly terminated, tagged and inspected.

   a. Power and Control.
   b. Signal.

C. Loop Testing:

1. Each instrument loop shall be tested as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

2. Testing of loops with an interface to a programmable logic controller shall include verification of the programmable logic controller input/output assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the programmable logic controller memory to verify proper operation.

3. Verify data communications are functional between the PLCs, Remote I/O, Local HMI Panels and the SCADA Servers. Verify the operations of Tag Name values in SCADA/HMI match PLC register values.

4. If the output control or monitoring device fails to indicate properly, corrections to the loop circuitry or device shall be made. The test shall be repeated until devices and instruments operate as required.

5. Correct loop circuitry and repeat the test until the instruments operate properly.

3.3 FUNCTIONAL TESTING

A. Process Control Strategy/Functional Testing:

1. Control Strategy Testing shall not commence until the Loop Testing has been completed and documented to the satisfaction of the Owner.

2. Control Strategy Testing is performed by the Systems Integrator and consist of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Control Strategy Testing will be performed on one PLC chassis at a time.

3. Provide qualified personnel to immediately correct any deficiencies in the Work that may be encountered during Control Strategy Testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete Control Strategy Testing.

B. Control System Closed Loop Testing:

1. Closed-Loop Commissioning shall not commence until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the Owner.

2. Closed-loop commissioning tests, performed as part of the system tests, shall demonstrate stable operation of each loop under operating conditions. Tests shall include adjustment of loop tuning parameters.

3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.

4. The loop response to a step disturbance shall be provided for each loop. Two graphs shall be made for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.

5. Control loops with "batch" features shall be adjusted to provide optimum response following start-up from an integral action saturation condition.

6. SCADA Historical Trace printout shall be provided showing the response and made at sufficient speed and amplitude to show 1/4 amplitude damping. Label to show loop number and title, and settings of parameters and set point.

7. Where a loop is controlled under the direction of a programmable logic controller, the Contractor will perform the necessary adjustment of loop tuning parameters and setpoints; Contractor shall record the loop response, adjusting final elements, and assuring total integrated loop performance as specified.

C. Functional Checkout:

1. Conducted to verify the operation of discrete and hardwired control devices. Exercise the operable devices and energizing the control circuit. Operate control element, alarm device, and interlocks to verify the specified action occurs.

3.4 OPERATIONAL TESTING

A. System Acceptance Test (SAT) shall be performed after component and subsystem tests have been completed. The test of the completed system shall be performed in full operation, shall demonstrate that all functional requirements of this specification have been met and shall be at least 24 hours in length. Acceptance tests shall not be initiated or performed over scheduled City recognized holidays. SAT shall demonstrate the following:

1. Each component of the system operates correctly with all other components of the system.

2. Analog control loops operate in a stable manner.

3. Hard-wired and software equipment interlocks perform correctly.

4. Process control sequences perform correctly.

5. PLC application program performs monitoring and control functions correctly.

6. Operator interface graphics represent the monitoring and control functions correctly.

3.5 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.
3. Loop Status Report—Example Format.

END OF SECTION

UNIT PROCESS STARTUP FORM

AGENCY:________________________________ PROJECT:_______________________________

Unit Process Description: (Include description and equipment number of all equipment a devices):

____

____

____

____

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves be opened/closed, order of equipment startup, etc.):

____

____

____

____

____

Startup Requirements (Water, power, chemicals, etc.):___________________________________

____

____

Evaluation Comments:____

____

____

____

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

AGENCY:________________________________ PROJECT:_______________________________

Unit Processes Description (List unit processes involved in facility startup):

____

____

____

____

**Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations,
if any):**

____

____

____

____

____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _________________________________ Date: __________________________, 20____

Owner: _____________________________________ Date: __________________________, 20____

(Authorized Signature)

LOOP STATUS REPORT—EXAMPLE FORMAT Rev.06.05.92

Project Name: *City of Bend*	Project No. *123456*
FUNCTIONAL REQUIREMENTS:	
1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
3. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

SECTION 40 62 63

OPERATOR INTERFACE TERMINALS (OIT)

PART 1 GENERAL

1.1 SCOPE

A. This Section specifies requirements for supply and installation of an Operator Interface Terminal.

1.2 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials
B. NEMA – National Electrical Manufacturer's Association
C. NEC – National Electrical Code

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 90 00 General Instrumentation and Controls

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.4 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

C. Manufacturer's installation instructions.

D. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Candidate manufacturers and models include the following

1. Rockwell Automation, PanelView Plus 7 series with touchscreen, model 2711P-T7C21D8S

2.2 ENVIRONMENTAL REQUIREMENTS

A. Operating Temperature of 32 to 131 degrees F.
B. Vibration tolerance of 57 to 500 hertz at 2 G peak acceleration
C. Shock withstand during operation of 11 G at 11 milliseconds
D. NEMA/UL Type 12, 13, 4X (indoor use) and IEC IP66

2.3 FEATURES

A. 512 MB RAM
B. 2 USB ports
C. Windows CE 6.0 or newer operating system.
D. Battery backed real time clock
E. Torch screen shall be 8 wire analog resistive

2.4 ELECTRICAL REQUIREMENTS

A. FM for Class I, Div. 1 Groups A, B, C &D; Class II, Div. 1, Groups E, F, & G.
B. Supply Voltage 120 VAC, single phase. Or 18 – 32 VDC as shown on the drawings

2.5 COMMUNICATION REQUIREMENTS

A. Ethernet TCP/IP 100 MB
B. Optional USB in addition to Ethernet

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 90 00.

B. Install Operator Interface panel per manufacturer's instructions.

C. The screens for the operator interface shall copy the layout of the existing operator interface screens within the system. The City shall provide access to those stations for preview. The City may provide a copy of the current programming of one of the stations.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.
B. Ensure proper installation per manufacturers recommendations

END OF SECTION

SECTION 40 66 56

POINT-TO-POINT RADIO EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. This Section specifies requirements for supply and installation of point-to-point radio system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, wiring, accessories and labor required for a complete, workable and integrated system.

C. Radios shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel

1.2 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 90 00

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

PART 2 PRODUCTS

2.1 RADIO

A. MANUFACTURERS

1. ESTEEM, Model 195C: 450-470MHZ, Ethernet/Serial Radios.

B. A power supply shall be provided for the radio as required by the manufacturer.

1. ESTEEM, Model 2412 DC-DC Converter, or approved equivalent.

C. Programming cables shall be provided as necessary to configure radio.

1. Provide RS-232 Interface Cable, AA0621.1

D. Provide all necessary accessories, cables and connectors as required for a complete functional radio system integrated into the control system.

2.2 DIRECTIONAL ANTENNA

A. MANUFACTURERS

1. ESTEEM, Model AA202C.1

B. Type: Directional, 5 Element Yagi, DC Ground

C. Frequency: 450 to 470 MHz.

D. Antenna impedance shall be 50 ohms

E. Gain: 9 dBd

F. Antenna hardware shall be provided as recommended by the manufacturer, or otherwise as shown on the drawings.

2.3 ANTENNA CABLE, LESS THAN 50 FEET

A. RG-08 Feedline Type, AA237

2.4 ANTENNA CABLE, LONGER THAN 50 FEET

A. Heliax Feedline Type, AA236

2.5 SHORT CABLE RUNS / JUMPERS

A. LMR195 COAX, AA234LMR

2.6 LIGHTNING ARRESTORS

A. MANUFACTURERS

1. ESTEEM, AA161

B. Lighting arrestors shall be used on all exterior mounted antennas.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components in accordance with manufacturer’s specifications and as shown on the drawings.

B. Ensure proper grounding of antennas.

C. Weather proof all exterior coaxial connections.

D. Comply with mounting details provided on the drawing.

3.2 TESTING

A. Radio shall be tested on site and in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

B. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

END OF SECTION

SECTION 40 67 00

PROCESS CONTROL PANELS AND HARDWARE

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section specifies requirements for panels, cabinets, consoles, termination cabinets, and 19-inch electronic racks for instrument, control, and communication equipment for New Airport Reservoir and Booster Station project.

2. This section specifies requirements for power supply and conditioning equipment required to support the instrumentation and communication systems as specified.

3. Provide the instrument, control, and monitoring features as specified and described in the contract documents. Panels shall meet the functionality as the drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panels shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring, in accordance with NEC Article 409. Panels shall be fabricated by a UL-508A recognized facility and shall bear appropriate UL 508A Industrial Control Panel assembly labels. All panels shall be labeled in accordance with Article 409 of the National Electrical Code.

4. Transmitters, Analyzers, signal conditioning modules and other equipment or devices as specified.

5. Panels that contain programmable logic controllers (PLC) and human machine interface (HMI) units shall be as indicated on the drawings. Specific panel devices are as specified herein to meet the functionality as shown on the drawings.

6. PLC and HMI shall comply with the with the requirements of the specifications. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to return the panels, perform the work as specified, re-test, certify and ship panels to the Project site shall be borne by the panel supplier should they not be accepted. No additional costs shall be borne by the Owner for unacceptable panels.

7. Field modifications requiring a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed are costs to be borne by the Contractor.

8. Contractor custom panels are specified herein.

9. The Contractor custom field panels shall adhere to the requirements in the specifications for controllers, and devices. Control circuits shall be arranged for Fail-Safe wiring and electrical operation, as defined herein.

B. Panel Design:

1. General:

   a. Provide panel hardware and software as specified and to match all functionality shown on the drawings.

2. Control Power Distribution:

   a. Panel containing 120-volt powered equipment shall use the din-rail power supplies with fuses and blown fuse indication and terminals. Control power voltages are limited to 120 Vac and 24 Vdc.

3. Panels containing power voltages greater than 480 Vac shall be separated from the control section by physical barrier.

4. Power Supplies:

   a. Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified herein.

5. Electrical Control Devices:

   a. Relays, timers, signal isolators, filters, and other similar equipment use in or in conjunction with panels specified in this section shall comply with the requirements of the specifications and match all the functionality as shown on the drawings.

   b. Remove all local push buttons, chart recorders, and indicators from all existing PLC cabinets in all areas where new PLCs are being installed. If new doors can be acquired, replace with new door panels. If new door panels are not available for the existing cabinets, cover all holes from removed equipment with CNC or equivalent cutting method to cover entire area with one new piece of steel painted closely to match exterior of cabinets.

6. Uninterruptible Power Supplies:

   a. 19-inch rack mounted in separate enclosure. 120 Vac input and 120 Vac output are specified herein.

1.2 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations
NFPA 79	Electrical Standard for Industrial Machinery
NFPA 70	National Electrical Code (NEC)
NEMA ICS 6	Industrial Control and Systems: Enclosures
ANSI/UL 497-1995	Standard for Protectors for Paired Conductor Communications Circuits
UL 1012	Power Supplies
EIA RS-310C	Racks, Panels, and Associated Equipment
UL 1449	UL Standard for Safety for Surge Protective Devices

4. This Section references other sections with associated work specified therein:

   a. Section 26 05 00, General Electrical Requirements
   b. Section 40 61 21, Process Control System Testing

c. Section 40 90 00, General Instrumentation and Controls
d. Section 40 90 01, Airport Booster Process Narrative
e. Section 40 94 43, Programmable Logic Controllers

B. Listed Products:

1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.

2. The control panel assemblies shall have factory applied UL 508A labels.

3. All panels shall be labeled in accordance with NEC Article 409.

C. Shipment, Protection and Storage:

1. Equipment shipment, protection and storage shall conform to the specifications.

1.3 SUBMITTALS

A. General:

1. Submit In accordance with the procedures set forth in the General Conditions of the Contract Documents that include drawings, information and technical data for equipment and as specified. Submittal information shall be included in one complete submittal.

a. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

1) A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

2) The Owner's Representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

3) *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

b. Marked City of Pendleton as-built record document Control Schematic diagrams related to the submitted equipment.

c. Marked City of Pendleton as-built record document Control Interconnection diagrams related to the submitted equipment.

d. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.

e. List of miscellaneous items, cables, spare and replenishment parts, and chemicals to be provided, including MSDS information.

f. Dimensioned drawings:

   1) Exterior panel and layout
   2) Interior devices and layout
   3) Door-in-door construction devices, where required

g. Panel assembly drawings including sections showing clearances between face and rear mounted equipment.

h. Nameplate engraving schedule:

   1) Indicate engraving by line
   2) Character size
   3) Nameplate size
   4) Panel and equipment tag number and description

i. Heat load calculations for each cabinet based on the highest ambient temperature listed in Section 26 05 00, General Electrical Requirements.

j. Wiring drawings:

   1) Schematic diagrams
   2) internal wiring diagrams
   3) Connection diagrams
   4) Power and control single line diagrams to comply with NEC Article 409.

1.4 ENVIRONMENTAL CONDITIONS

A. See Section 26 05 00, General Electrical Requirements.

PART 2 PRODUCTS

2.1 FABRICATION

A. General:

1. Panels shall be designed for local seismic requirements. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.

2. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.

3. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than

4. 10 pounds, or exert more than a 4-ft/lb. moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

5. Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.

6. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

B. Panel Layout:

1. Provide 20 percent spare contiguous sub-panel area for future expansion.

2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 channels analog, 10 discrete I/O circuits and 10 power circuits for 120 Vac and 24Vdc each.

3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.

4. Separation between the power components (over 120Vac) and the control/instrument components (120Vac and less) by locating the power components and the control/instrument components in separate sections of the cabinet enclosure.

5. Power cabinet section and the control/instrument cabinet section with separate door handles.

6. Separation between the power components and the control/instrument components using barriers.

7. External lockable circuit breaker handle for the main panel disconnect.

8. Individual power and control components with internal circuit breakers, as required.

9. Motor controllers, as required by the equipment specifications.

10. Displays with door-in-door construction accessible by opening the cabinet outer door, if required.

11. Face-mounted equipment flush or semi-flush with flat-black escutcheons.

12. Panel tops of wall-mounted panels: mounted at the same elevation.

13. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.

14. Panel inner door contains a drawing holder.

15. Panel drawings enclosed in a transparent, protective jacket.

16. Panel functions as specified.

17. Panels with floor stands, to raise the top of the panel to 60 inches above the floor or work platform.

18. Wall mounting of panel weighs less than 100 pounds, where wall space is available,

C. Enclosures:

1. Panel enclosures shall comply with the requirements of NEC Article 409 and NEMA 250.

2. Manufacturer:

    a. Hoffmann Enclosures, Inc.
    b. Saginaw,
    c. Rittal,
    d. or approved equal.

2.2 HEATING, VENTILATING AND COOLING

A. Existing heating, ventilation, and cooling systems shall remain in place

B. If there is not current and heating, ventilation, and cooling system in place in the panels, it is not necessary to provide any additional systems.

2.3 PROTECTION COATING AND FINISH

A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.4 NAMEPLATES

A. External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

B. The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

D. The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.

E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.5 PANEL FEATURES

A. Panel Interconnecting Wiring:

1. Panel control wiring: Single conductor stranded copper NEC rated Type MTW No. 16 AWG minimum (rated 10A per NFPA 79, Table 12.5.1), with an exception for factory supplied PLC wiring harnesses that are U.L. approved.

2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.

3. Panel power wiring: Conductors specified in Electrical Requirements Section and meet the NEC requirements for power including phase, grounded, and grounding conductors.

4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.

5. Wiring channels shall comply with UL 94, Type V.

6. Plastic wire-way with covers shall be used to route groups of wires. Wire-way fill shall be sized to provide 40% maximum fill.

7. Plastic spiral wrap or braided sleeve shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap or braided sleeve.

B. Wire Markers:

1. Wire marker shall comply with the requirements specified in Electrical Requirements Section.

C. Conductor Identification:

1. Wiring shall be tagged at terminations with machine printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:

   a. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.

   b. Part-2: Code letter and wire colors per the following tables.

   c. Part-3: Number that identifies individual circuit conductor terminal number.

Code	120 Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	Vdc Conductor	Color
PS PS	24 Vdc Power	Blue Violet
S+	Signal (+)	Black]
SG	Signal Ground	White
EG FV	Equipment Ground Panel	Green Yellow

D. Conductor Installation and Protection:

1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.

2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.

3. No more than two connections shall be made to one terminal.

4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.

5. Terminal blocks shall be;

   a. Allen-Bradley 1492-J Series,
   b. Phoenix Contact,
   c. Or approved equal.

E. Field Wiring:

1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only. Label all wires in PLC cabinet that go from the PLC to the terminals to field circuits.

F. Fuse and Fuse Holders:

1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.

2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.

3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.

4. Fuse holders shall be tip-out or draw-out type.

5. Fuse holders shall be;

   a. Allen Bradley 1492-FB1 Series,

b. Or approved equal.

G. Auxiliary Relays

1. Relays shall be provide as shown on the drawings or as required to perform the functional requirements of the system. Relays shall be suitable for control, interfacing, and interposing functions.

2. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.

3. Mounted via DIN rail mounted, finger-safe sockets.

4. Plug-in general purpose, 2PDT minimum, power type relays rated for industrial use.

5. Auxiliary Relays shall be:

   a. Allen Bradley,
   b. IDEC,
   c. Or approved equal.

H. Control Power:

1. 120 Vac control power source: Single power source for all control and DC power. Dual power sources, one for control power and one for DC power. Dual power sources, one for PLC and DC power and one for PLC control power.

   a. Provide control power transformers, as required for the load.

   b. Provide direct current power supplies, as required for the load.

   c. Provide UPS for PLC and derived loop power as defined above, as required for the load.

I. Panel power source:

1. Provide a 120 Vac circuit for the panel light, receptacle, heating, and cooling fan, as required.

J. Fail-Safe Wiring:

1. Fail-safe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.

2.6 ALARM AND TROUBLE DETECTION

A. The equipment control system shall incorporate a non-energized, open-state, output contact to activate on an alarm or trouble condition or on loss-of-power. Detection of a critical alarm or trouble condition shall cause the control system to initiate the shutdown or the operation of the equipment's controlled components to achieve a "Fail-Safe" condition.

B. Devices that signal an alarm or a trouble conditions shall latch in the alarm position and require a manual reset at the equipment control panel.

C. Alarm and trouble output shall:

1. Open an output dry-contact.

2. Remain open until manually reset.

3. Not indicate abnormal condition when the equipment shutdown manually or automatically.

4. Indicate the alarm at the equipment control panel.

D. Fail-Safe Design and Operation:

1. Failure of equipment or process shall not propagate beyond the failing device or equipment component.

2. Control design and operation shall prevent improper system functioning due to a circuit malfunction or operator error.

3. Control system design shall cause the controlled equipment to operate in a safe mode in the event of loss-of-power or the failure of a control system component.

2.7 CONTROL DEVICES

A. Control devices shall comply with Electrical Requirements Section and as shown on the drawings. If existing systems need to be interfaced with, documentation shall be provided as necessary.

2.8 POWER SUPPLY AND CONDITIONING EQUIPMENT

A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems, unless specifically shown differently on the drawings. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded.

B. Alternating Current (AC) Voltage Regulators:

1. Regulators shall be of the solid-state tap-changing type, insensitive to line frequency variations between 47 and 63 hertz. Ferroresonant units are not acceptable. Output regulation for input voltage variation from 85 to 125 volts shall not exceed 3.3 percent. Output regulation for load variation from 0 to 100 percent shall not exceed 1.0 percent. Response time shall be 1.0 cycles or less. Voltage regulators serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Voltage regulators serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the regulator shall not exceed 2 percent of the regulator capacity, and harmonic distortion introduced by the regulator shall not exceed 0.1 percent. Regulator output shall be fully protected against internal faults, external overloads and short circuits. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Regulators shall be Topaz 73000 series, or approved equal.

C. Noise-Suppression Isolation Transformers:

1. Isolation transformers shall be provided for AC powered instrumentation loads containing solid state circuitry where such is not included within the instrument. Isolation transformers shall be of the triple box shield type. Each coil shall be completely enclosed in a grounded conductive faraday shield, and the overall transformer enclosed in a faraday shield. Common mode noise attenuation between primary and secondary shall exceed 140 dB at 1.0 kHz. Isolation transformer dielectric strength shall be 2500 volts minimum. Isolation transformers serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Isolation transformers serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the isolation transformer shall not exceed 2.0 percent of the maximum load rating. Harmonic distortion introduced by the isolation transformer shall not exceed 0.1 percent. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Isolation transformers shall be Topaz, or approved equal.

D. Direct-Current Power Supplies:

1. Convert 120 VAC to 24 volt DC or other DC voltages required or as required for the application.

2. Sized to provide 40 percent excess rated capacity.

3. UL 508C listed to allow full rated output without de-rating.

4. Power Supplies shall be:

   a. Sola SDN,
   b. Or approved equal.

E. 24 VDC Uninterruptible Power System (UPS):

1. The UPS shall consist of two (2) sealed 12 VDC batteries in a sealed battery enclosure, separate from the PLC control panel.

2. The batteries shall be connected to the 24 VDC circuit in the control panel by sealed conduit and/or S.O cord.

3. The battery enclosure shall be located either below or adjacent to the PLC control panel. A shelf shall be provided to hold the enclosure.

2.9 SURGE PROTECTION

A. Provide primary surge protectors, per NEC Article 800.90 on all signal conductors entering the panel from outside the building. Surge protectors shall be multi-stage, plug-in type selected to protect the equipment, and listed per ANSI/UL497. Surge protectors shall be removable without changing the impedance of the circuit. Surge protector product manufactures shall be:

1. Circuit Components Inc: Din Rail SDD-400 Series for Data or Analog Signals.
2. Joslyn Model 1663-08
3. Taylor 1020FA
4. Phoenix Contact
5. Telematic
6. Edco
7. Or approved equal.

B. Provide Type 1 surge protective devices, per NEC Article 285, at the power feed to the panel. Surge Protective Devices (SPD) shall be designed to provide transient voltage protection for a service entrance panelboard. SPD units shall comply with UL 1449 3rd Edition, and shall be listed for such use. SPD units shall have a built-in diagnostic package with flashing trouble indicator, a display for the status of each phase, and a counter and display to indicate the number of surges that have caused the device to operate.

1. SPD units shall be:

   a. Allen Bradley DH120-25,
   b. Sola IE-110,

    c. Or approved equal.

2.10 PANEL GROUNDING

A. Each panel shall be provided with two copper ground bars.

B. One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.

C. Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.

D. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

E. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

F. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

G. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

2.11 PANEL DRAWING PROTECTION

A. Provide wiring diagrams in accordance with specifications. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.12 SPARE PARTS

A. The following spare parts shall be provided:

1. One of each type of indicator light used in the panel.
2. Five of each type and rating of fuse used in the panel.
3. One of each type of primary protector surge suppressor used in the panel.
4. One of each type of surge protective device used in the panel.

2.13 PRODUCT DATA

A. The following data shall be provided:

1. Manufacturer's operation and maintenance information as specified. Manual shall include final reviewed submittal and separate record of all final configuration, jumper, and switch settings.

2. Test results as specified.

3. Manufacturer's certification for the performance of features of the specified equipment that cannot be readily inspected.

4. Special requirements for delivery of the information such as time, manner, place, or quantity.

5. Installation and training forms specified in Part 3.

2.14 HUMAN MACHINE INTERFACE (HMI)

A. Panel mounted color touch sensitive graphics screen.

   1. Power: 24 VDC

   2. UL Listed.

   3. Communications:

      a. TCP/IP Ethernet connection.
      b. USB – 2 ports minimum.

B. Manufacturer:

   1. All new touchscreens shall be Rockwell Automation (Allen Bradley) PanelView Plus 7 TouchScreen 7” touchscreen, part number: 2711P-T7C21D8S

      a. Graphical workshop shall be scheduled with owner to coordinate desired esthetics by O&M Staff.

2.15 ETHERNET SWITCHES

A. Local Panel DIN Rail Mounted Ethernet switch(s) shall be provided with the following features:

   1. Unit shall provide for Ethernet copper to fiber optic conversion.

   2. A minimum of 6 RJ-45 10/100/1000 auto negotiating ports.

   3. A minimum of 2 SFP fiber connection ports.

   4. Power Supply: 24 VDC.

   5. All required cabling for internal connections shall be supplied by the panel supplier. Network cable shall be a minimum of CAT-6.

6. Fiber connectors and terminations shall be provided as necessary by the contractor.

7. Fiber connections shall be tested and test results shall be submitted for approval.

8. The ethernet switch shall be:

   a. Stratix 1783-US8TG2GX,
   b. Or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Floor mounted cabinets shall be mounted and shimmed to precise alignment so doors operate without binding. Sealant shall be provided for conduit entering the panels.

B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted as specified.

C. Terminals and terminal blocks shall be sprayed after all terminations have been completed with a silicone resin conformal coating, Fine-L-Coat Type SR, Dow Corning, or approved equal.

D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams. Place documentation in a water proof clear bag in the panel document holder.

3.2 MOUNTING

A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair its operation.

B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.

C. Steel used for support of equipment shall be 316 stainless steel. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

E. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

F. Center-line of wall-mounted panels shall be 48 inches above the floor.

G. Panel tops of wall-mounted panels shall be mounted at the same elevation.

3.3 PANEL POWER SUPPLY

A. Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions.

B. Line side disconnect switches shall be provided for power supply and conditioning equipment. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70. Disconnect switches shall comply with Electrical Requirements Section.

C. Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.

D. Power supply and conditioning equipment larger than 5 kVA load capacity supported from surfaces other than concrete shall be provided with sound isolators.

E. Final raceway connections shall be a flexible conduit.

3.4 FACTORY TESTING

A. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The Owner shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner at least two (2) weeks in advance prior of the scheduled functional shop test.

3.5 FIELD TESTING

A. Field verify the following for Instrument and Control Panels:

1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.

2. Control contacts installed in the ungrounded side of the circuit.

3. Panel signal and control wiring separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.

4. Barriers between the power wiring and the signal and control wiring.

5. Connected to the plant grounding system, as specified.

6. Inner door contains a copy of the Record elementary and wiring diagrams, in a protected drawing holder. Drawings shall be enclosed in a transparent, protective jacket.

7. Panel Functions as specified.

8. Mounted with stainless steel unistrut, fittings, and fasteners.

9. Tested in accordance with Section 40 61 21, Process Control System Testing.

END OF SECTION

SECTION 40 71 13

MAGNETIC FLOW METERS

PART 1 GENERAL

1.1 SCOPE

A. This Section specifies requirements for supply and installation of the Magnetic Flow Meters measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.2 REFERENCE STANDARDS

A. UL – Underwriters Laboratory approved
B. ASTM – American Society for Testing and Materials
C. NEMA – National Electrical Manufacturer's Association
D. NEC – National Electrical Code

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 90 00

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.4 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided.

1) Must include:

a) Dimensional Drawings

b) Materials of Construction

(1) Sensor
(2) Liner
(3) Electrodes
(4) Process Connection

2) Accuracy

3) Range

4) Enclosure Rating

5) Classification Rating

6) Power Requirements

7) Output Options

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Flow Meter candidate manufacturers and models:

1. Endress+Hauser Proline Promag
2. Siemens
3. Toshiba LF654 with LF620 series transmitter
4. Emerson\Rosemount 8705
5. Approved equal.
6. Krohne

B. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

A. Magnetic flow meter provided as a system consisting of a flow tube with locally or remotely mounted converter / indicating transmitter as shown on the drawings.

Meters to be provided with all required interconnecting cables between flow tube and transmitter.

2.3 FULL PIPE FLOW METERS

A. Flow Tube:

1. The flow meter shall be microprocessor based and possess a method in which to store the sensor calibration and transmitter setup information in non-volatile memory. The electronics shall be interchangeable for meters sizes 1” – 120”

2. The sensor shall consist of a stainless-steel flow tube with ANSI B16.5 or AWWA C207 carbon steel or stainless-steel flanges. The flanges shall carry Class 150 or 300 for 24” and smaller, and AWWA Class D for 28” and larger as specified.

3. The sensor tube shall be lined with polyurethane.

4. The sensor shall house two measuring electrodes, a grounding electrode, and one for physical empty pipe detection. The electrodes shall be made of 316L SS.

5. The full-bore magnetic flowmeter in sizes 1”-120” shall maintain zero pressure loss while achieving 0.5% of rate accuracy even when mounted directly before or after a piping elbow, T-fitting or insertion device. This flow tube shall have four measuring electrodes (sizes 1-2.5”) and six measuring electrodes (sizes 3”-120”) plus a grounding electrode and an empty pipe electrode.

6. The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.

7. Process Connection: Flange, ANSI B16.5, Class 150, raised face.

8. Flow tubes shall be pressure rated from full vacuum to 300 psig, unless otherwise noted.

9. Flow tube sizes below 2 inches may be wafer-style ductile-iron or full-body flanged construction.

10. Grounding Ring required and must be provided with flow meter.

11. The sensor shall be rated for NEMA 6P/IP68 service and shall allow for permanent immersion in water depths up to 10 feet.

12. Materials:

    a. Flow Tube: Stainless steel.

b. Flange: Stainless steel or epoxy coated steel
c. Electrodes: 316 L stainless steel
d. Grounding Rings: Same metal as for the electrodes
e. Liner: Polyurethane

B. Indicating Transmitter:

1. The transmitter shall be a three-stage microprocessor controller mounted as shown on the drawings. The transmitter shall operate on AC (100 to 240V) or DC (24 V) via a dedicated or universal power supply as specified. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

2. The measurement signals from the sensor shall be conducted up to 1,000 feet to the transmitter.

3. The transmitter display shall indicate simultaneous flow rate and total flow with three Totalizers (eg. forward, reverse and net total) and user-selectable engineering units, readout of diagnostic remedy messages.

4. 4-20 MA output proportioned to flow range.

5. The transmitter shall internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.

6. Pulse output selectable settable for flows from 1 to 500 gallons per pulse.

7. Hazardous Approval for installation is Class I Div 1 areas.

   a. FM &CSA approved

8. Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components of Magnetic Flow Meters system in accordance with manufacturer's specifications and instructions for the specified functional requirements.

B. Ensure proper installation of the Magnetic Flow Meters system so as to not result in false reading due to ambient conditions or equipment at the installation site.

C. Comply with mounting details provided on the drawings.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer’s recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

B. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER’S SERVICES

A. CONTRACTOR shall provide the services of the manufacturer’s representative for a minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 72 13

ULTRASONIC LEVEL METERS

PART 1 GENERAL

1.1 SCOPE

A. This Section specifies requirements for supply and installation of the Ultrasonic level measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.2 REFERENCE STANDARDS

A. UL – Underwriters Laboratory approved
B. ASTM – American Society for Testing and Materials
C. NEMA – National Electrical Manufacturer's Association
D. NEC – National Electrical Code
E. NFPA No. 70, NEC - National Electrical Code
F. NFPA No. 79, Electrical Standard for Industrial Machinery.
G. ISA – Instrumentation, Systems, and Automation Society.
H. ICS-1 – General Standards for Industrial Control and System
I. ICS-2 – Standards for Industrial Control Devices, Controllers and
J. ICS-3 – Industrial Systems.

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 90 00

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.4 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

   a. Mark data sheets to clearly show exact product and options being provided

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Ultrasonic Level Measurement System candidate manufactures and models:

1. Siemens-Milltronics HydroRanger 200, with Milltronics XPS-15 Sensor
2. Approved equal.

2.2 GENERAL

A. Ultrasonic Level Measurement provided as a system consisting of a level transmitter and a remotely mounted converter / indicating transmitter unless otherwise noted. Units to be provided with all required interconnecting cables.

2.3 FEATURES

A. Process Connection shall be a dedicated mounting bracket.

B. The transmitter shall have a multi-field backlit LCD display with individual alarm status lights and meet the following requirements:

1. Calibration and programming of the transmitter shall be via a removable keypad and shall not require opening the enclosure.

2. The resolution shall be 0.1% of program range or 2mm, whichever is greater Enclosure: Panel-Mounted.

3. Auto False-Echo Suppression to avoid false echoes from fixed obstructions.

4. Mount transmitter inside of PLC panel or as shown on the drawings.

C. The transducer operating principle shall be based on acoustic impulses emitted from an Ultrasonic transducer reflecting back from the material surface. The transit time of pulse travel from generation to echo is measured. The elapsed time is proportional to the distance between the transducer face and material surface.

D. The primary sensor shall be an acoustic transducer containing a polarized Zirconium crystal with acoustic impedance matching face and transformer and shall meet the following requirements:

1. The transducer housings shall be Kynar, or equal.
2. The Accuracy shall be +/- 0.25% of range or 6mm; whichever is greater.

2.4 ELECTRICAL REQUIREMENTS

A. Transmitter and transducer for the Ultrasonic level measurement system shall meet/provide following standards/requirements:

1. The transmitter power supply shall be 120 VAC, 60Hz. Transducer power shall only be supplied by a Milltronics certified controller.

2. Ambient operating temperature of -5F to 122F.

3. The transmitter shall have a minimum of (3) relay and (2) isolated 4- 20mA outputs.

4. Transmitter: 4 to 20 mA dc output signal rated for 500 ohm load.

   a. Outputs shall be scalable and assignable to measure distance to product being measured or depth/level or product/liquid being measured.

5. Signal cable between the transducer and the transmitters shall be provided by the system manufacturer with sufficient length of cable for continuous installation between the two components.

6. Transducer to be FM approved for Class I & II, Div. 1 Groups A, B, C & D; Class II, Div. 1, Groups E, F, & G.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components of Ultrasonic level measuring system in accordance with manufacturer’s specifications and instructions for the specified functional requirements.

B. Ensure proper installation of the Ultrasonic level measuring system so as to not result in false reading due to ambient conditions or equipment at the installation site.

C. Comply with mounting details provided on the drawings.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer’s recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

B. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER’S SERVICES

A. CONTRACTOR shall provide the services of the manufacturer’s representative for a minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 73 26

GAUGE-PRESSURE TRANSMITTERS

PART 1 GENERAL

1.1 SCOPE

A. This Section specifies requirements for supply and installation of Pressure and measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.2 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer's Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ICS-1 – General Standards for Industrial Control and System

G. ICS-2 – Standards for Industrial Control Devices, Controllers and

H. ICS-3 – Industrial Systems.

I. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 90 00

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.4 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

   a. Mark data sheets to clearly show exact product and options being provided.

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Pressure Transmitter candidate manufacturers and models:

1. Barksdale, Model 425H3-07 series, no exceptions.

2. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

A. Pressure measurement provided as a system consisting of a pressure transmitter with integral process connection.

2.3 FEATURES

A. Process Connection: as shown on the drawings.

B. System error shall not exceed ± 0.25% of pressure range

C. Combined non-linearity, hysteresis, and repeatability accuracy of 0.1% of full scale.

D. Temperature Range: -20 to 60 ºC (Operating), 0 to 50ºC (Compensated).

E. Transmitter Materials:

1. Body: Welded 316 stainless steel.

2.4 ELECTRICAL REQUIREMENTS

A. Input current: 20 mA max (loop Power)

B. Signal Output: 4-20mA, 0-5 VDC, 0-2.5VDC Analog signal. Signal shall change in direct linear proportional to changes in measured pressure.

C. Insulation resistance: 100 Mega Ω @ 500 VDC Capable of withstanding a 600 Volt spike in accordance with ENV 50142 without damage.

D. Circuit protection: polarity, surge/ shorted output.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components in accordance with manufacturer's specifications and instructions for the specified functional requirements.

B. Comply with mounting details provided on the drawings.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

3.3 MANUFACTURER'S SERVICES

A. CONTRACTOR shall provide the services of the manufacturer's representative to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 75 21

CHLORINE ANALYZERS

PART 1 GENERAL

1.1 SCOPE

A. This Section specifies requirements for supply and installation of the chlorine gas analyzers including testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.2 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials
B. NEMA – National Electrical Manufacturer's Association
C. NEC – National Electrical Code

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 90 00

B. The manufacturer shall warranty the above specified equipment for twenty-four months from equipment start-up or thirty months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.4 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Chlorine Monitoring candidate manufactures and models:

1. Kuntze Krypton DIS monitoring system

a. Options shall include:

1) Zirkon DIS Sensor, S24135140K
2) StabiFlow, for constant flow
3) Zirkon FTG flow monitor
4) ASR Automatic sensor cleaning

2.2 GENERAL

A. Chlorine Analyzer system shall provide free or total chlorine level outputs (as specified) up to 20.00 milligrams per litre outputs.

2.3 FEATURES

A. The transmitter shall have a multi-field backlit LCD display with individual alarm status lights and meet the following requirements:

1. The transmitter power supply shall be 120 VAC, 60Hz with an operating temperature of 32F to 122F.

2. The transmitter shall have a minimum of (3) relay and (2) isolated 4- 20mA outputs.

3. Calibration and programming of the transmitter shall be via a removable keypad and shall not require opening the enclosure.

4. Mount transmitter inside of PLC panel or as shown on the drawings.

B. The transducer will continuously measure, indicate, and transmit free chlorine residual and pH. The transducer shall be an amperometric type with pH buffering without the use of a reagent. The transducer shall be constructed with materials suitable for use with potable water and sodium hypochlorite.

1. Enclosure: Panel-Mounted

a. NEMA 4X
b. Material: Corrosion-resistant plastic.
c. Hardware: Stainless Steel

2. Amperometeric with pH buffering without the use of a reagent.

3. Sample flow: 500 ml per minute.

4. Range:0-5 mg/l (free chlorine residual); 0-14 pH

5. Display: Back-lit, displaying free chlorine residual, pH, and temperature on one screen.

6. Operating Pressure: 5-87 psi.

2.4 ELECTRICAL REQUIREMENTS

A. Transmitter and probe(s) for the chlorine monitoring system shall meet/provide following standards/requirements:

1. Transmitter: 4 to 20 mA dc output signal onto 500 ohms.

   a. Outputs shall be scalable and assignable to chlorine, pH, or temperature.

2. Alarm Relay: 3, fully programmable for logic (high or low operation), dead band, and set point.

3. Signal cable between the transducer and the transmitters shall be provided by the system manufacturer with sufficient length of cable for continuous installation between the two components.

4. FM for Class I, Div. 1 Groups A, B, C &D; Class II, Div. 1, Groups E, F, & G.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components of chlorine monitoring system in accordance with manufactures specifications and instructions.

B. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

C. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.

D. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Ensure proper installation of the chlorine analyzer transmitter so as to not be result in false reading due to ambient conditions or equipment at the installation site.

3.3 MANUFACTURER'S SERVICES

A. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the chlorine analyzer system.

END OF SECTION

SECTION 40 90 00

GENERAL INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section specifies general requirements which are applicable to providing a complete, functional process control, instrumentation, communication, and signal systems for the New Airport Reservoir and Booster Station project. The requirements of this section are applicable to all work.

2. Electrical requirements applicable to this work include those specified in Section 26 05 00, General Electrical Requirements.

B. Description of Work:

1. Instrumentation and Control System:

   a. The work consists of new process instrumentation, control panels, and data communications systems in support of the water treatment facility operations.

2. Programming:

   a. Programming shall be provided with the functionality as described in Section 40 90 01.

C. Definitions:

1. General:

   a. Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

2. Two-Wire Transmitter:

   a. A transducer which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a 24 volt direct current driving potential and a maximum circuit resistance of 600 ohms.

3. Four-Wire Transmitter:

    a. A transducer which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.

4. Galvanic Isolation:

    a. Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

5. Panel:

    a. An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be present in the atmosphere.

6. Data Sheets:

    a. Data sheets shall refer to ISA S20 or ISA TR20.00.01.

7. Signal Types:

    a. Used in systems specified:

        1) Low-Level Analog:

            a) Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.

        2) High-Level Analog:

            a) Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.

        3) Digital Code:

            a) Coded information from the output of an analog to digital converter or digital transmission terminal.

4) Pulse Frequency:

    a) Counting pulses emitted from speed or flow transmitters.

5) Modulated Signals:

    a) Signals from modems or low-level audio signals. Normal signal level: plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 Hertz.

6) Discrete Control or Events:

    a) Dry contact closures and signals monitored by solid state equipment, relays, or control circuits.

7) Low Voltage Discrete Control or Events:

    a) Dry contact closures and signals monitored by solid state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.

8) High-Level Audio Signals:

    a) Audio signals exceeding plus 4 dBm, including loudspeaker circuits.

9) Radio Frequency Signals:

    a) Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

8. Systems Integrator:

    a. A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, programming, and implementing the specified process control and industrial automation systems.

1.2 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).

3. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

4. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

B. Systems Integrator Responsibility:

1. The specified control system and instrumentation integration including panel building, programming, instrument calibration, testing, start-up, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations. Responsibilities include:

   a. Supply and detailed design of new custom back panels for PLC control panels and related components. Systems Integrator shall provide detailed design of all components on and in the control panels and determine specific requirements.

   b. Design of all interconnecting wiring of control equipment.

   c. Coordination with the Owner for specific requirements and locations of required ethernet cable, fiber cable and field wiring in control panels.

   d. Supplying the Owner with all necessary detailed installation plans and/or written instruction for installation of all control components for proper system operation.

   e. Programming for the PLC, operator interface, and Human Machine Interface (HMI).

f. Development of an assembly and testing schedule, to allow for testing of all new PLC programs in their shop.

g. Provide startup and training services.

C. Systems Integrator Qualifications:

1. The City's Control System Integrator, Simtek Industrial Controls and Automation, LLC, shall provide all system integration for this project.

2. Pre-Submittal Conference:

a. Schedule a pre-submittal conference with the Owner and Construction Manager within 21-calendar days after Contract award to discuss the work, equipment, submittal format, and establish the framework for project coordination and communication.

b. Provide materials 7-days prior to the conference:

1) Instrument Index that lists the devices and instruments specified, identify each by tag number, description, function, manufacturer, and model number.

2) Product descriptive literature with a statement that the item is as specified.

3) Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.

4) Project schedule with deliverables and milestones.

5) Project Control System Block Diagram, when specified.

6) Sample portion of documented PLC and Operator Interface program, when specified.

7) Sample control panel schematic diagram proposed for this project. Sample can be a copy from a previous project if it represents the format being proposed for this project.

8) Sample analog and discrete loop diagrams proposed for this project, when specified. Sample can be a copy from a previous project if it represents the format being proposed for this project.

9) A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or

marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

c. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

D. Process Equipment Coordination

1. Specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.

2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Systems Integrator shall obtain manufacturer’s technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.

5. Systems Integrator shall provide installation supervision for the duration of the project on-site.

6. Conflicts between the specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Construction Manager for resolution before proceeding.

1.3 ENVIRONMENTAL CONDITIONS

A. General:

1. Specified data communication and process control equipment shall suitable for operation in indoor locations and in outdoor locations. Ambient conditions are specified.

B. Corrosive Locations:

1. Corrosive locations shall be as specified.
2. Hazardous (Classified) Areas: Not Applicable.

C. Seismic:

1. Equipment and supports shall be braced.

1.4 FUNCTIONAL REQUIREMENTS

A. General:

1. The instrumentation and control system functions are shown on the drawings and specified in subsequent sections. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

B. Submittal Drawings:

1. General:

   a. The drawings included in the project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor’s Systems Integrator shall prepare detailed installation drawings as specified below.

      1) Drawings prepared in AutoCAD version .dwg and .pdf format with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall include the date and description of the revisions. Drawing prints shall be 11” x 17” with a minimum lettering size of 1/8”.

      2) Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring, to permit cross-referencing between as-built drawings.

2. Connection Diagrams:

   a. Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices within the panel. Show terminal blocks used for internal wiring or field wiring, identified as such. Indicate insulation color code, signal polarities, and wire numbers and terminal block numbers.

3. Interconnection Diagrams:

    a. Show panels, panel devices, and field devices with wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.

4. Elementary or Schematic Diagram:

    a. Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. Provide schematics for internal panel power distribution, lighting, and any panel cooling systems.

5. Arrangement, Layout, or Outline Drawings:

    a. Show the dimensioned external and interior control panel views with components and Bill of Material. Provide panel heat load calculations, and indicate cooling or ventilation provisions as required.

6. Network Block Diagram:

    a. A network block diagram is a diagram of the proposed overall SCADA system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols.

7. Loop Diagrams:

    a. Provide loop diagrams for analog and discrete loops interconnected into the control system circuits:

        1) Prepare per ISA S5.4 – Loop Diagrams using the draft Loop Diagrams provided within the Drawings. These are to be fully completed with terminal, cable, and wire numbering.

        2) Show device element wiring of the system.

        3) Show circuits for hardwired device interlocks.

        4) Show circuit cable and wire cable numbers, signal polarities, and terminal block numbers.

1.5 SUBMITTALS

A. The following information shall be provided in accordance with the specifications:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each

paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole.

a. If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

b. The Project Representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

c. *Failure to include a copy of the marked-up specification sections, along with justification for requested deviations from the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. Detailed product literature, showing product specifications and model number breakdown. Mark to denote features and options included. Include only the applicable pages.

3. Manufacturer's installation manual excerpts, as to be used for this project:

   a. Installation details/drawings
   b. Electrical connection diagrams
   c. Calibration procedures

4. Nameplate list with material, tag number and description as specified herein.

B. Review the submittal requirements specified in other sections.

1.6 WARRANTY

A. The Contractor shall return to the project and repair or replace all defects in workmanship and material discovered within one year after Final Acceptance of the Work. The Contractor shall start work to remedy any such defects within 7 calendar days of receiving Contracting Agency's written notice of a defect, and shall complete such work within the time stated in the Contracting Agency's notice. In case of an emergency, where damage may result from delay or where loss of services may result, such corrections may be made by the Contracting Agency's own forces or another contractor, in which case the cost of corrections shall be paid by the Contractor. In the event the Contractor does not accomplish corrections within the time specified, the work will be otherwise accomplished and the cost of same shall be paid by the Contractor.

B. When corrections of defects are made, the Contractor shall then be responsible for correcting all defects in workmanship and materials in the corrected work for one year after acceptance of the corrections by Contracting Agency.

C. This guarantee is supplemental to and does not limit or affect the requirements that the Contractor's work comply with the requirements of the Contract or any other legal rights or remedies of the Contracting Agency.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and Quality:

1. Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

2. Electronic equipment shall be of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

B. Enclosures:

1. Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application.

TABLE A

Location	Enclosure Material and NEMA Rating
Indoor	NEMA 12: painted mild steel
Outdoor	NEMA 4X: Type 316 Stainless Steel

2.2 NAMEPLATES

A. Nameplates shall be provided for all field mounted instrument, analyzer, or equipment specified. Nameplate lettering shall include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown. Nameplates shall be machine engraved black phenolic with white 5/32-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

B. Nameplates shall be attached to support hardware with a minimum of two self-tapping type 316 stainless steel screws in a readily visible location so the nameplate will remain to identify the service when the device is removed. Field instrument nameplates shall be attached with braided stainless-steel straps where not stand mounted.

2.3 PRODUCT DATA

A. The following information shall be provided in accordance with specifications.

1. Record drawings specified by paragraph 1.5 Submittals and the schedules shall be provided in the latest AutoCAD format and PDF format on USB flash drive.

    a. Provide record drawing prints of all drawings following project start-up, but prior to acceptance of the work showing the final constructed state of the instrumentation and control systems.

2. Operating and maintenance information shall be provided. Include the following in each Operation and Maintenance Manual:

    a. Final reviewed Submittals, including revised as-built record drawings.

    b. Manufacturer’s operation and maintenance instructions, edited for this project.

    c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.

    d. Fully completed instrument ISA datasheets.

    e. Fully documented control software printed reports and displays, in color.

    f. Detailed control description of all automatic functions and manual controls.

2.4 INSTRUMENTS

A. The following instruments are included in the design.

1. Ultrasonic Level Meters

    a. Requirements: Section 40 72 13

2. Magnetic Flow Meters

    a. Requirements: Section 40 71 13

3. Pressure Transmitters

    a. Requirements: Section 40 73 26

4. Chlorine Water Analyzer

    a. Requirements: Section 40 75 21

5. Intrusion Switches

    a. Door intrusion switches shall be two-pole plunger type switch with one normally open and one normally closed set of contacts. The switch shall be NEMA rated.

    b. Intrusion Switches shall be:

        1) Schneider, heavy-duty miniature MS Limit Switch, 9007MS01S0100
        2) Or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Equipment shall be installed in locations that are accessible for operation and maintenance services. Equipment not accessible shall be reinstalled at no cost to the Owner.

2. Installation, calibration, settings, and testing procedures as specified.

B. Field Equipment:

1. Equipment shall be provided with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 48 inches and 60 inches above the floor or permanent work platform. Equipment shall be mounted to avoid shock or vibration that may impair operation. Equipment shall be mounted for unobstructed access and walkways. Equipment support systems shall not be attached to handrails, process piping or mechanical equipment.

2. Instruments and cabinets supported by concrete walls shall be spaced 5/8 inch by framing channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall. Equipment supports shall be hot-dip galvanized after fabrication or shall be 316L stainless steel, as shown or specified.

3. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

4. In wet or outdoor areas, conduit penetrations into instrument housing shall be made through the bottom (preferred) or side of enclosures to minimize water entry

from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.

5. Nameplates shall be provided for all field mounted equipment. Nameplates shall be attached to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, but such that if the field device is changed out, the nameplate will remain to identify the service.

C. Electrical Power Connections:

1. Equipment electric power wiring shall comply with the specifications. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location. "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.

2. Equipment power disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location requirements cannot be met by a single disconnect switch, provide two disconnect switches: one at the equipment and one at the work platform.

3. Provide a surge arrestor on each 120-volt AC disconnect switch serving equipment located outdoors.

D. Signal Connections:

1. Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.

2. Jacketed flexible conduit shall be used between equipment and rigid raceway systems. Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

3.2 FIELD TESTS AND INSPECTIONS

A. Delivery Inspection:

1. The Contractor shall notify the Project Representative upon arrival of any material or equipment to be incorporated into the work. The Contractor shall remove protective covers or otherwise provide access in order that the Project Representative may inspect such items.

B. Inspection and Installed Tests:

1. See Section 40 61 21, Process Control System Testing.

END OF SECTION

SECTION 40 90 01

AIRPORT BOOSTER STATION PROCESS NARRATIVE

CONTROL STRATEGY 1

AIRPORT ZONE BOOSTER STATION

PART 1 GENERAL

1.1 PURPOSE:

A. The Airport Booster Station pumps water from the City of Pendleton Airport Reservoir or Gravity Pressure Zone to the Airport Pressure Zones. All functions described herein shall be responsibility of the system integrator to provide in coordination with Divisions 26 and 40 specifications defining the process, equipment, testing, and commissioning.

1.2 RELATED SECTIONS:

A. Drawing P&ID - Process Instrumentation and Control Diagram
B. Division 26 - Electrical Specifications
C. Division 40 - Process Equipment Control Specifications

1.3 SYSTEM DESCRIPTION

A. Water flows from the City's Gravity Pressure Zone to the Airport Reservoir through a 18-inch transmission main. The booster pumps draw water from the Airport Reservoir and pressurize it to feed the Airport Pressure Zone. The booster station will consist of four pumps. Pump 1, 2, and 3 will be the same size and provide peak domestic demands as well as adjusting to duplex operation. Pump 4 will supply low demands. The station will include pressure transducers to monitor the pump suction and discharge pressures. A flow meter will be provided to record instantaneous and cumulative flow readings from the station. The stations mechanical system will be protected from over pressurization and pressure surges by a surge anticipator valve.

B. This reservoir and booster station is at the far end of the City's Gravity Zone so a chlorine dosing system will be provided to maintain and increase the chlorine residual in the Airport Pressure Zone. This system will consist of two metering pumps, a hypochlorite tote, and a chlorine residual sensor.

C. The station will also house pressure reducing valves to serve one of the lower pressure zones in the Airport Service Area.

1.4 EQUIPMENT

Equipment Number	Description
P-1001	Pump 1
P-1002	Pump 2
P-1003	Pump 3
P-1004	Pump 4
V-1008	Pressure Relief & Surge Anticipator
V-1007	Pressure Reducing Valve (low flow)
V-1009	Pressure Reducing Valve (high flow)
P-1005	Chlorine Dosing Pump 1
P-1006	Chlorine Dosing Pump 2

1.5 OPERATOR CONTROLS

Location	Controls
VFD-1001	Pump 1 HOA
VFD-1002	Pump 2 HOA
VFD-1003	Pump 3 HOA
VFD-1004	Pump 4 HOA

1.6 AUTOMATIC OPERATION

A. Pumps

1. The pumps will modulate and turn on/off based on a pressure setpoint.
2. Pump 4 will turn on at the preset minimum speed when a low pressure set point is reached for a given period of time for stability. Once, stabilized, the VFD will modulate up or down to maintain a constant system pressure via automated PLC and VFD parameters. If the pressure increases to a high pressure set point for a given period of time coordinated with the owner's representative, Pump 4 will turn off.
3. If pump 4 is unable to maintain pressure then Pump 1, 2 or 3 will turn on at a preset minimum speed and Pump 4 will turn off. Pump 1, 2, or 3 will then modulate up/down to maintain constant system pressure. If the pressure increases to the high-pressure set point the pumps will turn off and, if necessary, any pump 1-4 will

turn on as necessary. Adequate staging of programming shall be planned for to eliminate the potential for pressure surges that could harm the process.

4. If pump 1, 2, or 3 is unable to maintain pressure then a second pump will turn on. They will then modulate up or down together to maintain a constant system pressure. If the pressure continues to drop, then pump 4 will turn on again. If the pressure increases to the high-pressure set point all pumps will turn off.

5. Pumps should operate in an automatic alternating manner to ensure that all pumps receive equal operation and exercise.

6. In the event of a transmitter fail that adversely effects operation, coordinate with owner on desired fail-safe programming mode.

7. All pumps will shut off if the low pressure set point in the suction pipe is reached. (PIT-1005)

8. All pumps will shut off if the high pressure set point in the discharge pipe is reached. (PIT-1006)

B. Generator Operation

1. When the station is operated under backup power provided from the generator the pumps operation will not change. When the station is powered from the generator only two of the large pumps (Pump 1, 2 or 3) can operate at a time.

C. Chemical Metering

1. The chemical metering pumps will be flow paced to provide a preset chlorine residual at the stations discharge or to the water reservoir. One pump will be designated to dose to the station discharge and the other to the reservoir. They will be plumbed so that with manual valves either pump could dose to the other location.

1.7 MANUAL OPERATION

A. Pumps

1. When one or more pump HOA switch is are placed in HAND position all pumps are shut off and the selected pump is MANUALLY operated. The selected pump runs continuously until switched OFF at the speed set on the local VFD HMI. MANUAL mode is used for maintenance purposes only and must be attended by an operator at all times. All low-level alarms and pump shut off setpoints are bypassed. MANUAL Mode can be used to cycle or operate the larger pumps as the high flow demands are only anticipated to occur during a fire event. When the HOA switch

is cycled to OFF and then all switches are in AUTO position then AUTOMATIC operation is resumed.

1.8 PROGRAMMABLE LOGIC CONTROLLER

A. See the drawings for the IO points to be supplied in the UL 508 listed and labeled panel.

1.9 SPECIAL CONSIDERATIONS

A. Signals required to be displayed at Pendleton Water SCADA system for operational considerations and be coordinated with owner including radio configuration, necessary SCADA configuration and programming prior to providing bid for programming services.

END OF SECTION

SECTION 40 94 43

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope

1. This Section specifies requirements for programmable logic controllers (PLC) designed to execute discrete and continuous control logic with high reliability in industrial applications. Enclosures and components are as specified.

B. General Requirements

1. PLC assemblies, Local Chassis', all associated Remote I/O Chassis' and associated modules and hardware, provided by Rockwell Automation, shall be fabricated by a certified UL508A Panel Shop and listed and labeled accordingly as specified in Section 40 67 00.

1.2 QUALITY ASSURANCE

A. References

1. This Section contains references to the following documents and documents listed elsewhere in the specifications. All PLC assemblies and components shall be capable of meeting or exceeding the requirements of the listed Standards documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).

3. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

4. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE C37.90.2	IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference
IEC 61131-3	Programmable Controllers – Part 3: Programming Languages
NEMA IA 2.2	Programmable Controllers – Equipment Requirements and Tests
NEMA IA 2.3	Programmable Controllers – Programming Languages
NEMA ICS 1.1	1984 Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control

B. Systems Integrator

1. See Section 40 90 00, General Instrumentation and Controls, paragraph 1.2 for Systems Integrator Responsibility and Qualifications.

1.3 SUBMITTALS

A. The following information shall be provided:

B. Shop Drawings:

1. Submit the following:

a. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole.

b. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

c. The Project Representative shall be the final authority for determining acceptability of system testing.

1) Refer to specification 40 61 21- Process Control System Testing

d. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

C. Operating and Maintenance (O&M) Information:

1. Contractor shall deliver to Owner three (3) sets of acceptable manufacturer's operating and maintenance instructions covering each piece of mechanical and electrical equipment, or equipment assembly, furnished under this contract. Each set of instructions shall be bound into multiple volumes; each volume to be complete with and index and bound in a suitable hard-cover binder. Manuals shall be assembled and indexed so that information on each piece of equipment can be readily found. Any additional operating and maintenance instructions from the Control Systems Programmer shall be submitted separately.

2. At least two (2) copies of the O&M manual will be provided in a digital format that can be editable such as CAD .DWG files and Microsoft Word documents. These documents will be formatted so that text can be searched using standard query tools.

3. Manuals shall be purposefully made for this installation, and general information manuals which have limited applicability will not be accepted. Manuals shall not contain information or reference to devices and equipment not supplied as part of the project. The manuals shall be written in a non-technical format suitable for reading by water system operators with no previous automatic control equipment experience. The decision of the Owner on the acceptability of the manual shall be final.

4. The Control System Integrator shall prepare and assemble detailed operation and maintenance manuals in accordance with the project general requirements. The manuals shall include, but not be limited to, the following:

   a. Name, location and phone number of nearest supplier and spare part warehouse;

   b. Step by step operating procedures;

   c. Narrative of overall system performance and operation;

   d. Listing of all equipment set points;

   e. Preventative maintenance procedures;

   f. Trouble-shooting of master and remote equipment;

   g. Calibration;

h. Testing;

i. Replacement of components;

j. System schematics / shop drawings;

k. As-built elementary and one-line diagrams;

l. Catalog data and complete parts list for all equipment and control devices;

m. Listing of recommended spare parts;

n. Listing of recommended maintenance tools and equipment;

o. Warranties;

p. Disassembly and reassembly instructions;

q. Program documentation printout with tag numbers and descriptive comments.

5. Provide as-built programmable controller application programs prepared using the software type specified in Part 2. See Section 40 90 01 for additional requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. Manufacturer

1. The Owner requires the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The listed Manufacturer's standard product will comply with the requirements of this Section.

2. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted. The Contractor shall be responsible for determining final quantities and part number configurations to fulfill the specified requirements to meet or exceed the functionality of the existing PLC system in every aspect.

B. Materials

1. Equipment and/or products shall be new and unused at the time of system assembly.

C. Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points.

1. RFI/EMI Susceptibility: MIL STD 461B CS02.
2. Showering Arc Test: NEMA Pub No ICS2-230.42.
3. Surge Withstand: ANSI C37.90a.
4. RFI Immunity: IEC 801-3.
5. Ground Continuity: IEC 801-5.
6. Electrostatic Discharge: IEC 801-2.
7. Electromagnetic Field: IEC 61000-4-3.
8. Fast transients: IEC 61000-4-4.

2.2 PROGRAMMABLE LOGIC CONTROLLER

A. Manufacturer:

1. Rockwell Automation CompactLogix products to match existing inventory

B. NEMA IA 2.3 and IEC 61131-3 compliant program editor with program written in Ladder Logic, or Function Block Language. Program to be written using the same type of software as is specified below.

C. Networking Connections:

1. Provide all communication interfaces, network cables, taps, terminators, power supplies, and accessories for a complete Ethernet/IP operating network.

D. Processor:

1. Rockwell Automation CompactLogix processor/controllers shall be 5069-L306ER

E. Communication Interface Modules:

1. An Ethernet Adapter Module shall be used in order to use 1769 series input/output modules with the 5069 series PLC. In this configuration the 1769 series modules will be configured as a remote input/output rack.

2. Ethernet Adapter shall be 1769-AENTR

F. Input and Output Modules:

1. Discrete Input Modules shall be 1769-IQ16
2. Relay Outputs Modules shall be 1769-OW8I
3. Analog Inputs Modules shall be 1769-IF4
4. Analog Outputs Modules shall be 1769-OF4

G. Chassis Power Supplies:

1. 24 Vdc, 1769-PB4 CompactLogix.

H. Miscellaneous:

1. Provide all cables, taps, terminators, jumpers and accessories for a complete operating PLC system.

2.3 CONTROL PANEL FABRICATION

A. Refer to specification Section 40 67 00.

B. Detail shop drawings showing field connections and any terminal block jumpers are required.

C. Terminate all used and spare I/O wiring to terminal blocks.

D. Create wire markers with "to-from" component name, PLC slot/base, or terminal column number and terminal number information identical at each end.

1. Provide terminal Blocks for field connections to all PLC Discrete Inputs.
2. Provide terminal Blocks for field connections to all PLC Discrete Outputs.
3. Provide terminal Blocks for field connections to all PLC Analog Inputs.
4. Provide terminal Blocks for field connections to all PLC Analog Outputs.

PART 3 PART 3 EXECUTION

3.1 INSTALLATION

A. As specified in other sections.

B. Connect input and output devices to the PLC via control panel terminal blocks, not directly to the PLC.

C. Contractor shall host a factory acceptance testing

1. Contractor to provide check-off plan with sign off sheet that shall be signed off by contractor and owner prior to commissioning.

3.2 FIELD INSPECTION AND TESTING

A. As specified in other sections.

B. Equipment Manufacturer and Systems Integrator: The Rockwell Automation supplier of each PLC system shall provide a qualified service representative to perform the following:

1. Inspect the PLC installation including I/O and network systems, hardware configuration switch and jumper settings.

2. Monitor all PLC system diagnostic indicators, both hardware and software, and certify that the PLC system performance meets or exceeds the Manufacturer's published specifications.

3. Assist in all testing. The Systems Integrator will provide a minimum of two man-weeks on-site for each PLC I/O rack.

4. Modify PLC programs as required.

5. Certify in writing to the Owner that the PLC system has been installed and configured in accordance with the Manufacturer's published guidelines.

C. Contractor

1. Fault or trouble conditions shall be investigated and resolved by the Contractor to the satisfaction of the PLC supplier and the Owner.

3.3 TRAINING

A. Operations and Troubleshooting

1. The Systems Integrator shall conduct application program maintenance, modification, re-loading and training as specified.

2. Training shall be provided for Owner personnel and shall include a minimum of three separate four-hour sessions on-site after start-up including training materials.

END OF SECTION

SECTION 41 22 00

HOISTS AND CRANES, GENERAL

PART 1 GENERAL

1.1 REQUIREMENT

A. The CONTRACTOR shall provide the hoisting equipment, ancillary steel, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of this Section apply to all hoists and cranes unless indicated otherwise.

1.2 RELATED SECTIONS

A. Section 41 22 13 - Overhead Bridge Crane System.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

AISC	Specifications for the Design, Fabrication, and Erection of Structural Steel for Building
ANSI HST-4	Performance Standard for Overhead Electric Wire Rope Hoists
ANSI B30.2	Safety Standard-Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Hoist)
ANSI B30.10	Hooks
ANSI B30.11	Monorails and Underhung Cranes
ANSI B30.16	Overhead Hoists (Underhung)
ANSI B30.17	Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
ASTM A 36	Carbon Structural Steel
OSHA 1910.179 of Title 29	Occupational Safety and Health Regulations-Overhead and Gantry Cranes
CMAA	A division of Material Handling Industry of America

NEMA	National Electrical Manufacturer's Association
NEC	National Electric Code

1.4 CONTRACTOR SUBMITTALS

A. Make, model, weight, voltage, full load amps, and horsepower of each equipment assembly.

B. Complete catalog information, descriptive literature, specifications, and identifications of materials of construction.

C. Shop Drawings shall include electrical requirements, weights, wheel loads, dimensions, and clearances required.

D. Power and control wiring diagrams.

E. Manufactures printed installation instructions.

F. Suggested spare parts list to maintain equipment in service for period of 1 year. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

G. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

H. Technical Manuals: Include complete operating and maintenance instructions of the hoist and crane systems.

1.5 QUALITY ASSURANCE

A. Inspection and Testing Requirements: After installation, the CONTRACTOR shall inspect and test hoists and crane systems in the presence of the manufacturer's service representative, for proper operation and conformance to the Specifications.

B. Acceptance Criteria and Tolerances: The OWNER's Representative reserves the right to reject any equipment not conforming to the tolerances, deflections, and lateral stiffness indicated.

1.6 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall arrange for the hoist or crane manufacturer to furnish the services of a trained, qualified representative for at least one day after the units are installed, for the purpose of inspecting the installation and instructing the OWNER's operating personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment of similar design shall be from a single manufacturer.

B. The capacity of each hoist and trolley shall be permanently marked in a conspicuous manner on the equipment.

C. Hooks shall be safety type with latch.

D. The CONTRACTOR shall verify dimensions and clearances in the field prior to installation and shall be responsible for the proper fitting and operation of the equipment.

2.2 BRIDGE CRANE

A. See Section 41 22 13, Overhead Bridge Crane System.

2.3 PLANT FABRICATED ITEMS

A. Fabrication, assembly, and welding shall be carried out by factory-trained specialists and certified welders.

2.4 TOOLS AND SPARE PARTS

A. Tools: The CONTRACTOR shall furnish one complete set of special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality and furnished in labeled toolboxes of suitable design.

B. Spare Parts: Furnish spare parts as required by the hoist or crane section. Parts shall be properly labeled and identified with the name and number of the equipment to which they belong.

PART 3 EXECUTION

3.1 INSTALLATION

A. Hoist and crane equipment shall be installed in strict accordance with the manufacturer's printed instructions.

B. Workmanship shall be in accordance with the referenced standards and codes.

C. Care shall be taken that the structural integrity of beams, columns, walls, floors, and roofs will be maintained at all times.

3.2 FIELD TESTING

A. After completion of the work, the CONTRACTOR shall test hoist and crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets applicable standards and specifications.

B. See Section 41 22 13, Overhead Bridge Crane System, for specific requirements for field testing of overhead bridge crane system.

END OF SECTION

SECTION 41 22 13

OVERHEAD BRIDGE CRANE SYSTEM

PART 1 GENERAL

1.1 REQUIREMENT

A. The CONTRACTOR shall provide an electrically-operated bridge crane system complete and operable, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 26 20 00 - Low-Voltage AC Induction Motors.

B. Section 41 22 00 - Hoists and Cranes.

1.3 CONTRACTOR SUBMITTALS

A. Provide submittals in accordance with Section 41 22 00, Hoists and Cranes, General.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Requirement -- The bridge crane system shall be a single girder, top running motor driven trolley, motor-driven end trucks, with an electric chain hoist, equipped for electronic lift and travel in both directions. The crane shall be a low headroom type per the Design Criteria listed within this specification section. The crane shall be controlled from its own pendant pushbutton station and be furnished complete with required safety devices and overload protection. Each bridge girder shall be a wide flange beam. The power supply shall be from a festoon cable system.

B. Site Conditions

Equipment	Bridge Crane
Location	Pump Room
Atmosphere	Indoor

C. Design Criteria -- The bridge crane system shall have the following capacities and dimensions:

Equipment	Bridge Crane
Type of Crane	Top Running
Type of Bridge	Single Girder
Capacity, tons	3.0
Maximum lift, feet	15
Top of Runway Beam from Finish Floor, feet	15
Length of Runway	28’-8”+/-
Length of bridge	20’-8”+/-
Hoist Speed Control	2 speed
Lifting Speed, fpm	20/3.2
Trolley Speed, fpm	65 infinitely variable
Bridge Speed, fpm	100 infinitely variable
Supply Power, hp	6.77
Power Supply, V-ph-Hz	480-3-60

D. HOIST AND TROLLEY

1. Top-running and under-running single girder cranes shall utilize low headroom or standard headroom electric wire rope hoists.

2. The hoist shall be equipped with an electro-mechanical load-limiting device that shall prevent lifting more than 110% of the rated load.

3. Hoisting motor(s) shall be two-speed/two winding squirrel cage type with a speed ratio of 6:1.

4. Hoisting motor(s) shall be totally enclosed with IP55 protection, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 60% ED rating.

5. Trolley shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.

6. Trolley motors shall be inverter duty motors with minimum class “F” insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].

7. Rotary cam type limit switch equipped with 4 micro-switches shall be provided. Limit switch shall provide upper and lower limit of hoist travel, hoist slow down prior to reaching upper limit and phase sequence supervision at upper limit. An additional block operated limit shall be included.

8. Hoist motor brake shall be DC disc type with adequate torque to stop and hold over **125%** of the hoist rated load.

9. Large diameter rope drum with a minimum of 36:1 drum to wire rope diameter ratio. Groove depth shall be at least 35% of rope diameter. The rope drum shall be equipped with a rope guide to help keep the rope aligned in the grooves of the drum.

10. Wire rope shall be constructed from galvanized steel having a minimum safety factor of 5.

11. Hoist reeving shall be single reeved. Lateral hook drift shall not exceed 1/8 inch per foot of vertical travel on single reeved models.

12. The hoist nameplate is to carry a CSA c/us rating. The actual hoist control enclosure rating shall be at least equivalent to IP55 / NEMA 4 type.

13. Hooks shall be made of forged alloy steel (34CrMo4QT or 34CrNiMo6QT) and shall be fitted with a spring-loaded flipper-type safety latch.

14. AGMA quality class 12 machine cut, hardened and precision ground hoist gearing. The gears inside the hoist gearboxes on models up to 5 ton capacity are lubricated by semi-fluid grease. On models over 5 ton capacity the gears inside the hoist gearbox are lubricated with semi-fluid grease or oil.

15. AGMA quality class 10, hardened and precision ground trolley drive gearing, lubricated by semi-fluid grease.

16. Trolleys shall have safety drop lugs and energy absorbing bumpers.

E. BRIDGE GIRDER

1. Bridge girders shall be constructed from welded box girders or Structural beams, Steel, ASTM A36 or A992, as required.

F. END TRUCKS AND BRIDGE DRIVE

1. End trucks shall be designed in accordance with CMAA specifications as applicable.

2. End trucks shall be bolted to bridge girder.

3. Bridge drive shall be dual-motor (A-4 arrangement per CMAA).

4. Bridge drive shall be designed to stop the bridge within CMAA specifications.

5. End trucks shall be equipped with rail sweeps and energy-absorbing rubber bumpers.

6. Travel limit switches to be provided as necessary for safe operation.

7. Bridge shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.

8. Bridge motors shall be inverter duty motors with minimum class “F” insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].

9. AGMA quality class 10, hardened and precision ground bridge drive gearing, lubricated by semi-fluid grease.

G. POWER SUPPLY

1. Power supply for the hoist shall be 480 volt, 3 ph., 60 Hz. All power required for the operation of the hoist, trolley, and end trucks shall be developed from this source.

2. Runway electrification shall be 4-bar safety type rigid conductors as manufactured by Insul-8, Duct-O-Wire Company or Wampfler. Wall mounted disconnect switch and power to runway conductors provided by Electrical Contractor.

3. Cross bridge electrification shall be flat cable style festoon system with terminal box, multi-conductor cord, plug connectors (when available) and accessories. Cables are to be hardwired when plug connectors are not available.

H. CONTROLS

The following controls shall be used as applicable:

1. Six-way operation, plug-in pushbutton pendant suspended from independent festoon track.

2. Pendant shall include Start (momentary) button and Emergency Stop (push to maintain, turn to release) that controls a mainline contactor in the bridge control panel.

3. Pushbutton shall be clearly marked with hoist, trolley and bridge travel directions.

4. Hoist shall be 2 speed magnetic reversing type and the trolley and bridge controls shall be variable frequency inverter control

5. Electrical control enclosures shall be IP55 or NEMA 4 type. Pushbutton enclosure shall have a rating of IP65, NEMA 4X, 4 or 5.

I. LABELING

1. Hoist and bridge beam shall be labeled with load rating.

2. A corrosion-resistant nameplate shall be fixed to the bridge with the following information:

   a. Name of manufacturer
   b. Mfg.'s model number and serial number
   c. Capacity
   d. Date of manufacture (month and year)

J. PAINTING

1. Hoist and trolley shall be factory painted (2-part epoxy) per manufacturer's standards.

2. Bridge shall be shop cleaned, primed, and painted per manufacturer's standards.

3. The following items shall not be painted:

   a. Rail surfaces in contact with wheels
   b. Wheel running surfaces
   c. Hoist wire rope
   d. Conductor bar, festoon cables and supports

2.2 SHOP ASSEMBLY TESTS (NO-LOAD)

A. Bridge crane and appurtenant items shall be completely assembled, tested, and inspected in the shop, unless otherwise approved, to demonstrate that the equipment and accessories are fully functional and meet the performance requirements in these Specifications.

B. Adjoining components shall be fitted, doweled, and bolted together to ensure proper fit during field erection and assembly.

C. Assembled components shall be shop-welded in their final positions as much as shipping limitations and field installation conditions will permit.

D. Shop-assembled components shall be inspected for accurate fit, correctness of dimensions, accuracy of alignment, ease of movement, and proper painting. Errors, misalignments, and quality deficiencies discovered shall be corrected.

E. Perform mechanical, electrical, and functional shop tests on crane equipment.

F. Crane shall be completely wired to energize the various motors, brakes, and limit switches through electrical panels using the crane's own controls.

G. Hoist and drive machinery shall be checked for correct direction of rotation and quiet and uniform engagement of gearing.

H. The trolley shall be placed on the bridge and traveled the entire length to verify adequate clearances and demonstrate proper tracking.

I. Operating devices, brakes, switches, and control devices, and the like, shall be inspected and tested to ensure proper operation.

J. Hoist and drives shall be verified for satisfactory operation and proper speeds.

K. No equipment shall be shipped to the Site until it has been inspected and released for shipment.

L. Before disassembling, and after installation of dowels and fitted bolts between bolted subassemblies, parts shall be clearly match-marked. Match-mark diagrams shall be prepared for field erection and submitted for review.

M. Shop Test Report

1. Prepare a complete test report showing in detail the results of shop tests, including dimensional checks. Copies of shop inspection records shall be furnished to OWNER’s Representative.

2. The test report shall include a detailed tabulation showing design values, values of measurements, and adjustments recorded during the tests.

2.3 MANUFACTURER

A. Overhead bridge crane system shall be manufactured by R&M Materials Handling, represented by Idaho Material Handling, or approved equal.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Bridge crane equipment shall be installed in strict conformance with the manufacturer’s published or written instructions. Cranes shall be factory assembled and given a no-load test. Major components of the system shall be marked at the factory to assure prompt and correct field identification.

B. Bridge crane equipment shall be installed in strict conformance with the manufacturer’s drawings and written instructions.

C. After completion of the Work, the CONTRACTOR shall test hoist and crane equipment in the presence of the manufacturer’s field representative, who shall certify, in writing, that the testing performed shall satisfy State of Oregon and other applicable codes and specifications in order to certify each crane for operation.

3.2 FIELD TESTING

A. Personnel and equipment necessary to conduct the testing of the installed equipment shall be furnished by CONTRACTOR. The equipment shall include at least test weights, rigging, safety gear, electrical meters, measuring devices and other equipment required during the course of testing. The CONTRACTOR shall bear all costs of field tests, including related services of the manufacturer's representative.

B. Equipment shall be checked, operated, adjusted, and tested in accordance with the requirements herein and the manufacturer's written instructions and procedures as approved by the OWNER's Representative. Suitable checks shall be made for physical connections, clearances, wiring, controls, limit switches, and other devices as required.

C. The tests shall be conducted in the presence of OWNER's Representative and OWNER, for the purpose of demonstrating compliance with these Specifications.

D. Equipment shall have operated and have necessary corrections and adjustments made before testing in the presence of OWNER's Representative and OWNER.

No-Load Tests

1. Hoist

    a. Each load hook shall be raised and lowered through the full range of normal travel at rated speed and other speeds of the crane.

    b. The load hook shall be stopped below the geared limit switch upper setting.

    c. Proper set-point and operation of upper and lower limit switches shall be verified at a slow speed.

    d. The test shall be repeated a minimum of 3 times to demonstrate proper operation, followed by operation at a high speed.

    e. Brake action shall be tested in each direction.

    f. Dynamic and holding brake action shall be verified.

    g. Load float shall be verified to ensure that holding brakes set and release properly.

2. Trolley Travel

    a. Trolley shall be operated the full distance of the rails exercising drive speed controls in each direction.

    b. Brake operation shall be verified in each direction.

c. Proper operation (interrupt power, automatic reset) of the trolley limit switches at both limits of trolley motion shall be tested in slow speed.

d. The trolley bumpers shall contact the trolley stops in slow speed.

e. The trolley shall be run in each direction of travel for at least 4 complete cycles of trolley travel to disclose any noisy operation and misalignments at bearings, gearing, or motors.

3. Bridge Travel

a. The bridge shall be operated the full distance of its runway exercising drive speed controls in each direction.

b. Brake operation shall be verified in each direction.

c. Proper operation (interrupt power, automatic reset) of the bridge limit switches at both limits of bridge motion shall be tested in slow speed.

4. Hoist Loss of Power No-Load Test

a. Raise each hook to a safe working level above deck to perform no-load test.

b. While slowly lowering each hook, the main power source shall be disconnected verifying that the hook stops lowering and that holding brakes are set.

5. Travel Loss of Power No-Load Test

a. With the hook raised to clear obstructions and one traversing motion (trolley and gantry) in slow speed, the main power source shall be disconnected verifying that the traversing motion stops and that the parking brake sets.

b. Repeat test for each traversing motion of each crane.

c. Repeat loss of power test at full speed to verify that brakes operate properly within acceptable stopping distance.

E. Load Tests: Load tests shall be carried out using a test load between 110 and 125 percent rated load.

1. Hoist Static Load Test

a. Holding brake and hoisting components shall be tested by raising the test load approximately one-foot above the deck.

b. The load shall be held for 10 minutes.

c. Any lowering of the load during this test indicates a malfunction of the brake or lowering components.

2. Hoist Dynamic Load Test

   a. The test load shall be raised and lowered over the full travel with the hook accelerating through the full speed range.

   b. The hook shall be stopped, the load floated, then holding brake allowed to set with the load suspended.

   c. The hook shall be restarted in both raise and lower directions, demonstrating floating of the load before holding brake release on start of motion, and floating of the load before holding brake set.

   d. Load memory shall also be demonstrated for rapid restart of the hoist after holding brake has been set.

3. Hoist Loss of Power Test: After raising the test load to approximately 8-feet above the deck, begin slowly lowering the test load and trip off the main power source to verify that the test load does not lower and that the brake set.

4. Travel Dynamic Load Test

   a. With test load on the hook, one traversing motion (trolley or bridge travel) shall be operated for the full length of its runway in both directions.

   b. Proper function of drive speed control points and brake action without mechanical binding shall be verified, including load swing control and the ability to do a bumpless restart of the drive into a load that is already moving.

   c. Repeat test for each traversing motion of crane.

5. Travel Loss of Power Test

   a. With the load test raised to clear obstructions and one traversing motion (trolley or bridge travel) in slow speed, the main power source shall be disconnected verifying that the traversing motion stops and that the parking brake sets.

   b. Repeat test for each traversing motion of each crane.

   c. Repeat loss of power test at full speed to verify that brakes operate properly within acceptable stopping distance.

END OF SECTION

SECTION 43 21 00

LIQUID PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated.

B. Where two or more pump systems of the same type or size are required, all pumps shall all be produced by the same manufacturer.

C. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps selected by the OWNER.

D. Coordinate and utilize all factory testing, installation, start-up and field testing services supplied in conjunction with the pumping equipment.

E. All work performed under this Section shall be in accordance with all approved trade practices and manufacturer's recommendations.

F. Section includes:

1. General design requirements for liquid pumps.
2. Factory testing.

1.2 RELATED SECTIONS

A. Section 43 21 20 - Vertical Split Case Pumps.
B. Section 43 21 21 - End Suction Pumps.
C. Section 43 21 50 - Mechanical Diaphragm Metering Pump.

1.3 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Provide the following information:

1. Pump name, identification number and applicable Section number from Project specifications.

2. Performance Data Curves:

    a. Showing head, capacity, horsepower demand, NPSH required and pump efficiency over the entire operating range of the pump.

    b. Pump manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.

    c. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable speed drive, and a curve for each speed on two-speed pumps.

3. The limits on the performance curves recommended for stable operation without surge, cavitation or excessive vibration.

4. Assembly and Installation Drawings: Including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

C. Complete motor nameplate data as defined by NEMA, motor manufacturer and any motor modifications.

D. Operation and Maintenance Manual: Containing the required information for each pump section.

E. Spare Parts List: Containing the required information for each pump section.

F. Factory Test Data: Signed, dated and certified for each pump system which requires factory testing submitted before shipment of equipment.

G. Certifications:

1. Manufacturer's certification of proper installation.
2. CONTRACTOR's certification of satisfactory field testing.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be standard products of a manufacturer and distributor regularly engaged in the manufacture and distribution of such products for at least 2 years and shall be suitable for the service intended.

B. All materials and equipment shall be new and unused except for the testing specified herein.

C. Compliance with the requirements of the individual pump sections may necessitate modifications to the manufacturer's standard equipment.

D. All centrifugal pumps shall have a continuously rising performance curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine or encroach on the service factor.

E. All components of each pump system provided under the pump sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings and appurtenances.

F. The pumps shall be supplied by a distributor authorized to service them throughout the warranty period and beyond. The distributor shall be located within a 300-mile radius of the site.

G. The pumps shall be warranted by the manufacturer for a minimum of 1 year from the date of installation.

H. All materials and coatings coming in contact with potable water shall be ANSI/NSF Standard 61 approved.

I. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors, suction cans, baseplates, couplings, guards and other accessories.

J. The complete pump assembly shall be designed and built for continuous service at any and all points within the specified range of operation, without overheating, without damaging cavitation, and without excessive vibration or noise.

2.2 MATERIALS

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

1. Anchor bolts, washers, and nuts supplied by the CONTRACTOR for non-corrosive applications shall be galvanized steel in accordance with the requirements of Section 05 50 00, Metal Fabrications. Anchor bolts, washers and nuts in corrosive service applications shall be stainless steel in accordance with that Section.

2.3 PUMP COMPONENTS, GENERAL

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 12, 125, 250, and 800 or B16.5 - Flanges and Flanged Fittings dimensions.

B. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless-steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed and manufacturer’s name and model number.

B. Gauges: Provide and install pressure gauges as shown on the Drawings.

1. All pumps (except sample pumps, sump pumps, hot water circulating pumps and chemical metering pumps) shall be equipped with pressure gauges on the pump discharge.

2. Pump suction lines shall be provided with compound gauges.

3. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

4. Isolation diaphragms shall be provided for all gauges except where pumping potable water.

5. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

2.5 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system:

1. Pump Systems: All centrifugal pump systems 50 hp and larger shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute.

2. Tests shall be performed using the complete pump system to be furnished, including the motor.

3. For motors 100 hp and smaller, the manufacturer’s certified test motor shall be acceptable. The following minimum test data shall be submitted:

    a. Hydrostatic test data.

    b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.

    c. Pump curves showing head, flow, bhp, efficiency and NPSH requirements.

    d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

    e. Pump test data curves showing head, flowrate, bhp, and efficiency. Acceptance level shall be Grade 1E as defined by ANSI/HI 14.6.

4. Factory Witnessed Tests: Factory witnessed testing for this project not required.

5. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR and Pump Manufacturer shall make all necessary modifications, repairs or replacements to conform to the requirements of the Contract Documents and the pump shall be retested at no additional cost to the OWNER until found satisfactory.

PART 3 EXECUTION

3.1 SERVICES OF PUMP MANUFACTURER

A. An authorized service representative of the manufacturer shall visit the Site to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted and readied for operation:

1. Installation of the equipment.

2. Inspection, checking and adjusting the equipment.

3. Startup and field testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

5. Requirements are more specifically detailed herein and in individual pump specifications.

B. Instruction of the OWNER’s Personnel:

1. An authorized training representative of the manufacturer shall visit the Site to instruct the OWNER’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

2. Instruction shall be specific to the models of equipment provided.

3. The pump manufacturer’s representative shall have at least two years’ experience in training.

4. Training shall be scheduled a minimum of three weeks in advance of the first session.

5. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

6. The training materials shall remain with the trainees.

7. The OWNER may videotape the training for later use with the OWNER’s personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the manufacturer’s written recommendations.

B. Alignment:

1. All equipment shall be field tested to verify proper alignment, operation as specified and freedom from binding, scraping, vibration, shaft runout or other defects.

2. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing.

3. Equipment shall be secure in position and neat in appearance.

C. Lubricants: Provide the necessary oil and grease for initial operation.

3.3 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or overheating of bearings.

B. Field testing methods and allowable tolerances shall comply with current version of the Hydraulics Institute standards for the type of pumps installed.

C. The following field testing shall be conducted:

1. Startup, check and operate the pump system over its entire speed range. Where vibration analysis and measurement is required, it shall be within the amplitude limits specified and recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the OWNER'S REPRESENTATIVE.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.

4. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.

5. Field vibration readings shall be conducted by an Owner-selected certified testing agency, paid for by the CONTRACTOR, with readings taken at the following positions with the average not exceeding the current Hydraulic Institutes standards for the type of pump installed.

   a. Measurements shall be taken at the locations as specified in the current Hydraulic Institute standards for the type of pump installed.

6. Provide written proof of vibration readings and provide test data.

D. Field testing will be witnessed by the OWNER'S REPRESENTATIVE. The CONTRACTOR shall furnish three days advance notice of field testing.

E. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

F. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests and the test data.

G. CONTRACTOR shall bear all costs of field tests, including additional services of the manufacturer's representative required beyond those specified.

END OF SECTION

SECTION 43 21 13 - END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Work covered in this Section includes furnishing, installing, start-up and operation training for centrifugal pumps.

B. Like items of equipment specified herein shall be the end product of one manufacturer.

C. Electrical controls and motor design requirements are specified in this section and the electrical section of these specifications.

D. The pump supplier shall be responsible for coordinating the pump requirements with the pump drive manufacturer and shall be responsible for the overall pump and drive requirements.

1.2 SUBMITTALS

A. Submittals during construction shall be made in accordance with Section 01 33 00, Submittal Procedures and Section 43 21 00, Common Work Results for Liquid Pumps.

1.3 PUMP ANALYSIS AND VIBRATION TESTING

A. Pump vendor shall provide testing per Section 43 21 00, Liquid Pumps.

B. Field vibration measurements during field testing of each pump-motor unit shall be provided per Section 43 21 00, Liquid Pumps.

1. The specialist or their assigned representative who shall similarly be experienced in this type of work and who shall be approved by the OWNER shall visit the project site during startup and testing of the equipment to analyze and measure the amount of pump vibration and make a written recommendation for keeping the vibration at a safe limit.

2. If vibration results exceed the specified limits as identified in Section 43 21 00, CONTRACTOR and Pump Supplier shall make corrections until the vibration limits are met. This could include balancing of the pumps, resurfacing of pump mounting flanges or base plate, or other approved corrective measures to meet the vibration limits according to HI standards.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable pump manufactures Grundfos, Goulds, Patterson, or approved equal.

Duty	Continuous
Drive	Variable Frequency Drive
Ambient Environment	Indoor
Ambient Temperature	33-104°F
Fluid Service	Potable Water
Fluid Temperature	45-80°F
Fluid pH Range	6.0-8.5
Fluid Specific Gravity	1.0
Fluid Viscosity (Absolute) (centipoise at 60°F)	1.12
Pump Station Floor Elevation	Aprox. 1,290 ft msl

2.2 PERFORMANCE REQURIMENTS

A. Operating Conditions all Pumps:

Pump 4 & 5	
Primary Duty Point	
Flow Rate (gpm)	500
Total Dynamic Head (ft)	298
Minimum Overall Pump Efficiency (at duty point)	77%
Nominal Pump Speed (rpm)	3600
Motor Size (hp)	60

See pump curves and system curves in the contract drawings.

B. Performance Requirements at Full Pump Speed:

1. The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading throughout the entire pump curve.

2. All flow capacity and head duty points shall be within the Preferred Operating Range (POR) of 70% to 120% of the Best Efficiency Point (BEP). Pumps shall only operate within the POR.

3. Refer to contract drawings for connection sizes and other project specific dimensional requirements.

2.3 PUMP CONSTRUCTION

A. General

1. The pumps shall be close coupled, single stage, end suction top discharge design, cast iron stainless steel fitted construction.

B. Casing

1. Pump shall be of the back pull-out design so that the rotating element can be removed from the casing without disconnecting the suction or discharge piping. The casing material shall be close-grained cast iron ASTM A48 - Class 30 with a minimum tensile strength of 30,000 P.S.I. Volute shall have integrally cast suction and discharge connections, gauge ports at nozzles, and vent and drain ports. Pumps with specific speed greater than 1600 shall have double volute casing. Casings shall be designed for scheduled working pressure and can withstand hydrostatic test at 150% of the maximum working pressure under which the pump could operate at design speed.

2. Pumps with discharge size 2.5” and larger shall have full flanged connections on both suction and discharge. Suction and discharge flanges shall be drilled to ANSI Class 125# standards and be machined flat face.

3. Pumps with discharge sizes 2” and below shall have NPT threaded connection.

C. Wear Ring

1. A replaceable labyrinth type suction wear ring of Tin Bronze AST B584-90500 (B18) or Vesconite shall be provided and held securely by means of an interference fit in the casing suction.

D. Impeller

1. Impeller shall be of the enclosed francis vane type, single suction design, made of Stainless Steel 316 (UNS S30400), both hydraulically and dynamically balanced to ISO 1940-1:2003 balance grade G6.3 and keyed to the shaft. The impeller shall be trimmed to meet the specific hydraulic requirements.

2. A stainless-steel bolt and washer shall provide positive attachment of the impeller to the shaft.

E. Seal Housing

1. The seal housing shall be constructed of Seal Plate in Cast Iron ASTM A48 Class 30 material and shall hold the stationary seat of the mechanical shaft seal. The seal housing shall be clamped in place over a machined fit on the power frame adapter

by the pump casing to maintain component alignment and is "O-ring" sealed to insure against leakage

F. Mechanical Seal

1. The pump shaft seal shall be a John Crane Type 21 mechanical seal, or equal, constructed of the following materials:

   a. Stationary Face: silicon carbide
   b. Rotating Face: Carbon
   c. Elastomers: Buna-N
   d. Metal Components: 18-8 SS

G. Shaft Sleeve

1. The pump shaft sleeve shall be constructed of Bronze, III932, C89835 or 416SS. Locked in place by the impeller without necessity of other mechanical locking devices. The sleeve design must allow the shaft to remain dry during pump operation.

H. Pump Power Frame Assembly

1. The pump shall be supported by means of a foot mounted, cast iron ASTM A48 Class 30, or equal, power frame which carries all thrust and radial loads imposed by the pump with a minimum B-10 life of 10,000 hours.

2. Pump Shaft

   a. The pump shaft shall be keyed to impeller hub.

I. Bedplate

1. A rigid, channel-type steel bedplate shall be provided to maintain support and alignment of the complete pump and motor assembly.

2. Bedplate shall be suitable for anchor bolt mounting and include provision for grouting.

J. Motor Shaft

1. The motor shaft shall be of cold rolled steel AISI 1045 with bronze sleeves covering the wetted area of the shaft. Motors with 56J frame shall have a motor shaft of stainless steel AISI 416.

2.4 MOTORS

A. Motors shall be standard premium efficiency for use with variable speed drives, drip-proof, induction style. Motors shall be of NEMA design B, with normal starting torque and low starting current, Class F insulation, rated for continuous duty, with a 1.15 service factor. Motors shall be suitable for 460 volts, 60 Hertz, 3 phase power. Motors shall be inverter ready. All motors used with variable frequency drives shall be inverter duty, have insulated motor bearings and shaft grounding rings.

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Installation -- The service representative of the manufacturer shall be continuously present at the site to supervise the assembly and installation of the pumps.

B. A factory Certified Representative of the pump manufacture shall be provided to conduct all testing and training as specified in 43 21 00 Liquid Pumps. Coordinate with ENGINEER and OWNER.

C. Field Vibration: Test for acceptable vibration will be made at no additional cost to the OWNER in the field on each pump system. All field tests will be running tests with the pump pumping product for which it is intended and each pump system will be tested separately with no other pump running. All tests will be done in the presence of the design ENGINEER. Amplitude as used in this specification will mean peak to peak displacement, the requirements for testing for acceptable vibration will be the measurement of this peak-to-peak displacement at 5 separate points on the motor and five separate points on the discharge head.

D. Field Harmonics: During star-up the pump manufacture will perform a Reed Critical Frequency (RCF) analysis commonly referred to as a “bump test”. The bump test will be done through the full operating range of the pump speed, from min speed to max speed. If there are any reflections of harmonics through the operating range of the pump it will be the pump manufactures responsibility to either correct the problem or inform the OWNER of the speeds that will need to be avoided through the Variable Frequency Drive Settings. A full report of these findings will be provided to the OWNER before final acceptance of the equipment.

E. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in separate trips.

END OF SECTION

SECTION 43 21 15

VERTICAL SPLIT-CASE PUMPS

PART 1 GENERAL

1.1 REQUIREMENTS

A. The CONTRACTOR shall provide split-case pumps, including, controls, wiring, and associated piping, complete and operable, in accordance with the Contract Documents. Existing Electric Motors will be re-used.

B. The requirements of Section 43 21 00, Liquid Pumps, apply to this Section.

C. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 43 21 00, Liquid Pumps.

1.3 QUALIFICATION REQUIREMENTS

A. The pump manufacturer shall be experienced in the manufacture of split-case pumps for at least 30 years. At least 20 split-case centrifugal pump installations of the same size units as indicated in this section, or larger, shall have been in operation for at least 15 years.

B. The manufacturer shall have a local service facility within 300 miles of job site, capable of installation, alignment, part replacement and stocking parts of pumps of the same size or larger as the units in this section. Suppliers who do not meet this requirement will not be considered.

PART 2 PRODUCTS

2.1 GENERAL DESCRIPTION TABLE

Duty	Continuous
Drive	Variable Frequency Drive
Ambient Environment	Indoor
Ambient Temperature	33-104°F
Fluid Service	Potable Water
Fluid Temperature	45-80°F
Fluid pH Range	6.0-8.5
Fluid Specific Gravity	1.0
Fluid Viscosity (Absolute) (centipoise at 60°F)	1.12
Pump Station Floor Elevation	Aprox. 1,145 ft msl
LOCATION	Pump 1, 2, 3
Condition	
Capacity (GPM)	2,000
Total Head (ft)	336
Minimum Efficiency (%)	75
Net Positive Suction Head Available (ft)	28
Pump to have system curve characteristics similar to system curve with pump curves in drawings.	
Pump Suction Connection Size (inch)	8
Pump Discharge Connection Size (inch)	6
Nominal Pump/Motor Speed (RPM)	1800 or 3600
Maximum Motor Horsepower (HP)	250

2.2 PUMP CONSTRUCTION

A. Construction: Construction of vertical, split-case pumps shall conform to the following requirements:

1. The pumps shall be long coupled, vertical mounted, single stage, double suction, axial split case design, in cast iron bronze fitted construction specifically designed for quiet operation.

2. Pumps shall have the casing divided on the horizontal centerline. The casing halves shall be accurately machined, bolted and doweled together. A non-asbestos type gasket material shall be furnished between the casing halves. The casing material shall be close-grained cast iron ASTM A48 - Class 35 with a minimum tensile strength of 35,000 P.S.I. Pumps shall be fitted with lead-free bronze renewable case wear rings indexed with a dowel pin for fixed positioning. Removal of the upper casing half and bearing housings shall permit removal of the complete rotating assembly without disturbing piping connections. Volute shall have integrally cast

support feet, gauge ports at nozzles, and vent and drain ports. Casings shall be designed for scheduled working pressure and shall be hydrostatically tested at 150% of the maximum working pressure under which the pump could operate at design speed. Suction and discharge flanges shall be drilled to ANSI Standards and be machined flat face. Flanges shall be extra heavy-duty design and will be of 250# thickness while capable of being drilled for 125# ANSI flat face use.

3. Pumps shall be provided with removable bearing housings which will permit inspection and/or replacement of the mechanical seals, shaft sleeves, and bearings without removing the rotating assembly or upper half of the casing. Straightening vanes shall be cast in both the bearing housings and casing to reduce pre-rotation of fluid prior to entry into the impeller.

4. The upper bearing housing shall be removable and supply support for heavy-duty single row grease lubricated ball bearings, with provision for purging or flushing if desired. The lower bearing housing shall be removable and supply support for the sleeve bearing, with required provision for purging or flushing. The pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to 0.002 inches. Ball bearings shall be ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads. Sleeve bearing shall be graphite material. Each bearing housing shall be bolted to the upper and lower casing halves for a full 360-degree support registered fit to insure positive alignment. Ball bearings shall provide a minimum L10 life of 10 years when calculated at the duty point for the scheduled pump.

5. The pump shaft shall be of solid, stress-proof steel AISI1144 or AISI1141 with sleeves covering the wetted area of the shaft. Upper sleeve shall be bronze and lower sleeve shall be stainless steel.

6. The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule. Mechanical seals, at a minimum, shall have ceramic stationary seats, carbon rotating seats, Buna elastomers and stainless-steel hardware. Application of a mechanical seal shall be internally flushed type, without requiring external flushing lines. Seals shall be capable of being inspected and easily replaced without removing the upper half of the casing. The pump should be available with an option of no mechanical seal at the bottom, for easy maintenance.

7. Impeller shall be of the enclosed Francis Vane type, double suction design, made of silicon bronze, ASTM B584 C87600 or 95400, both hydraulically and dynamically balanced to ISO 1940- 1:2003 balance grade G6.3 and keyed to the shaft. The impeller shall be locked in position by threaded shaft sleeves. The impeller shall be trimmed to meet the specific hydraulic requirements.

8. A coupling, capable of absorbing torsional vibration and of operating in variable speed applications, shall be employed between the pump and motor.

9. The pump shall be supported from below by a fabricated steel stand, which shall be bolted directly to the bottom of the casing. Supporting the casing from the side or top shall not be required, nor allowed.

10. Lower pump bearing will be of sleeve bearing design. It shall eliminate the need for a lower mechanical seal and replace radial ball bearing with a journal bearing.

11. Pump rotation shall be clockwise or counter-clockwise as viewed from the pump's motor end.

12. Pump shall be of a maintainable design for ease of maintenance and should use machine fit parts which are easily disassembled.

13. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5, section 1.4.6.1.1 for recommended acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings.

14. Each pump shall be painted with one coat of high-quality factory approved paint and name- plated before shipment from the factory.

15. The pump shall also be NSF-61 certified.

16. Pump manufacturer shall be ISO-9001 certified.

17. Standard Pump Construction Casing:

    a. Cast iron ASTM A48 – Class 35

    b. Case wear ring: Lead-Free Bronze, ASTM B584-90500 or B505-95400

    c. Impeller: ASTM B584 C87600 or 95400

    d. Shaft: Stress-proof steel, AISI1144 or AISI 1141

    e. Mechanical Seals: Carbon–Ceramic with Buna elastomers and stainless-steel hardware

    f. Bearings/Sleeve-Upper: Grease lubricated Heavy duty Ball bearing/Bronze, III932, C89835, or ASTM B505-95400

    g. Bearings/Sleeve-Lower: Sleeve bearing- Graphalloy grade GM 343.3/Stainless Steel, AISI 416

B. Motor

1. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned and shall be realigned after installation by the manufacturer's representative.

2. Motors shall be suitably sized per ISO5199 and shall meet NEMA specifications and conform to the standards outlined in EISA 2007.

3. Motor Shall meet requirements in specification 26 20 00

2.3 MANUFACTURERS, NO EQUALS

A. Patterson Pumps
B. Grundfos / PACO Pumps
C. ITT Industries / Goulds Pumps Inc.
D. Peerless
E. Or approved equal

PART 3 EXECUTION

3.1 INSTALLATION

A. Per Manufacture recommendations.

3.2 MANUFACTURES SERVICES

A. Provided as listed in 43 21 00, Liquid Pumps.

END OF SECTION

SECTION 43 21 50

MECHANICAL DIAPHRAGM METERING PUMP

PART 1 GENERAL

1.1 DESCRIPTION

A. The pump shall be reciprocating, positive displacement, mechanically actuated, flat Teflon diaphragm type, motor driven metering pump.

B. Pump shall be driven by a microprocessor-controlled stepper motor providing a minimum of 3000:1 turndown ratio. The stepper motor is to be coupled to a flat, Teflon diaphragm via a gear assembly. The drive assembly shall be a maintenance free design.

C. Solenoid-driven pumps, hydraulically actuated diaphragm pumps will not be accepted.

D. Each pump shall have a maximum capacity of 0.2 to 1.98 GPH at 145 PSI or as noted in the pump schedule.

E. Each unit shall be Grundfos DDA 7.5 -16 series or approved equal.

PART 2 PRODUCT

2.1 ENCLSOURE

A. Drive mechanism and microprocessor shall be housed in a corrosion resistant, plastic UV stabilized enclosure.

B. The pump design shall include provisions for optional positioning of the control interface/display, for right/left side and front mounting.

C. Pump enclosure rating shall be to NEMA 4X standards.

D. The pump design shall include an integral removable click stop mounting plate, to allow for flat base or wall mounting. DRIVE

2.2 DRIVE

A. The pump’s stroke length will always be 100%. No adjustment to the stroke length, to regulate flow, or for other reasons, is acceptable.

B. An integral variable speed stepper motor shall be used to ensure the pump discharge phase extends throughout the full period between suction intervals.

C. Variable frequency drives shall not be accepted.

D. The motor shall be integral, supplied with power cord and plug.

E. The drive mechanism shall not require regular field service or external lubrication.

2.3 INTERFACE

A. User interface/display shall be backlit LCD with selectable on-site positioning for either side or front mounting.

B. The interface shall provide a selection of metered output to be displayed in Gal/hr or l/hr. Pumps displaying percent of output only will not be accepted.

C. The interface should include a turn and push (click wheel) for easy navigation.

D. The interface shall include a lock function to protect against unauthorized changes.

E. A built-in counter shall be included to provide a running total of, accumulated strokes, cumulative hours of operation and dosing flow.

F. A priming button shall be provided on the interface. The priming button shall initiate a time selectable prime cycle operating at full capacity without need of attenuating the pumps output setpoint.

G. A system of white, red, orange and green LCD shall indicate pump status and alarm conditions.

H. The pump shall be able to automatically de-aerate the pump head without the need for external devices.

2.4 LIQUID END

A. The process diaphragm shall be Teflon, Teflon faced diaphragms are not acceptable.

B. Head and valves body material shall be PVC, with ceramic ball material.

C. Wetted gasket material shall be PTFE.

D. Suction and discharge valve design shall incorporate double ball arrangement. Spring-loaded valves shall be available as an option. Direction of flow shall be clearly marked on each check valve to ensure correct installation.

E. Head design shall incorporate integral priming valve.

F. A back-plate with separation chamber shall have a safety lip seal and drain hole.

G. Pump head shall include NPT threaded or tube fitting connectors for suction and discharge connections.

2.5 OPERATION

A. Repeatable metering accuracy shall be ±1 percent at constant hydraulic conditions throughout the entire output range.

B. Pump shall have an integral flow control system with selective fault diagnostic and pressure monitoring.

C. The pump shall be equipped with a slow mode function for use with high-viscosity liquids. The slow mode function shall reduce the suction speed to either 50 or 25 percent of maximum capacity to ensure optimal priming and pumping reliability.

D. The pump shall be able to compensate automatically for pressure fluctuations on the injecting point, maintaining the flow rate constant.

E. The pump shall be able to precisely measure and display the actual flow and transfer the actual value via a proportional analog signal 0/4-20mA.

F. The pump shall be equipped with a calibration function which when initiated operates the pump for a set number of strokes and displays the anticipated pumped volume. The calibration process allows adjustment of the pump to set the calibration relative to the drawdown volume.

G. The pump shall be equipped with an analog re-scalable 0/4-20mA signal input. The scaling menu should allow for four-point adjustments (two for signal, two for flow) within the signal and flow ranges.

H. The pump shall be equipped with provisions for selectable mode NO/NC external pump enable/disable interface.

I. A configurable maximum capacity limit shall be included in the interface menu. The limit value is to be specified as (gal or liters)/ hr.

J. The pump shall be equipped with input connections for dual level control and alarm outputs for low-level and empty tank warnings.

K. The pump shall be equipped with a programmable proportional 0/4-20mA signal output.

L. The pump shall be able to automatically de-aerate the pump head without the need for external devices.

M. The pump shall be equipped with two potential free selective programmable outputs

2.6 CONTROL

A. The pump shall come equipped with 5 menu selectable control modes; Manual, analog, pulse, timer or batch. Optionally, the pump shall also be Profibus compatible.

1. Manual Control

   a. Output of pump is displayed in gal or liters per hour. Pump output adjustment is performed with the turn and push knob (click wheel) on the interface.

   b. Pumping rate changes are to be achieved through precise speed control with fixed full stroke length.

   c. Pump output is to comply with prescribed menu maximum capacity value.

   d. Pump should include a start/stop key.

2. Automatic Control

   a. Analog: Pump shall include direct interface provisions for analog control. Both direct and reverse acting 0/4-20ma input configurations are to be acceptable inputs. The menu configuration shall permit pump maximum output multipoint scaling. The pump shall include a local alarm for loss of input signal.

   b. Pulse: The pump shall include direct interface provisions for pulse output devices. In pulse control mode, the pump shall be configured to deliver a volume of product per incoming pulse. The pump speed shall attenuate the delivery rate based on the frequency of pulses generated by the external device.

   c. Batch: In batch mode the pump shall respond to deliver a menu configurable quantity of liquid after receiving a remotely provided contact input.

   d. Timer: The pump shall be equipped with a ten-day internal timer. The configuration menu shall permit the user to prescribe timed sequence start point and the time between each successive timed delivery cycle. The pump should also allow for weekly timed feed.

PART 3 EXECUTION

3.1 INSTALLATION

A. The equipment shall be installed per the contract documents and manufacturer's recommendations.

3.2 WARRANTY

A. The equipment/system warranty, unless otherwise stated, shall be warranted to be free of defects in material and workmanship for a period of 24 months from the date of installation, but not more than 30 months from the date of manufacture.

END OF SECTION

SECTION 43 40 01

POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install a chemical storage tank for Sodium Hypochlorite.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM (American Society for Testing and Materials) Standards:

a. D618 Conditioning Plastics and Electrical Insulating Materials for Testing

b. D638 Tensile Properties of Plastics

c. D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

d. D883 Definitions of Terms Relating to Plastics

e. D1505 Density of Plastics by the Density-Gradient Technique

f. D1525 Test Method for Vicat Softening Temperature of Plastics

g. D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

h. D1998 Standard Specification for Polyethylene Upright Storage Tanks

i. D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction

j. D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials

k. D3892 Practice for Packaging/Packing of Plastics

l. F412 Definitions of Terms Relating to Plastic Piping Systems

2. ARM (Association of Rotational Molders) Standards: Low Temperature Impact Resistance (Falling Dart Test Procedure)

3. ANSI Standards: B-16.5 Pipe Flanges and Flanged Fittings

4. OSHA Standards: 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

5. IBC CODE: International Building Code 2018 Edition

6. CBC Code: California Building Code 2019 Edition

7. NSF/ANSI Standard 61 – Drinking Water System Components (Type II resin)ASTM International (ASTM):

1.3 SUBMITTALS

A. Data and specifications for the equipment shall include, but shall not be limited to the following submittals.

B. Contractor shall submit for review sufficient literature, detailed specifications, and drawings to show dimensions, materials used, design features, internal construction, weights.

C. Shop drawings for the tanks shall include as a minimum the following:

1. Service Conditions: Chemical environment and tempera¬ture.

2. Statement that fabrication shall be in accordance with ASTM D 1998, where applicable.

3. Sizing and description of the fittings and accessories for each tank that are to be supplied by the tank manufacturer.

4. Layouts and assembly schedules for each tank identify¬ing the location and elevation from the bottom of the tank for all inlet, outlet and other integrally molded connections and appurtenances supplied by the tank manufacturer.

D. Resin - A copy of the resin data sheet from the resin manufacturer for the tank is to be supplied and the tank manufacturer is to certify that it will be the resin used in the manufacture of the tank. Verification may be required if the resin is to be FDA or NSF 61 listed.

E. Wall thickness - Prior to the manufacture of the tank the designed wall thickness audit is to be supplied based upon ASTM D1998 @ 100 degrees F. (Note: See 1.08 A.2 for chemicals being stored above 100 degrees F)

F. Tank restraint – If supplied, the drawings and calculations for the system are to be supplied. Note: Wet stamped or site specific drawings and calculations may be required.

G. Supporting information on fittings and accessories to be supplied; heat system, insulation, mastic coating, etc.

H. Technical Manuals: The tank manufacturers Guideline for Use & Installation is to be submitted for review.

I. Manufacturer’s warranty

J. Manufacturer Qualifications: The manufacturer is to have rotationally molded tanks based upon ASTM D 1998 utilizing Type I and Type II resins for the last 10 years.

K. Factory Test Report: Upon completion of the tank the manufacturer’s inspection report is to be supplied for each tank.

1. Verification of wall thickness (See 1.09 E.)
2. Impact test (See 1.09 C.)
3. Gel test – (Type I resin only) (See 1.09 D.)
4. Hydrostatic test (See 1.09 F.)
5. Verification of fitting placement (See 1.09 B.)
6. Visual inspection (See 1.09 G.)
7. Verification of materials

1.4 QUALITY ASSURANCE

A. The tanks of the same material furnished under this Section shall be supplied by a manufacturer who has been regularly engaged in the design and manufacturing of rotationally molded chemical storage tanks using cross-linked and high density linear polyethylene tanks for over ten years.

B. Dimensions and Tolerances

1. All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

2. The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.

3. The tolerance for fitting placements shall be +/- 0.5 in. in elevation and 2 degrees radial at ambient temperature.

C. Degree of Crosslinking Test (% Gel – Type I – Crosslink Resin Only)

1. The test method used is to be the o-xylene insoluble fraction (gel test) per ASTM D2765 Method C. This test method is for determination of the ortho-xlene insoluble fraction (gel) of crosslinked polyethylene. A Gel test will be conducted if ordered by the customer.

2. The percent gel level for Type I tanks on the inside 1/8 in. of the wall shall be a minimum of 65%.

D. Workmanship

1. The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel. Fine bubbles are acceptable with Type II tanks to the degree in which they do not interfere with proper fusion of the resin melt.

2. All cut edges where openings are cut into the tanks shall be trimmed smooth. All materials fabricated to this Specification must be packaged, crated, or protected in such manner so as to prevent damage in handling and while in transit. Details of these procedures shall be the responsibility of manufacturer.

PART 2 PRODUCTS

2.1 GENERAL

A. All equipment specified herein shall be factory fabricated and assembled to the maximum extent possible requiring a minimum of field assembly. Field installation shall be limited to anchoring the tank and making external piping connections.

B. All equipment specified herein shall be suitable for contact with the stored chemicals.

C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer’s service.

2.2 MANUFACTURERS

A. Snyder Industries, Inc
B. Poly Processing Company.
C. Chem-Tainer Industries, Inc.
D. Or equal.

2.3 SERVICE CONDITIONS

Tank #	Chemical Stored	Concentration / Specific Gravity	Tank Location Inside / Outside	Operating Temperature	Tank Resin	Fitting Material	Gasket Material	Bolt / SUMO Material
1	Sodium Hypochlorite	<16.5% / 1.9	Inside	40 to 104 F	HDLPE	PVC	Viton	titanium

2.4 TANK DESIGN CRITERIA

A. Seismic Load: See Structural Drawing BPS-S-1

B. Live Load: 200 pounds per square foot.

C. Concentrated Load: 300 pounds.

D. Special Loads: Design tank for dead loads from all attached piping.

E. Hydrostatic Load: For specific gravities of stored materials specified herein. Tank shall be designed to withstand the hydrostatic pressure resulting from a full tank.

2.5 TANK CONSTRUCTION

A. Tank shall be vertical, flat bottom, dome top construction with translucent materials to allow observation of liquid level.

B. Tanks are classified according to type as follows and it is the responsibility of the purchaser to specify Type I or Type II.

1. Type I – Tanks molded from cross-linkable polyethylene resin.
2. Type II - Tanks molded from linear polyethylene resin (not cross-linkable resin).

C. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Type I tanks shall be made from crosslinked polyethylene (XLPE) resin as manufactured by Ingenia Polymers Corp., or resin of equal physical and chemical properties. Type II tanks shall be made from high density linear polyethylene (HDLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.

D. All polyethylene resin material shall contain a minimum of a U.V. 8 -15 stabilizer as compounded by the resin manufacturer. Pigments may be added at the purchaser's request, but shall not exceed 0.25% (dry blended) of the total weight.

E. Mechanical Properties of Type I tank material: Cross-linked (XLPE)

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.942 -0.946 g/cc
Tensile (Yield Stress 2"/min)	D638	2700 - 2900 PSI
Elongation at Break (2.0in/min (50 mm/min)	D638	300-800%
ESCR (100% Igepal, Cond. A, F50)	D1693	>1000 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	>1000 hours
Flexural Modulus 1% Secant	D790	110,000 PSI

F. Mechanical Properties of Type II tank material: High density Linear (HDLPE)

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.941-0.950 g/cc
Tensile (Yield Stress 2"/min)	D638	2800 - 3500 PSI
Elongation at Break (2"/min.)	D638	>1000%
ESCR (100% Igepal, Cond. A, F50)	D1693	>500 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	40 - 48 hours
Flexural Modulus 1% Secant	D790B	130,000 – 145,000 PSI

G. The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 in. thick.

T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD
T = wall thickness
SD = hydrostatic design stress, PSI
P = pressure (.433 x S.G. x H), PSI
H = fluid head, ft.
S.G. = specific gravity, g/cm3
O.D. = outside diameter, in.

1. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress would be ≤ 660 PSI at 73 degrees Fahrenheit for Type I and Type II materials based the resin density. In accordance with the formula in 1.08 A., the tank shall have a stratiform (tapered wall thickness) wall. In no case shall the wall thickness be less than the minimum allowed per calculation of ASTM D1998.

2. The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.

3. The standard design specific gravity shall be 1.35, 1.5 or 1.9.

4. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support.

5. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2000 or more gallons of capacity shall be designed to provide a minimum of 1300 square inches of flat area for fitting locations.

6. Tanks with 2000 or more gallons of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.

7. The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading. Refer to section 2.02 H. for tank tie-down accessories.

2.6 FITTINGS

A. Tank fittings and openings shall be provided as listed on the drawings.

B. Fittings shall be Schedule 80 or greater PVC, compressive type, with long shank, deep cut threaded with dual wide nut assembly. End type of fittings

C. All flanged fittings shall be gasketed with materials compatible with the chemical service.

D. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.

2.7 ACCESSORIES AND APPURTENANCES

A. All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.

B. Calibration Tape: Calibration tape shall be self-adhesive, translucent tape calibrated in multiples of 50 gallons or less. Strips shall use black numerals and tick marks to denote number of gallons.

C. Gaskets:

1. Material compatible with chemical service, low torque, full face, ASME B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.

2. Type: 1/4-inch thick, low torque, full face, ASME B16.1 dimensions.

D. Tie Down Systems

1. The tie down system shall be designed to withstand 150 MPH wind loads. Tie down systems are based on requirements for nonbuilding structures and must meet seismic requirements per IBC 2018 / CBC 2019 code with seismic loads ≤ .445g

(Seismic Design Category "D" - Fa=1.0, Fv=1.5, Ss=1.4, S1=0.5). Anchor bolts shall be provided by the contractor per the calculations and the base plates for the system. A registered engineer's wet stamped calculations and or drawings may be required.

2. The tie down system shall be offered in either galvanized steel, 304 or 316 stainless steel.

3. Mild steel parts shall be deburred and galvanized.

PART 3 EXECUTION

3.1 INSTALLATION

A. In accordance with the manufacturer's written instructions.

B. CONTRACTOR shall provide all supervision, labor, tools, construction equipment, incidental materials, and the necessary services required to complete the installation and testing of the equipment.

C. Tank shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.

D. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.2 FIELD QUALITY CONTROL

A. Field Tests:

1. Hydrostatic Test: Storage tank shall be filled with clean water to the overflow level after all connections have been made. There shall be no leakage, no signs of weeping, and no signs of capillary action over a period of 48 hours.

2. Quality control shall include a final inspection by CONTRACTOR and a written record of this final inspection.

3. After testing, the tank shall be thoroughly cleaned and dried.

END OF SECTION

SUPPLEMENTARY INFORMATION

Geotechnical Engineering Evaluation

Proposed City of Pendleton Water and Sewer System Upgrades Project
Water Storage Reservoir
Pendleton, Oregon

for
Murraysmith, Inc.

June 5, 2018

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Evaluation

Proposed City of Pendleton Water and Sewer
System Upgrades Project
Water Storage Reservoir
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for
Murraysmith, Inc.

June 5, 2018

GeoEngineers

523 East Second Avenue
Spokane, Washington 99202
509.363.3125

Geotechnical Engineering Evaluation

Proposed City of Pendleton Water and Sewer System Upgrades Project Water Storage Reservoir Pendleton, Oregon

File No. 8946-003-00

June 5, 2018

Prepared for:

Murraysmith, Inc.
888 SW 5th Avenue, Suite 1170
Portland, Oregon 97204

Attention: Preston Van Meter, PE
Principal Engineer

Prepared by:

GeoEngineers, Inc.
523 East Second Avenue
Spokane, Washington 99202
509.363.3125

David R. Lauder
Project Manager

Teresa A. Dugger, PE
Associate

REGISTERED OREGON CRAIG ERDMAN G2530 GEOLOGIST
EXPIRES AUGUST 1, 2018

REGISTERED PROFESSIONAL ENGINEER 82049PE OREGON 11/12/2006 TERESA ANN DUGGER EXPIRES: 12/31/2019

Craig F. Erdman, RG
Senior Engineering Geologist

EBD:JR:CFE:DRL:TAD:tjh:mce

GEOENGINEERS

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APPENDICES

1.0 INTRODUCTION

This report presents the results of our geologic and geotechnical engineering evaluation in support of design and construction of the Water System improvements that are part of the City of Pendleton Water and Sewer System Upgrades project in Pendleton, Oregon. More specifically, this report is for the planned approximately 2-million-gallon water storage reservoir (Reservoir) located in northwest Pendleton, south of the Pendleton Airport. The general location of the proposed Reservoir is shown on the New Reservoir Vicinity Map, Figure 1, and more specifically on the Site Plan, Figure 2.

Based on a review of the Preliminary Reservoir Site Plan provided by Murraysmith, Inc. (Murraysmith) dated October 2017, we understand the proposed Reservoir will be approximately 107 feet in diameter and about 30 feet tall. The bottom of the proposed Reservoir will be at about Elevation 1,296 feet (elevations in this report are based on the North American Vertical Datum of 1988). The proposed Reservoir will be located on a vacant parcel with a moderately inclined slope. Existing ground surface elevations within the proposed Reservoir footprint range from about 1,298 to 1,330 feet. Excavation from about 2 to 40 feet will be required to establish foundation grade for the proposed Reservoir. Structural loads and foundation type were not provided at the time we prepared this report; however, based on the provided geometry of the proposed Reservoir we anticipate that bearing pressures will be in the range of 2,000 and 5,000 pounds per square foot (psf).

2.0 SCOPE OF SERVICES

The purpose of our evaluation was to provide geotechnical engineering recommendations for design and construction of the proposed Reservoir based on subsurface explorations, laboratory testing and engineering analyses. Our scope of services was presented in our proposal dated July 14, 2017. Our services were authorized by Murraysmith, Inc. (Murraysmith) in the Task Order dated September 6, 2017. Our specific scope of services included:

1. Exploring subsurface conditions near the proposed Reservoir by drilling four borings to depths of about 15 feet below existing site grades. Our subsurface exploration program was modified to three borings advanced to depths of about 30 to 40 feet below site grade to account for anticipated excavations required based on the selected Reservoir location.
2. Laboratory testing of select rock core to estimate pertinent parameters.
3. Recommendations for site preparation and fill placement including: criteria for clearing, stripping and grubbing; an evaluation of the suitability of on-site soil or rock for use as structural fill; gradation and compaction criteria for structural fill; and recommendations for preparation of subgrade soil beneath concrete slabs, pavements and other soil-supported structural improvements. We also will provide recommendations for allowable inclination of temporary and permanent cut and fill slopes.
4. Results of the site-specific seismic hazard evaluation.
5. Recommendations for design and construction of shallow spread foundations, including: allowable bearing pressures; minimum width and depth requirements; friction and passive earth pressure criteria for estimating resistance to lateral foundation loads and soil deformation required to mobilize the soil

strength for each component; recommendations for embedment of foundations based on potential frost penetration; and estimates of total and differential foundation settlement.

6. Design of concrete slabs-on-grade including modulus of vertical subgrade reaction values for subgrade soil.
7. An evaluation of the potential for shrinkage, consolidation, expansion, liquefaction and corrosivity of on-site soil and possible adverse effect on buried metal and concrete components of the proposed Reservoir, booster pump stations and associated improvements. Because the proposed Reservoir will be located within a rock cut, laboratory corrosivity testing was not conducted.

At the time of scoping for this project, the location of the proposed Reservoir was not known. Our scope did not include evaluation of proposed rock cut slopes. However, based on the selected Reservoir location, we completed stability analyses of required cut slopes, and provided recommendations for cut slope design and construction. Our additional services were completed under the same terms and conditions as our authorized scope of services.

3.0 LITERATURE REVIEW

3.1. Geology

We reviewed mapping by McConnell (2003) to evaluate the regional geology. The site is situated along the Deschutes-Umatilla Plateau region, which encompasses the southeast portions of the Columbia Plateau and extends from the western boundary of the Blue Mountains province to the Columbia River. The Deschutes-Umatilla Plateau primarily consists of relatively un-deformed basalt with a gentle, rolling slope with fluvial incised canyons. Elevations generally decline to the northwest.

Geologic units within and surrounding the site generally include the following:

- Middle Miocene-age (about 16 to 10 million years ago [Ma]) basalt of the Columbia River Basalt Group (CRBG).
- Late Miocene to Quaternary-age (less than about 10 Ma) sediments.

3.1.1. Columbia River Basalt Group

The CRBG was deposited during an extended period of Miocene volcanism that extruded a series of fluid lava flows. The lava flowed from north-northwest trending fissures as much as 90 miles long, which were located primarily in northeastern Oregon and southeast Washington (Hooper 1982). The resulting basalt deposits are hundreds to thousands of feet thick in some areas and extend throughout the Columbia Plateau.

The stratigraphic framework for the Columbia River Flood Basalt Province subdivides the CRBG into five formations that include, from oldest to youngest, the Steens Basalt, Imnaha Basalt, Grande Ronde Basalt (including the Picture Gorge Basalt), Wanapum Basalt and Saddle Mountains Basalt. The geology surrounding the site has been mapped in the Sentinel Gap and Sand Hollow Units of the Wanapum Basalt (McConnell 2003).

3.1.2. Late Miocene to Quaternary-Age Sediments

Near the site, bedrock primarily is overlain by Late Miocene to Quaternary-age fluvial and eolian sediments. Fluvial deposits generally consist of unsorted mixtures of silt, sand, gravel, cobbles and boulders. Where present, loess (wind-blown clay, silt and fine sand) overlies fluvial deposits, and in some areas, directly overlies bedrock. Within the proposed reservoir, these overburden deposits are minimal.

3.2. Soil Survey

The United States Department of Agriculture (USDA), National Resources Conservation Service (NRCS), Web Soil Survey (NRCS 2016) mapping indicates surficial (upper approximate 5 feet of ground surface) soil at the proposed Reservoir site consists of 70-Pits, gravel. The Web Soil Survey classifies this unit as a miscellaneous unit and does not provide specific soil data.

4.0 SITE CONDITIONS

4.1. General

As part of our Geotechnical Exploration scope of services, we evaluated soil, rock and groundwater conditions at the proposed Reservoir site on November 30 and December 1, 2017, by advancing three borings (3.2 B-1 through 3.2 B-3) to depths ranging from 30 to 40 feet below existing site grade (bgs). The approximate locations of our borings are shown on Figure 2.

Representative rock samples from the borings were returned to our laboratory for examination and testing. Detailed descriptions of our site exploration and laboratory testing programs, the logs of explorations and laboratory test results are presented in Appendix A.

4.2. Surface Conditions

The proposed Reservoir site is located on the east side of an inside bend of Airport Road as it ascends from Highway 30 up to the Pendleton Airport. The site is bounded by Airport Road to the north, storage sheds to the west, undeveloped land to the east and undeveloped land and a warehouse to the south. The site slopes moderately upward from south to north at inclinations in the range of about 3H:1V (horizontal to vertical) to 4H:1V, with an overall grade change on the order of about 30 feet from the north to the south side of the proposed Reservoir. The site is vegetated with native grasses, weeds and sagebrush and with one tree occupying the east side of the site. Rock is exposed in many areas at the site.

4.3. Subsurface Conditions and Engineering Parameters

4.3.1. General

At the ground surface of boring 3.2 B-2, we encountered about 6 inches of topsoil. For the purposes of this report, we generally define topsoil as a fine-grained soil with an appreciable amount (generally more than about 15 percent by volume) of organic matter based on visual examination. At the locations of borings 3.2 B-1 and 3.2 B-3, topsoil, if present, was removed during preparation of a pad for the drilling operations, and was generally less than about 6 inches thick.

Underlying the topsoil in boring 3.2 B-2 and at the ground surface in borings 3.2 B-1 and 3.2 B-3, we encountered basalt rock. Based on the results of the subsurface explorations, we characterized the basalt into three general sub-units as described below and presented in Cross Section A-A', Figure 3. Selected rock cores from each unit were analyzed in the laboratory for unconfined compressive strength.

4.3.1.1. Dense Basalt

A dense basalt unit was encountered in all three site borings and generally consisted of very hard, non-vesicular basalt with Rock Quality Designation (RQD) values that varied from 50 to nearly 90 percent. Fracture spacing within the dense basalt unit varied from about 2 to 24 inches.

4.3.1.2. Columnar Basalt

A columnar basalt unit was encountered in all three site borings and generally consisted of medium to very hard, non-vesicular to slightly vesicular basalt with RQD values that varied from 0 to nearly 65 percent. Fractures within the columnar basalt unit were generally near vertical and generally persisted within the core samples for up to 6 inches.

4.3.1.3. Vesicular Basalt

A vesicular basalt unit was encountered in all three site borings and generally consisted of soft to medium hard, highly vesicular basalt with RQD values that varied from 0 to nearly 70 percent. Fracture spacing within the vesicular basalt unit varied from very closely space to about 8 inches.

4.3.2. Shear Strength Parameters

Shear strength parameters or the basalt rock were estimated using the computer program RocData. RocData is used to determine the parameters of linear and non-linear strength envelopes for rock and soil based on Hoek and Brown classification parameters that include the following inputs:

- Unified compressive strength (UCS)
- Geologic Strength Index (GSI);
- Hoek-Brown constant (m_i); and
- Disturbance factor.

Based on laboratory results, rock strength is variable with estimated unconfined compressive strengths ranging from about 6,000 to over 38,000 pounds per square inch (psi). The GSI estimates a reduction in rock mass strength based on a visual impression of the rock structure. Based on our review of the rock core and calculated RQD values, GSI values generally ranged from blocky/disturbed (35) to intact or massive (90). A m_i value of 25 was selected, based on literature values for basalt rock and our professional judgment. To model the effects of poor blasting, thereby providing a conservative strength envelope, we set the disturbance factor to 1.

We used the RocData program to estimate the shear strength parameters (c and phi) of the rock units based on the values described above. Based on the Mohr-Coulumb failure criterion, we estimate the instantaneous angle of internal friction (ϕ_i') of the rock mass ranges from about 45 to 66 degrees. We also estimate the cohesion value (c_i) of the rock mass ranges from 1,660 psf to 268,000 psf.

4.3.3. Unit Weight

The measured unit weight of the laboratory tested rock specimens ranged from about 145 pounds per cubic foot (pcf) to 180 pcf.

4.3.4. Selected Engineering Parameters

Selected engineering parameters of the basalt rock units are presented in Table 1.

TABLE 1. ESTIMATED ROCK PARAMETERS

Parameter Description	Vesicular Basalt	Columnar Basalt	Dense Basalt
Total Unit Weight (pcf)	145	170	180
Internal Friction Angle (Degrees)	45	58	66
Cohesion (psf)	1,660	5,300	268,000

A cross section of the basalt rock layers relative to the proposed reservoir is presented in Figure 3. The location of the cross section is shown on Figure 2.

4.3.5. Groundwater Conditions

Because of the rock coring method used, we were unable to monitor groundwater levels in the borings during drilling. Regional and perched groundwater elevations are expected to vary seasonally in response to precipitation, irrigation and other factors. It is possible that zones of perched groundwater could be encountered within the fractured and vesicular basalt rock.

5.0 ROCK CUT ANALYSES

5.1. General

Two general failure modes were analyzed for the anticipated rock cut that will be required to achieve proposed site grades. The first potential failure mode is a global (slope) failure. The second potential failure mode consists of dislodgement of individual rocks exposed along the cut face (rock topple/fall). Computer-based analyses were completed to evaluate both potential failure modes. SLOPE/W (GEO-SLOPE International, Ltd. 2016) was used to analyze the static and seismic global stability of various slope geometries. Based on our experience, rock topples can occur in either natural or man-made slopes comprised of columnar basalt; therefore, we assume that rock topples and rockfall is possible. The Colorado Rock-Fall Simulation Program (CRSP) was used to evaluate potential rock topple/fall patterns and trajectories.

5.2. Rock Slope Stability

Slope stability analyses were completed using the computer program SLOPE/W. SLOPE/W is used to evaluate the stability of the critical failure surfaces identified using vertical slice limit-equilibrium methods. Spencer's Method was used for this project, which solves for both force and moment equilibrium conditions. Both circular and block failure surfaces were analyzed. The model identifies the most critical failure surface for specified topography, subsurface conditions, soil properties and groundwater profile. The stability of the rock mass is reported as a safety factor, which is the ratio of resisting forces to driving forces. A safety factor of 1.0 indicates that the resisting forces are equal to the driving forces and that the slope is at marginal stability. A safety factor less than 1.0 indicates that the resisting forces are smaller than the driving forces and that the slope will fail. A safety factor greater than 1.0 indicates that the resisting forces are greater than the driving forces. Safety factors greater than 1.0 are commonly required for long-term stability of slopes and when mitigating failed or marginally stable slopes.

We considered three general cases: (1) 1H:1V (Horizontal:Vertical) slope gradient; (2) 0.5H:1V slope gradient; and (3) 0.25H:1V slope gradient. The engineering parameters provided in Table 1 were generally used to model the strength of the rock units, however, we used the more conservative strength values of the columnar basalt instead of the higher strength dense basalt within the cut slope. The results of our preliminary analysis are summarized in Table 2. The safety factors presented below are for potential block failures, as they produce lower safety factors compared with circular failures.

TABLE 2. SUMMARY OF SLOPE STABILITY ANALYSES

	Safety Factor	
Gradient (H:V)	**Static**	**Seismic (Horizontal Coefficient = 0.04)**
1:1	4.5	4.2
0.5:1	2.5	2.3
0.25:1	2.5	2.3

5.1. Rockfall Evaluation

We completed evaluation for the potential of rock blocks to impact the wall of the proposed Reservoir using the CRSP. Specifically, we used the CRSP to aid in the design of rockfall mitigation for a 0.25H:1V, 0.5H:1V and a 1H:1V cut slope at the project site. The primary concern was where rock falling from the slope could impact the proposed Reservoir. A model profile was developed from survey data and proposed cut slope angles. Parameters for tangential and normal coefficients of slope roughness were estimated from tables in the CRSP Manual and our professional judgment.

We used the CRSP to simulate the fall pattern for 500 spherical rock blocks with rockfall initiating near the crest of the cut slope. To simulate the effects of block size on the model, we ran numerous iterations of the CRSP model with various spherical rock blocks ranging in size from 6 inches to 3 feet in diameter. Three analysis points were used in the plots (AP1, AP2 and AP3) that were initially located 10, 20 and 30 feet from the toe of the profile, respectively. Based on our analyses, block size of approximately 1 to 2 feet in diameter are most likely to impact points further than 30 feet from the toe of the slope without any mitigation measures, as summarized in Table 3. Based on our analyses, larger blocks (e.g. 3 feet in diameter) will be captured at or near the toe of the slope.

TABLE 3. SUMMARY OF ROCKFALL EVALUATION

	AP-1 (10 feet from toe)		AP-2 (20 feet from toe)		AP-3 (30 feet from toe)	
Gradient (H:V)	**Percent Passing (%)**	**Velocity[1] (ft/sec)**	**Percent Passing (%)**	**Velocity[1] (ft/sec)**	**Percent Passing (%)**	**Velocity[1] (ft/sec)**
1:1	90	26.05	80	24.04	72	22.19
0.5:1	80	18.83	63	16.78	42	14.98
0.25:1	48	17.13	36	14.79	21	12.64

[1]Based on 90% Cumulative Probability (i.e. there is a 90% probability that velocity will not exceed stated value); ft/sec = feet per second

The effects of constructing a catchment basin with about a 1-foot-thick layer of sand in a flatbed that extends 10, 15 and 20 feet from the toe of the slope were modeled and are summarized in Table 4. Simulations indicated that about 99 to 100 percent of the rockfall from a 0.25H:1V slope located 20 feet from the edge of the tank should stop within a 20-foot-wide catchment basin. However, shallower slopes and reduced offsets from the toe of the slope to the edge of the tank generally increased the potential for rockfall to impact the proposed tank. This is because the sloping surface helped to translate the downward driving gravitational force into the horizontal direction.

TABLE 4. SUMMARY OF EFFECTS OF CATCHMENT BASIN ON ROCKFALL

Gradient (H:V)	Mitigation Measure	AP-1 (10 feet from toe)		AP-2 (20 feet from toe)		AP-3 (30 feet from toe)	
		Percent Passing Catchment Basin (%)	Velocity[1] (ft/sec)	Percent Passing Catchment Basin (%)	Velocity[1] (ft/sec)	Percent Passing Catchment Basin (%)	Velocity[1] (ft/sec)
1:1	10-foot-wide catchment	77	23.78	68	21.67	58	19.74
	15-foot-wide catchment	78	23.78	61	20.32	49	18.54
	20-foot-wide catchment	78	23.77	51	19.61	39	17.41
0.5:1	10-foot-wide Catchment	64	16.52	39	14.78	23	12.63
	15-foot- wide catchment	61	16.16	22	13.22	10	11.34
	20-foot-wide catchment	60	16.45	13	12.73	5	10.80
0.25:1	10-foot-wide catchment	36	13.46	17	10.88	<1	8.25
	15-foot-wide catchment	37	13.25	6.4	9.05	<1	5.56
	20-foot-wide catchment	36	13.30	<1	3.91	–	–

[1]Based on 90% Cumulative Probability (i.e. there is a 90% probability that velocity will not exceed stated value); ft/sec = feet per second; "—" = no rocks passing

These results appear to be consistent with charts of catchment areas based on 40-foot-high slope cuts prepared for cut slope inclinations of 02.5H:1, 0.5H:1V, 0.75H:1V and 1H:1V (Pierson et al. 2001). The velocity information can be used for part of the design basis for a barrier if a catchment basin is not designed and constructed.

We also noticed that the model is relatively sensitive to small changes in the roughness of the slope surfaces, and even with the catchment basin, some rock could impact the proposed Reservoir. Given the potential for slight variation in slope because of blasting and excavation means and methods, secondary containment might be necessary. Recommendations for addressing rockfall are provided in the section titled "Permanent Slopes" below.

6.0 CONCLUSIONS

6.1. General

Based on the results of our site exploration, geotechnical and analytical laboratory testing program and engineering analyses, we believe that the proposed Reservoir may be designed and constructed as envisioned, provided the recommendations presented herein are incorporated in to the design and construction documents. A summary of the primary geotechnical considerations for the site is provided below. The summary is presented for introductory purposes only and should be used in conjunction with the complete recommendations presented in this report.

- Rock is present at the ground surface throughout the project site. Therefore, excavation required to establish foundation grade for the proposed Reservoir will almost entirely consist of rock excavation. We recommend the grading design be completed using a maximum slope gradient of 0.25H:1V in cut slopes. Based on our analyses, flatter slopes would require an increase in the volume of rock excavated without providing an increase in the performance of the slope or to reduce risk from rockfall.
- Precision blasting should be used to reduce overbreak, which could lead to potential instability of cut slopes and rock at and below foundation grade. In addition, irregular cut slopes caused by poor blasting efforts could result in decreased (shallower) slope inclinations which would result in rockfall material projecting farther out from the slope during the operational phase of the Reservoir. The contractor should provide a blasting plan, including steps the contractor will take to measure and document that blasting activities will not negatively impact nearby structures. It also will be critical for an experienced engineering geologist from GeoEngineers to be on-site during rock excavation activities to evaluate the condition of exposed rock and provide recommendations to mitigate potential unstable areas, if encountered.
- Suitable setbacks and rockfall protection should be incorporated into design and construction to reduce the potential for rockfall to damage the proposed Reservoir.
- Foundations and slab-on-grade mats should be supported on undisturbed rock, or a structural fill pad overlying undisturbed rock.

These and other geotechnical considerations are discussed further and recommendations pertaining to the geotechnical aspects of the project are presented in the following sections.

7.0 RECOMMENDATIONS

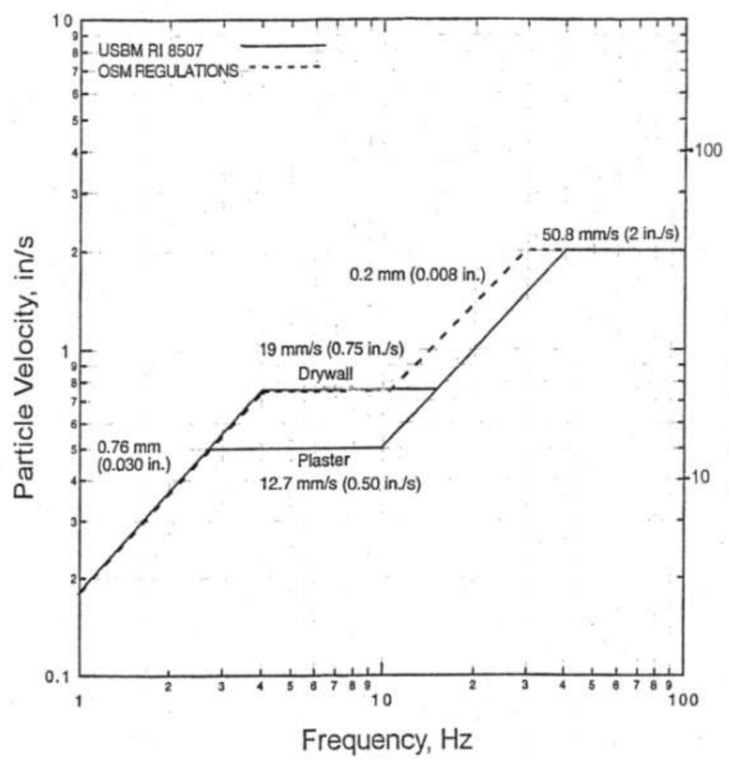
7.1. Site Preparation and Earthwork

7.1.1. Grading and Excavations

A preliminary site plan for the Reservoir provided by Murraysmith indicates that the floor elevation of the Reservoir will be approximately at elevation 1,296 feet. Based on the anticipated geometry, cuts ranging from less than several feet, up to about 35 to 40 feet will be required to establish proposed final foundation grade for the Reservoir. Based on the results of our explorations, basalt rock will likely be present approximately from the ground surface to foundation grade.

Weak or highly fractured rock may often be excavated using conventional earthwork equipment and/or ripping with specialty designed tools. However, we anticipate harder rock might be encountered in the cut slope that might require blasting to remove. Overbreak caused by blasting can adversely affect stability of the final slope and strength and compressibility of rock below the proposed Reservoir. Overbreak also could affect rockfall patterns, potentially causing rockfall to project out beyond designed buffers. Therefore, we recommend use of precision pre-splitting techniques to help create the final rock slope face. Selection of a qualified blaster is equally important with an appropriate level of experience designing and successfully completing precision pre-splitting. The contractor should provide a blasting plan for review before mobilizing to the site. The contractor also should be responsible for measuring peak ground velocities near the site and maintaining ground velocities from blasting operations below allowable thresholds.

Several structures are located within about 200 to 500 feet of the proposed Reservoir location. There is an existing modular storage unit facility located about 100 to 200 feet west of Reservoir location, and a cast-in-place concrete or precast commercial building located about 200 to 300 feet south of the proposed Reservoir location. The threshold at which there is a risk of architectural/structural damage is commonly taken to be about 2.0 inches per second peak particle velocity. However, lower values may be applicable for more sensitive structures. In addition to vibration level, the frequency of the vibrations plays an important role in potential structural damage. Lower frequency vibrations are typically more damaging to structures than high frequency vibrations. In the United States, common standards for allowable vibrations at various frequency levels are those published for the US Bureau of Mines (USBM) and the Office of Surface



USBM and OSMRE Allowable Vibration Limits

Mines Reclamation and Enforcement (OSMRE). The allowable vibration levels from these publications are shown below.

The USBM and OSMRE vibration levels were developed for blasting. Another commonly used vibration standard is the Federal Transit Administration (FTA) standard. The FTA Noise and Vibration Manual is a widely cited source for vibration standards for road construction projects in the United States and may be more appropriate for this project. A simplified standard from the FTA manual using four structural categories is shown in Table 5.

TABLE 5. FTA VIBRATION LIMITS

Building Category	Maximum Peak Particle Vibration (inches/second)
I. Reinforced-concrete, steel or timber (no plaster)	0.50
II. Engineered concrete and masonry (no plaster)	0.30
III. Non-engineered timber and masonry buildings	0.20
IV. Buildings extremely susceptible to vibration damage	0.12

Reference: Federal Transit Administration's Noise and Vibration Manual, Chapter 12.

A number of other vibration standards are also available including ISO (International Organization for Standardization), ANSI (American National Standards Institute) and ASTM International (ASTM) standards. While the vibration standards presented above set an allowable threshold, it should be understood there is no precise level of vibration which will or will not cause damage to a structure. It is possible structural damage may occur at vibration levels lower or higher than the allowable vibration levels presented above. These vibration levels are all related to shaking of the structure. Damage due to settlement of soil below structures may occur at lower levels. Human perception of vibration is typically well below the allowable vibration levels presented above.

Due to the proximity of existing buildings to the proposed cut slope, we recommend vibration monitoring be performed during construction. Vibration monitoring information can be used by the Contractor to alter means and methods, if necessary, to reduce the risk of vibration damage to the existing nearby buildings. Prior to determining the actual threshold value, we recommend a series of baseline readings be measured to evaluate the existing vibration levels from normal operating traffic. GeoEngineers can be retained to monitor vibrations, upon request.

To summarize, we recommend the following actions be conducted for this project:

- Selection of maximum peak particle velocities for nearby structures to be included in project specifications. Preliminarily, we suggest a peak particle velocity of 2 inches per second for the storage unit facility and 0.5 inches per second for the commercial building.
- Pre- and post-construction surveys to document the condition of the adjacent structures.
- Vibration monitoring to document construction vibrations on adjacent structures.

7.1.2. Permanent Slopes

Based on our analyses, we recommend a maximum slope gradient of 0.25H:1V in cut slopes. Flatter slopes will require an increase in the volume of rock excavated without providing an increase in the performance of the slope or to reduce risk from rockfall.

In our opinion, the potential for slope failure of a 0.25H:1V cut slope is low; however, based on our experience with basalt rock cuts, rock topple can occur from slopes in columnar basalt. Furthermore, highly fractured vesicular basalt was encountered in our subsurface borings near the base of the proposed cut. Our analyses of rock mass properties indicated this vesicular basalt unit to have less strength than the overlying units. Accordingly, the vesicular basalt unit has the potential to undermine the more competent columnar and dense basalt units which can increase the potential for slope failure. Cuts should be inspected by an engineering geologist or geotechnical engineer experienced with rock slope evaluations during and during and following completion of rock slope excavations to review our design assumptions, observe any changes in rock mass properties and provide additional recommendations for treatment, if deemed necessary.

Simulations of a 0.25H:1V cut slope using the CRSP suggest that small to moderately-sized boulders (up to 2 feet in diameter) could impact the proposed tank; however, the analyses indicated shallower slopes generally increased the potential for rockfall impacting the proposed tank. To mitigate potential rockfalls, we recommend that either:

1. A 20-foot-wide catchment and offset area be constructed at the base of the slope per our discussion below.
2. Construction of a 16-foot-wide catchment area, provided the base of the catchment area is graded at a 4H:1V inclination to match with the planned finished grade.
3. Construction of a 10-foot-wide catchment area and installation of a secondary barrier. The barrier could consist of gabion baskets, jersey barriers or ecology blocks at least 4 feet high. Alternatively, a dynamic mesh barrier could be designed and constructed, but may not be economical. If barriers are used in conjunction with a catchment area, the design should include provisions for accessing the catchment area to remove debris periodically.
4. Construction of a 5-foot-wide catchment area and installation of a cable mesh with a finer mesh backing. We should be consulted for design of the cable net system, if it is implemented.

Our rockfall mitigation recommendations, based on the 0.25H:1V cut slope simulations, are summarized in Table 6. The recommended catchment should extend a minimum of 2 feet below the planned toe of slope (finished grade of the tanks) at a grade of 0.25H:1V. We recommend that a 1-foot-thick layer of well-graded and free-draining sand be placed to help absorb the energy of falling rock.

TABLE 6. ROCKFALL MITIGATION ALTERNATIVES

Gradient (H:V)	Catchment Basin	Minimum Recommended Setback (feet)	Install Barrier
0.25:1	10-foot Catchment	20	Yes
	16-foot Catchment	20	No[1]
	20-foot Catchment	20	No

Notes: [1]Barrier not needed assuming a catchment with a 4H:1V bottom is designed and constructed.

Alternatively, it is our opinion that a cable net material may be placed over the slope to protect against rockfall. A cable net material placed over the slope will absorb the energy of falling rock. If a cable net material is placed over the slope, we recommend a minimum 5-foot-wide catchment basin excavated below grade or with a barrier at the toe of the slope and a setback of 15 feet. We can provide additional design criteria for such a system at your request.

Depending on the final constructed slope gradient, the catchment basin width, inclination and necessity for barriers (jersey barriers, gabion basket, e.g.) could be modified. However, the results of our analyses indicated that setback between the rock slope and the Reservoir flattening the cut slope inclination does not reduce the minimum catchment widths and setbacks.

7.2. Subgrade Preparation

Following blasting and grading, and before placing concrete or other Reservoir components, structural fill or forms and rebar reinforcement for concrete, we recommend that loose/disturbed rock beneath the Reservoir be excavated and removed. Methods that have proven reliable for cleaning foundation excavations in rock include the use of a vacuum truck or power washing the rock surface and collecting the residual soil and rock fragments in a downgradient sump. Sharp, pointed or protruding rock should be broken to provide a relatively smooth surface on which to construct the foundation.

Following removal of loose and disturbed rock, foundations may be placed directly on undisturbed rock, or on a structural fill pad overlying undisturbed rock. A structural fill pad should consist of either crushed rock base course or concrete (either lean mix or structural concrete). In the event rock is present below portions of the Reservoir foundation and structural fill will be required to establish foundation grade below other portions of the proposed Reservoir, we recommend one of the following:

- Over-excavate rock to provide at least a 6-inch-thick structural fill pad of crushed rock base course below the foundations.
- Use concrete to fill in low areas to establish foundation grade.

The intent of these recommendations is to provide uniform bearing conditions below the Reservoir, thereby reducing “hard spots” and potential for differential settlement. Which of these two options should be evaluated during construction based on the locations, extent and thickness of required structural fill.

Any rock pockets present at foundation grade after blasting should be filled with structural fill. Additionally, drainage should be provided to any low areas to prevent issues with freeze-thaw.

The evaluation of structural fill compaction should be accomplished through in-place density testing of the prepared areas and/or visual observations and probing. The most appropriate method for evaluating soil compaction should be determined by a representative of GeoEngineers at the time the site work is performed.

7.3. Structural Fill

Soil used to support structures, pavements and hardscape areas, and as backfill against below-grade structures, is classified as structural fill for the purposes of this report. Structural fill material requirements vary depending upon its use as described below. Regardless of use, all soil used as structural fill for this project should be free of debris, organic contaminants, frozen soil and particles larger than 6 inches in maximum dimension. In addition, structural fill should not be placed on frozen soil.

7.3.1. Imported Structural Fill

Imported aggregate base course material for use beneath Reservoir foundations or other areas should consist of crushed aggregate base course, such as material meeting criteria outlined in Section 3:04-D of the *City of Pendleton Standard Specifications for Roadway Aggregate Rock Base Fill Material.*

7.3.2. Use of On-site Soil

In our opinion, the on-site soil overlying the basalt generally consists of topsoil. For this reason, we do not recommend reusing the on-site silt unit as structural fill. Excavated basalt rock could potentially be reused as drain rock or quarry spalls. However, screening might be required. Alternatively, excavated rock could be crushed on-site to produce crushed rock base course.

7.3.3. Fill Placement and Compaction Criteria

Structural fill should be placed in loose lifts not exceeding 8 inches in thickness and mechanically compacted to a firm, non-yielding condition. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. We recommend all structural fill within the proposed Reservoir footprint, regardless of depth below foundation grade, be compacted to at least 95 percent of the maximum dry density (MDD) based on the ASTM D 1557 laboratory test procedure. We further recommend that structural fill conditions be evaluated by in-place density tests, visual evaluation, probing and proof-rolling of the structural fill as it is prepared to check for compliance with the contract documents and recommendations in this report.

7.4. Weather Considerations

Structural fill placement will be difficult to accomplish if earthwork is performed during extended periods of wet or sub-freezing weather. Unprotected site soil or weathered rock material can erode over time and/or deteriorate under construction traffic if exposed to inclement weather. Accordingly, we recommend a work plan be developed as part of initial bid documents to protect site soil during inclement weather, such as rain, snow and freezing conditions. Excavations for proposed structures that are prepared before inclement weather should be protected and re-inspected after such weather to identify if any areas require repair. Areas requiring repair should be recompacted or overexcavated to firm bearing or a depth of 2 feet, whichever is less, and replaced with compacted structural fill as discussed in a previous section of this report.

7.5. Foundation Support

7.5.1. Foundation Design

Based on the results of our subsurface explorations and analysis, it is our opinion the proposed Reservoir may be designed and supported on a shallow mat foundation or spread footings, supported on undisturbed rock or structural fill pad overlying rock as recommended in this report. We recommend structural fill be placed and compacted as recommended in the "Structural Fill" section of this report.

Based on our initial understanding of the proposed Reservoir dimensions and loads as summarized at the beginning of this report, we estimate the approximate bearing pressure of the Reservoir will be in the range of about 2,000 to 2,500 psf. Assuming the above recommendations are implemented during construction, the mat foundation or thickened slab may be designed using an allowable bearing pressure of 6,000 psf. This value may be increased by one-third to account for short-term live loads, such as those induced by wind and seismic conditions. The weight of the foundation and any backfill placed above the mat may be neglected when considering downward loads.

7.5.2. Settlement

We estimate that settlement of the proposed reservoir should occur primarily as elastic settlement and that most of the settlement will occur as loads are applied. We estimate total settlement of the Reservoir should be less than about ½ inch. Disturbed rock not removed from before placing structural fill could result in larger settlements than estimated.

7.5.3. Lateral Resistance

The soil pressure available to resist lateral foundation loads is a function of the frictional resistance against the foundation base and the passive resistance, which can develop on the face of below-grade elements of the structure as those elements move horizontally into the soil. For foundations bearing on in-place basalt, or a crushed rock base course or concrete leveling pad prepared as recommended, the allowable frictional resistance may be computed using a coefficient of friction of 0.40 applied to vertical dead-load forces for the contact between concrete foundations and rock or leveling pad. The allowable passive resistance on the face of foundations or other embedded foundation elements may be computed using an equivalent fluid density of 250 pcf, triangular distribution, for structural fill. The above values include a factor of safety of about 1.5 and is based the assumption that backfill placed against foundations has been compacted to at least 95 percent of MDD. Mobilization of passive resistance will require movement of foundations. We recommend ignoring passive resistance unless lateral foundation movement of about 0.005H (where H is thickness of the embedded foundation element mobilizing passive resistance) can be tolerated.

7.5.4. Mat Foundations

A coefficient of subgrade reaction of 300 pounds per cubic inch (pci) may be used for structural design of structural slabs, provided that the subgrade has been prepared as recommended in this report. This coefficient is a K_{s1} value for a 1-foot by 1-foot square plate. The coefficient of subgrade reaction for a foundation varies based on its minimum width according to the following equation:

$$k_s = k_{s1}[(B+1)/2B]^2$$

Where k_s is the coefficient of subgrade reaction, k_{s1} is the coefficient of subgrade reaction for a 1-foot by 1-foot plate, and B is the minimum width or diameter of the slab. This equation may be used to estimate K_s values for area loads exceeding 1 foot in minimum dimension.

8.0 SEISMIC DESIGN

As required for the project, a site-specific seismic hazard analysis has been performed. Results of the study, including a geologic hazards analysis, are presented in Appendix C of this report. The parameters provided in Table 7 are based on the conditions encountered during our subsurface exploration program and the results of the site-specific study. These parameters are appropriate for code level seismic design in accordance with the 2015 International Building Code (IBC).

TABLE 7. SEISMIC DESIGN PARAMETERS

Parameter	Value
Site Class	B
Spectral Response Acceleration, S_s	0.35 g
Spectral Response Acceleration, S_1	0.13 g
Site Coefficient, F_a	1.00
Site Coefficient, F_v	1.00
Spectral Response Acceleration (Short Period), S_{DS}	0.23 g
Spectral Response Acceleration (1-Second Period) S_{D1}	0.09 g

8.1. On-Site Material Considerations

8.1.1. Shrinkage, Consolidation and Expansion of On-Site Material

Because the proposed Reservoir will be supported on in-place rock (or a structural fill pad overlying in-place rock), considerations for volume change of in-place materials, as a result of loading or changes in moisture content (shrink/swell), are negligible. Table 8 can be used to estimate the potential volume change of in-place rock following excavation.

TABLE 8. SUMMARY OF SOIL VOLUME CHANGE ESTIMATES

Soil/Rock Unit	Percent Expansion from In-Situ to Loose (Excavated or stockpiled) Condition	Percent Shrinkage (-) or Expansion (+) from In-Situ to Compacted Condition
Basalt	65 to 75	+ 25 to 30 (reuse requires processing/crushing)

9.0 DESIGN REVIEW AND CONSTRUCTION SERVICES

Recommendations provided in this report are based on the assumptions and preliminary design information stated herein. We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GeoEngineers should be retained to review the geotechnical-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in this report. We also recommend that we be retained to provide geotechnical consultation services during construction to assist the City if geotechnical-related questions arise during construction.

10.0 LIMITATIONS

We have prepared this report for Murraysmith, Inc. for the proposed Water Reservoir that is part of the City of Pendleton Water and Sewer System Upgrades project in Pendleton, Oregon. Murraysmith, Inc. may distribute copies of this report to the City of Pendleton (City) and the City's authorized agents and regulatory agencies as may be required for the project.

Our services were provided to assist in the design of foundations for a planned structure to be located adjacent to sloping ground in rock to be excavated as part of the project. Our recommendations are intended to improve the overall stability of the site and to reduce the potential for future property damage related to earth movements, drainage or erosion. Qualified engineering and construction practices can help mitigate the risks inherent in construction on slopes, although those risks cannot be eliminated completely. Favorable performance of structures in the near term is useful information for anticipating future performance, but it cannot predict or imply a certainty of long-term performance, especially under conditions of adverse weather or seismic activity.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix D titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

11.0 REFERENCES

Crouse, C.B. 1991. Ground-motion attenuation equations for earthquakes on the Cascadia subduction zone. Earthquake Spectra 7, pp. 201-235.

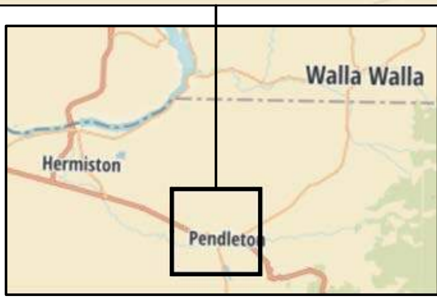
McConnell, V.S. 2003. Preliminary Geologic Map of Services Buttes, Echo, Nolin, Barnhart, and Pendleton 7.5' Quadrangles (west to east), Umatilla County, Oregon. Oregon, Department of Geology & Mineral Industries.

United States Department of Agricultural (USDA), Natural Resources Conservation Service (NRCS), Web Soil Survey, 2016. Available online at http://websoilsurvey.nrcs.usda.gov. Accessed January 5, 2018.

U.S. Geological Survey, 2017. Quaternary fault and fold database for the United States, accessed January 23, 2018, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/. Dated 2017.

Walker, G.W. 1973: Reconnaissance Geologic Map of the Pendleton Quadrangle, Oregon and Washington, U.S. Geological Survey I-727, scale 1:250,000.

FIGURES



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Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2017

Projection: NAD 1983 UTM Zone 11N

New Reservoir Vicinity Map

Proposed City of Pendleton Water
and Sewer System Upgrades
Pendleton, Oregon

GeoEngineers

Figure 1

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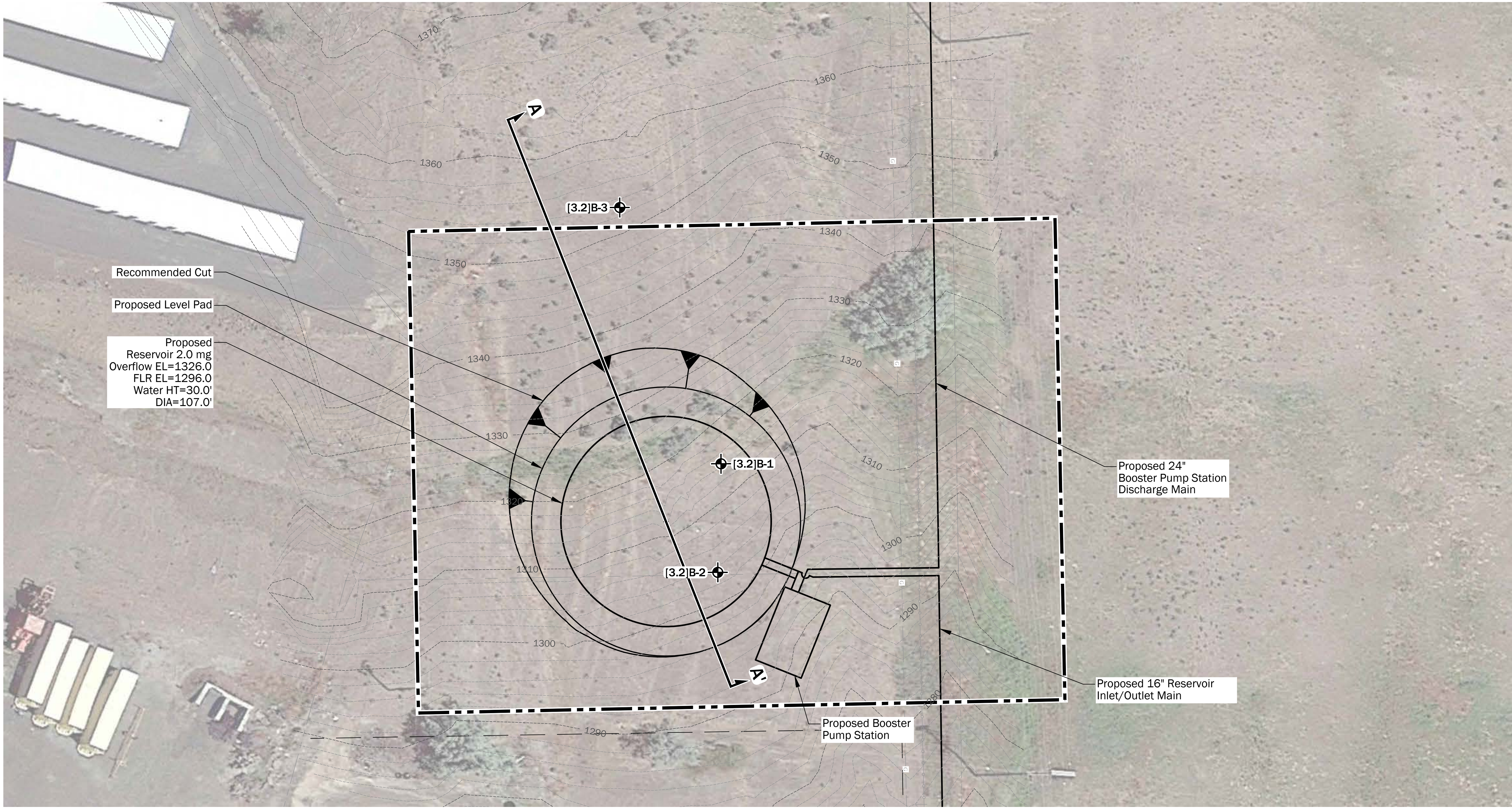

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Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base from Murraysmith, no date given.

Projection: Pendleton Project Datum, US Foot

Legend

[3.2]B-1 Pendleton Borings Location

Site Boundary

A A' Cross Section Location

N W E S

50 0 50

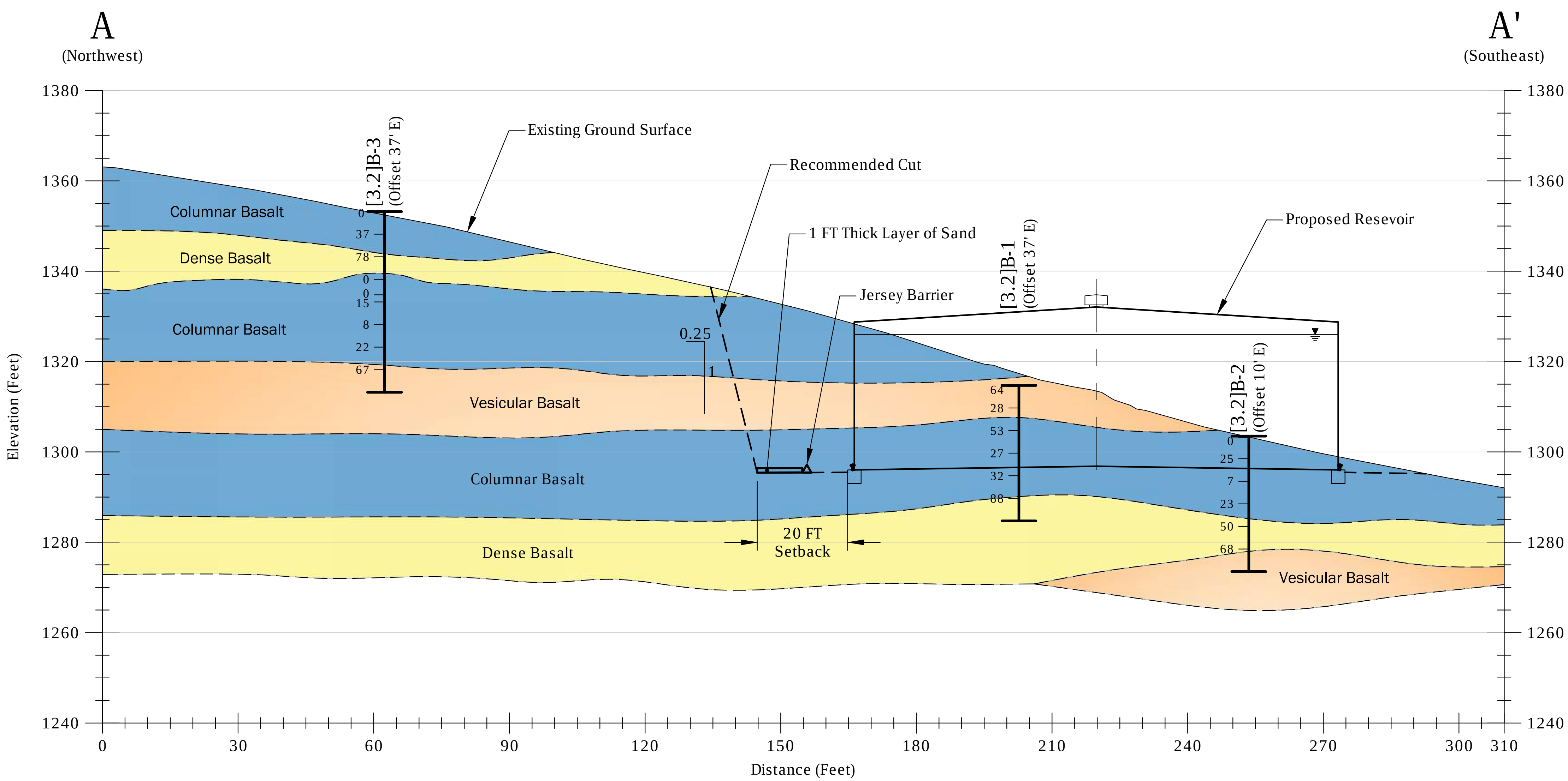
Feet

New Reservoir Site Plan

Proposed City of Pendleton Water and Sewer System Upgrades
Pendleton, Oregon

GeoEngineers

Figure 2



Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Datum: NAVD 88, unless otherwise noted.

Legend

[3.2]B-1 (Offset 10' East)

Boring

Inferred Intra-flow Unit Contact

20 RQD %

Columnar Basalt

Dense Basalt

Vesicular Basalt

30 0 30
Horizontal Scale in Feet

30 0 30
Vertical Scale in Feet
Vertical Exaggeration: 1X

Cross Section A - A'

Proposed City of Pendleton Water and Sewer System Upgrades
Pendleton, Oregon

GeoEngineers

Figure 3

APPENDICES

APPENDIX A
Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

Soil and rock conditions at the site were explored on November 30 and December 1, 2017, by drilling three borings (3.2 B-1 through 3.2 B-3) at the approximate locations shown on Figure 2. The borings were advanced to depths in the range of about 30 to 40 feet below existing ground surface using a track-mounted Diedrich D-50 hollow-stem auger drill rig owned and operated by Holocene Drilling, Inc. Because rock was at or near the ground surface at the boring locations, the borings were drilled using wireline rock coring techniques beginning at the ground surface as described below.

The borings were continuously monitored by an engineer from our firm who examined and classified the soil and rock encountered, obtained representative soil and rock samples and maintained a detailed log of the explorations. Soil encountered in the explorations was classified in the field in general accordance with ASTM D 2488, the Standard Practice for Classification of Soils, Visual-Manual Procedure, which is summarized in Figure A-1, Key to Exploration Logs. Rock encountered in the explorations was classified in general accordance with the Oregon Department of Transportation (ODOT) Soil and Rock Classification Manual (1987), which is summarized in Figure A-2, Explanation of Bedrock Terms.

Logs of the borings are presented in Logs of Borings, Figures A-3 through A-5. The logs are based on interpretation of the field and laboratory data, and indicate the depth at which subsurface materials or their characteristics change, although these changes might actually be gradual.

Where rock was encountered, the driller used NQ, triple barrel continuous wire-line rock coring methods. The rock core samples were logged in the field, stored in core boxes and transported to GeoEngineers laboratory in Spokane, Washington. Field logging of rock core samples included determining the RQD and core sample description. The RQD provides an approximate measure of the degree of jointing or fracture in a rock mass. RQD is calculated by measuring the length of rock particles greater than 4 inches divided by the total length of the rock core. The RQD designation is provided on the boring logs at the corresponding core run depths. Photographs of the core samples are presented in Appendix B.

The boring locations were selected based on a preliminary site plan provided by Murraysmith. The boring locations were established in the field using an iPad with GISPro software and/or by taping and pacing from existing site features. Boring elevations were estimated from contours provided on Figure 2. Exploration locations and elevations should be considered accurate to the degree implied by the method used.

Laboratory Testing

Rock samples obtained from the explorations were returned to our laboratory for further examination and testing.

The test procedures were performed in general accordance with the applicable ASTM test procedures ("in general accordance" means certain local and common descriptive practices and methodologies have been followed). The laboratory testing program is summarized in Table A-1, Summary of Laboratory Testing.

TABLE A-1. SUMMARY OF LABORATORY TESTING

Standard Test Method for:	Test Method Designation	Total Tests Performed	Results Location
Point Load Index	ASTM D 5731	3	Summarized on the applicable exploration logs in the 'Remarks' Column.
Uniaxial Compressive Strength of Rock	ASTM D 7012	4	Summarized on the applicable exploration logs in the 'Remarks' column.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

- 2.4-inch I.D. split barrel
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab
- Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

EXPLANATION OF BEDROCK TERMS

Scale of Relative Rock Weathering (ODOT, 1987)

Designation	Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 inch into rock.
Moderately Weathered	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Predominantly Decomposed	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

Scale of Relative Rock Hardness (ODOT, 1987)

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	< 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocket knife. Scratched with fingernail.	100-1000 psi
Soft	R2	Can be peeled by a pocket knife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1000-4000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4000-8000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8000-16000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	> 16000 psi

Rock Quality Designation (RQD)

RQD (Percent)	Description of Rock Quality
0 to 25	Very Poor
25 to 50	Poor
50 to 75	Fair
75 to 90	Good
90 to 100	Excellent

RQD is a modified core recovery measurement which expresses the number of hard and sound rock pieces of 4" or more in size as a percentage of the total length of core run.

Discontinuity Spacing (ODOT, 1987)

Description for Bedding, Foliation, or Flow Banding	Spacing	Description of Joints, Faults, or Other Fractures
Very Thickly	>10 feet	Very Widely
Thickly	3-10 feet	Widely
Medium	1-3 feet	Moderately Closely
Thinly	2-12 inches	Closely
Very Thinly	< 2 inches	Very Closely

Drilled	Start 11/30/2017	End 11/30/2017	Total Depth (ft)	30	Logged By JJB	Checked By DRL	Driller	Holocene Drilling, Inc.	Drilling Method	Wireline Rock Coring

Surface Elevation (ft) Vertical Datum	1315 NAVD88	Hammer Data	Automatic 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50 Track-mounted
Latitude Longitude		System Datum	OR State Plane North WGS84	Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		57		Run 1	64		Basalt	Gray basalt, moderately weathered, soft to medium hard, poor to fair rock quality, very closely to closely spaced fractures, highly to slightly vesicular (vesicular basalt)			$I_{S(50)}$ = 58 psi Estimated UC Strength = 1,283 psi
1310	5		57		Run 2	28						
								Basalt	Gray basalt, slightly to moderately weathered, medium hard to hard, poor to fair rock quality, very closely to closely spaced fractures, slightly vesicular (columnar basalt)			
1305	10		58		Run 3 UC	53						UC Strength = 14,512 psi Unit weight = 168.4 pcf
1300	15		62		Run 4	37						
1295	20		60		Run 5	32						
1290	25		60		Run 6	88		Basalt	Gray basalt, fresh, very hard, good rock quality, closely spaced fractures, non-vesicular (dense basalt)			
1285	30											

Note: See Figure A-1 for explanation of symbols; Figure A-2 for ASTM Rock Classification System (ODOT, 1987).
Coordinates Data Source: Horizontal approximated based on Topographic Survey. Vertical approximated based on Topographic Survey.

Log of Boring 3.2 B-1

GEOENGINEERS

Project: Proposed City of Pendleton Water and Sewer System Upgrades
Project Location: Pendleton, Oregon
Project Number: 8946-003-00

Drilled	Start 11/30/2017	End 11/30/2017	Total Depth (ft)	30	Logged By JJB, Checked By DRL	Driller Holocene Drilling, Inc.	Drilling Method Wireline Rock Coring

Surface Elevation (ft) 1303 Vertical Datum NAVD88	Hammer Data: Automatic 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50 Track-mounted
Latitude 45° 41' 01.068" Longitude -118° 50' 20.832"	System OR State Plane North Datum WGS84	Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0							ML	Approximately 6 inches brown sandy silt with gravel and organic matter (roots) (medium stiff, moist) (topsoil)			
			48		Run 1	0		Basalt	Gray basalt, predominately decomposed to moderately weathered, very soft to medium hard, very poor rock quality, very closely to closely spaced fractures, slightly vesicular (columnar basalt)			
1300								Basalt	Gray basalt, predominately decomposed to moderately weathered, soft to medium hard, very poor rock quality, very closely to closely spaced fractures, non-vesicular (columnar basalt)			
	5		58		Run 2	25						
1295												
	10		54		Run 3	7						$I_{S(50)}$ = 227 psi Estimated UC Strength = 4,421 psi
1290								Basalt	Gray basalt, slightly weathered, medium hard to very hard, very poor rock quality, closely spaced fractures, non-vesicular (columnar basalt)			
	15		57		Run 4 UC	23						UC Strength = 18,185 psi Unit weight = 174.7 pcf
1285								Basalt	Gray basalt, slightly weathered, very hard, fair rock quality, closely spaced fractures, non-vesicular (dense basalt)			
	20		58		Run 5	50						
1280								Basalt	Gray basalt, moderately to slightly weathered, soft to hard, fair rock quality, very closely spaced fractures, slightly to non-vesicular (columnar basalt)			
	25		57		Run 6	68		Basalt	Gray basalt, moderately weathered, medium hard, fair rock quality, closely spaced fractures, highly vesicular, blue-gray mineralization (vesicular basalt)			
1275												
	30											

Note: See Figure A-1 for explanation of symbols; Figure A-2 for ASTM Rock Classification System (ODOT, 1987).
Coordinates Data Source: Horizontal approximated based on Topographic Survey. Vertical approximated based on Topographic Survey.

Log of Boring 3.2 B-2

GeoEngineers

Project: Proposed City of Pendleton Water and Sewer System Upgrades
Project Location: Pendleton, Oregon
Project Number: 8946-003-00

Drilled	Start 12/1/2017	End 12/1/2017	Total Depth (ft)	40	Logged By JJB	Checked By DRL	Driller	Holocene Drilling, Inc.	Drilling Method	Wireline Rock Coring

Surface Elevation (ft) / Vertical Datum	1353 / NAVD88	Hammer Data	Automatic 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50 Track-mounted
Latitude / Longitude	45° 41' 02.904" / -1188393° 00' 00"	System / Datum	OR State Plane North / WGS84	Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		48		Run 1	0		Basalt	Gray basalt, moderately weathered, soft to medium hard, very poor rock quality, very closely spaced fractures, non-vesicular (columnar basalt)			
1350								Basalt	Gray basalt, slightly weathered, hard, very poor to poor rock quality, very closely to closely spaced fractures, non-vesicular (columnar basalt)			
	5		60		Run 2	37						
1345								Basalt	Gray basalt, slightly weathered to fresh, very hard, poor to good rock quality, closely spaced fractures, non-vesicular (dense basalt)			
	10		60		Run 3	78						
1340								Basalt	Gray basalt, moderately to slightly weathered, medium hard to very hard, very poor rock quality, very closely to closely spaced fractures, non-vesicular (columnar basalt)			
	15		41		Run 4	0						$I_{S(50)}$ = 1,230 psi Estimated UC Strength = 26,979 psi
1335			15		Run 5	0						
	20		60		Run 6 UC	15						UC Strength = 38,950 psi Unit Weight = 180.8 pcf
1330												
	25		60		Run 7	8						
1325												
	30											

Note: See Figure A-1 for explanation of symbols; Figure A-2 for ASTM Rock Classification System (ODOT, 1987).
Coordinates Data Source: Horizontal approximated based on Topographic Survey. Vertical approximated based on Topographic Survey.

Log of Boring 3.2 B-3

GeoEngineers

Project: Proposed City of Pendleton Water and Sewer System Upgrades
Project Location: Pendleton, Oregon
Project Number: 8946-003-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	30		58		Run 8	22						
1320												
								Basalt	Gray basalt, moderately weathered, medium hard, fair rock quality, closely spaced fractures, blue-gray mineralization (vesicular basalt)			
	35		60		Run 9	67						
1315					UC							UC Strength = 6,128 psi Unit Weight = 145.4 pcf
	40											

Log of Boring 3.2 B-3 (continued)

GEOENGINEERS

Project: Proposed City of Pendleton Water and Sewer System Upgrades
Project Location: Pendleton, Oregon
Project Number: 8946-003-00

Figure A-5
Sheet 2 of 2

APPENDIX B
Rock Core Photos

Boring 3.2 B-1, 0 to 10 feet

Boring 3.2 B-1, 10 to 19.8 feet

Core Photos

Proposed City of Pendleton Water and Sewer System Upgrades
Pendleton, Oregon

GEOENGINEERS

Figure B-1

Boring 3.2 B-1, 19.8 to 27.5 feet

Boring 3.2 B-1, 27.5 to 30 feet

Core Photos	
Proposed City of Pendleton Water and Sewer System Upgrades Pendleton, Oregon	
GEOENGINEERS	Figure B-2

Boring 3.2 B-2, 0 to 11.9 feet

Boring 3.2 B-2, 11.9 to 21.9 feet

Core Photos	
Proposed City of Pendleton Water and Sewer System Upgrades Pendleton, Oregon	
GeoEngineers	Figure B-3

File No. 8946-003-00 1/5/2018

Boring 3.2 B-2, 21.9 to 30 feet

Boring 3.2 B-3, 0 to 10.5 feet

Core Photos	
Proposed City of Pendleton Water and Sewer System Upgrades Pendleton, Oregon	
GeoEngineers	Figure B-4

Boring 3.2 B-3, 10.5 to 20 feet

Boring 3.2 B-3, 20 to 30 feet

Core Photos

Proposed City of Pendleton Water and Sewer System Upgrades
Pendleton, Oregon

GeoEngineers

Figure B-5

File No. 8946-003-00 1/5/2018

Boring 3.2 B-3, 30 to 39.3 feet

Boring 3.2 B-3, 39.3 to 40 feet

Core Photos	
Proposed City of Pendleton Water and Sewer System Upgrades Pendleton, Oregon	
GeoEngineers	Figure B-6

APPENDIX C
Site-Specific Seismic Hazard Report

APPENDIX C
SITE-SPECIFIC SEISMIC HAZARD REPORT

Regional Seismicity

Earthquake Source Zones

Seismicity in the Pendleton area is dominated by local crustal faults. Other seismic sources, such as the Cascadia Subduction Zone (CSZ), have a relatively low contribution to the seismicity for the area. A discussion of both potential seismic sources is provided below.

Crustal Earthquake Sources

The closest mapped fault to the site is the Hite Fault System (Agency Section) with the closest portion of the fault located approximately 9.8 miles southeast of the site (Personius et al. 2003a). The second closest mapped fault is the approximately 39-mile-long northwest-southeast trending Wallula Fault System that is located approximately 20.8 miles northeast of the site (Personius et al. 2017). Based on the deaggregation model, these faults have the highest contribution to the overall seismic hazard and have been analyzed as the main local crustal fault sources below. The historical seismicity in relation to the project site is shown in Figure C-1. The location and relative distance of Quaternary faults from the US Geological Survey (2017) within a 50-mile radius from the site have been summarized from geologic publications and are indicated in Figure C-2. The estimated distance, displacement and relative age of faults within a 50-mile radius from the site is indicated in Table C-1 (Personius et al. 2002b-d; Personius et al. 2003a-d; Personius et al. 2017).

Cascadia Subduction Zone

The CSZ is the zone where the westward advancing North American Plate is overriding the subducting Juan de Fuca Plate. The interaction of these two plates results in two potential seismic source zones: (1) the CSZ subduction-zone (or "interface") source zone; and (2) the subducting slab/Benioff (or "intraslab") source zone.

The closest portion of the CSZ to Pendleton are several strands of the "Cascadia Fold and Thrust Belt" mapped approximately 225 to 250 miles west of the site (Personius 2002a). This structure is a forearc-portion of the roughly 720-mile-long zone of active tectonic convergence where oceanic crust of the Juan de Fuca Plate is subducting beneath the North American continent at a rate of 5 centimeters/year (DeMets et al. 2010). The hazard to the Pendleton region from a great Cascadia/interface event, while present, is considered to be low.

Typically, the region of maximum curvature of the subducting Juan de Fuca slab is where large intraslab earthquakes are expected to occur. This area is located roughly 215 to 220 miles west of the site. However, Wong (2005) notes that "…no moderate-to-large intraslab earthquakes of moment magnitude (M) 5.5 or greater have occurred within the subducting Juan de Fuca plate of the central CSZ from south of the Puget Sound in northwestern Washington to the Oregon–California border. Also, very few intraslab earthquakes as small as M3 have been instrumentally located within the central CSZ since 1960." Therefore, we conclude that the hazard to the site from intraslab earthquakes is low.

TABLE C-1. FAULTS WITHIN SITE VICINITY

Fault Name	Proximity to the Site (surface projection in miles)	Estimated Displacement Description	Estimated Age
Hite Fault System (Agency Section)	9.8	Offsets Columbia River Basalt Group rocks. Does not offset surficial Quaternary deposits.	Quaternary (<1.6 million years before present)
Hite Fault System (Thorn Hollow Section)	17.2	Offset of Miocene Columbia River Basalt Group and Quaternary surficial deposits at one location.	Late Quaternary (<130,000 years before present)
Wallula Fault System	20.8	Probable offset of upper Pleistocene to Holocene surficial deposits and late Pleistocene offset of colluvial deposits	Latest Quaternary (<15,000 years before present)
Columbia Hills Structures	30.2	Probable offset of Late Pleistocene loess deposits	Quaternary (<1.6 million years before present)
Ukiah Valley Faults	30.3	Offsets Miocene volcanic rocks	Middle and Late Quaternary (750,000 years before present)
Hite Fault System (Hite Section)	30.6	Offsets Miocene Columbia River Basalts. Does not offset Quaternary surficial deposits.	Quaternary (<1.6 million years before present)
West Grande Ronde Valley Fault Zone (Mount Emily Section)	35.5	Offsets Miocene Columbia River Group volcanic rocks, Mio-Pliocene Powder River volcanic field and Quaternary surficial deposits.	Latest Quaternary (<15,000 years before present)
Hite Fault System (Kooskooskie Section)	40.0	Offsets Miocene Columbia River Basalts.	Middle to Late Quaternary (<750,000 years before present)
East Grande Ronde Valley Fault Zone	41.1	Offsets Miocene Columbia River Group volcanic rocks, Mio-Pliocene Powder River volcanic field and Quaternary surficial deposits.	Latest Quaternary (<15,000 years before present)

Seismic Hazards

Based on our subsurface explorations, literature review and experience, a summary of the seismic hazards at the site are as follows:

Seismic Hazard Mapping

DOGAMI Oregon HazVu: Statewide Geohazards Viewer maps the relative earthquake hazard for the site as within Hazard Zone 2 on a six-category scale from Zone 6 (highest hazard) to Zone 1 (lowest). Hull (1999) maps the maximum earthquake shaking (peak ground acceleration) for the site as 0.08g, 0.14g and 0.22g for the 500-year, 1,000-year and 2,500-year return period, respectively.

Liquefaction

Based on our explorations, subsurface conditions onsite generally consisted of basalt rock which is not liquefiable.

Fault Surface Rupture

The closest mapped fault to the site possibly capable of surface rupture is the Hite Fault System which is located approximately 9.8 miles southeast of the site (Personius 2003a). Other local crustal faults are listed in the preceding text. No faults are mapped as crossing the site, therefore the potential for fault surface rupture at the site is low.

Earthquake-Induced Landslides

Proposed site cuts at the water tank are inclined at 0.25H:1V. Provided the setback and rockfall protection recommendations presented in the main body of the report are followed, we do not anticipate earthquake induced landslides will impact the site.

Tsunami Inundation/Seiche/Subsidence

The site is inland and elevated away from tsunami inundation and subsidence zones and away from large bodies of water that may develop seiches.

Design Earthquakes and Base Rock Motions

We evaluated three potential earthquake sources that could impact design at the site. These include local crustal earthquakes, CSZ interface earthquakes and CSZ intraplate earthquakes.

The closest potentially active crustal faults to the site are the Hite Fault System and the Wallula Fault System, with theoretical magnitudes of Mw=5.9 and Mw=7.0, respectively.

Geologic evidence indicates that CSZ interface earthquakes occur approximately every 100 to 1,000 years with average recurrence intervals of approximately 400 years. Based on postulated rupture lengths, widths and displacements (as well as historical Pacific tsunamis), coastal subsidence and liquefaction evidence, magnitudes for such earthquakes are estimated to range from approximately Mw= 7.5 to 9.1.

CSZ intraplate earthquakes have occurred in the Puget Sound area and are also postulated to occur beneath Western Oregon. These earthquakes have a deep focus of 40 to 80 kilometers in the subducted Juan de Fuca Plate and theoretical magnitudes of up to 7.8. These earthquakes are expected to have epicenters from 215 to 220 miles from the site. Base rock motions estimated for these earthquakes are less than those from either CSZ interface earthquakes or crustal earthquakes at the site and do not control design.

Ground Motion Estimation

Peak ground accelerations (PGAs) were estimated for each of the events discussed above. The PGA values for the CSZ events were computed with the BCHydro ground motion prediction equation (Abrahamson 2016). The PGAs for specific and random crustal events were computed using the attenuation relationships of Boore et al. (1997). Figure C-3 shows the computed response spectra for the postulated ground motion events. Because the calculated response spectra are below the code-based spectra, we recommend using the code-based spectra for this project. The code level seismic design parameters are presented in Table 3 of the report. Table C-2 shows the postulated earthquakes and computed PGAs.

TABLE C-2. CALCULATED PGA VALUES

Earthquake Source	Magnitude	Focal Depth (miles)	Epicentral Distance (miles)	Anticipated PGA (g)
Hite Fault System (Agency Section)	5.9	-	9.8 (14.6)[1]	0.06
Wallula Fault System	7.0	-	20.8 (23.2)[1]	0.10
CSZ Interface	9.1	20	225	0.04
CSZ Intraplate	7.8	30	220	0.02

Note: [1] MCER epicentral distance to center of fault.

REFERENCES

Abrahamson, Norman, Nicholas Gregor and Kofi Addo (2016) BC Hydro Ground Motion Prediction Equations for Subduction Earthquakes. Earthquake Spectra: February 2016, Vol. 32, No. 1, pp. 23-44.

Boore, David M., William B. Joyner and Thomas E. Fumal. 1997. Equations for Estimating Horizontal Response Spectra and Peak Acceleration from Western North American Earthquakes: A Summary of recent Work, Seismological Research Letters, Vol. 68, No. 1, 128-153.

DeMets, C., Gordon, R. G., and Argus, D. F. 2010. Geologically current plate motions. Geophysical Journal International, 181(1), 1-80.

Hull, D.A. 1999. Earthquake Hazard Maps for Oregon. Oregon, Department of Geology & Mineral Industries.

Oregon Department of Geology and Mineral Resources (DOGAMI), Oregon HazVu; Statewide Geohazards Viewer, available at: http://www.oregongeology.org/sub/hazvu/index.htm

Personius, S.F., compiler. 2002a. Fault number 784, Cascadia fold and fault belt, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, available at: http://earthquakes.usgs.gov/hazards/qfaults. Accessed 1/22/2018 2:30 PM.

Personius, S.F., compiler. 2002b. Fault number 710, Ukiah Valley faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

Personius, S.F., and Haller, K.M., compilers. 2002c. Fault number 802a, West Grande Ronde Valley fault zone (Mount Emily section), in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

Personius, S.F., and Haller, K.M., compilers. 2002d. Fault number 803, East Grande Ronde Valley fault zone, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

Personius, S.F., and Lidke, D.J., compilers. 2003a. Fault number 845d, Hite fault system, Agency section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

Personius, S.F., and Lidke, D.J., compilers. 2003b. Fault number 845c, Hite fault system, Thorn Hollow section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

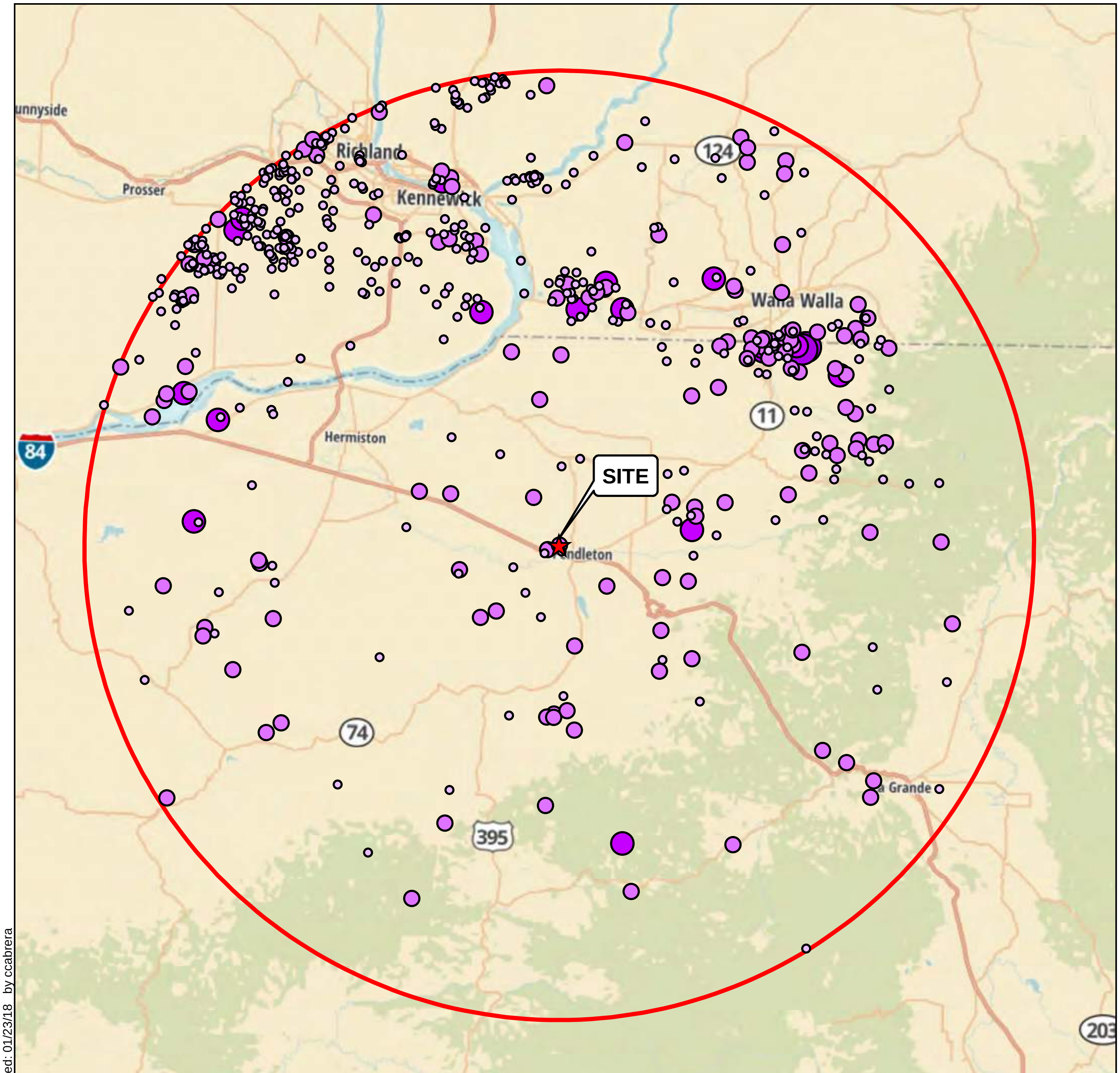
Personius, S.F., and Lidke, D.J., compilers. 2003c. Fault number 845a, Hite fault system, Hite section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

Personius, S.F., and Lidke, D.J., compilers. 2003d. Fault number 845b, Hite fault system, Kooskooskie section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

Personius, S.F., Haller, K.M., and Lidke, D.J., compilers. 2017. Fault number 846, Wallula fault system, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, Accessed 1/23/2018 9:00 AM.

U.S. Geological Survey, 2017. Quaternary fault and fold database for the United States, accessed January 23, 2018, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/. Dated 2017.

Wong, I.G. 2005. Low Potential for Large Intraslab Earthquakes in the Central Cascadia Subduction Zone: Bulletin of the Seismological Society of America, Vol. 95, No. 5, pp. 1880–1902.



Legend

★ Project Site

50-mile Radius

USGS Earthquakes by Magnitude

> 5

4 - 5

3 - 4

2 - 3

< 2

N
W E
S

16 0 16

Miles

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2015

Seismic locations from USGS, http://earthquake.usgs.gov/earthquakes

Projection: NAD 1983 UTM Zone 11N

Historical Seismicity Map

Proposed City of Pendleton Water and Sewer System Upgrades
Pendleton, Oregon

GEOENGINEERS

Figure C-1

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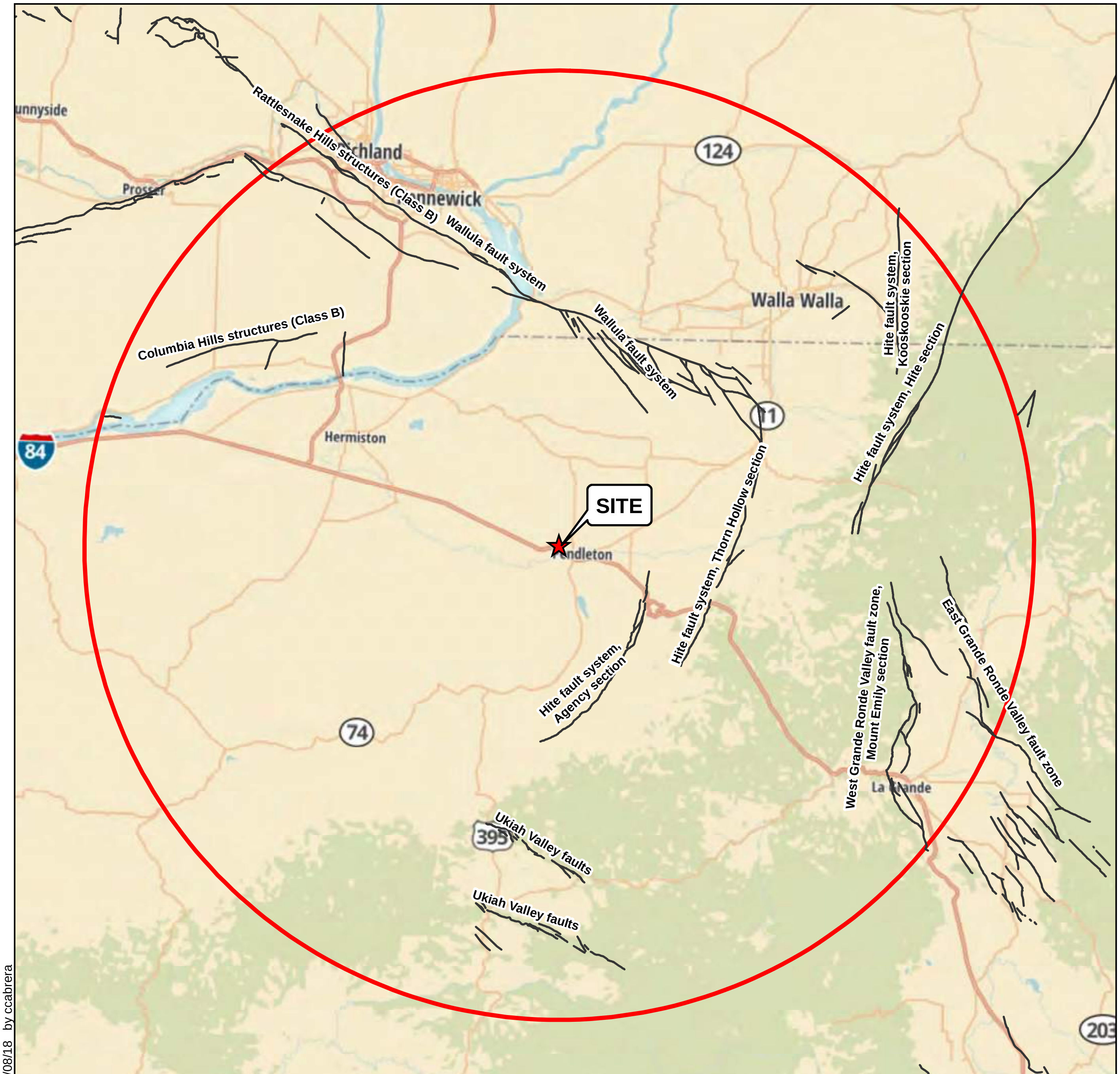


Legend

- ★ Project Site
- USGS Quaternary Faults
- 50-mile Radius

N
W E
S

16 0 16
Miles

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2015
Quaternary faults from USGS, http://earthquake.usgs.gov/hazards/qfaults/
Projection: NAD 1983 UTM Zone 11N

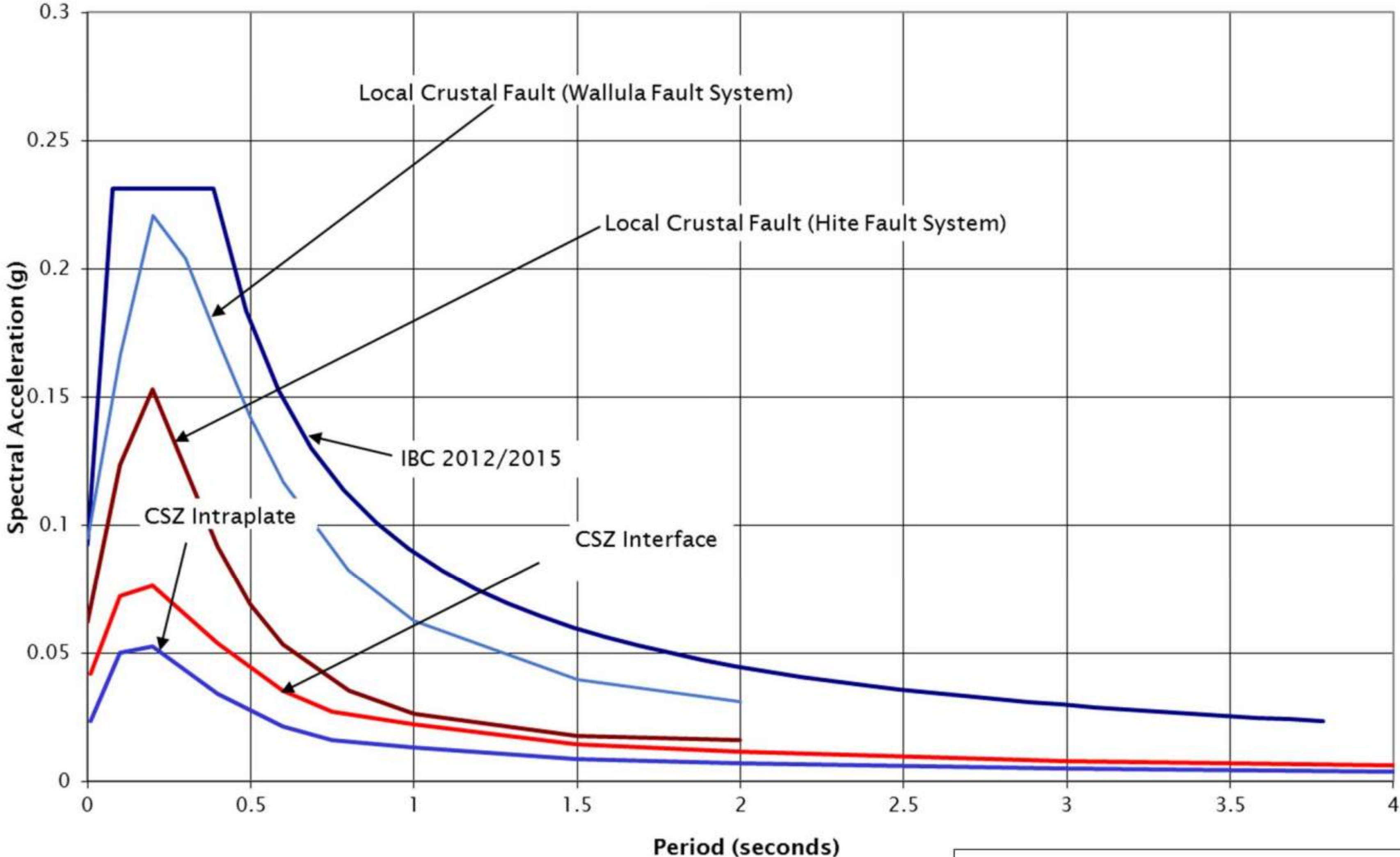
Quaternary Fault Map

Proposed City of Pendleton Water
and Sewer System Upgrades
Pendleton, Oregon

GEOENGINEERS

Figure C-2

P:\8\8946003\GIS\MXD\894600300_FC2_Faults_Tsk32.mxd Date Exported: 02/08/18 by ccabrera



Response Spectra	
Proposed City of Pendleton Water and Sewer System Upgrades Pendleton, OR	
GeoEngineers	**Figure C-3**

APPENDIX D
Report Limitations and Guidelines for Use

APPENDIX D
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Murraysmith, Inc. and for the project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project and its schedule and budget, our services have been executed in accordance with our Agreement with Murraysmith, Inc. dated September 6, 2017, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for the proposed Water Storage Reservoir in Pendleton, Oregon. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations are Not Final

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

www.geoengineers.com

GeoEngineers

GeoEngineers
523 East Second Avenue
Spokane, Washington 99202
509.363.3125

April 2, 2021

Murraysmith, Inc.
888 SW 5th Avenue, Suite 1170
Portland, Oregon 97204

Attention: Lael Alderman, PE
Principal Engineer

Subject: Addendum Report
Task 3 - Water Improvements North Cedar Road and West Montgomery Road Evaluation
City of Pendleton Water and Sewer System Upgrades
Pendleton, Oregon
File No. 8946-003-03

INTRODUCTION AND SCOPE

This addendum report supplements information and recommendations presented in our report for the planned Water Storage Reservoir titled "Proposed City of Pendleton Water and Sewer System Upgrades Project, Water Storage Reservoir, Pendleton, Oregon," dated June 5, 2018 (GEI File No. 8946-003-00). Following the submittal of our previous report, the location of the proposed Water Storage Reservoir has been moved approximately 1,500 feet to the east of the previously planned location. We understand the City of Pendleton elected to conduct supplemental test pit explorations as a basis for evaluating subsurface conditions at the new Water Storage Reservoir location. The approximate location of the proposed Water Storage Reservoir is shown in the Vicinity Map, Figure 1 and Site Plan, Figure 2.

Our services were completed in accordance with our scope and fee estimate date February 10, 2021. Our specific scope of services included:

1. Observing excavation of six test pits near the proposed Water Storage Reservoir.
2. Reviewing the recommendations provided in our June 5, 2018 report and updated recommendations for design and construction based on the subsurface conditions encountered at the new site.

SITE CONDITIONS

General

The test pits were excavated by City of Pendleton personnel on March 11, 2021 using a John Deere 120D excavator with a reinforced bucket and ripping teeth. A representative of GeoEngineers observed and documented the test pits. The approximate locations of the test pits relative to existing and proposed site features are shown in Figure 1. Logs of the test pits are presented in Attachment A.

Surface Conditions

The new site is located east of the old Airport Road. Site grades are inclined at about 8H:1V (horizontal to vertical), and the ground surface is covered with sparge grass and weeds.

Subsurface Conditions

At each of the test pits, we observed approximately 4 to 6 inches of topsoil consisting of brown silt with sand and organic matter. Below the topsoil, we observed:

- Soft to medium stiff silt to depths of about 1 to 2½ feet below ground surface.
- Caliche underlying the silt and consisting of hard (weakly cemented) silt with gravel to depths of about 1½ to 3 feet below ground surface.
- Basalt rock underlying the caliche. The excavator was generally able to excavate about 2 to 12 inches into the basalt before encountering refusal.

Groundwater

We did not observe groundwater seepage in the test pits at the time of exploration. We anticipate the regional groundwater table is likely below the zone of planned excavation.

UPDATED RECOMMENDATIONS

General

Based on the results of the limited supplemental explorations, it is our opinion that subsurface conditions at the new location are similar to subsurface conditions at the previous location.

Grading and Excavations

Finished floor elevation for the proposed Reservoir will remain at Elevation 1,296 feet. Based on the anticipated geometry, cuts ranging from less than several feet to about 20 feet will be required to establish final foundation grade. Additionally, based on the results of the supplemental test pits, excavation will predominantly be in rock. In our opinion, our previous recommendations for permanent cut slope inclinations in rock and set back criteria between the cut slope and proposed Reservoir remain valid.

Furthermore, we provide supplemental commentary regarding rockfall hazard based on review of a study by Pierson et al. (2001). They indicate that ditches at the foot of a 40-foot-high rock slope cut at 0.25H:1V with a ditch backsloped (towards the slope) at 4H:1V that is 9 feet wide would capture about 90 percent of the rockfall. A ditch with a bottom backsloped at 6H:1V and a width of 10 feet would capture a similar amount. Based on this study, it is our opinion that with a 20-foot-high cut, no additional rockfall analyses are required. It is our opinion that the proposed backsloped ditch inclined at 6H:1V and a width of about 6 feet should be adequate to capture at least 90 percent or more of potential rock falls.

Our recommendations for preparation of foundation grade for the proposed Reservoir remain in effect.

Rock excavation quantities within proposed utility trenches in support of the proposed Reservoir also should be updated based on the new project location and rock elevations encountered.

Foundation Support

The previous recommendations for the proposed Reservoir remain valid and do not need to be revised.

With regards to the supporting Booster Station, we recommend shallow spread footings be founded on on-site caliche or rock, or structural fill overlying caliche or rock. Silt soil should be excavated from below the proposed Booster Station and replaced with imported structural fill, as required to establish final foundation and floor slab grade elevations. Booster Station footings should be embedded at least 2 feet below finished exterior grade to resist frost heave. Unless footings bear directly on rock, in which case the criteria for minimum embedment depth for frost protection can be omitted. Booster Station continuous wall footings should have a minimum dimension of at least 16 inches and isolated column footings should have a minimum dimension of at least 2 feet, and they should be designed using an allowable bearing pressure of 4,000 pounds per square foot.

Seismic Design Parameters

Our previous report provided seismic design parameters based on the 2015 International Building Code (IBC). If the 2018 IBC will be used, the code-based design parameters in our previous report (Table 7) should be updated to reflect the 2018 IBC. Table 1 below presents updated seismic parameters based on the 2018 IBC. Since our site-specific spectrum is below code, the code-based values will govern, and the site-specific report does not need to be updated.

TABLE 1. 2018 IBC SEISMIC DESIGN PARAMETERS

Parameter	Value
Site Class	B
Spectral Response Acceleration, S_s	0.363g
Spectral Response Acceleration, S_1	0.137g
Site Coefficient, F_a	0.9
Site Coefficient, F_v	0.8
Spectral Response Acceleration (Short Period), S_{DS}	0.218g
Spectral Response Acceleration (1-Second Period) S_{D1}	0.073g

LIMITATIONS

We have prepared this data report for Murraysmith for the Water Storage Reservoir project in Pendleton, Oregon. Murraysmith may distribute copies of this report to their design team members, the City of Pendleton and their authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for geotechnical engineering in this area at the time this report was prepared.

Please refer to the appendix titled "Report Limitations and Guidelines for Use" in our previous report titled "Proposed City of Pendleton Water and Sewer System Upgrades Project, Water Storage Reservoir, Pendleton, Oregon" dated June 5, 2018 for additional information pertaining to use of this report.

Sincerely,
GeoEngineers, Inc.

Dave R. Lauder
Project Manager

Teresa A. Dugger, PE
Associate

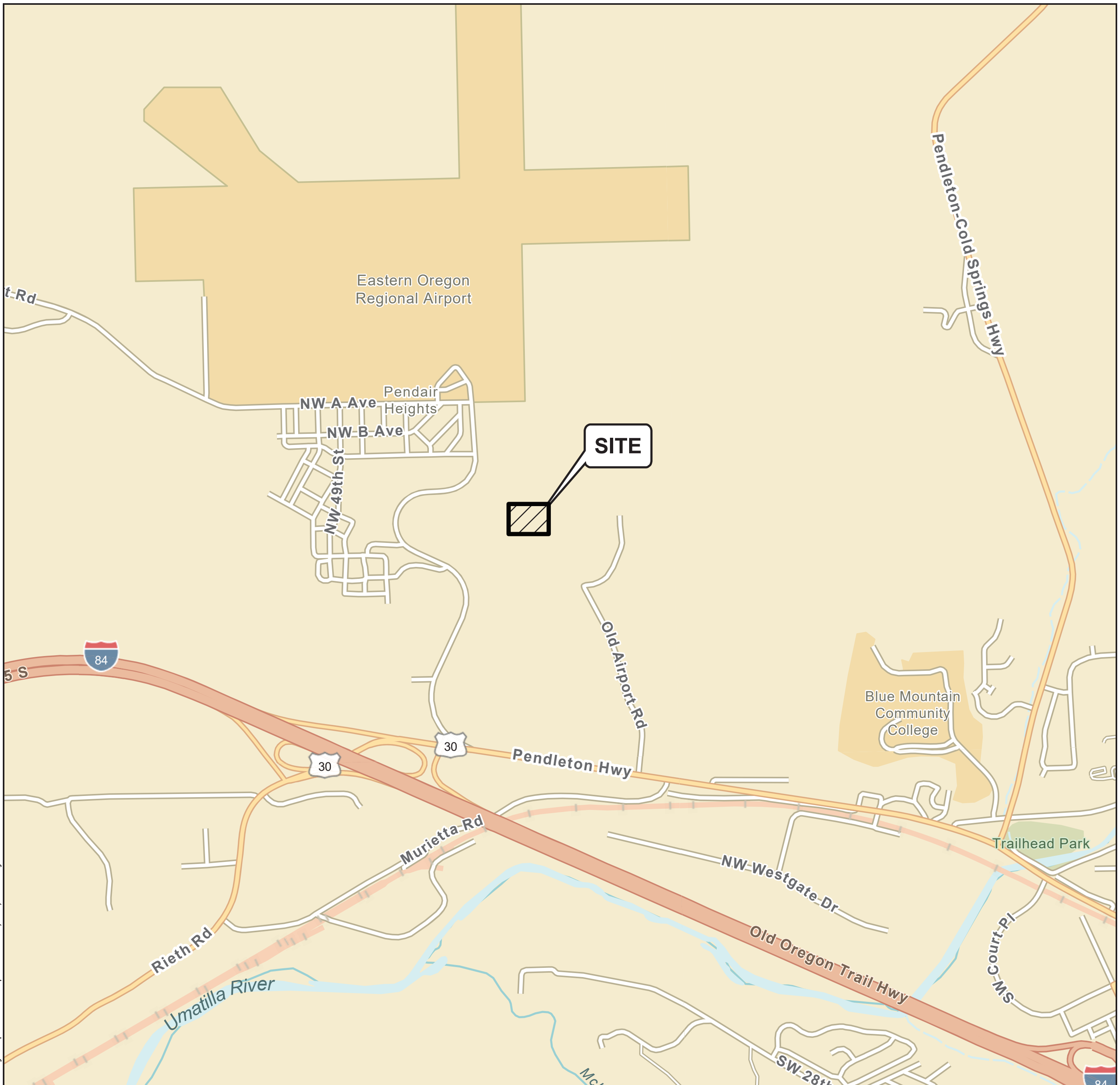
Craig F. Erdman, CEG
Senior Engineering Geologist

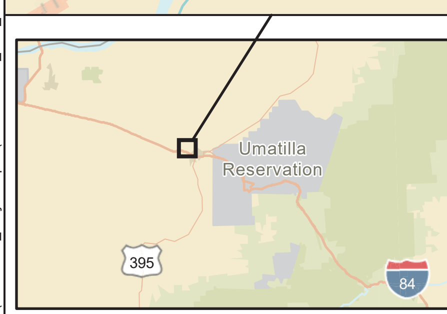
CERTIFIED
OREGON
CRAIG FRASER ERDMAN
Craig Fraser Erdman
E2530
ENGINEERING GEOLOGIST

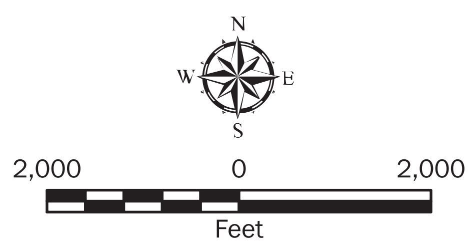
Expires: 08/01/2021
Responsible for cut slopes & rockfall assessment

DRL:TAD:CFE:tjh

Attachments:
Figure 1. Vicinity Map
Figure 2. Site Plan
Attachment A. Field Explorations
Figure A-1. Key to Exploration Logs
Figure A-2 through A-7. Test Pit Logs







Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Vicinity Map

City of Pendleton Water Storage Reservoir 2021
Pendleton, Oregon

GEOENGINEERS

Figure 1

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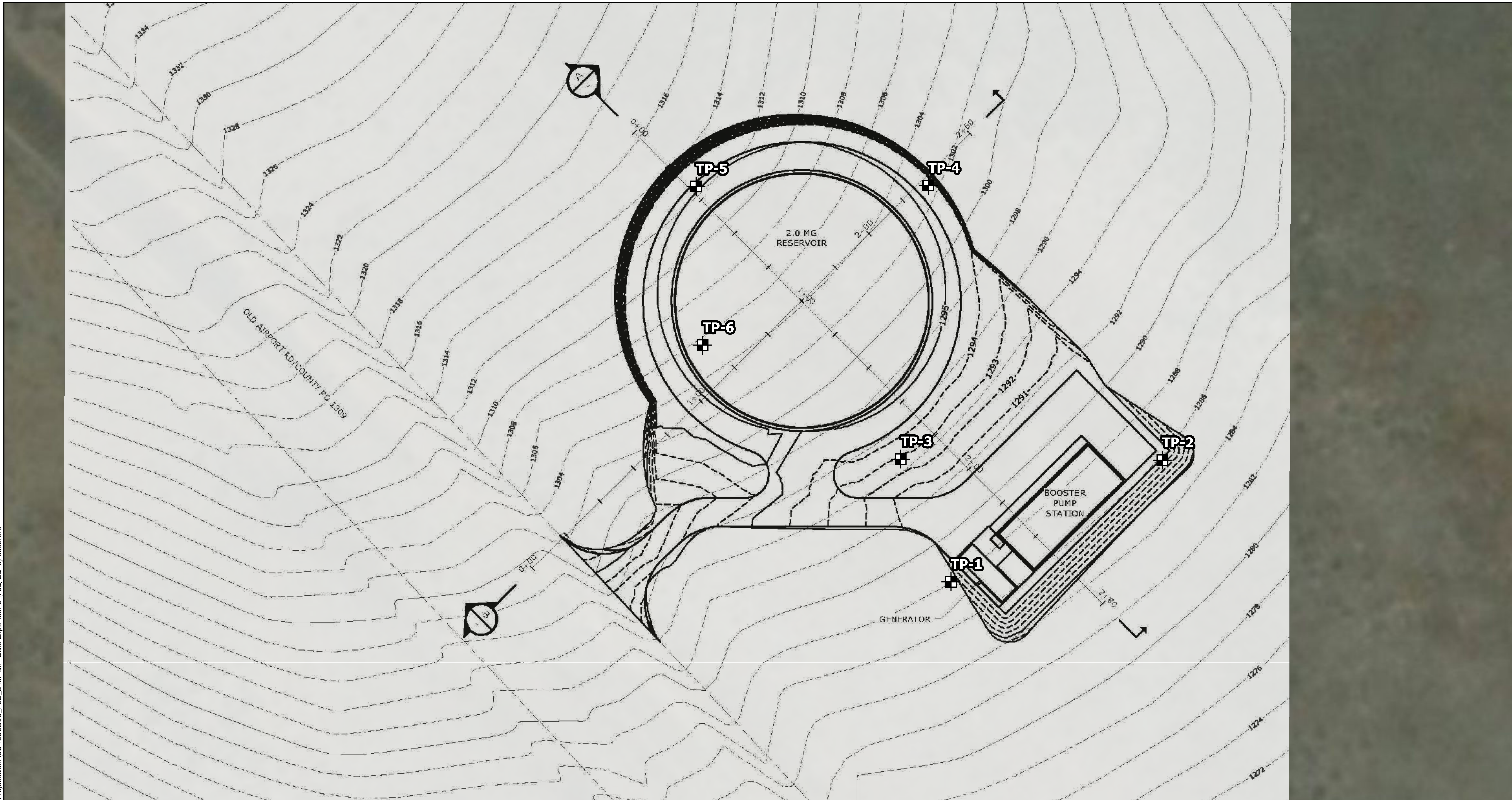

Notes:
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Data Source: Bing Image

Projection: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Legend

Test Pit Number and Approximate Location

40 0 40
Feet

Site Plan

City of Pendleton Water Storage Reservoir 2021
Pendleton, Oregon

GEOENGINEERS

Figure 2

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ATTACHMENT A
Test Pit Logs

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

Sampler Symbol Descriptions

- 2.4-inch I.D. split barrel
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab
- Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers

Figure A-1

Date Excavated	3/11/2021	Total Depth (ft)	3.75	Logged By	BH	Excavator	City of Pendleton	Groundwater not observed
				Checked By		Equipment	John Deere 120D	Caving not observed

Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)	Coordinate System Horizontal Datum

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
			1		TS	Brown silt with sand and organics (soft, moist) (topsoil)			
					ML	Brown silt with sand and occasional organics (roots) (medium stiff, moist)			
	1		2						PP = 2.25 tsf
	2								
					ML	Tan silt with sand (hard, moist) (caliche)			
			3						
	3								
					BSLT	Basalt: black, very fine grained, slightly weathered, hard			Able to rip approximately 6 inches into rock with excavator

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-01

GeoEngineers

Project: City of Pendleton Water Storage Reservoir 2021
Project Location: Pendleton, Oregon
Project Number: 8946-003-03

Date Excavated	3/11/2021	Total Depth (ft)	3	Logged By	BH	Excavator	City of Pendleton	Groundwater not observed
				Checked By		Equipment	John Deere 120D	Caving not observed

Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Brown silt with sand and organics (medium stiff, moist) (topsoil)			
					ML	Brown silt with sand and occasional organics (roots) (very soft, moist)			
	1		1						PP = 0.75 tsf
	2				ML	Tan silt with sand (hard, moist) (caliche)			
					BSLT	Basalt: black, very fine grained, slightly weathered, hard			Able to rip approximately 6 inches with excavator
	3								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-02

GeoEngineers

Project: City of Pendleton Water Storage Reservoir 2021
Project Location: Pendleton, Oregon
Project Number: 8946-003-03

Figure A-3

Date Excavated	3/11/2021	Total Depth (ft)	3.25	Logged By	BH	Excavator	City of Pendleton	Groundwater not observed
				Checked By		Equipment	John Deere 120D	Caving not observed

Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Brown silt with sand and organics (soft, moist) (topsoil)			
					ML	Brown silt with sand and occasional organics (roots) (medium stiff, moist)			
	1		1						PP = 0.75 tsf
	2								
			2		ML	Tan silt with sand (hard, moist) (caliche)			
	3				BSLT	Basalt: black, very fine grained, slightly to moderately weathered, hard			Able to rip approximately 2 inches with excavator

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-03

GEOENGINEERS

Project: City of Pendleton Water Storage Reservoir 2021
Project Location: Pendleton, Oregon
Project Number: 8946-003-03

Figure A-4
Sheet 1 of 1

Date Excavated	3/11/2021	Total Depth (ft)	2	Logged By	BH	Excavator	City of Pendleton	Groundwater not observed
				Checked By		Equipment	John Deere 120D	Caving not observed

Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Brown silt with sand and organics (soft, moist) (topsoil)			
			1		ML	Brown silt with sand and trace organics (roots) (medium stiff, moist)			
	1		2		GP-GM	Tan-red fine to coarse gravel with silt and sand (very dense, moist) (calcified weathered basalt)			
					BSLT	Basalt: black-red, very fine grained, moderately weathered, hard, vesicular			Able to rip approximately 8 inches with excavator
	2								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-04

GeoEngineers

Project: City of Pendleton Water Storage Reservoir 2021
Project Location: Pendleton, Oregon
Project Number: 8946-003-03

Date Excavated	3/11/2021	Total Depth (ft)	3	Logged By	BH	Excavator	City of Pendleton	Groundwater not observed
				Checked By		Equipment	John Deere 120D	Caving not observed

Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE Testing Sample	SAMPLE Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0				TS	Brown silt with sand and organics (soft, moist) (topsoil)			
	1				ML	Brown silt with sand and trace organics (roots) (soft to medium stiff, moist)			
	2		1		GM	Brown silty fine to coarse gravel with sand and cobbles (dense, moist) (angular basalt, caliche)			
	3				BSLT	Basalt: tan-red-black, very fine grained, moderately weathered, hard, vesicular			Able to rip approximately 6 inches with excavator

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-05

GeoEngineers

Project: City of Pendleton Water Storage Reservoir 2021
Project Location: Pendleton, Oregon
Project Number: 8946-003-03

Date Excavated	3/11/2021	Total Depth (ft)	3	Logged By	BH	Excavator	City of Pendleton	Groundwater not observed
				Checked By		Equipment	John Deere 120D	Caving not observed

Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Brown silt with sand and organics (soft, moist) (topsoil)			
	1		1		ML	Brown silt with sand and trace organics (roots) (soft, moist)			
					GP-GM	Tan-black fine to coarse gravel with silt, sand and cobbles (very dense, moist) (weathered basalt with caliche)			
	2				BSLT	Basalt: black-tan, very fine grained, slightly to moderately weathered, hard			Able to rip approximately 12 inches with excavator
	3								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-06

GeoEngineers

Project: City of Pendleton Water Storage Reservoir 2021
Project Location: Pendleton, Oregon
Project Number: 8946-003-03

Explosives Near Gas Facilities

Reference CP ### - Explosives Near Gas Facilities

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.

PART I -- BLASTING DATA

Company Name:	Contractor Address:
Sub-Contracted By:	
Telephone Number:	Blasting Location:
Date of Blasting: Start Time: End Time:	

Type of Explosive:		
Depth of Explosives: ft	Detonation to occur under water?	Number of holes per detonation per delay:
Weight of Explosive per Hole: lb	Weight of Explosive per Delay: lb	Density of Explosive: g/cc
Single (one-point) source or line source:		Delay Frequency: milliseconds
Hole Diameter: in	Distance from Pipeline to Nearest Explosive: ft	

Type of Rock Being Blasted:	Does rock extend to pipeline trench?
Description of rock (structure, density):	

Include a detailed, scale drawing of the Blast Plan/Drill Pattern below, or include a separate drawing with this form

The drawing must include hole spacing, gas pipeline, any aboveground gas structures, angle of blast lines and all applicable dimensions

Completed By: ____________________ Date: ________________

Explosives Near Gas Facilities

Reference Engineering Procedure 3415

PART II -- PIPELINE DATA -- To be completed by Company District Operations Personnel

Project No.	Town	District

Depth of Pipeline: in	Pipeline Operating Pressure: psig	Grade of Pipeline:
Pipeline Diameter: in	Is the pipeline installed within or on top of a rock formation?	
Is facility uphill or downhill from blast site?	Is the pipe/facility in standing or ground water?	
Were explosives used to create the pipeline trench?	Is the ground surface free of other structures?	

Consequences of Potential Pipeline Failure:

Number of customers potentially losing service: ________

Available control measures if pipeline needs to be shut-in: ________________________________

Cut and paste a Company pipeline map of the affected area or include a separate map with this form. Add description of facilities/structures other than the pipeline.

Completed By: ______________________ Date: ________________