

TECHNICAL SPECIFICATIONS



For the Construction of

WWSD JIMMY CAMP LIFT STATION FORCE MAIN EXTENSION

WIDEFIELD, COLORADO

ISSUED FOR CONSTRUCTION

Garver Project No. 22W23080

Prepared For:

Widefield Water and Sanitation District

April 2026



CERTIFICATIONS

**WIDEFIELD WSD JIMMY CAMP FORCE MAIN DESIGN
GARVER PROJECT NO. 22W23080
WIDEFIELD WATER AND SANITATION DISTRICT**

I hereby certify that the applicable portions of this project's specifications, details, and plans were prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Project State.

SEAL AND SIGNATURE

**APPLICABLE DIVISION OR
PROJECT RESPONSIBILITY**

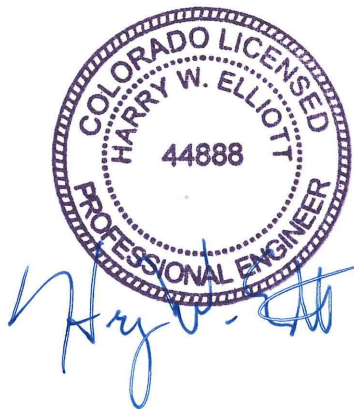
Paul Banschbach, PE



Digitally Signed: April 30, 2026

Division 31
Division 32
Division 33
Division 40

Harry W. Elliott, PE



Digitally Signed: April 30, 2026

Division 03
Division 08
Division 09

CERTIFICATIONS

GARVER, LLC CERTIFICATE OF AUTHORIZATION:
 CO Certificate of Good Standing Confirmation No. 16903028 Issued: 03/12/2026

WIDEFIELD WATER AND SANITATION DISTRICT
JIMMY CAMP LIFT STATION FORCE MAIN EXTENSION

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REPORT FOR SUBSURFACE UTILITY ENGINEERING BY T2 UTILITY ENGINEERS, INC.

PLANS FOR SUBSURFACE UTILITY ENGINEERING BY T2 UTILITY ENGINEERS, INC.

REPORT FOR ENVIRONMENTAL STUDY BY ECOPOINT, INC.

THE FOLLOWING DOCUMENTS ARE INCLUDED BY REFERENCE ONLY AND ARE CONSIDERED
PART OF THE CONTRACT DOCUMENTS:

WIDEFIELD WATER AND SANITATION DISTRICT WATER AND WASTEWATER SYSTEM
STANDARD SPECIFICATIONS (REVISED JULY 2023)

COLORADO SPRINGS UTILITIES WASTEWATER LINE EXTENSION AND SERVICE
STANDARDS (*WASTEWATER LESS*, 2023 EDITION)

EL PASO COUNTY ENGINEERING CRITERIA MANUAL (REVISED DECEMBER 13, 2016) AND
DEPARTMENT OF PUBLIC WORKS ENGINEERING DEVISION STANDARD DRAWINGS
(ADOPTED FOR USE JULY 18, 2023)

CITY OF COLORADO SPRINGS STANDARD SPECIFICATIONS MANUAL (REVISED MARCH
2005)

CITY OF FOUNTAIN DESIGN AND CONSTRUCTION SPECIFICATIONS MANUAL (ADOPTED
FEBRUARY 15, 2016)

FOUNTAIN SANITATION DISTRICT SPECIFICATIONS AND REGULATION MANUAL
(ADOPTED FEBRUARY 8, 2024)

In case of conflict between Contract documents, priority of interpretation shall be in the following order:

Signed Agreement (or Contract)

Project Drawings

Project Technical Specifications

Widefield Water and Sanitation District Water and Wastewater System Standard Specifications
(Revised July 2023)

Colorado Department of Public Health and Environment Design Criteria for Wastewater Systems
(Effective June 7, 2022)

Colorado Springs Utilities Wastewater Line Extension and Service Standards (2023 Edition)

El Paso County Engineering Criteria Manual (Effective July 18, 2023)

City of Fountain Design and Construction Specifications Manual (Adopted February 15, 2016)

Fountain Sanitation District Specifications and Regulations Manual (Adopted February 8, 2024)

SECTION 00670
NOTICE TO PROCEED

Colorado Springs, Colorado

Date _____

TO: _____

You are hereby authorized to proceed on the Jimmy Camp Lift Station Force Main Extension, or within ten (10) consecutive calendar days thereafter, with the Work as set forth in the Contract Documents.

You are to notify the **ENGINEER** forty-eight (48) hours before starting Work.

Widefield Water and Sanitation District

By: _____

Title: GENERAL MANAGER

ACKNOWLEDGEMENT OF RECEIPT OF NOTICE TO PROCEED:

Receipt of the above Notice to Proceed is hereby acknowledged this _____ day of _____, 20 ____.

CONTRACTOR: _____

BY: _____

TITLE: _____

END OF SECTION

SECTION 00680

CHANGE ORDER

Project: WWSD Jimmy Camp Lift Station Force Main Extension **Date of Issuance:** _____

Owner: Widefield Water and Sanitation District
Address: 8495 Fontaine Blvd.
Colorado Springs, Colorado 80925

Change Order No. _____

Contractor: _____

Engineer: _____

You are directed to make the following changes in the Contract Documents:

Description: _____

Purpose of Change Order: _____

Attachments (List Documents Supporting Change): _____

THIS CHANGE ORDER CONSTITUTES FULL AND FINAL SETTLEMENT FOR ALL COSTS AND TIME ASSOCIATED WITH THE WORK DESCRIBED HEREIN. COSTS ARE DEFINED TO INCLUDE ALL DIRECT AND INDIRECT LABOR COSTS RELATED TO, AND/OR OCCASIONED BY THE WORK DESCRIBED HEREIN; ALL MATERIAL AND EQUIPMENT COSTS RELATED HERETO; ANY AND ALL IMPACT COSTS RELATED TO AND/OR OCCASIONED BY THE PERFORMANCE OF THIS WORK; AS WELL AS ALL APPLICABLE TAXES, INSURANCE, BONDS, AND PROFIT. ALL OTHER TERMS AND CONDITIONS OF THIS CONTRACT REMAIN IN FULL FORCE AND EFFECT.

CHANGE IN CONTRACT PRICE:	CHANGE IN CONTRACT TIME:
Original Contract Price: \$	Original Contract Time: (days or date)
Previous Change Orders No. _____ to No. _____: \$	Net Change from Previous Change Order: (days)
Contract Price Prior to this Change Order: \$	Contract Time Prior to this Change Order: (days or date)
Net Increase of this Change Order: \$	Net Increase of the Change Order: (days)
Net Decrease of this Change Order: \$	Net Decrease of this Change Order: (days)
Net Change of this Change Order: \$	Net Change of this Change Order: (days)
Contract Price with all approved Change Orders: \$	Contract Time with all approved Change Orders: (days or date)

RECOMMENDED:

By: _____
Engineer

APPROVED:

By: _____
Owner

APPROVED:

By: _____
Contractor

END OF SECTION

SECTION 00681

REQUEST FOR INFORMATION

Project: WWSD Jimmy Camp Lift Station Force Main Extension

Date of Issuance: _____

Owner: Widefield Water and Sanitation District

RFI No. _____

Address: 8495 Fontaine Blvd.

Colorado Springs, Colorado 80925

Request Reply Date: _____

Contractor: _____

Engineer: _____

Request for Information from Contractor:

RFI Description (*fully describe the question or type of information requested*): _____

Attachments/References (*List all specific documents researched when seeking the information requested*): _____

Requester's Recommendation (*If RFI concerns a site or construction condition, the requester may recommend solution, including cost and/or schedule considerations*): _____

Receiver's Reply (*Provide answer to RFI, including accost and/or schedule considerations*): _____

By: _____ By: _____ By: _____
Engineer Owner Contractor

Note: This reply is not an authorization to proceed with work involving additional cost, time, or both. If any reply requires a change to the Contract Documents, and Change Order (Specification Section 00680) in the work must be executed in accordance with the Contract Documents.

END OF SECTION

SECTION 00682

WORK CHANGE DIRECTIVE

Project: WWSD Jimmy Camp Lift Station Force Main Extension **Date of Issuance:** _____

Owner: Widefield Water and Sanitation District **WDC No.** _____

Address: 8495 Fontaine Blvd.

Colorado Springs, Colorado 80925 **Effective Date:** _____

Contractor: _____ **Engineer:** _____

You are directed to proceed promptly with the following change(s):

WCD Description: _____

Purpose of Work Change Directive: _____

Attachments (*List documents supporting change*): _____

If a claim is made that the above change(s) have affected Contract Price or Contract Times, any claim for a Change Order based thereon will involve one or more of the following methods of determining the effect of the change(s).

Method of determining change in Contract Price:

___ Unit Price

___ Lump Sum

___ Other _____

Estimated increase (decrease) in Contract Price:

\$ _____

If the change involves an increase, the estimated amount not to be exceeded without further authorization

Method of determining change in Contract Time:

___ Contractor's Record

___ Engineer's Record

___ Other _____

Estimated increase (decrease) in Contract Time

Substantial Completion _____

Final Completion _____

If the change involves an increase, the estimated times are not to be exceeded without further authorization

By: _____ By: _____ By: _____
Engineer Owner Contractor

Note: This Work Change Directive is not an authorization to proceed with work involving additional cost, time, or both. If any reply requires a change to the Contract Documents, and Change Order (Specification Section 00680) in the work must be executed in accordance with the Contract Documents.

END OF SECTION

SECTION 00685

LIEN WAIVER

Name of Owner: Widefield Water and Sanitation District
Name of Contractor: _____
Date of Agreement: _____
Name of Project: WWSD Jimmy Camp Lift Station Force Main Extension
Location of Project: Colorado Springs, CO (the "Premises")

1. The undersigned has performed the following work at the Premises:

2. In consideration of Owner's payment of \$_____, receipt of which is acknowledged, the undersigned waives any right it may have to claim any lien against the Premises for labor performed on and/or materials furnished to the Premises up to and including the date of _____, 20____, excepting only retention applicable thereto.

3. The undersigned executes this lien waiver voluntarily and with full knowledge of its significance under the laws of the state of Colorado.

_____,
a _____

Date: _____ By: _____
Title: _____

STATE OF COLORADO)
)ss.
COUNTY OF)

The foregoing instrument was acknowledged before me this _____ day of _____, 20____, by _____.

Witness my hand and official seal.

My commission expires: _____

Notary Public

END OF SECTION

SECTION 00690

NOTICE OF FINAL PAYMENT

NOTICE is hereby given that Widefield Water and Sanitation District of El Paso County, Colorado, will make final payment at the District Office, 8495 Fontaine Blvd., Colorado Springs, Colorado, 80925 on _____, at the hour of 10 A.M. to _____ of _____ for all equipment supplied and services rendered in construction or work on Jimmy Camp Lift Station Force Main Extension, performed within the Widefield Water and Sanitation District, County of El Paso, State of Colorado.

Any person, co-partnership, association of persons, company or corporation that has furnished labor, materials, team hire, sustenance, provisions, provender, or other supplies used or consumed by such contractors or their subcontractors, in or about the performance of the work contracted to be done or that supplies rental machinery, tools, or equipment to the extent used in the prosecution of the work, and whose claim therefor has not been paid by the contractors or their subcontractors, at any time up to and including the time of final settlement for the work contracted to be done, is required to file a verified statement of the amount due and unpaid, and an account of such claim, to the Widefield Water and Sanitation District, on or before the date and time hereinabove shown for final payment. Failure on the part of any claimant to file such verified statement of claim prior to such final settlement will release Widefield Water and Sanitation District, its directors, officers, agents, and employees, of and from any and all liability for such claim.

BY ORDER OF THE BOARD OF DIRECTORS
WIDEFIELD WATER AND SANITATION DISTRICT

By: /s/ _____

First Publication: _____, 20

Last Publication: _____, 20

Fountain Valley News

END OF SECTION

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 WORK COVERED BY THE CONTRACT DOCUMENTS

The proposed Jimmy Camp Lift Station Force Main Extension project will extend the existing force main pipeline to the Owner's wastewater treatment facility.

1.02 SUBSURFACE INFORMATION

- A. A geotechnical investigation is available for the pipeline alignment. The report is included in the Appendix A of the Construction Specifications.

1.03 SEQUENCE OF WORK

- A. The **CONTRACTOR** shall coordinate his efforts with the **OWNER** so as to minimize disruption of existing service and inconvenience to adjacent property owners.

- 1. Refer to Section 01014 for the Construction Sequence.

- B. Procedures and methods other than those specified will be considered by **ENGINEER** and **OWNER**, provided they afford equivalent continuity of operations.

- C. Inspection by Public Agencies

Authorized representatives of the **Widefield Water and Sanitation District** shall have access to the work wherever it is in preparation or progress.

- D. It will be the **CONTRACTOR's** responsibility to schedule and sequence his activities so as to best meet environmental conditions imposed by winter weather.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Supervision - The **CONTRACTOR** will supervise and direct the work. He will be solely responsible for the means and methods, techniques, and procedures of construction. The **CONTRACTOR** will employ and maintain on the work a qualified Supervisor or Superintendent who shall have been designated in writing by the **CONTRACTOR** and the **CONTRACTOR's** representative at the site. The Supervisor shall have full authority to act on behalf of the **CONTRACTOR**, and all communications given to the Supervisor shall be as binding as if given to the **CONTRACTOR**. The Supervisor shall be present on the site at all times as required to perform adequate supervision and coordination of the work. The Supervisor shall not be changed except with the consent of the **ENGINEER**, unless the Supervisor has proven to be unsatisfactory to the **CONTRACTOR** and ceases to be in his employ.

- B. Subcontracting:

- 1. The **CONTRACTOR** may utilize the services of specialty Subcontractors on those parts of the work which, under normal contracting practices, are performed by specialty Subcontractors.
 - 2. The **CONTRACTOR** shall not award work to Subcontractor(s) in excess of fifty (50%) percent of the Contract Price without prior written approval of the **OWNER**.

3. The **CONTRACTOR** shall be fully responsible to the **OWNER** for the acts and omissions of his Subcontractors, and or persons either directly or indirectly employed by them, as he is for the acts of persons directly employed by him.
4. The **CONTRACTOR** shall cause appropriate provisions to be inserted in all Subcontracts relative to the work to bind Subcontractors to the **CONTRACTOR** insofar as applicable to the work of Subcontractors and to give the **CONTRACTOR** the same power as regards terminating any subcontract that the **OWNER** may exercise over the **CONTRACTOR** under any provision of the Contract Documents.
5. Nothing contained in this Contract shall create any contractual relations between any Subcontractor and the **OWNER**.

C. Safety and Protection

1. **CONTRACTOR** shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work. **CONTRACTOR** shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
 - All employees on the work and other persons who may be affected thereby;
 - All the work and all materials or equipment to be incorporated therein, whether in storage on or off the site; and
 - Other property at the site or adjacent thereto, including, but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation or replacement in the course of construction.
2. **CONTRACTOR** shall comply with all applicable laws, ordinances, rules, regulations, and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

D. Contractor's Use of Premises

1. **OWNER** controls all lands upon which the work is to take place. The **CONTRACTOR** shall not enter upon private property for any purpose without first obtaining permission, and he shall be responsible for the preservation of all public and private property, trees, fences, monuments, underground structures, etc., on and adjacent to the site and shall use every precaution necessary to prevent damage or injury thereto. He shall protect carefully from disturbance or damage, all land monuments and property corners until an authorized agent has witnessed or otherwise referenced their location, and shall not remove them until directed. He shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect or misconduct in his or any Subcontractor's manner, or method or executing said work, due to this or any Subcontractor's non-execution of said work, or at any time due to defective work or materials, and said responsibility shall not be released until the work shall have been completed and warranty period expired.
2. Necessary sanitary conveniences for the use of laborers shall be properly secluded from public observation, shall be erected and maintained by the **CONTRACTOR** at such points acceptable to the **ENGINEER**.

1.05 CONSTRUCTION OBSERVATION

- A. The **OWNER** and **ENGINEER** will supply construction observation services as described in the Supplementary Conditions. Observation will be provided at no additional cost to the **CONTRACTOR** between the hours of 8:00 a.m. and 5:00 p.m. (or such hours as previously agreed to during the Preconstruction Meeting not to exceed ten (10) hours per day, Monday through Friday, excluding **OWNER's** holidays. Any observation time required outside of the

above indicated hours will be billed to the **CONTRACTOR**, or withheld from payments due the **CONTRACTOR**, at a rate of 1.5 times the **ENGINEER's** billing rate for observation plus a twenty (20%) percent administrative charge.

1.06 COORDINATION WITH OTHER CONTRACTORS

- A. The **CONTRACTOR** shall coordinate as necessary with other contractors at the site who may be providing facilities under separate contracts.
- B. Alterations of the start, duration, and/or completion dates for work of other contractors shall not relieve the **CONTRACTOR** of the responsibility of completing the Work of this Contract in the time specified herein.
- C. Any conflicts or potential conflicts between the Work and the work provided by other contractors shall be immediately brought to the attention of the **ENGINEER** for resolution in accordance with the Contract documents.

1.07 PERMITS

- A. The **CONTRACTOR** shall contact all Federal, State, and Local agencies to determine permitting requirements for construction-related activities under their jurisdiction. **CONTRACTOR** shall obtain and pay for all permits required for completion of the Work. The mention of specific permits in the Contract Documents shall not imply that those are the only permits required, and shall not relieve the **CONTRACTOR** from obtaining any and all permits required for construction. **CONTRACTOR** shall coordinate with appropriate permit authorities to arrange for progress inspections of the Work, as required.

1.08 OSHA STANDARDS

The **CONTRACTOR** shall be bound to at least the latest provisions of Subpart F, Section 1926, of the OSHA Safety and Health Standards for Construction.

1.09 ATTACHED PLANS AND SPECIFICATIONS

- A. Drawings

The design drawings are bound herewith and/or furnished separately and are made a part of these specifications and show the detailed work to be completed. The design drawings herewith indicate approximate routing of proposed pipelines and facilities and schematically show the work to be completed. Existing utilities are shown based on the best current information. Final staking may not reflect exactly the drawings, and staking changes due to existing utilities and conditions do not constitute design changes and are not extras or change orders except for additional fittings, pipe, valves, base course, asphalt, etc. required to complete the physical and intent of the project.

- B. Specifications

The Specifications furnished and bound herewith are separated into several Divisions, generally according to the Construction Specifications Institute (CSI). The Specifications provide the technical and general guidelines governing the progress of the work on the project.

Computed or written dimensions shall govern over scaled dimensions. In the event of discovery of discrepancies or any type of error whatsoever in the specifications, plans, and drawings, the **CONTRACTOR** shall not adjust them, save at his own risk and expense, but shall immediately request in writing, and the **ENGINEER** shall give in writing, an interpretation of the intent of the Contract, which interpretation shall govern. If the **CONTRACTOR**, as the work progresses, finds any discrepancies between the drawings and the physical conditions, it shall be his duty to

immediately inform the **ENGINEER** in writing. The **ENGINEER** shall promptly interpret the intent of the contract and, in its sole judgment, authorize the **CONTRACTOR** to proceed to the extent allowed herein and in accordance with the Contract documents. Any work done after such discovery, until authorized, will be done at the Contractor's risk.

1.10 COMMENCEMENT OF CONSTRUCTION

The **CONTRACTOR** shall not commence construction on the approved projects until:

- A. **CONTRACTOR** has fulfilled all applicable requirements relating to permits and licenses.
- B. 48-hour written notice of intention to commence construction is given to the **ENGINEER** stating date, time, and location of construction commencement.
- C. A mandatory preconstruction conference is attended by, but not limited to, the **ENGINEER** or designated representative, the **CONTRACTOR**, the **CONTRACTOR's** Foreman or Superintendent assigned to the project, the **OWNER's** representative, and representatives of all utility companies affected by the proposed construction.
- D. The **CONTRACTOR** has submitted written notice of the date of construction commencement.
- E. Compliance with any and all other applicable requirements in these specifications not specially mentioned in this section.

END OF SECTION

SECTION 01014

SEQUENCE OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: This Section covers the organizing, staging and sequencing of the Work.
- B. Related Work Specified Elsewhere:
 - 1. Section 01010 - Summary of Work
 - 2. Section 01310 - Construction Schedules
 - 3. Section 01560 - Temporary Controls

1.02 SUBMITTALS

- A. Schedules; Submit Schedules in accordance with Section 01310 Construction Schedules

PART 3 - EXECUTION

3.01 GENERAL

- A. The **CONTRACTOR** shall coordinate his efforts with the **OWNER** so as to minimize disruption of use of existing facilities.
- B. Procedures and methods other than those specified will be considered by **ENGINEER** and **OWNER**, provided they afford equivalent continuity of operations.
- C. Submit and update Progress Schedules and subschedules.
- D. Discuss Sequence of Work and Notice Required at Progress Meetings.
 - 1. Review with and obtain **ENGINEER's** and **OWNER's** input to **CONTRACTOR's** initial scheduling of Work sequence during Preconstruction Conference.
 - 2. Review any changes in scheduling at regularly scheduled Progress Meetings.
 - 3. Schedule additional construction meetings required to discuss work sequence.

- E. Inspection by Public Agencies

Authorized representatives of the **Widefield Water and Sanitation District** shall have access to the work wherever it is in preparation or progress.

Additionally, El Paso County DOT and other agencies of jurisdiction shall have access to the work wherever it is in preparation or progress.

Provide proper facilities for such access and inspection.

- F. It will be the **CONTRACTOR's** responsibility to schedule and sequence his activities so as to best meet environmental conditions imposed by inclement weather.

3.02 WORK SEQUENCE

- A. **CONTRACTOR** to coordinate all tie-ins and startup with Owner staff. All planned tie-ins and shutdowns to be coordinated a minimum of 72 hours prior to actual implementation.

3.03 COMPLETION SCHEDULE

A. Substantial Completion

- 1. The Work will be considered Substantially Complete after all pipeline and appurtenances pass all respective tests and are operational.

- a. Substantial Completion: On or before July 30, 2025

B. Final Completion:

- 1. The Work will be considered Final after all asphalt road replacement, recovery, revegetation, stabilization, and clean up has been completed at the site.

- a. Final Completion : On or before September 30, 2025

END OF SECTION

SECTION 01040

COORDINATION

PART I - GENERAL

1.01 DESCRIPTION

- A. Coordinate job operations to achieve the most efficient work progress.
- B. Coordinate efforts with **OWNER** to minimize utility disruptions and customer inconveniences.

1.02 GENERAL

- A. Work included in these Contract Documents is to be performed under the responsibility of a single prime contract.
- B. **CONTRACTOR** is responsible for coordination of all Work, whether performed by his own personnel or his subcontractors.
- C. **CONTRACTOR** shall maintain procedures necessary to keep his workmen and suppliers informed of project progress so as not to unnecessarily delay completion of the Work.

1.03 COORDINATION WITH UTILITIES

- A. The **CONTRACTOR** is to coordinate construction activities with affected utilities.
- B. The **CONTRACTOR** is to coordinate and keep in contact with the **Widefield Water and Sanitation District** at all times in regard to each days construction activities. This can be accomplished through regular interface with the **OWNER'S** field representative. The **CONTRACTOR** is to coordinate all tie-ins as described in the Contract Drawings with the **Widefield Water and Sanitation District**.

1.04 COORDINATION WITH OTHERS

- A. The **CONTRACTOR** is responsible for acquiring the appropriate permits for construction within El Paso County right-of-ways, City of Fountain right-of-ways, BNSF right-of-ways, and UP right-of-ways.
- B. El Paso County Stormwater Permits (if required) will be the responsibility of the **CONTRACTOR**. The **CONTRACTOR** will be listed on the final permit and will be required to meet the terms and conditions as describe within the permit.

END OF SECTION

SECTION 01070

ABBREVIATIONS

PART I - GENERAL

1.01 DESCRIPTION:

A. This Section defines abbreviations used in the Specifications.

1. AASHTO: American Association of State Highway and Transportation Officials
2. ACI: American Concrete Institute
3. AFBMA: Antifriction Bearing Manufacturers Association
4. AGA: American Gas Association
5. AGMA: American Gear Manufacturers Association
6. AI: Asphalt Institute
7. AIA: American Institute of Architects
8. AISC : American Institute of Steel Construction
9. AISI: American Iron and Steel Institute
10. ANSI: American National Standards Institute
11. APA: American Plywood Association
12. ASCE: American Society of Civil Engineers
13. ASTM: American Society for Testing and Materials
14. AWWA: American Wood Preservers Association
15. AWS: American Welding Society
16. AWWA: American Water Works Association
17. BHMA: Builders Hardware Manufacturers Association
18. cfm: Cubic Feet per Minute
19. cfs: Cubic Feet per Second
20. CISPI: Cast Iron Soil Pipe Institute
21. CMP: Corrugated Metal Pipe
22. CRSI: Concrete Reinforcing Steel Institute
23. CS: U.S. Department of Commerce, Commercial Standard

- 24. cu: Cubic
- 25. dia: Diameter
- 26. E.F.: Each Face
- 27. ELEV./EL: Elevation
- 28. E.W.: Each Way
- 29. Fed. Spec. (FS): Federal Specifications
- 30. FES: Flared End Section
- 31. ft: Foot
- 32. ga: Gage
- 33. gal: Gallon
- 34. gpm: Gallons per Minute
- 35. hr: Hour
- 36. I.D.: Inside Diameter
- 37. IEEE: Institute Electrical and Electronics Engineers
- 38. in: Inch
- 39. KW: Kilowatt
- 40. lf: Lineal Foot
- 41. lb: Pound
- 42. max: Maximum
- 43. MH: Manhole
- 44. MIL: Military Specifications
- 45. min: Minimum
- 46. mgl: milligrams per liter
- 47. MUTCD: Manual on Uniform Traffic Control Devices
- 48. NAAMM: National Association of Architectural Metal Manufacturers
- 49. NBS: National Bureau of Standards
- 50. NEC: National Electric Code
- 51. NEMA: National Electrical Manufacturers Association

- 52. NPT: National Pipe Thread
- 53. O.C.: On Center
- 54. O.D.: Outside Diameter
- 55. PCI: Prestressed Concrete Institute
- 56. PS: U.S. Department of Commerce, Product Standard
- 57. ppd: pounds per day
- 58. ppm: parts per million
- 59. psig: pounds per square inch (gauge)
- 60. PVC: Polyvinyl Chloride
- 61. RCP: Reinforced Concrete Pipe
- 62. RPM: Revolutions per Minute
- 63. sq: Square
- 64. SSPC: Steel Structures Painting Council
- 65. UBC: Uniform Building Code
- 66. UL: Underwriter's Laboratory
- 67. UMC: Uniform Mechanical Code
- 68. UPC: Uniform Plumbing Code
- 69. USBR: U.S. Bureau of Reclamation
- 70. USBS: U.S. Bureau of Standards
- 71. yd: Yard

END OF SECTION

SECTION 01150

MEASUREMENT AND PAYMENT

PART I - GENERAL

1.01 DESCRIPTION

- A. Review Applications for Payment as prepared by **ENGINEER** in accordance with the General and Supplemental General Conditions and the Agreement between **OWNER** and **CONTRACTOR**.
- B. Additional Requirements Specified Elsewhere.
 - 1. Progress Payments, Retainage and Final Payment: General Conditions and Supplemental General Conditions, Standard Specifications, and Agreement between Owner and Contractor.
 - 2. Construction Schedules: Section 01310.
 - 3. Contract Closeout: Section 01700.

1.02 FORMAT AND DATA REQUIRED

- A. Application for Payment prepared by the **ENGINEER** with itemized data typed on white paper continuation sheets.
- B. Itemized data on continuation sheets

Format, schedules, line times, and values: Those of the approved Schedule of Values.

1.03 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

- A. Application Form Prepared by **ENGINEER**.
 - 1. Required information completed, including that for Change Orders executed prior to the date of submittal of application.
 - 2. Summary of dollar values to agree with the respective totals indicated on the continuation sheets.
- B. Continuation Sheets:
 - 1. Total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
 - 2. Dollar value in each column for each scheduled line item when work has been performed.
 - 3. Each Change Order executed prior to the date of submission shall be listed at the end of the continuation sheets.

List by Change Order number and description as for an original component item of work.
- C. **CONTRACTOR** shall execute certification with the signature of responsible officer of the **CONTRACTOR's** firm.

1.04 SUBSTANTIATING DATA FOR PROGRESS PAYEMENTS

- A. When **OWNER** or **ENGINEER** requires substantiating data, **CONTRACTOR** shall submit suitable information with a cover letter identifying:
 - 1. Project name and number.
 - 2. Application number and date.
 - 3. Detailed list of enclosures.
- B. Submit one (1) copy of data and cover letter for each copy of application.

1.05 SCHEDULE OF VALUES

- A. Refer to General Conditions for requirements.
- B. Where payment is to be based on fixed price correlate Schedule of Values with divisions and section of specification unless otherwise approved by the **ENGINEER**.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

- A. **ENGINEER** shall complete Application form as specified for progress payments
- B. Continuation sheets used for presenting the final statement of accounting as specified in Section 01700-Contract Closeout.

1.07 SUBMITTAL PROCEDURE

- A. Review Applications for Payment as prepared by **ENGINEER** as stipulated in the Contract Documents and specified in the pre-construction conference.

CONTRACTOR shall execute certification with the signature of a responsible officer of the **CONTRACTOR's** firm.
- B. When certification by **CONTRACTOR** is completed, **ENGINEER** will transmit a Certification for Payment to **OWNER**, with a copy to **CONTRACTOR**.

END OF SECTION

SECTION 01300

SUBMITTALS

PART I - GENERAL

1.01 REQUIREMENTS INCLUDED

The **CONTRACTOR** shall submit to the **ENGINEER** for approval all submittals required by the General Conditions and these Specification sections. Submittal shall be submitted on form 01300-A.

1.02 INSURANCE CERTIFICATES

Refer to General Conditions for submittal requirements. Submit updated certificates as necessary to verify current coverage.

1.03 SCHEDULE OF VALUES

Refer to General Conditions for requirements.

1.04 CONSTRUCTION SCHEDULE

(See Section 01310 for Construction Schedule Submittal details).

1.05 SHOP DRAWINGS

(See Section 01340 for Shop Drawing Submittal details).

1.06 PROJECT RECORD DOCUMENTS

A. Maintenance of Documents:

1. Maintain at job site one record copy of Contract Drawings, Specifications, Addenda, approved Shop Drawings, Change Orders, other modifications to the Contract, field test records, and other approved documents submitted by **CONTRACTOR** in compliance with specification requirements.
2. Maintain documents at the project site apart from documents used for construction. Do not use record documents for construction purposes. Maintain records in clean, legible condition. Make documents available at all times for inspection by the **ENGINEER** and **OWNER**.

B. Recording: Label each document "**PROJECT RECORD COPY**" in 2-inch-high printed letters. Keep record documents current. Do not permanently conceal any work until required information has been recorded.

1. Contract Documents: Legibly mark most appropriate drawing to record, where applicable:
 - Depths of various elements of foundations in relation to existing ground surfaces.
 - Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
 - Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
 - Field changes of dimension and detail made during construction process.

- Changes made by Change Order or Field Order.
 - Details not on original Contract Drawings.
2. Specifications and Addenda: Legibly mark up each section to record:
- Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
 - Changes made by Change Order or Field Order.
 - Other matters not originally specified.
3. Submittal:
- At completion of project, deliver record documents to the **ENGINEER**.
 - Accompany submittal with transmittal letter, in duplicate, containing date; project title and number; **CONTRACTOR**'s name and address; title and number of each record document; certification that each document has been prepared and approved by either the **CONTRACTOR** or his authorized representative.

END OF SECTION

Submittal Description: _____

Submittal No.: _____

Spec. Section: _____

	Routing	Date Sent	Date Received
OWNER:	Contractor/Engineer		
PROJECT:	Engineer/Contractor		
CONTRACTOR:			

We are sending you: ☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No.	Description	Review action ^a	Reviewer initials	Review comments attached

^aNote: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected, Develop Replacement
 Attach additional sheets if necessary.

Contractor

Certify either A or B:

- ☐ A. We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).
- ☐ B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.Deviation

Certified by: _____

Contractor's Signature

SECTION 01310

CONSTRUCTION SCHEDULES

PART I

1.01 GENERAL

- A. Within ten (10) days after EFFECTIVE DATE OF AGREEMENT or by the pre-construction conference, the **CONTRACTOR** shall prepare and submit to the **ENGINEER** estimated construction progress schedules for the Work, with sub-schedules of related activities which are essential to the progress of the Work.
- B. Submit revised progress schedules periodically.
- C. **OWNER** may require **CONTRACTOR** to add to his plant, equipment or construction forces, as well as increase the working hours, if operations fall behind schedule at any time during the construction period.
- D. Related Requirements Specified Elsewhere.
 - 1. General Conditions.
 - 2. Supplemental General Conditions.
 - 3. Standard Specifications.
- E. Additional Requirements Specified Elsewhere.
 - 1. Summary of Work: Section 01010.
 - 2. Measurement and Payment: Section 01150.
 - 3. Shop Drawings: Section 01340.

1.02 FORM OF SCHEDULES

- A. Prepare schedules in the form of a horizontal bar chart.
 - 1. Provide separate horizontal bar for each trade or operation.
 - 2. Horizontal time scale: Identify the first work day of each week.
 - 3. Scale and spacing: To allow space for notations and future revisions.
 - 4. Maximum sheet size: 24" x 36".
- B. Computer generated schedule.
 - 1. Network analysis system may be utilized in lieu of bar chart.
- C. Format of Listings.
 - 1. The chronological order of the start of each item of work.

1.03 CONTENT OF SCHEDULES

- A. Construction Progress Schedules to include:
1. The complete sequence of construction by activity.
 2. The dates for the beginning, and completion of, each major element in each major area of construction, including but not limited to:
 - a. Shop Drawing Submittal
 - b. Excavation and subgrade preparation
 - c. Pipeline, Hydrant, Service Lines, Metering Pits installation
 - d. Facility installation
 - e. Testing
 - f. Landscaping and re-vegetation
 - g. Substantial Completion
 - h. Start-up
 - i. Final Completion
 3. Projected percentage of completion for each item, as of the date on which each scheduled Application for Payment is due.
 4. Complete projected progress payment schedule.
- B. Schedule of Submittals for Shop Drawings and Product Data to include:
1. The dates for **CONTRACTOR's** submittals.
 2. The dates approved submittals will be required from the **ENGINEER**.
- Extensions of time for delays in submittal review and distribution will only be allowed as provided for in Section 01340.
- C. Products Delivery Schedule.
- Show delivery dates for all major items of material and equipment.

1.04 PROGRESS REVISIONS

- A. Indicate progress of each activity to date of submission.
- B. Show changes occurring since previous submission of schedule.
1. Major changes in scope.
 2. Activities modified since previous submission.
 3. Revised projections of progress and completion.

4. Revisions to projected progress payment schedule.
 5. Other identifiable changes.
- C. Provide a narrative report as needed to define:
1. Problem areas, anticipated delays, and the impact on the schedule.
 2. Corrective action recommended and its effect.

1.05 SUBMISSIONS

- A. Submit initial schedules within ten (10) days after effective date of Agreement.
1. **ENGINEER** will review Schedules and return review copy within ten (10) days after receipt.
 2. If required, resubmit within seven (7) days after return of review copy.
- B. Submit revised progress schedules with each Application for Payment.
- C. Number of copies required at each submission:
1. The number of opaque reproductions required by the **CONTRACTOR** plus three (3) copies which will be retained or distributed by the **ENGINEER**.
 2. Do not submit fewer than five (5) copies.

1.06 DISTRIBUTION

- A. After review, **ENGINEER** will distribute copies of schedules to:
1. Two (2) copies to **OWNER**.
 2. One (1) copy to Resident Project Representative.
 3. One (1) copy to be retained in **ENGINEER's** file.
 4. One (1) copy to **CONTRACTOR** to be kept on file at **CONTRACTOR's** field office.
 5. Remainder to **CONTRACTOR** for his distribution following modifications if required.
- B. Schedule recipients will report promptly to **ENGINEER** and **CONTRACTOR**, in writing, any problems anticipated by the projections shown on the schedules.

END OF SECTION

SECTION 01320

PRODUCT DELIVERY, STORAGE AND HANDLING

PART I – GENERAL

1.01 RELATED REQUIREMENTS

- A. General and Supplementary Conditions

1.02 PRODUCTS

- A. Products include material, equipment and systems.
- B. Comply with Specifications and referenced standards as minimum requirements.

1.03 TRANSPORTATION AND HANDLING

- A. Transport products by methods to avoid product damage; deliver in undamaged condition in manufacturer's unopened containers or packaging, dry.
- B. Provide equipment and personnel to handle products by methods to prevent soiling or damage.
- C. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

1.04 STORAGE AND PROTECTION

- A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.
- C. Store loose granular materials on solid surfaces in a well drained area; prevent mixing with foreign matter.
- D. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

END OF SECTION

SECTION 01330

SURVEY DATA

PART I - GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The **CONTRACTOR** will be responsible for all staking required for construction.
- B. The **CONTRACTOR** will be responsible for the maintenance of control points, bench marks and construction stakes. Re-staking will be at the **CONTRACTOR's** expense.

END OF SECTION

SECTION 01340

SHOP DRAWINGS

PART I - GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The **CONTRACTOR** shall submit to the **ENGINEER** for approval all shop drawings required by the specification sections.

1.02 SHOP DRAWINGS

- A. Shop drawings shall be prepared by a qualified detailer for **CONTRACTOR**, subcontractor, supplier, or manufacturer, and shall illustrate some portion of the work, showing fabrication, layout, setting, or erection details.
- B. Identify details by reference to sheet and detail numbers shown on Contract Drawings. Use same symbols used on Contract Drawings to identify shop drawing details wherever practicable.

1.03 PRODUCT DATA

- A. Submit manufacturer's standard schematic drawings:
 - 1. Modify drawings to delete information which is not applicable to the project.
 - 2. Supplement standard information to provide additional information applicable to project.
- B. Submit manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, and other standard descriptive data.
 - 1. Clearly mark each copy to identify pertinent materials, products or models.
 - 2. Show dimensions and clearances required, performance characteristics and capabilities, wiring diagrams and controls, and any other pertinent data applicable to the project.
- C. Submit manufacturer's certificate of compliance certifying to compliance with specification requirements, applicable reference standards and test data requirements. Include reference to the specification section and paragraph with which the product or materials is intended to comply.

1.04 CONTRACTOR RESPONSIBILITIES

- A. **CONTRACTOR** shall submit five (5) copies of each shop drawing required.
- B. Submittals shall be made by **CONTRACTOR** to the **ENGINEER** with a transmittal form or letter and not by subcontractors, suppliers or manufacturers. **CONTRACTOR** shall review, stamp with his approval, and submit in orderly sequence all submittals required by the specifications. By approving and submitting items, **CONTRACTOR** represents that he has verified all field measurements, field construction criteria, materials, catalog numbers, and similar data, and has coordinated each shop drawing with requirements of the project.
- C. The **CONTRACTOR** shall not begin work which requires submittals until the **ENGINEER** reviews and approves submittals. The **ENGINEER** will return an approved copy of the submittal to the **CONTRACTOR**.

- D. **CONTRACTOR's** responsibility for errors and omissions in submittals, or for deviations in submittals from requirements of the Contract Documents, shall not be relieved by review of submittals unless **ENGINEER** gives written acceptance of specific deviations. The **CONTRACTOR** shall notify **ENGINEER** in writing at time of submission of deviations in submittals from requirements of the Contract Documents.

END OF SECTION

SECTION 01400

QUALITY CONTROL

1.01 RELATED REQUIREMENTS

- A. General Conditions
- B. Supplementary Conditions
- C. Testing Laboratory Services

1.02 TESTING - GENERAL

- A. Provide such equipment and facilities as the **ENGINEER** may require for conducting field tests and for collecting and forwarding samples. Do not use any materials or equipment represented by samples until tests, if required, have been made and the materials or equipment found to be acceptable. Any product which becomes unfit for use after approval thereof shall not be incorporated into the work.
- B. All materials or equipment proposed to be used may be tested at any time during their preparation or use. Furnish the required samples without charge and give sufficient notice of the placing of orders to permit the testing. Products may be sampled either prior to shipment or after being received at the site of the work.
- C. Tests shall be made by an accredited testing laboratory selected by the **OWNER**. Except as otherwise provided, sampling and testing of all materials and the laboratory methods and testing equipment shall be in accordance with the latest standards and tentative methods of the American Society for Testing Materials (ASTM).
- D. Where additional or specific information concerning testing methods, sample sizes, etc., is required, such information is included under the applicable sections of the Specifications. Any modification of, or elaboration on, these test procedures which may be included for specific materials under their respective sections in the Specifications shall take precedence over these procedures.
- E. Failed tests shall be paid for by the **CONTRACTOR**, as per paragraph 1.06, A.3 in this section.

1.03 FILL AND BACKFILL TESTS

Control test of fill and backfill shall be paid for by the **OWNER**.

1.04 CONCRETE TESTS

Control tests of concrete work shall be made at such times and in such number as specified in Section 03300, "Cast-in-Place Concrete". Testing will be paid for by the **CONTRACTOR**.

1.05 PRISM TESTS

Prism tests, if required, shall be performed on Mortar as specified in Sections 04100. One prism test shall be performed for block installed and shall be performed in a manner which will duplicate the completed wall by combining the masonry units, the mortar and grout, to verify the f'm of the masonry assemblage. Testing will be paid for by the **CONTRACTOR**.

1.06 OTHER TESTING

- A. If required, the following testing shall be performed at the expense of the **CONTRACTOR** installing the material being tested:

1. Material Substitution: Any tests of basic material or fabrication equipment offered as a substitute for specified item on which a test may be required in order to prove its compliance with the Specifications.
 2. Mechanical/Electrical: Tests on mechanical or electrical systems required to insure their proper installation and operation.
 3. Any test that fails shall be paid for by the installing **CONTRACTOR** subject to the following conditions:
 - a. Quantity and nature of tests will be determined by the **ENGINEER**.
 - b. All tests shall be taken in the presence of the **ENGINEER** or his representative.
 - c. Proof of noncompliance will make the installing **CONTRACTOR** liable for any corrective action which the **ENGINEER** feels is prudent, including complete removal and replacement of defective material.
- B. Nothing contained herein is intended to imply that the installing **CONTRACTOR** does not have the right to have tests performed on any material at any time for his own information and job control so long as the **OWNER** does not assume responsibility for costs or for giving them consideration when appraising quality of materials.

1.07 TEST REPORTS

Reports of all tests made by testing laboratories shall be distributed by the testing laboratory as follows:

1 copy	-	CONTRACTOR
1 copy	-	OWNER
1 copy	-	ENGINEER
1 copy	-	RESIDENT PROJECT REPRESENTATIVE
Other copies	-	As Directed

1.08 CONTRACTOR'S QUALITY CONTROL SYSTEM

- A. General: Establish a quality control system to perform sufficient inspection and tests of all items of work, including that of subcontractors, to ensure conformance to the Contract Documents for materials, workmanship, construction, finish, functional performance and identification. Establish this control for all construction except where the Contract Documents provide for specific compliance tests by testing laboratories or engineers employed by the **OWNER**. **CONTRACTOR's** control system shall specifically include all testing required by the various sections of the Specifications.
- B. **CONTRACTOR's** quality control system is the means by which he assures himself that his construction complies with the requirements of the Contract Documents. Controls shall be adequate to cover all construction operations and shall be keyed to the proposed construction schedule.
- C. Records: Maintain correct records on an appropriate form for all inspections and tests performed, instructions received from the **ENGINEER** and actions taken as a result of those instructions. These records shall include evidence that the required inspections or tests have been performed (including type and number of inspections or tests, nature of defects, causes for rejection, etc.) proposed or directed remedial action, and corrective action taken. Document inspections and tests as required by each section of the Specifications.

END OF SECTION

SECTION 01410

TESTING LABORATORY SERVICES

PART I - GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Cooperation with testing laboratory services employed by the **OWNER**.
- B. Provision of specified testing laboratory services.

1.02 DESCRIPTION

- A. **OWNER** will employ and pay for services of an independent testing laboratory through the **ENGINEER** who shall perform specified field tests.
- B. Employment of testing laboratory shall in no way relieve **CONTRACTOR** of obligation to perform work in accordance with requirements of Contract Documents.

1.03 REFERENCES

- A. ANSI/ASTM D-3640 - Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- B. ANSI/ASTM E-329 - Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction.

1.04 LABORATORY REQUIREMENTS

- A. Test samples of mixes submitted by **CONTRACTOR**.
- B. Provide qualified personnel at site after due notice; cooperate with **ENGINEER** and **CONTRACTOR** in performance of services.
- C. Perform specified inspection, sampling and testing of products in accordance with specified standards.
- D. Ascertain compliance of materials and mixes with requirements of Contract Documents.
- E. Promptly notify **ENGINEER** and **CONTRACTOR** of observed irregularities or non-conformance work or products.
- F. Perform additional inspections and tests required by **ENGINEER**.
- G. Attend preconstruction conferences and progress meetings, as needed.

1.05 LABORATORY REPORTS

After each inspection and test, promptly submit one copy of laboratory report to **ENGINEER, OWNER, CONTRACTOR, RESIDENT PROJECT REPRESENTATIVE**, and Record Documents file. Include date issued, project title, number and name of inspector, date and time of sampling or inspection, identification of product and specifications section, location in the project, type of inspection or test, date of test, results of tests, and conformance with Contract Documents. When requested by **ENGINEER**, provide interpretation of test results.

1.06 LIMITS ON TESTING LABORATORY AUTHORITY

- A. Laboratory may not release, evoke, alter, or enlarge on requirements of Contract Documents.
- B. Laboratory may not approve or accept any portion of the work.
- C. Laboratory may not assume any duties of **CONTRACTOR**.
- D. Laboratory has no authority to stop work.

1.07 CONTRACTOR RESPONSIBILITIES

- A. Cooperate with laboratory personnel; provide access to work and to manufacturer's operations.
- B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.
- C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other materials mixes which require control by the testing laboratory.
- D. Furnish copies of product test reports as required.
- E. Furnish incidental labor and facilities:
 - 1. To provide access to work to be tested.
 - 2. To obtain and handle samples at the project site or at the source of the product to be tested.
 - 3. To facilitate inspections and tests.
 - 4. For storage and curing of test samples of concrete cylinders.
- F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
- G. Pay for the services of the independent testing laboratory to perform additional inspections, sampling and testing required: When initial tests indicate work does not comply with Contract Documents.
- H. Make arrangements with laboratory and pay for additional samples and tests required for **CONTRACTOR**'s convenience.

END OF SECTION

SECTION 01560

TEMPORARY CONTROLS

PART I - GENERAL

1.01 NOISE CONTROL

- A. Take precautions against unnecessary construction noise levels when in inhabited areas.
- B. Provide and maintain appropriate mufflers on construction equipment.

1.02 DUST CONTROL

Where construction activities expose earth surfaces allowing dusting, water shall be used in controlling dust.

1.03 POLLUTION CONTROL

- A. Protect waterways from pollution by debris, sanitary wastes, runoff, and spills.
- B. Protect water systems from any contamination.
- C. Protect storm sewers from sanitary wastes, sediment or other substance except storm water.
- D. Protect sanitary sewers from runoff or any other substance except sanitary sewer wastewater.

1.04 DRAINAGE CONTROL

Provide site grading which shall prevent excess runoff from entering construction area.

1.05 SANITARY FACILITIES

CONTRACTOR shall provide and maintain, throughout project duration, adequate temporary toilet facilities in a neat and sanitary condition for all employees and authorized visitors at the site. Place facilities at approved locations near the work at each location.

1.06 TEMPORARY UTILITIES

- A. Electric Power and Lighting:
 - 1. The **CONTRACTOR** shall be responsible for locating a temporary source of electrical energy for use during the construction period, and for providing needed power to the site.
 - 2. Temporary electrical work shall meet the requirements of the National Electrical Code (NEC 70), latest edition.
 - 3. **CONTRACTOR** may use permanent electrical system for construction purposes provided that use is regulated to prevent interference with orderly progress of the work or adjacent facilities in use, and permanent system (including lamps) is restored to a condition as good as new upon completion of construction.
- B. Temporary Heat and Protection:
 - 1. **CONTRACTOR** shall provide and maintain temporary enclosures, weather barriers, heat and ventilation as necessary to properly protect and cure all portions of the work, whether or not

permanently incorporated into the project, at all times during the construction period. Do not use solid fuel burning space heaters or use or leave unattended any equipment or apparatus which might create an unsafe condition.

1.07 FENCING AND BARRIERS

- A. Refer to General Conditions for responsibilities with respect to protection of persons and property.
- B. Provide and maintain temporary fences, barricades, lights, and guardrails as indicated in the Contract Documents or as necessary to regulate vehicular and pedestrian traffic, to secure the Work and adjacent property, and to protect persons, animals and property.
 - 1. Obtain necessary approvals and permits and provide temporary expedients as necessary to accommodate controls.
 - 2. All barricading and traffic controls shall be in accordance with a traffic control plan prepared and submitted by the **CONTRACTOR** in accordance with the Manual on Uniform Traffic Control Devices.

1.08 FIELD OFFICES AND STORAGE FACILITIES

- A. Provide and maintain storage sheds, trailers or other facilities as necessary to store and protect materials, tools and equipment.

END OF SECTION

SECTION 01650
STARTING OF SYSTEM

PART I - GENERAL

1.01 DESCRIPTION

- A. Work Included: This section covers the initial startup of systems, **OWNER** training and operations of all systems.
- B. Related Work: Refer to Section 01010, Summary of Work.

1.02 GENERAL

- A. The **CONTRACTOR**, after initial startup, will operate the system for a period of two weeks to adjust equipment and demonstrate its readiness for the uses intended.
- B. Startup:
 - 1. The **CONTRACTOR** will schedule with **OWNER** and **ENGINEER** the times at which systems are ready for operation as designed.
 - 2. On the date of startup, the **CONTRACTOR** shall provide a two day training session for **OWNER's personnel**. The training session shall discuss all aspects of the operation and maintenance of facilities and equipment.
 - b. The training sessions shall include a demonstration of all alarms if applicable and operating conditions.
- C. Two (2) Week Operation and Training Period:
 - 1. After startup, the **CONTRACTOR** shall operate the system for a period of two (2) week.
 - 2. During the two (2) week period, the **CONTRACTOR** shall make any minor adjustments necessary in the facilities for the existing conditions.
 - 3. During the period, the **OWNER's** personnel will attend operational activities with the **CONTRACTOR** to further gain an understating of the system.
 - 4. At the end of the two (2) week operational phase, the **CONTRACTOR** must continue operations while making the necessary corrections until satisfactory demonstration is shown.
 - 5. If operating conditions cannot be successfully demonstrated, the **CONTRACTOR** must continue operations while making the necessary corrections until satisfactory demonstration is shown.
 - 6. Upon successful completion of this phase, **OWNER** will assume operational responsibility.
- D. Post Start-up Training Period:
 - 1. Following the assumption of operational responsibility by the **OWNER**, the contractor will provide a (1) day post start-up training session to **OWNER's** personnel lasting a minimum of (4) hours.

END OF SECTION

SECTION 01666

TESTING PRESSURE PIPE SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

This section covers the pressure and leakage testing of force mains.

1.02 QUALITY ASSURANCE

A. Pressure Test Criteria

1. The minimum test pressure shall not be less than the rated pressure class of the specified pipe or 150 psig, whichever is greater.
2. Once the line is pressurized to the specified test pressure, the line must maintain the test pressure within 5 psig for at least three (3) hours.

B. Leakage Test Criteria

1. A leakage test can be conducted concurrently with the pressure test.
2. Leakage is the quantity of water that must be added to the section being tested in order to return the section to the test pressure at the conclusion of the pressure test.
3. Allowable leakage (that amount used to re-fill the pipeline), gallons per hour per one thousand feet (1,000') of pipe, for each section between line valves for mechanical joint or push-on joint pipe shall not exceed the following rates:

Avg. Test Pressure	Pipe Size – Inches (Gallons)						
	3	6	8	12	16	20	24
PSI	3	6	8	12	16	20	24
250	0.47	0.71	0.95	1.42	1.90	2.37	2.85
225	0.45	0.68	0.90	1.35	1.80	2.25	2.70
200	0.43	0.64	0.85	1.28	1.70	2.12	2.55
175	0.40	0.59	0.80	1.19	1.59	1.98	2.38
150	0.37	0.55	0.74	1.10	1.47	1.84	2.21

4. If testing indicates a leakage rate in excess of the rates above, the pipeline will not be accepted. The pipeline shall be repaired, re-chlorinated, and re-tested as described in this section until all test requirements are met.

1.03 PERFORMANCE

A. Preparation and Testing:

1. Provide equipment, materials and personnel to maintain internal pipe pressure as required and accurately measure leakage from the pipe over a three (3) hour, minimum, test period.

2. Pressure and leakage tests shall take place only after the pipeline is adequately blocked or cast-in-place thrust blocks have had sufficient time to cure.
3. After pipeline completion, conduct pressure test and leakage test concurrently.
4. If not already filled, slowly fill pipe with water.
5. Remove all air.
 - Install corporation cocks at high points to evacuate the air if permanent air vents are not located there. Remove and plug after filling.
6. Leave pipe filled with water for a minimum of 24 hours prior to the hydrostatic pressure test if mortar lined pipe is being tested.
7. No allowance shall be made for pressure reductions accomplished by means of pressure reducing valves or other mechanical means.
8. Record times, leakage readings and pressure over test period.

B. Inspection:

1. Notify **ENGINEER** at least 48 hours in advance of testing.
2. **ENGINEER** or representative must be present during testing.

C. Acceptance:

1. Acceptance shall be on the basis of maximum allowable leakage.
2. Locate and repair defective materials and joints if the tests disclose leakage greater than that specified.
3. Repeat tests until the leakage is within the permitted allowance.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART I - ADMINISTRATIVE PROCEDURES

1.01 GENERAL

- A. Comply with requirements stated in general conditions and in Specifications for administrative procedures in closing out the Work.
- B. Additional Requirements Specified Elsewhere.
 - 1. Fiscal provisions, legal submittals, and additional administrative requirements: General Conditions, Supplemental General Conditions, Standard Specifications, and the Agreement.
 - 2. Measurement and Payment: Section 01150.

1.02 SUBSTANTIAL COMPLETION

- A. When **CONTRACTOR** considers the Work is substantially complete, he shall submit to **ENGINEER**.
 - 1. A written notice that the Work is substantially complete.
 - 2. A list of items to be completed or corrected.
- B. Within a reasonable time after receipt of such notice, **ENGINEER** will make an inspection to determine the status of completion.
- C. Should **ENGINEER** determine that the Work is not substantially complete:
 - 1. **ENGINEER** will promptly notify the **CONTRACTOR** in writing, give the reasons therefore;
 - 2. **CONTRACTOR** shall remedy the deficiencies in the Work and send a second written notice of substantial completion to **ENGINEER**.
 - 3. **ENGINEER** will reinspect the Work.
- D. When **ENGINEER** finds that the Work is substantially complete, he will
 - 1. Prepare and deliver to **OWNER** a tentative Certificate of Substantial Completion with a tentative list of items to be completed or corrected before final payment.
 - 2. After consideration of any objections made by the **OWNER** as provided in General Conditions and when **ENGINEER** considers the Work substantially complete, he will execute and deliver to the **OWNER** and the **CONTRACTOR** a definite Certificate of Substantial Completion with a revised list of items to be completed or corrected.

1.03 FINAL INSPECTION

- A. When **CONTRACTOR** considers the Work is complete, he shall submit written certification that
 - 1. Contract Documents have been reviewed

2. Work has been inspected for compliance with Contract Documents
 3. Work has been completed in accordance with Contract Documents
 4. Systems have been tested and are operational
 5. Work is completed and ready for final inspection
- B. **ENGINEER** will make an inspection to verify the status of completion with reasonable promptness after receipt of such certification
- C. Should **ENGINEER** consider that the Work is incomplete or defective
1. Engineer will promptly notify the **CONTRACTOR** in writing, listing the incomplete or defective work
 2. **CONTRACTOR** shall take immediate steps to remedy the stated deficiencies, and send a second written certification to **ENGINEER** that the Work is complete
 3. **ENGINEER** will reinspect the Work
- D. When the **ENGINEER** finds that the Work is acceptable under the Contract Documents, he shall request the **CONTRACTOR** to make closeout submittals.

1.04 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

- A. Project Record Documents
- B. Certificates of Compliance: As specified in individual sections

1.05 FINAL ADJUSTMENT OF ACCOUNTS

- A. Review the Final Statement of Accounting as prepared by the **ENGINEER**
1. Refer to Section 01150 - Measurement and Payment, for additional requirements
- B. Statement will reflect all adjustments to the contract sum
1. The original Contract Sum
 2. Additions and deductions resulting from
 - a. Previous Change Orders
 - b. Deductions for uncorrected work
 - c. Deductions for liquidated damages
 - d. Deduction for retesting payment, Section 01400 - Quality Control.
 - e. Deduction for additional review of Shop Drawing or Product Data Submittals, Section 01340 - Shop Drawings.
 - f. Other adjustments

3. Total Contract Sum, as adjusted
4. Previous payments
5. Sum remaining due

1.06 FINAL APPLICATION FOR PAYMENT

Contract shall review and certify the final Application for Payment as prepared by the **ENGINEER** in accordance with procedures and requirements stated in the General Conditions, Standard Specifications, and Section 01150 - Measurement and Payment

PART III - FINAL PAYMENT

3.01 GENERAL

Final payment will not be made until the **OWNER** has completed the statutorily required public advertisement of a notice of final payment and any claims filed with the **OWNER** have been resolved to the satisfaction of the **OWNER** and the applicable governing agency.

PART IV - POST-CONSTRUCTION INSPECTION

4.01 GENERAL

- A. Prior to expiration of one year from date of Substantial Completion, **ENGINEER** will make visual inspection of project site in company with the **OWNER** to determine whether correction of work is required.
- B. **CONTRACTOR** to attend inspection if requested by the **ENGINEER**.

END OF SECTION

SECTION 01710

CLEANUP

PART I - GENERAL

1.01 DESCRIPTION

- A. Scope
 - 1. Maintain premises and public properties free from accumulations of wastewater and debris caused by work on this project.
 - 2. At project completion, leave all new and existing facilities affected by the Work clean and ready for occupancy.
- B. Related Requirements Specified Elsewhere
 - 1. Cleaning of certain parts of the Work described in various sections of the Specifications.
- C. Failure by **CONTRACTOR** to maintain project site and facilities in a state of cleanliness shall be adequate reason for **ENGINEER** to recommend that **OWNER** withhold any present and future progress payments until **CONTRACTOR** complies with specification requirements.

1.02 STIPULATIONS

- A. Hazards Control: As required by regulatory agencies.
- B. Conduct cleaning and disposal operations in compliance with laws and safety orders of governing authorities including anti-pollution laws.

PART II - PRODUCTS

2.01 CLEANING MATERIALS

- A. Use only cleaning materials recommended by manufacturer of surface to be cleaned or finish to be applied.
- B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART III - EXECUTION

3.01 DURING CONSTRUCTION

- A. Prevent dust nuisance attributable to this work.
- B. Provide trash receptacles
 - 1. Strategically located around site.
 - 2. Fifty-five (55) gallon drums, minimum.

- 3. Promptly empty when full, do not allow trash to overflow, keep surrounding area free from trash accumulation.
- C. At reasonable intervals during progress of work, legally dispose of waste materials, debris, and rubbish off the site.
 - 1. Waste materials shall not be burned or buried on site or disposed of into storm drains, sanitary sewers, streams, or waterways.
- D. Handle materials in a controlled manner with as few handlings as possible.
- E. Neatly stack construction materials such as concrete forms when not in use.

3.02 FINAL CLEANING

- A. Repair, patch, and touch-up marred surfaces to specified finish to match adjacent surfaces.
- B. Broom clean paved surfaces, rake clean other surfaces of grounds.
- C. Restore site to condition equal to or better than that which existed prior to commencement of Work.

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE INFORMATION

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.
- B. O&M instructions must be submitted and accepted before on-site training may start.

PART 2 PRODUCTS

2.1 TYPES OF INFORMATION REQUIRED

- A. GENERAL: O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.
- B. OPERATING INSTRUCTIONS: Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
 - 1. SAFETY PRECAUTIONS: List personnel hazards for equipment and list safety precautions for all operating conditions.
 - 2. OPERATOR PRESTART: Provide requirements to set up and prepare each system for use.
 - 3. STARTUP, SHUTDOWN, AND POSTSHUTDOWN PROCEDURES: Provide a control sequence for each of these operations.
 - 4. NORMAL OPERATIONS: Provide control diagrams with data to explain operation and control of systems and specific equipment.
 - 5. EMERGENCY OPERATIONS: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
 - 6. OPERATOR SERVICE REQUIREMENTS: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
 - 7. ENVIRONMENTAL CONDITIONS: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.
- C. PREVENTIVE MAINTENANCE: The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

1. LUBRICATION DATA: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 2.0-B6.
 - a. A table showing recommended lubricants for specific temperature ranges and applications;
 - b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
 - c. A lubrication schedule showing service interval frequency.
 2. PREVENTIVE MAINTENANCE PLAN AND SCHEDULE: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.
- D. CORRECTIVE MAINTENANCE: Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
1. TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
 2. WIRING DIAGRAMS AND CONTROL DIAGRAMS: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
 3. MAINTENANCE AND REPAIR PROCEDURES: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
 4. REMOVAL AND REPLACEMENT INSTRUCTIONS: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.
 5. SPARE PARTS AND SUPPLY LISTS: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
 6. CORRECTIVE MAINTENANCE MANHOURS: Provide manufacturer's projection of corrective maintenance manhours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.
- E. APPENDICES: The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.
1. PARTS IDENTIFICATION: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification.

Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

2. **WARRANTY INFORMATION:** List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.
3. **PERSONNEL TRAINING REQUIREMENTS:** Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
4. **TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION:** Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

PART 3 EXECUTION

3.1 TRANSMITTAL PROCEDURE

- A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01300 accompanied by Transmittal Form 01730-A and Equipment Record Forms 01730-B and/or 01730-C, as appropriate. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.
- B. Six (6) copies of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.
- C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

3.2 FIELD CHANGES

- A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

END OF SECTION

01730-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date: _____ Submittal No. _____
To: _____ Contract No: _____

Spec. Section: _____

Submittal Description: _____

From: _____
Attention: _____

Checklist	Contractor		Construction manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Startup, shutdown, and post shut down procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Trouble-shooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance manhours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks: _____

Contractor's Signature

^a See paragraph 01300-1.4 A, Transmittal Procedure.

01730-B. EQUIPMENT RECORD FORM

EQUIP DESCRIP				EQUIP LOC			
EQUIP NO.		SHOP DWG NO.		DATE INST		COST	
MFGR				MFGR CONTACT			
MFGR ADDRESS						PHONE	
VENDOR				VENDOR CONTACT			
VENDOR ADDRESS						PHONE	
MAINTENANCE REQUIREMENTS						D	W
						M	Q
						S	A
						HOURS	
LUBRICANTS RECOMMENDED:							
ALTERNATIVE:							
MISC. NOTES:							
RECOMMENDED SPARE PARTS				ELECTRICAL NAMEPLATE DATA			
PART NO.	QUAN.	PART NAME	COST	EQUIP			
				MAKE			
				SERIAL NO.		ID NO.	
				MODEL NO.		FRAME NO.	
				HP	V	AMP	HZ
				PH	RPM	SF	DUTY
				CODE	INSL CL	DES	TYPE
				NEMA DES	C AMB	TEMP RISE	RATING
				MISC			
				MECHANICAL NAMEPLATE DATA			
				EQUIP			
				MAKE			
				SERIAL NO.		ID NO.	
				MODEL NO.		FRAME NO.	
				HP	RPM	CAP	SIZE
				TDH	IMP SZ	BELT NO.	CFM
				PSI	ASSY NO.	CASE NO.	
				MISC			

[illegible]

DIVISION 3
CONCRETE

SECTION 03 10 00 – CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for furnishing Concrete Forming.
- B. Related Sections:
 - 1. Section 03 35 00 – Concrete Finishing
 - 2. Section 03 62 00 – Non-Shrink Grouting

1.2 REFERENCES

- A. ACI:
 - 1. 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. 350 – Code Requirements for Environmental Engineering Concrete Structures
 - 3. 347 – Formwork for Concrete.
- B. NSF International:
 - 1. 61 – Drinking Water System Components – Health Effects.

1.3 DESIGN REQUIREMENTS

- A. Design formwork as specified in ACI 301, ACI 347, and ACI 350 to provide concrete finishes specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.
- C. Make joints in forms watertight.
- D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.
- E. Ensure compatibility between form liner and concrete mixture with manufacturer and concrete producer.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Shop Drawings:
 - a. Form Ties-Tapered Through-Bolts:
 - 1) Proposed method of sealing form tie hole.
 - 2) Coordinate with details shown.
 - b. Manufacturer's Data for:
 - 1) Form-release agent.
 - 2) Form liners.
 - 2. Samples:
 - a. Form ties.
- C. Information Submittals:
 - 1. Statement of qualification for formwork designer.

2. Statement of qualification for form liner designer and installer.
3. Mockup Panel – for each form liner type.

1.5 QUALIFICATIONS

- A. Formwork Designer:
 1. Formwork, falsework, and shoring design shall be by an Engineer licensed in the State of the project site.
- B. Form liner designer shall have previous experience with the design and installation of similar form liners.
- C. Form liner installer shall be approved by the manufacturer.

1.6 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Wall Forms and Underside of Slabs:
 1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
 2. Circular Structures:
 - a. Conform forms to circular shape of structure.
 - b. Straight panels may be substituted for circular forms provided panels DO NOT exceed 2 ft in horizontal width and angular deflection is no greater than 3 1/2 degrees per joint.
- B. Painted Surface Forms:
 1. High density overlay plywood for flat concrete surfaces to be painted.
- C. Form Liners:
 1. Elastomeric FRP, ABS or PVC.
- D. All Other Forms:
 1. Materials as specified for wall forms.
- E. Form-Release Agent:
 1. Material: Release agent shall NOT bond with, stain, or adversely affect concrete surfaces, and shall NOT impair subsequent treatments of concrete surfaces when applied to forms or form liners. A “ready to use” water-based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations and can be used in potable water facilities. Certified as complying with NSF 61.
 2. Manufacturers and Products:
 - a. Atlas Construction Supply; Bio-Guard
 - b. Cresset Chemical Company; Crete-Lease 20-VOC.
 - c. Hill and Griffith; Grifcote LV-50 Plus
- F. Rustication Grooves and Beveled Edge Corner Strips:

1. Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
- G. Form Ties:
1. Material: Steel
 2. Spreader Inserts:
 - a. Conical or spherical type.
 - b. Design to maintain positive contact with forming material.
 - c. Furnish units that shall leave no metal closer than 1" to concrete surface when forms, inserts, and tie ends are removed.
 3. Wire ties NOT permitted.
 4. Flat bar ties for panel forms furnish plastic or rubber inserts with minimum 1" depth and sufficient dimensions to permit patching of tie hole.
 5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
 - a. Integral steel water stop 0.103 in. thick and 0.625 in. in diameter tightly and continuously welded to tie.
 - b. Neoprene water stop 3/16 in. thick and 15/16 in. diameter whose center hole is 1/2 the diameter of tie, or molded plastic water stop of comparable size.
 - c. Orient water stop perpendicular to tie and symmetrical about center of tie.
 - d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
 6. Through-Bolts: Tapered minimum 1 in. diameter at smallest end.
 7. Elastic Vinyl Plug:
 - a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.
 - b. Manufacturer and Product:
 - 1) Dayton/Richmond Co.
Miamisburg, OH
A58 Sure Plug.
 - c. Sika Corporation
X-Plug
 - d. Recess plug 1 in. minimum and grout over hole. See Section 03 62 00 – Non-Shrink Grouting.

PART 3 - EXECUTION

3.1 FORM SURFACE PREPARATION

- A. Thoroughly clean form surfaces that shall be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.
- B. Exposed Wood Forms in Contact with Concrete:
 1. Apply form-release agent as recommended by the manufacturer.
- C. Steel Forms:
 1. Apply form-release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.
- D. Form Liner Forms:
 1. Prepare forms as recommended by the manufacturer.
 2. Provide liners in full sheets and locate seams as specified on approved shop drawings.
 3. Clean form liner after each use and use only form-release agents approved by the manufacturer.

3.2 ERECTION

- A. General:
 - 1. Unless specified otherwise, follow applicable recommendations of ACI347.
- B. Beveled Edges (Chamfer):
 - 1. Form 3/4" bevels at concrete edges, unless otherwise shown.
 - 2. Where beveled edges on existing adjacent structures are other than 3/4", obtain Engineer's approval of size prior to placement of beveled edge.
- C. Wall Forms:
 - 1. DO NOT reuse forms with damaged surfaces.
 - 2. Locate form ties and joints in an uninterrupted uniform pattern.
 - 3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.
- D. Forms Supporting Form Liners:
 - 1. Construct to withstand the high hydraulic pressures associated with rapid filling and heavy high-frequency vibration.
- E. Form Liner Installation:
 - 1. Protect form liners from extended exposure to sunlight and high surface temperatures during installation.
 - 2. Install form liners per manufacturer's written instructions.
 - 3. Place form liners in accordance with specified patterns and joints.
 - 4. Maintain required concrete cover between form liner and reinforcement.
- F. Forms for Curbs and Sidewalks:
 - 1. Provide standard steel or wood forms.
 - 2. Set forms to true lines and grades, and securely stake in position.
- G. Form Tolerances:
 - 1. Provide forms in accordance with ACI 117, 347 and 318.
 - 2. Wall Tolerances:
 - a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
 - b. Wall Type W-A:
 - 1) Plumb within 1/4 in. in 10 ft or within 1 in. from top to bottom for walls over 40 ft high.
 - 2) Depressions in Wall Surface: Maximum 5/16 in. when 10 ft straightedge is placed on high points in all directions.
 - c. Wall Type W-B:
 - 1) Plumb within 1/8 in. in 10 ft or within 1/2 in. from top to bottom for walls over 40 ft high.
 - 2) Depressions in Wall Surface: Maximum 1/8 in. when 10 ft straightedge is placed on high points in all directions.
 - 3. Thickness: Maximum minus 1/4 in. or plus 1/2 in. from dimension shown.
 - 4. Form Offset: Between adjacent pieces of form work, facing material shall NOT exceed 1/8 in. where exposed to public view and 1/4 in. maximum for all other conditions.

3.3 ADDITIONAL REQUIREMENTS

- A. Construct forms tight enough to prevent loss of concrete mortar.

- B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses and the like for easy removal.
 - 2. DO NOT use rust-stained steel form-facing material.
 - 3. Use only form or form-tying methods which DO NOT cause spalling of the concrete upon form stripping or tie removal.
- C. Elevated Structural Slabs and Beams:
 - 1. DO NOT strip forms until concrete has reached 80% of the specified 28-day strength as determined by test cylinder breaks.
- D. Forms with Form Liners:
 - 1. Remove per manufacturer's recommendations.
 - 2. Use consistent removal timing to avoid variations in concrete color.
 - 3. Avoid damaging formed profiles.
- E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- F. Provide temporary 12 in. wide by 18 in. high openings for cleanouts and inspection ports every 7 ft at the bottom of each lift form and where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations, where possible.
- G. Chamfer exterior corners and edges of permanently exposed concrete.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and waterstops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 in. clear from the opening surfaces and encased items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions before placing reinforcement.
- L. Embedded Items:
 - 1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts/rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles and other conditions.
 4. Check special castings, channels or other metal parts that are to be embedded in the concrete prior to and again after placing the concrete.
 5. Check nailing blocks, plugs and strips necessary for the attachment of trim, finish, and similar work prior to placing the concrete.
- M. Pipes and wall spools cast in concrete:
1. Install wall spools, wall flanges, and wall anchors before placing concrete. DO NOT weld, tie or otherwise connect the wall spools or anchors to the reinforcing steel.
 2. Support pipe and fabricated fittings to be encased in concrete-on-concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement shall occur during construction.
 3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. DO NOT block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.
- N. Removing and reusing forms:
1. DO NOT remove forms from concrete which has been placed with outside temperature below 50°F without first determining and verifying with Engineer if the concrete has properly set without regard for time. DO NOT apply loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.
 2. Leave formwork for beam soffits, joists, structural slabs, beams, girders, and other structural elements that support weight of concrete in place until concrete has achieved 100 percent its 28-day design compressive strength.
 3. Formwork for sides of beams, walls, columns, and similar parts of the Work that does NOT support weight of concrete may be removed after cumulatively curing at NOT less than 50°F (10°C) for 48 hours after placing concrete, if concrete is hard enough to NOT be damaged by form-removal operations and curing and protection operations are maintained.
 4. Leave bracing for walls until the top or roof slab concrete reaches 100% of its 28-day design compressive strength.
 5. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 6. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material shall NOT be acceptable for exposed surfaces. Apply new form-release agent.
 7. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. DO NOT use patched forms for exposed concrete surfaces.
- O. Aluminum surfaces in contact with concrete:
1. Aluminum surfaces in contact with concrete or grout or dissimilar metals shall be protected with a Mylar isolator, bituminous paint or other material approved by Engineer.
- P. Shores and reshores:
1. Comply with ACI 318 and ACI 301 for design, installation and removal of shoring and reshoring.
 - a. DO NOT remove shoring or reshoring until measurement of slab tolerances is complete.
 2. In multistory construction, extend shoring or reshoring over enough stories to distribute loads in such a manner that no floor or member shall be excessively loaded or shall induce tensile stress in concrete members without sufficient steel reinforcement.

3. For multi-storied structures, the shoring and reshoring diagrams and procedures shall be signed and sealed by a Registered Professional Engineer in the state where the construction is being undertaken. These diagrams and procedures shall consider the effect of the loads on the uncured concrete and the construction load on each floor.
4. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

END OF SECTION

SECTION 03 20 00 – CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Reinforcing steel and related items required for cast-in-place concrete.
- B. Related Sections:
 - 1. Section 03 10 00 – Concrete Forming.
 - 2. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

- A. ACI (American Concrete Institute):
 - 1. SP-66 – Detailing Manual.
 - 2. 318 – Building Code Requirements for Structural Concrete.
 - 3. 350 – Code Requirements for Environmental Engineering Concrete Structures.
- B. ASTM International:
 - 1. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. A1064 – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- C. CRSI (Concrete Reinforcing Steel Institute):
 - 1. Manual of Standard Practice.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Shop drawings shall be prepared for all reinforcement required by the project. Shop drawings shall be logically and legibly prepared to permit reasonable ease of sorting, selecting, placing reinforcement as well as checking drawings. Preparer and fabricator shall be identified on the drawings.
 - 2. Reinforcement shall NOT be fabricated until the shop drawings have been processed, approved, and returned.
 - 3. Check all shop drawings to verify reinforcement dimensions required by drawings are satisfied.
 - 4. Provide bar sizes, bar lengths, bar material, bar grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and lap lengths, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Reinforcement
 - 1. Review of reinforcement shop drawings by the Engineer shall be limited to general compliance with the Contract Documents.
 - 2. Submit reinforcement shop drawings in a complete package for each specific structure. Partial submittals shall be rejected.
- D. Changes to Reinforcing Steel Contract Drawing Requirements:
 - 1. Specify in separate letter submitted with shop drawings any changes of requirements specified in Drawings for reinforcing steel.

2. Such changes shall NOT be acceptable unless the Engineer has accepted such changes in writing.

1.4 SUPERVISION

- A. Workmanship:
 1. Always provide qualified supervision reinforcing work is in progress. Workmen shall be experienced iron workers.
- B. Codes:
 1. Reinforcement placement and detailing shall comply with practice specified in the ACI SP-66 – Detailing Manual – latest edition of the American Concrete Institute or its latest revision, unless otherwise specified in this section.

1.5 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 CONCRETE REINFORCEMENT

- A. General:
 1. All reinforcement shall be free from rust, loose mill scale, and other contaminants.
- B. All bars shall be billet steel bars for concrete reinforcement ASTM A615 Grade 60.
- C. Wire bar supports located between reinforcing bars and face of concrete:
 1. Stainless steel. Type 304 stainless steel bar supports.
 2. Support reinforcing for concrete placed on ground using bar support chairs with Type 304 stainless steel plates for resting on ground welded to the chairs.
- D. Concrete Bar Supports Located Between Reinforcing Bars and Face of Concrete:
 1. Manufactured expressly for supporting reinforcing bars.
 2. Manufactured with two annealed steel wires to securely tie concrete bar support to reinforcing steel.
 3. Manufactured with minimum $f'_c = 5,000$ psi concrete.

2.2 WWR (WELDED WIRE REINFORCEMENT):

- A. See ASTM A185 (withdrawn in 2013, replaced by A1064), 75 ksi minimum tensile strength.
- B. WWR may NOT be used in place of reinforcing bars unless accepted in writing by the Engineer.
- C. Provide WWR in flat sheet form.
- D. If WWR is used, provide WWR having cross-sectional area per linear foot of NOT less than cross-sectional area per linear foot of reinforcing bars specified in Drawings.

2.3 ACCESSORIES

- A. General:
 1. Accessories shall be subject to Engineer's approval.
 2. Tie wire – 18 GA annealed steel wire.
 3. Number of chairs shall be adequate to prevent sag during steel and concrete placement.

4. Wall layer spacers shall be 1/4 in. round "Z" bar.
5. Horizontal layer spacers shall be wire bar supports or reinforcing bars bent to support top layer.
6. Dowel bar splicer:
 - a. Dowel bar splicer shall be Richmond or approved equal, manufactured from standard specified rebar material, with NC threads and shop fabricated to specified dowel configurations.
7. Mechanical Connectors:
 - a. Approved Manufacturers: Dayton Superior, Erico, or approved equal.
 - b. The mechanical connection shall meet the code requirements of developing in tension and compression as required by the referenced codes. Install per the manufacturer's approved procedures.

PART 3 - EXECUTION

3.1 GENERAL

- A. Reinforcing bars and welded wire fabric reinforcement:
 1. Verify that reinforcement is new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.
- B. Other trades:
 1. Coordinate all work of other trades to avoid conflict with reinforcement.
- C. Shop Drawings:
 1. Check all shop drawings to verify dimensions required.

3.2 FABRICATING

- A. General:
 1. Fabricate steel reinforcement as specified in CRSI's "Manual of Standard Practice."
 2. Reinforcement shall be shop fabricated except where straight bars No. 5 or smaller are required.
- B. Bending:
 1. All bending shall be by using bending jigs and mandrels. All bars shall be bent cold.
- C. Cutting:
 1. Bars shall be cut by cold shearing. Torch cutting in the field may be permitted in special situations.

3.3 PREPARATION

- A. Surface Preparation:
 1. Reinforcing bars: thin coating of red rust resulting from short exposure shall NOT be considered objectionable. Thoroughly clean any bars having rust scale, loose mill scale, or thick rust coat.
 2. Cleaning of reinforcement materials: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.4 PLACING

- A. General:

1. Accurately place all bars to meet tolerances as outlined in ACI 318 and tie in place before placing concrete, include dowels. Tie with 18 GA steel wire.
2. Corner bars required for horizontal reinforcing. Unless otherwise noted on plans corner bars shall be same size and spacing as horizontal bar.
3. No field bending of bars shall be allowed.

B. Clearance:

1. Preserve clearance between bars of 1 in. minimum, NOT less than one bar diameter or 1 1/3 times large aggregate, whichever is larger.
2. Provide concrete coverage over reinforcing steel unless otherwise specified on plans:
 - a. 3 in. above subgrade – in excavation.
 - b. 2 in. above subgrade – slab on fill.
 - c. 2 in. from form – walls exposed to water or earth and for slab over water.
 - d. 1 1/2 in. from form – normal cover interior walls, beams, columns, etc.
 - e. 3/4 in. on top steel – interior slabs.
 - f. 1 1/2 in. on top and bottom – exterior slab.
3. Lap all reinforcing bars as required by ACI 318-latest edition Class B as specified in Drawings except where otherwise required by ACI.
4. Stagger splices except where otherwise specified.
5. Welded splices are NOT permitted.
6. Lap welded wire reinforcement a minimum of two spaces.

C. Dowels:

1. All dowels shall be placed and securely anchored before placing concrete.

D. Supports:

1. Provide enough to prevent sagging, to prevent shifting, and to support loads during construction; but in no case less than quantities and at locations as specified in ACI 315 (SP-66).
2. DO NOT use brick, broken concrete masonry units, spalls, rocks, wood, or similar materials for supporting reinforcing steel.
3. DO NOT use reinforcing bars that have less cover than required by the Contract Documents.
4. DO NOT adjust location of reinforcement required by the Contract Documents to provide cover to these bars.
5. Wire chairs shall NOT be accepted to hold reinforcing clearance on walls.

E. Tying of bar reinforcement:

1. Fasten bars securely in place with wire ties.
2. Tie bars sufficiently often to prevent shifting.
3. Provide at least 3 ties in each bar length.
4. DO NOT apply to dowel lap splices or to bars shorter than 4 ft, unless necessary for rigidity.
5. Tie slab bars at every intersection around periphery of slab.
6. Tie wall bars and slab bar intersections other than around periphery at NOT less than every fourth intersection, but at NOT greater than following maximum spacings:

Bar Size	Slab Bar Spacing (in.)	Wall Bar Spacing (in.)
Bars Number 5 and Smaller	60	48
Bars Number 6 – Number 9	96	60
Bars Number 10 – Number 11	120	96

7. After tying wire ties, bend ends of wire ties in towards the center of the concrete section.

- a. The cover for wire ties shall be the same as the cover requirements for reinforcing bars.
- F. Openings and Obstructions:
 - 1. Place additional reinforcing around openings as shown on the drawings and standard details.
 - 2. Bend reinforcing around obstructions. Place extra reinforcing where cutting is authorized. Engineer's approval required before cutting steel.
 - 3. Consult Engineer on special situations.
- G. Welded Wire Reinforcement:
 - 1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
 - 2. Bend fabric as specified in Drawings or required to fit work.
 - 3. Unroll or otherwise straighten fabric to make flat sheet before placing in the Work.
 - 4. Lap splice welded wire fabric as specified in Drawings.
 - 5. If lap splice length is NOT specified in Drawings, splice fabric as specified in ACI 318 and ACI 350.
- H. Certification:
 - 1. Certify material and type of deformation.
- I. Condition:
 - 1. All reinforcement shall be free from loose rust, dirt coating, oil, paint, or any foreign substance.

END OF SECTION

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Hydraulic (liquid containing) structures.
 - 2. Beams and columns.
 - 3. Building walls.
 - 4. Retaining walls.
 - 5. Foundation walls.
 - 6. Footings.
 - 7. Suspended slabs.
 - 8. Slabs on grade.
 - 9. Equipment pads.
- B. Related Sections:
 - 1. Section 03 15 00 – Concrete Joints and Accessories
 - 2. Section 03 35 00 – Concrete Finishing
 - 3. Section 03 39 00 – Concrete Curing

1.2 REFERENCES

- A. ACI (American Concrete Institute):
 - 1. ACI 117 – Specification for Tolerances for Concrete Construction and Materials
 - 2. ACI 301 – Specifications for Structural Concrete
 - 3. ACI 305R – Guide to Hot Weather Concreting
 - 4. ACI 306.1 – Standard Specification for Cold Weather Concreting
 - 5. ACI 308.1 – Specification for Curing Concrete
 - 6. ACI 318 – Building Code Requirements for Structural Concrete
 - 7. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
 - 8. ACI 350.1 – Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures
 - a. Manual of Concrete Practice
- B. ASTM International:
 - 1. C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
 - 2. C33 – Standard Specification for Concrete Aggregates
 - 3. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - 4. C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - 5. C94 – Standard Specification for Ready-Mixed Concrete
 - 6. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
 - 7. C150 – Standard Specification for Portland Cement
 - 8. C172 – Standard Practice for Sampling Freshly Mixed Concrete
 - 9. C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - 10. C227 – Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
 - 11. C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - 12. C260 – Standard Specification for Air-Entraining Admixtures for Concrete
 - 13. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

14. C330 – Standard Specification for Lightweight Aggregates for Structural Concrete
15. C494 – Standard Specification for Chemical Admixtures for Concrete
16. C595 – Standard Specification for Blended Hydraulic Cements
17. C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
18. C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
19. C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
20. C1012 – Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
21. C1017 – Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
22. C1064 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
23. C1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
24. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
25. C1116 – Standard Specification for Fiber-Reinforced Concrete
26. C1218 – Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
27. C1240 – Standard Specification for Silica Fume Used in Cementitious Mixtures
28. C1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
29. C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
30. D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
31. D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types)
32. D1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
33. E96 – Standard Test Methods for Water Vapor Transmission of Materials
34. E329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
35. E1155 – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
36. E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
37. E1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.3 DEFINITIONS

- A. Cementitious Materials:
 1. Portland cement alone or in combination with one or more of:
 - a. Blended hydraulic cement
 - b. Fly ash and other pozzolans
 - c. Ground granulated blast-furnace slag
 - d. Silica fume
 2. Subject to requirements.
- B. Cold Weather:
 1. Ambient temperature below 40°F or approaching 40°F and falling.
- C. Defective Area:
 1. Surface defects, Including:
 - a. Honeycomb
 - b. Rock pockets

- c. Indentations
 - d. Surface voids greater than 3/16 in. deep
- 2. Surface voids greater than 3/4 in. diameter
- 3. Cracks in liquid containment structures and below-grade habitable spaces that are 0.010 in. wide and wider.
- 4. Cracks in other structures that are 0.015 in. wide and wider.
- 5. Spalls, chips, embedded debris, lift lines, sand lines, deviations that exceed specified tolerances and include, but are NOT limited to, fins, form popouts, and other projections, stains, and other color variations that can NOT be removed by cleaning.
- D. Exposed Concrete:
 - 1. Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when the structure is drained.
- E. Hot Weather:
 - 1. As defined in ACI 305R.
- F. Hydraulic Structure:
 - 1. Liquid containment structure.
- G. New Concrete:
 - 1. Less than 60 days old.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Product Data:
 - 1. Submit data for each type of product indicated.
- C. Design Data:
 - 1. Submit concrete mix design for each mix included in the Supplement at the end of this Section.
 - a. Proportions of all materials in the mix, signed by the mix designer.
 - b. Average strength per ACI 301.
 - c. Manufacturer's Certificate of Compliance as specified in Section 01320 – Product Storage, Delivery, and Handling.
 - d. Cementitious materials.
 - e. Admixtures.
 - f. Test Reports – chemical analysis, chloride-ion content, shrinkage test results.
 - g. Coarse and fine aggregate gradations.
 - h. Water to be withheld for later addition at Project site.
 - 2. Detailed plan for placing and curing concrete in cold weather.
 - 3. Detailed plan for placing and curing concrete in hot weather.
 - a. Thermal control plan for concrete sections greater than 2 ft 6 in.
 - b. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - c. Manufacturer Instructions: Submit installation procedures and interfacing required with adjacent Work.
 - d. Field Quality requirements Submittals: Indicate results of Contractor-furnished tests and inspections, including tightness test results and floor surface flatness and levelness measurements.
- D. Ready-Mix Concrete Delivery Tickets
 - a. Record the amount of water added at the Project site on the delivery ticket.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01700 – Contract Closeout specifies requirements for closeout submittals.
- B. Project Record Documents:
 - 1. Record actual locations of embedded utilities and components concealed from view in finished construction.

1.6 QUALITY ASSURANCE

- A. Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.
- B. Perform Work as specified in ACI 301 and ACI 117.
- C. See ACI 305R when placing concrete during hot weather.
- D. See ACI 306.1 when placing concrete during cold weather.
- E. Obtain each type or class of cementitious material from a single source, obtain aggregate from a single source and obtain admixtures from a single supplier for the Project. If any of these sources need to, by necessity, change, notify the Engineer.
- F. Installer Qualifications:
 - 1. Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician. If an ACI-certified Technician is NOT available, submit flatwork installer qualifications to the Engineer.
- G. Manufacturer Qualifications:
 - 1. A firm with a minimum of 5 years of experience in manufacturing ready-mix concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
 - 2. Manufacturer certified as specified in NRMCA – “Certification of Ready-Mixed Concrete Production Facilities” or equivalent program.
 - 3. Mix Designer: Certified as NRMCA Concrete Technologist Level 2 or Licensed Engineer. If neither, the Mix Designer’s qualifications shall be submitted to the Engineer.
- H. Testing Agency Qualifications:
 - 1. An independent agency, acceptable to the Authority Having Jurisdiction, qualified as specified in ASTM C1077 and ASTM E329 for the testing indicated.
 - 2. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, as specified in ACI CP-1 or an equivalent certification program.
 - 3. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.
- I. Concrete Preinstallation Conference:
 - 1. Schedule and conduct at Project site prior to submitting mix designs.
 - 2. Required meeting attendees:
 - a. Contractor’s superintendent.
 - b. Structural Engineer in responsible charge or designee.
 - c. Independent testing agency.
 - d. Ready-mix producer.
 - e. Concrete Subcontractor.

- f. Admixture representative.
- 3. Agenda shall include:
 - a. Concrete testing and special inspection.
 - b. Mix designs and admixtures.
 - c. Formwork and formwork removal.
 - d. Reinforcement.
 - e. Placement methods.
 - f. Concrete finishing.
 - g. Curing procedures.
 - h. Hot and cold weather placement protections.
 - i. Joints.
 - j. Placement of anchors and miscellaneous embeds.
 - k. Tolerances including floor and slab flatness and levelness.
 - l. Concrete repair procedures.

1.7 AMBIENT CONDITIONS

- A. Section 01 50 00 – Temporary Facilities and Controls, specifies requirements for ambient condition control facilities for product storage and installation.
- B. Maintain concrete temperature after installation at minimum 50°F for minimum seven days.

1.8 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete:
 - 1. Cement:
 - a. Comply with ASTM C150, for cement type, see Supplement at End of Section.
 - b. Type: Portland.
 - 2. Blended Cement:
 - a. Comply with ASTM C595.
 - b. For sulfate resistance option, see Supplement at End of Section.
 - c. Color: Gray.
 - 3. Normal Weight Aggregates:
 - a. Comply with ASTM C33.
 - b. Coarse Aggregate Maximum Size: 1 in. nominal.
 - c. Coarse Aggregate – NOT more than 15% by weight of thin or elongated pieces having a length of five times the average thickness.
 - d. Fine Aggregate – consisting of clean natural sand or of sand prepared from crushed stone or crushed gravel.
 - 4. Water:
 - a. Comply with ACI 318.
 - b. Potable, without deleterious amounts of chloride ions.
- B. Admixtures:
 - 1. Manufacturers:
 - a. BASF Admixtures, Inc, Shakopee, MN.
 - b. Euclid Chemical Co., Cleveland, OH.
 - c. W.R. Grace & Co., Cambridge, MA.
 - d. Substitutions: As specified in Section 01 60 00 – Product Requirements.

2. Air Entrainment: Comply with ASTM C260.
3. Chemical:
 - a. Comply with ASTM C494.
 - b. Type A – Water-Reducing. Type B – Retarding.
 - d. Type C – Accelerating.
 - e. Type D – Water-Reducing and Retarding.
 - f. Type E – Water-Reducing and Accelerating.
 - g. Type F – Water-Reducing, High Range.
 - h. Type G – Water-Reducing, High Range, and Retarding.
4. Fly Ash: Comply with ASTM C618, Class F.
5. Silica Fume: Comply with ASTM C1240.
6. Slag:
 - a. Description: Ground-granulated blast-furnace slag.
 - b. Comply with ASTM C989.
 - c. Grade 100 or 120.
7. Plasticizing:
 - a. Comply with ASTM C1017.
 - b. Type I or Type II.
8. Shrinkage Reducing Admixture:
 - a. BASF; Tetraguard AS20.
 - b. Euclid; Eucon SRA Series.
 - c. W.R. Grace; Eclipse Series.

2.2 CONCRETE MIX

- A. See Supplement at the End of this Section for design requirements for each concrete mix.
- B. Select proportions for concrete as specified in ACI 318.
- C. Use water-reducing admixture in concrete that is part of a Hydraulic Structure or with a water-cementitious ratio below 0.50.
- D. Where fly ash is used, it shall be limited to 25% of total cementitious materials, unless approved in writing by the Engineer.
- E. Limit water-soluble chloride-ion content in hardened concrete to 0.15% by weight of cement for nonhydraulic structures and 0.10% for hydraulic structures.
- F. Fine aggregate shall be in the range of 36 – 40 % of total aggregate weight.
- G. Concrete Shrinkage Limits:
 1. See Subsection 3.5.J.
- H. Target Slump:
 1. Without high-range water reducers – 4 in.
 - a. With high-range water reducers – 2 in. prior to the addition of the admixture, 8 in. maximum at point of delivery, unless otherwise permitted.
 - b. Target slump for drilled pier – 6 in. – 8 in.
- I. Admixtures:
 1. Include admixture types and quantities indicated in concrete mix designs only if approved by Architect/Engineer.
 2. Cold Weather:
 - a. Use accelerating admixtures in cold weather.
 - b. Use of admixtures shall NOT relax cold weather placement requirements.

3. Hot Weather: Use set-retarding admixtures.
4. DO NOT use calcium chloride or admixtures containing calcium chloride.
 - a. Add air entrainment admixture to concrete mix for Work exposed to freezing and thawing.
 - b. Average Compressive Strength Reduction: NOT permitted.

J. Ready-Mixed Concrete:

1. Mix and deliver concrete as specified in ASTM C94 and deliver batch ticket information.
2. When air temperature is between 85°F – 90°F, reduce mixing and delivery time from 90 minutes to 75 minutes; when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.
 - a. Contractor may coordinate with the concrete producer and admixture manufacturer to demonstrate the efficacy of using a retarding admixture to extend placement times during hot weather.

K. Site-Mixed Concrete:

1. Mix concrete as specified in ACI 318.

2.3 ACCESSORIES

A. Bonding Agent:

1. Manufacturers:
 - a. BASF Building Systems Inc.
 - b. Euclid Chemical Co.
 - c. Prime Resins
 - d. Sika Chemical Corp.
2. Substitutions: As specified in Section 01 60 00 – Product Requirements.
3. Furnish materials as specified in ASTM C881, Type V standards. Description: Two-component moisture insensitive, 100% solids epoxy resin.

B. Vapor Retarder:

1. Manufacturers:
 - a. Fortifiber Corp.
 - b. Revan Industries, Inc.
 - c. Stego Industries, LLC
2. Substitutions: As specified in Section 01 60 00 – Product Requirements.
3. Furnish materials as specified in E1745, Class B standards. Description: Clear polyethylene film.
5. Thickness: 10 mils min.
6. Type: As recommended for below-grade application.
 - a. Joint Tape: As recommended by manufacturer.

C. Bond Breaker:

1. Manufacturers:
 - a. Dayton Superior: EDOCO Clean Lift Bond Breaker
2. Substitutions: As specified in Section 01 60 00 – Product Requirements.
3. Description: Nonstaining, providing positive bond prevention.

D. Concrete Reinforcing Fibers:

1. Manufacturers:
 - a. Euclid Chemical Co.
 - b. Propex Concrete Systems Corp.
 - c. Substitutions: As specified in Section 01 60 00 – Product Requirements.
2. Description: High-strength industrial-grade fibers specifically engineered for secondary reinforcement of concrete.
3. Comply with ASTM C1116.

4. Tensile Strength: 130 ksi.
5. Toughness: 15 ksi.
6. Fiber Length: 3/4 in.
7. Fiber Count: 34 million/lb.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01700 – Contract Closeout specifies requirements for installation examination.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and shall NOT interfere with placing concrete.

3.2 PREPARATION

- A. Section 01700 – Contract Closeout specifies requirements for installation preparation.
- B. Previously Placed Concrete:
 1. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.
 - a. Remove laitance, coatings, and unsound materials.
 - b. Doweled Joints: Install dowel bars and support assemblies at joints as indicated on drawings.
 - c. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- C. Remove water from areas receiving concrete before concrete is placed.

3.3 INSTALLATION

- A. Placing Concrete:
 1. Place concrete as specified in ACI 301.
 2. Notify testing laboratory Engineer minimum 24 hrs. prior to commencement of operations.
 3. Make sure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and waterstop are NOT disturbed during concrete placement.
 4. Install vapor retarder under interior slabs on grade as specified in ASTM E1643. Lap joints minimum 6 in. and seal watertight by taping edges and ends as specified in manufacturer's instructions.
 - a. Repairs:
 - 1) Repair vapor retarder damaged during placement of concrete reinforcement.
 - 2) Using vapor retarder material, lap over damaged areas minimum 6 in. and seal watertight.
 - 5) Joint Filler:
 - b. Separate slabs on grade from vertical surfaces with 1/2 in. thick joint filler.
 - c. Place joint filler in floor slab pattern placement sequence; set top to required elevations; secure to resist movement by wet concrete.
 - d. Extend joint filler from bottom of slab to within 1/2 in. of finished slab surface.
 6. Deposit concrete at final position, preventing segregation of mix. Limit vertical free fall to 5 ft.
 7. Place concrete in continuous operation for each panel or section as determined by predetermined expansion, control and construction joints.
 - a. Place in horizontal layers NOT to exceed 2.0 ft in depth, except for slabs which shall be placed full depth.

- b. DO NOT exceed formwork design pressures.
- 8. DO NOT use aluminum conveying devices.
- 9. Retempering of concrete is NOT permitted where cement has partially hydrated.
- 10. Pumping of Concrete:
 - a. Provide standby pump, conveyor system or other system onsite during pumping to ensure completion of concrete placement without cold joints in case of equipment failure.
- 11. Consolidate concrete using mechanical vibrating equipment per ACI 301
 - a. DO NOT use vibrators to transport concrete within formwork. Insert and withdraw vibrators vertically at uniform spacing to quickly penetrate placed layer and at least 6 in. into preceding layer. DO NOT insert vibrators into lower layers that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement, waterstop and other items without causing segregation.
 - b. Slabs with horizontal waterstop: limit concrete placement to elevation of waterstop in first pass, ensure space beneath waterstop completely fills with concrete, vibrate under waterstop, then place remaining concrete to full height of slab.
 - c. Maintain at least one standby vibrator prior to placing concrete.
- 12. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
- 13. Maximum Size of Concrete Placements:
 - a. Locate expansion, control and contraction joints where shown on drawings.
 - b. Locate construction joints where shown on drawings or where approved in joint location submittal per Section 03 15 00 – Concrete Joints and Accessories.
 - c. Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
 - d. Place joints to avoid penetrations.
- 14. DO NOT interrupt successive placement and DO NOT permit cold joints to occur.
- 15. Minimum Time Between Adjacent Placements:
 - a. Construction or Control Joints: 7 days unless otherwise specified.
 - b. Construction joint between top of footing or slab and column or wall: NOT less than 24 hrs.
 - c. Expansion or Contraction Joints: NOT less than 24 hrs.
- 16. Hot Weather Placement:
 - a. Comply with ACI 305.1
 - b. Maintain concrete temperature below 95°F at time of placement. If chilled water or ice are used to maintain concrete temperature, that water equivalent shall be included in the total water used to calculate the water-cement ratio.
 - c. Fog-spray forms, reinforcement, and subgrade just before placing concrete, without creating standing water or dry areas.
- 17. Cold Weather Placement:
 - a. Comply with ACI 306.1
 - b. DO NOT place concrete on frozen subgrade or subgrade containing frozen materials. Top 12 in. of subgrade shall be thawed prior to concrete placement.
 - c. DO NOT place concrete in contact with reinforcement or embedment with surfaces less than 35°F.
 - d. Provide supplemental heat when other means of thermal protection are insufficient. Vent carbon-based fuel heaters away from concrete surface to avoid concrete carbonation.
 - e. Provide temperature sensors placed on the concrete surfaces throughout the work. Record surface temperature at least once every 12 hrs.
 - f. Protect concrete from freezing until the end of the curing period.
- 18. Saw-Cut Joints (where permitted):
 - a. Saw-cut joints within 12 hrs after placing.
 - b. Use 3/16 in. thick blade.
 - c. Cut into 1/4 depth of slab thickness.

19. Screeding:
 - a. Screed floors and slabs to elevations and slopes shown on drawings.
 - b. Surface Flatness: FF 20 (conventional slab).
- B. Concrete Finishing:
 - a. Per Section 03 35 00 – Concrete Finishing.
- C. Curing and Protection:
 1. Per Section 03 39 00 – Concrete Curing.
- 3.4 BACKFILL AGAINST STRUCTURES
 - A. DO NOT backfill against walls until the concrete has reached the design 28-day strength as demonstrated by concrete cylinder breaks.
 - B. For structures with top slabs or diaphragms, the top slab shall reach design strength, or the diaphragm shall be secured per the contract documents prior to backfill.
 - C. Unless otherwise permitted, backfill evenly around structure to prevent differential horizontal pressures.
- 3.5 FIELD QUALITY REQUIREMENTS
 - A. Section 01400 – Quality Control, specifies requirements for inspecting and testing.
 - B. Inspection and Testing:
 1. Performed by testing laboratory as specified in ACI 318.
 - C. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.
 - D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.
 - E. Concrete Inspections:
 1. Continuous Placement Inspection: Inspect for proper installation procedures.
 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
 - a. Samples for testing air content in pumped concrete shall be taken at point of placement and point of delivery to establish a correlation to estimate air content at point of placement. All other samples shall be taken at point of delivery.
 - b. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hrs.
 - F. Strength Test Samples:
 1. Sampling Procedures: Comply with ASTM C172.
 2. Cylinder Molding and Curing Procedures: Comply with ASTM C31.
 - b. Cylinder Specimens: Standard cured.
 3. Sample concrete and make one set of four 4 in. diameter test cylinders for every 50 yd³ or less of each class of concrete placed each day, and for every 5,000 ft² of surface area for slabs and walls.
 4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five random batches, or from every batch if less than five batches are used.
 - a. Make one additional cylinder during cold weather concreting and field cure.
 - G. Field Testing:

1. Slump Test Method: Comply with ASTM C143.
 2. Air Content Test Method: Comply with ASTM C173 or C231.
 3. Temperature Test Method: Comply with ASTM C1064.
 4. Frequency of Testing:
 - a. Measure slump and temperature for each sample.
 - b. Measure air content in air-entrained concrete for each sample.
- H. Cylinder Compressive Strength Testing:
1. Test Method: See ASTM C39.
 2. Test Acceptance: See ACI 318.
 3. Test one cylinder at seven days.
 4. Test two cylinders at 28 days. Retain one cylinder for 56 days for testing when requested by Engineer.
 - a. Dispose of remaining cylinders if testing is NOT required.
- I. Core Compressive Strength Testing:
1. Sampling and Testing Procedures: Comply with ASTM C42.
 2. Test Acceptance: As specified in ACI 318.
 - a. Drill three cores for each failed strength test from failed concrete.
- J. Shrinkage Testing:
1. As specified in ASTM C157 with modifications:
 - a. Prisms shall be moist cured for 7 days prior to the 28-day drying period.
 - b. Measurement at the end of the 7-day moist cure shall be considered the initial length.
 - c. The reported results shall be the average of three prisms.
 2. If the drying shrinkage measurement of a specimen varies from the average by more than 0.04%, disregard the results from that specimen.
 3. Test shrinkage characteristics every 5,000 yd³ and every 3 months during construction of hydraulic structures.
 4. Results at the end of the 28-day drying period shall NOT exceed 0.04% if 3 in. prisms are used or 0.038% if 4 in. prisms are used.
 - a. If the 7-day or 14-day field shrinkage tests exceed the limits established by testing of the mix design, furnish an additional 14 days of water cure beyond the original curing period for hydraulic structures. Modify the mix design to reduce shrinkage.
- K. Liquid Tightness Tests:
1. As specified in ACI 350.1.
 2. Purpose:
 - a. To determine the integrity and water tightness of finished concrete surfaces of liquid containment structures.
 - b. Contractor shall perform and pay for all costs associated with liquid tightness tests.
 - c. Report all test results to the Engineer.
 3. For All Water-Holding Structures:
 - a. Perform tightness tests after the concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength.
 - b. Perform tightness tests before backfill, brick facing, or other work that shall cover the concrete wall surfaces has begun.
 - c. Install all temporary bulkheads, cofferdams and pipe blind flanges and close all valves. Inspect each to assure that it provides a complete seal.
 - d. Fill with water to test level shown, or maximum liquid level if no test level is given. Maintain this level for 72 hrs. prior to the start of the test to allow for water absorption, structural deflection, and temperature to stabilize.
 - e. Measure evaporation and precipitation by floating a partially filled, transparent, calibrated, open top container.

- f. Measure the water surface at two points 180 degrees apart, when possible where attachments such as ladders exist, at 24 hr. intervals. Use a sharp pointed hook gage and fixed metal measure capable of reading to 1/100 in. Continue the test for a period sufficient to produce at least 1/2 in. drop in the water surface based on the assumption that leakage would occur at the maximum allowable rate specified or for 72 hrs, whichever is the lesser time.
 - 4. Acceptance Criteria:
 - a. Volume loss shall NOT exceed 0.075% of contained liquid volume in a 24-hr. period, correcting for evaporation, participation, and settlement.
 - b. No damp spots or seepage visible on exterior surfaces. A damp spot is defined as sufficient moisture to be transferred to a dry hand upon touching.
 - 5. Repairs when test fails:
 - a. Dewater the structure; fill leaking cracks with crack repair epoxy as specified in Section 03 64 00 – Concrete Repair Crack Injection. Patch areas of damp spots previously recorded and repeat tightness test in its entirety until the structure successfully passes the test.
 - L. Water-Soluble Chloride-Ion Concentration Test Method:
 - 1. Comply with ASTM C1218.
 - 2. Test at 28 days.
 - a. Maximum Chloride-Ion Concentration: As permitted by applicable code.
 - M. Patching:
 - 1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
 - 2. Honeycombing or Embedded Debris in Concrete:
 - a. NOT acceptable.
 - b. Notify Engineer upon discovery..
 - N. Defective Concrete:
 - 1. Description: See Definitions.
 - 2. Repair or replacement of defective concrete shall be determined by Engineer.
 - 3. DO NOT patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.
- 3.6 SUPPLEMENTS
- A. Requirements of concrete mix designs after “End of Section” are a part of this section.
- END OF SECTION

4500 PSI CONCRETE MIX

- A. Use for nonhydraulic structural concrete exposed to freezing and thawing cycles, moderate sulfate exposure and requiring low permeability. Typically used for buildings.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.45.
 - 2. Minimum compressive strength at 28 days of 4,500 psi.
 - 3. Air content of 5.5% – 7.0% for 3/4 in. and 1 in. maximum aggregate size.
 - 4. Provide Cementitious Materials as Specified in Either:
 - a. ASTM C150 Type II – type F fly ash may be included as an option.
 - b. ASTM C595 Type IP – complies with moderate sulfate resistance option.
 - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.30%.
 - b. Refer to this section for additional requirements.

4000 PSI CONCRETE MIX

- A. Use for secondary elements NOT exposed to freezing and thawing cycles, with moderate sulfate exposure. Typically used below grade for electrical duct banks, pipe encasements NOT cast monolithically with structural slabs, thrust blocks, and drilled piers.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.50.
 - 2. Minimum compressive strength at 28 days of 4,000 psi.
 - 3. Air content of 1.5% – 4.5% for 3/4 in. and 1 in. maximum aggregate size.
 - 4. Provide Cementitious Materials as Specified in Either:
 - a. ASTM C150 Type II – type F fly ash may be included as an option.
 - b. ASTM C595 Type IP – complies with moderate sulfate resistance option.
 - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.30%.
 - b. Refer to this section for additional requirements.

SECTION 03 39 00 – CONCRETE CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Curing Methods.
 - 2. Curing Products.

1.2 REFERENCES

- A. ASTM International:
 - 1. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- B. American Concrete Institute:
 - 1. 308.1 – Specification for Curing Concrete.
- C. NSF International:
 - 1. 61 – Drinking Water Components – Health Effects.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Manufacturer's Product Data:
 - 1. Curing Compound.
 - 2. Evaporation Retardant.
 - 3. Penetrating Water Repellant Sealer.
- C. Curing Methods:
 - 1. For each type of element in the facility such as slabs, walls, beams, or columns.

1.4 WARRANTY

- 1. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Curing Compound:
 - 1. Water-based, high-solids, white pigmented, nonyellowing curing compound meeting the requirements of ASTM C309, Type 2, Class A.
 - 2. Manufacturers:
 - a. Euclid Chemical; Kurez VOX White Pigmented.
 - b. WR Meadows; 1640 – White.
 - c. Vexcon; Certi-Vex Envio Cure White.
- B. Evaporation Retardant:
 - 1. Manufacturers:
 - a. BASF; MasterKure ER 50.
 - b. Euclid Chemical; Eucobar.
- C. Penetrating Water Repellant Sealer:

1. Water-based, single component, silane/siloxane, penetrating, clear water repellent sealer.
2. Manufacturers:
 - a. BASF; MasterProtect H 400.
 - b. Euclid Chemical; Baracade WB 244.

PART 3 - EXECUTION

3.1 CONCRETE CURING

- A. General:
 1. Cure all concrete per project specifications and ACI 308.1.
 2. Use only water curing procedures where surfaces are to receive paint or other coatings.
 3. Use only water curing procedures on potable water structures.
 4. If the result of the 7-day concrete strength test is less than 50 percent of the specified 28-day strength, extend the moist curing period for an additional 7 days.
 5. Protect concrete from freezing during curing period.
- B. Use one of the curing methods below as approved by the Engineer:
 1. Vertical Surfaces:
 - a. Method 1 – leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
 - b. Method 2 – apply curing compound, where allowed, immediately after removal of forms.
 2. Horizontal Surfaces:
 - a. Method 1 – water pond surface for 7 days.
 - b. Method 2 – continuously sprinkle surface for 7 days.
 - c. Method 3 – cover surface with material that will retain moisture such as burlap or cotton mats, sand or sawdust and keep continuously wet for 7 days.
 - d. Method 4 – apply curing compound, where allowed, immediately after final finishing.
- C. All slabs for structures defined as Environmental Structures per ACI 350 – Code Requirements for Environmental Engineering Concrete Structures shall be cured per the Horizontal Surfaces Methods 1, 2 or 3.

3.2 EVAPORATION RETARDANT APPLICATION

- A. Use when environmental conditions will cause rapid drying of the concrete surface. DO NOT use on potable water structures unless NSF 61 approved.
- B. Apply and reapply as required per manufacturer's written instructions.

3.3 PENETRATING WATER REPELLENT SEALER APPLICATION

- A. Apply as specified in Drawings.
- B. Water cure concrete to receive sealer. DO NOT use membrane curing compounds. Keep surface clean and unpainted.
- C. Apply per manufacturer's recommendations for coverage and curing time.

END OF SECTION

SECTION 03 41 00 – PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Precast concrete required for this Project.
 - 2. Reinforcing.
 - 3. Accessories.
- B. Related Sections
 - 1. Section 03 20 00 – Concrete Reinforcing
 - 2. Section 03 30 00 – Cast-In-Place Concrete
 - 3. Section 03 39 00 – Concrete Curing

1.2 REFERENCES

- A. ACI (American Concrete Institute):
 - 1. 304R – Guide for Measuring, Mixing, Transporting and Placing Concrete.
- B. ASTM International:
 - 1. A36 – Standard Specification for Structural Steel.
 - 2. A416 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - 3. C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- C. PCI (Precast/Prestressed Concrete Institute):
 - 1. MNL-117 – Manual for Quality requirements for Plants and Production of Architectural Precast Concrete Products.
 - 2. MNL-120 – Design Handbook for Precast and Prestressed Concrete.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Sealer for Exterior Surfaces:
 - 1. Product data with mixing and application instructions.
- C. Form Liners:
 - 1. Manufacturer's literature and product data.
- D. Calculations and Technical Data:
 - 1. Proposed design calculations and details for all loading conditions including transportation, handling, and erection.

1.4 QUALITY ASSURANCE

- A. Qualifications of Precasting Manufacturers:
 - 1. Minimum of 3 years of experience producing the products specified.
 - 2. PCI-certified precast plant with current certification.
 - 3. Calculations sealed by an Engineer registered in the same state as the project.
- B. Qualifications of Workmen:

1. Provide at least one person to always be present during execution of this portion of the work and who shall be thoroughly trained and experienced in placing and erecting the type of concrete described in this section and who shall direct all work performed under this Section.
 2. Precast Subcontractor shall be experienced in constructing the type of precast material required for the project. Submit data for approval.
 3. For finishing of exposed surfaces of the concrete, use only thoroughly trained and experienced journeyman concrete finishers.
 4. Approval required in advance as specified in Section 01 33 00 – Submittal Procedures.
- C. Mockup Panels for Architectural Precast Panels:
1. Construct one mockup panel for each different type of color or finish as specified in detail shown using the materials, forming systems, reinforcing details, and mix proportions that will be used for the final product.
 2. The panel shall constitute the standard of quality required for the completed work.
- 1.5 PRODUCT HANDLING
- A. Protection:
1. Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the installed work and materials of all other trades.
- B. Replacements:
1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.
- 1.6 DESIGN
- A. All design of prestressed members shall be done as specified in procedures set forth in the current edition of ACI 318 – "Building Code Requirements for Reinforced Concrete" and applicable sections of PCI MNL-120.
- B. All precast structural concrete members shall be designed to meet requirements of the Building Code.
- 1.7 WARRANTY
1. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete:
1. Cement shall be Portland Cement conforming to ASTM C150, Portland Cement.
 2. Aggregates shall conform in quality to ASTM C33 for heavyweight aggregate.
 3. Heavyweight aggregates shall be graded crushed stone with a resulting unit weight of concrete of up to 155 lbs/ft³.
 4. Water shall be clean and free of injurious and deleterious substances.
 5. Concrete strength shall be minimum 5,000 psi at 28 days.
 6. Water/Cement Ratio: 0.38 maximum.
- B. Steel:
1. Prestressing steel shall be:
 - a. High tensile strength uncoated seven wire strand which is low-relaxation strand or has been stress-relieved as a unit after the wires have been formed into a strand.

- b. Manufactured and tested as specified in ASTM A416.
 - c. Either 250K or 270K strand may be used.
- 2. All reinforcing bars shall conform to the requirements of ASTM A615, Grade 60 as required.
- 3. Welded wire fabric shall conform to the requirements of ASTM A185.
- 4. Cast in plates shall conform to the requirement of ASTM A36, or A572 as required.

2.2 OTHER MATERIALS

- A. All other materials NOT specifically described but required for a complete and proper installation of the work of this Section, shall be as selected by the Contractor subject to the approval of the Engineer.

2.3 FABRICATION

- A. Comply with PCI MNL-117
- B. Pretensioning Force, if used:
 - 1. Determine by elongation and gauge pressure per PCI.
 - 2. Release strength minimum 4,000 psi, unless otherwise approved.
- C. Coordinate quantity, size, and location of required embedded items.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Inspections:
 - 1. Prior to all work of this Section, carefully inspect the installed work of all other trades, and verify that all such work is complete to the point where this installation may properly commence.
 - 2. Verify that the work of this Section may be performed as specified in all pertinent codes and regulations, the original design, and the manufacturer's recommendations for the items being installed.
- B. Discrepancies:
 - 1. In the event of discrepancy, immediately notify the Engineer.
 - 2. DO NOT proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 QUALITY

- A. Manufacturer of precast concrete shall be adequately equipped to form, place, and cure the required precast concrete, and shall have experience to produce precast concrete of required strength and water resistance.

3.3 PLACEMENT OF REINFORCEMENT

- A. Place all standard reinforcement as specified in Drawings and with the provisions of Section 03 20 00 – Concrete Reinforcing.

3.4 PLACEMENT OF CONCRETE

- A. General:

1. Concrete shall be placed and compacted by tamping or vibrating to produce a dense waterproof product.
2. Finish all concrete surfaces in smooth finish to the tolerances specified in Section 03 30 00 – Cast-In-Place Concrete.

B. Curing:

1. Cure all concrete of this section as specified in the methods specified in Section 03 39 00 – Concrete Curing, or approved alternative.

3.5 OPENINGS

- A. Locations and sizes of all openings 3 in. wide or larger to be cast into the members, if NOT shown on the contract drawings, shall be supplied when shop drawings are submitted for approval. All other openings NOT so located shall be job cut by the various trades requiring them. All holes less than 3 in. in dimension through precast members are to be made by drilling or cutting in the field, by the various trades requiring them. However, field holes or cuts may NOT be made in the precast members without prior approval of the manufacturer.

3.6 ERECTION

A. Responsibility:

1. The entire method and sequence of erection shall be the responsibility of the Contractor.

B. Alignment:

1. Set all units in true alignment in all directions.
2. Verify that anchorage inserts are in the correct location.

- C. All precast concrete items with cracks or other flaws that will detract from the appearance, shall be replaced.

- D. Grind to remove sharp edges.

- E. Field cutting is NOT allowed without prior approval.

3.7 FIELD QUALITY REQUIREMENTS

- A. Inspect precast panels for chips, cracks, and discoloration.

- B. Compare to approved mockup panel.

- C. Record location of damage.

- D. Repair or replace panels with damage determined to be unacceptable.

END OF SECTION

SECTION 03 62 00 – NON-SHRINK GROUTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cementitious non-shrink grout.
 - 2. Epoxy non-shrink grout.

1.2 REFERENCES

- A. ASTM International:
 - 1. C307 – Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts and Monolithic Surfacing.
 - 2. C579 – Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
 - 3. C882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - 4. C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - 5. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Product data and manufacturer's written instructions.
- C. Forming method for fluid grout placements under machinery base plates.
- D. Curing methods.
- E. Qualifications of grout installers for specific grout type(s) selected.

1.4 QUALITY ASSURANCE

- A. Evaluation and Acceptance of Non-Shrink Grout:
 - 1. Inspect the concrete substrates and formwork for conformance with the manufacturer's recommendations.
 - 2. Make three 2 in³ for every 25 ft³ of grout used to perform flow cone tests per ASTM C939.
 - 3. An independent testing laboratory shall prepare, store, cure, and test cubes per ASTM C1107.
 - 4. Grout cubes shall meet specified strength requirements – grout that fails strength test shall be removed and replaced at no additional cost to the Owner.
- B. Evaluation and Acceptance of Epoxy Grout:
 - 1. Inspect the concrete substrates and formwork for conformance with the manufacturer's recommendations.
 - 2. Verify that the consistency of the epoxy grout mix is appropriate for proper field placement at the installed temperatures.
 - 3. Record that the "pot life" of the epoxy grout has NOT been exceeded.
 - 4. A set of (3) shall be made for testing at 7 days per ASTM C579.
 - 5. Grout cubes shall meet specified strength requirements – grout that fails strength test shall be removed and replaced at no additional cost to the Owner.

- C. Qualification of Grout NOT Listed Herein
 - 1. Provide independent laboratory test results conducted within the last 18 months.

1.5 WARRANTY

- 1. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 CEMENTITIOUS NON-SHRINK GROUT

- A. Use For:
 - 1. Column baseplates
 - 2. Precast joints
 - 3. Machine bases 25 hp or less
 - 4. Tank foundations
 - 5. Form tie and through bolt patching
- B. Shall Have the Following Properties:
 - 1. Ready to use, requiring only the addition of water.
 - 2. Nonmetallic and non-gas generating.
 - 3. Test as specified in ASTM C1107.
 - 4. Fluid consistency as specified in ASTM C939.
- C. Manufacturers and Products:
 - 1. BASF Building Systems; MasterFlow 928
 - 2. Five Star Products; Five Star Fluid Grout 100
 - 3. Euclid Chemical Co.; Hi Flow Grout

2.2 EPOXY GROUT

- A. Use For:
 - 1. Machine bases over 25 hp
 - 2. Machine baseplates that are anticipated to have vibration or thermal movement.
- B. Shall Have the Following Properties:
 - 1. Premeasured, prepackaged system.
 - 2. 100 percent solids two-component epoxy resin system.
 - 3. Flowable, noncorrosive, moisture insensitive.
 - 4. Minimum compressive strength per ASTM C579 of 9,500 psi at 7 days, 11,000 psi fully cured.
 - 5. Minimum bond strength per ASTM C882 of 2,000 psi.
 - 6. Minimum tensile strength per ASTM C307 of 2,000 psi.
 - 7. Minimum working time of 1.0 hours at 70°F.
- C. Manufacturers and Products:
 - 1. Euclid Chemical Co; E³ Flowable
 - 2. BASF Building Systems; MasterFlow 648
 - 3. Five Star Products, Inc.; DP Epoxy Grout

PART 3 - EXECUTION

3.1 GENERAL

- A. All areas to be grouted shall be clean and free of oil, grease, dirt, and contaminants. All metal components in contact with grout shall be free of rust, paint, and oils.

- B. All concrete slabs shall be fully cured for a minimum of 28 days. Concrete shall be in saturated surface dry condition when placing grout.
- C. Machinery and Tank Foundations:
 - 1. Prepare concrete surface by sandblasting or chipping to remove loose material. Create surface roughness per manufacturer's instructions.
 - 2. Form with watertight forms at least 2 in. higher than the bottom of the plate. Treat any form materials that could absorb water.
 - 3. Place grout at one edge and flow to the opposite edge, if possible. Otherwise, create air vents in plate to prevent air entrapment.

3.2 MIXING AND PLACING

- A. Grout shall be mixed with a paddle-type or other mechanical mixer. DO NOT mix more grout than can be placed within the manufacturer's allotted work time.
- B. Place grout immediately after mixing at a temperature range between 45°F – 75°F. Place grout per manufacturer's written instructions.

3.3 CURING

- A. Per manufacturer's written instructions.

END OF SECTION

DIVISION 8
OPENINGS

SECTION 08 31 00 – ALUMINUM HATCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work to furnish aluminum hatches:
 - a. Either single-leaf or double-leaf hatches.
 - b. Flush-type.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Submit aluminum hatch location, identification number and specification number.
- C. Submit drawing plan and cross sections of equipment.
- D. Materials and manufacturing specifications.
- E. Equipment Booklet:
 - 1. Descriptive literature and bulletins.
 - 2. Customer contact list with telephone numbers (minimum of ten contacts from similar size facility)
- F. Detailed list of any exceptions taken to these Specifications. Include specification reference and proposed alternative with reason stated for exception.

1.3 QUALITY ASSURANCE

- A. All aluminum hatches furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.
- B. Unit Responsibility:
 - 1. Aluminum hatches, complete with frame and all other specified accessories and appurtenances, shall be furnished by the aluminum hatch manufacturer to ensure compatibility and integrity of the individual components and provide the specified warranty for all components.
- C. The aluminum hatches specified in this Section, complete with frame and all other specified accessories and appurtenances, shall be furnished by and be the product of one manufacturer.

1.4 ALUMINUM HATCH DESIGN

- A. Aluminum hatches specified in this Section shall be designed for a 300 psf live load.
- B. Aluminum hatches specified as gutter-type shall be designed to be watertight when a 2 in. head of water is present over the hatch.
- C. Aluminum hatches shall be designed to open a minimum of 90 degrees.
- D. Aluminum hatches shall be designed for easy opening from both inside and outside.

- E. Unless otherwise indicated, hinges shall be located on the longer dimension side.

1.5 WARRANTY

- A. Warrant all parts to be free from defects in materials and workmanship for a period of five years after Substantial Completion.
- B. Furnish replacement parts to the Owner for any items found to be defective within the five-year warranty period.
- C. See Section 00610 - Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Experience in design and manufacture of aluminum hatches is required for this project. Submit references for a minimum of ten installations of similar design as specified, having yielded successful performance for a period of NOT less than five years.
- B. Manufacturers are subject to requirements.
- C. Acceptable Manufacturers:
 - 1. Bilco
 - 2. Syracuse Castings
 - 3. Thompson Fabricating
 - 4. Halliday

2.2 MATERIALS

- A. Hatches shall be fabricated from aluminum 6061-T6, unless otherwise indicated. Aluminum hatch hardware shall be Type 316 stainless steel, unless otherwise indicated.
- B. Cover Leafs:
 - 1. Shall be 1/4 in. 5086 aluminum checkered plate reinforced with structural aluminum channels capable of withstanding a 300 psf uniform live load with minimal deflection.
- C. Hardware:
 - 1. Cover shall be equipped with the following features: Gas spring assist, heavy-duty hinges, tamperproof attaching hardware, automatic hold-open arm with latch.
 - 2. Gas Spring Assist: Type 316 stainless steel.
 - 3. Hold-Open Arm with Aluminum Release Handle: Type 316 stainless steel. Shall automatically lock in the open 90-degree position. Hold-Open arm shall be fastened to the frame with a 1/2 in. 316 stainless steel bolt.
 - 4. Heavy-Duty Hinges: Type 316 stainless steel. Each hinge shall have a grade 316 stainless steel 3/8 in. diameter hinge pin. Hinge shall be fastened to angle and diamond plate with 316 stainless steel bolts and ny-lock nuts.
 - 5. All fasteners which penetrate into the dry area of the hatch shall be sealed with O-ring seals to prevent incidental leakage.
- D. The gutter-type frame shall be 1/4 in. aluminum channel with continuous anchor flange and shall incorporate a neoprene gasket between the frame and the cover leaf when in the closed position. The gutter-type frame shall be provided with a 1 1/2 in. threaded drainage coupling located on the Drawings.

- E. The gutterless-type frame shall be 1/4 in. aluminum angle with continuous anchor flange and shall incorporate a neoprene gasket between the frame and the cover leaf when in the closed position.
- F. Frame Coating:
 - 1. The portion of the frame in contact with concrete shall receive a protective bituminous coating.
- G. Locking system:
 - 1. type 316 stainless steel slam lock with one T-wrench provided per unit.
- H. Built-in neoprene gasket shall reduce air leakage to less than 1 cfm/LF of frame when the interior of the hatch is subjected to a 2 in. water column vacuum.
- I. All double-leaf hatches shall have two interconnected slam locks which latch at both ends of the plate and can be unlatched from a single point.
- J. Units shall be supplied with hinged safety grates to provide protection against fall through and to control access to the confined space.
- K. Each hatch shall be equipped with an aluminum lift handle. The lift handle shall be flush with the top of the 1/4 in. diamond plate.

PART 3 - EXECUTION

3.1 INSTALLATION PROCEDURE

- A. Follow equipment manufacturer's recommendations for equipment installation.
- B. Fasteners and Anchors to Concrete
 - 1. Expansion and wedge anchors shall NOT be allowed.
 - 2. All fasteners and anchors which are NOT integrally cast within the concrete shall be adhesive anchor systems.
 - 3. Adhesive Anchor System: A hybrid adhesive mortar used in conjunction with threaded steel rods or deformed steel reinforcement bars. The adhesive shall be a manufactured product combining urethane methacrylate resin, hardener, Portland cement and water.
 - a. Design Requirements:
 - 1) Adhesive anchors shall be designed based upon the more stringent of the manufacturer's recommendation or the International Council of Building Officials Evaluation Service Report, as applicable.
 - b. Available Products
 - 1) Hilti HIT HY-150 by Hilti Corporation for concrete and grout filled CMU.
 - 2) Or approved equal.
 - 4. Material for Anchor Rods/Bolts: Alloy Group 2 (A4) (316) stainless steel bolts complying with ASTM F593 and nuts complying with ASTM F594. Alloy Group 2 (A4) (316) flat washers, as required.
- C. All threads on stainless steel rods/bolts shall be protected with an anti-seize lubricant suitable for submerged stainless bolts and complying with Federal Specification MILI-A-907E.

END OF SECTION

DIVISION 9
FINISHES

SECTION 09 90 00 – PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Surface preparation and field application of paints, and other coatings.

1.2 DEFINITIONS

- A. See ASTM D16 for definitions of terms used in this Section.

1.3 REFERENCES

- A. ASTM International:
 - 1. D16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - 2. D4442 – Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
 - 3. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. MPI (Master Painters Institute):
 - 1. Approved Products List.
 - 2. Architectural Painting Manual.

1.4 PREINSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing Work of this Section.

1.5 SEQUENCING

- A. Do not apply finish coats until paintable sealant is applied.
- B. Back prime wood trim before installation of trim.

1.6 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Product Data:
 - 1. Submit manufacturer data on finishing products, special coatings.
 - 2. Include MPI – Approved Products Lists with proposed products highlighted.
- C. Samples:
 - 1. Submit two paper chip samples, 10 in. by 10 in. in size, illustrating range of colors and textures available for each surface finishing product as scheduled.
 - 2. Painted Samples:
 - a. Submit two painted samples, illustrating selected colors and textures for each selected color and system with specified coats cascaded.
 - b. Submit on tempered hardboard 2, 10 in. by 10 in. in size.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions:

1. Submit special surface preparation procedures, substrate conditions requiring special attention.
- F. Field Quality-Control Submittals:
 1. Indicate results of Contractor-furnished tests and inspections.
- G. Qualifications Statements:
 1. Submit qualifications for manufacturer and applicator.
 2. Submit manufacturer's approval of applicator.
- H. Closeout Submittals:
 1. Section 01700 – Contract Closeout: Requirements for submittals.
 2. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of painted and coated surfaces.
- I. Maintenance Material Submittals:
 1. Section 01700 – Contract Closeout: Requirements for maintenance materials.
 2. Extra Stock Materials:
 - a. Furnish [1] gal. of each color, type, and surface texture as provided for Project.
 - b. Label each container with manufacturer's label, color, type, texture, room number, and site location.
 - c. Store where directed by Owner.

1.7 QUALITY ASSURANCE

- A. MPI Standards:
 1. See indicated MPI standards.
 2. Products: Listed in MPI – Approved Products List.
- B. Surface Burning Characteristics:
 1. Fire-Retardant Finishes: Maximum 25/450 flame-spread/smoke-developed index when tested as specified in ASTM E84.
- C. Perform Work as specified in ASTM standards.

1.8 QUALIFICATIONS

- A. Manufacturer:
 1. Company specializing in manufacturing products specified in this Section with minimum three years of documented experience.
- B. Applicator:
 1. Company specializing in performing Work of this Section with minimum three years of documented experience and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Container Labeling:
 1. Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

- C. Inspection:
 - 1. Accept materials on Site in manufacturer's sealed and labeled containers.
 - 2. Inspect for damage and to verify acceptability.
- D. Store materials in ventilated area and otherwise as specified in manufacturer instructions.
- E. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection as specified in manufacturer instructions.

1.10 AMBIENT CONDITIONS

- A. Section 01560 – Temporary Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Storage Conditions:
 - 1. Minimum Ambient Temperature: 45°F.
 - 2. Maximum Ambient Temperature: 90°F
- C. Application Conditions:
 - 1. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint manufacturer.
 - 2. Do not apply exterior coatings during rain or snow, when relative humidity is outside humidity ranges, or when moisture content of surfaces exceeds those required by paint manufacturer.
 - 3. Minimum Application Temperatures for Latex Paints: 45°F for interiors and 50°F for exteriors, unless otherwise indicated by manufacturer instructions.
 - 4. Minimum Application Temperature for Varnish and Finishes: 65°F for interiors and exteriors, unless otherwise indicated by manufacturer instructions.
 - 5. Lighting Level: 80 fc measured mid-height at substrate surface.

1.11 WARRANTY

- A. Furnish five-year manufacturer's warranty for paint and coatings.
- B. See Section 00610 - Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 PAINTS AND COATINGS

- A. Manufacturers:
 - 1. Sherwin Williams Dura-Plate 6100
 - 2. Raven 405
 - 3. Or Approved Equal.
- B. Substitutional Manufacturers:
 - 1. Furnish materials as specified in ASTM standards.
- C. Materials:
 - 1. Coatings:
 - a. Ready mixed, except field-catalyzed coatings.
 - b. Capable of drying or curing free of streaks or sags.
 - 2. Patching Materials: Latex filler.

3. Fastener Head Cover Materials: Latex filler.
4. Accessories:
 - a. Grade: Commercial.
 - b. Linseed oil.
 - c. Shellac.
 - d. Turpentine.
 - e. Paint thinners.
 - f. Other materials not specifically indicated but required to achieve specified finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01700 – Contract Closeout: Requirements for application examination.
- B. Verify that surfaces and or substrate conditions are ready to receive Work as recommended by product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of Work, and report conditions capable of affecting proper application to Engineer.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Moisture Content:
 1. Measure moisture content of surfaces using electronic moisture meter.
 2. Do not apply finishes unless moisture content of surfaces is below following maximums:
 - a. Gypsum Wallboard: 12%.
 - b. Masonry, Concrete, and Concrete Unit Masonry: 12%.
 - c. Interior Wood: 15%, measured as specified in ASTM D4442.
 - d. Exterior Wood: 15%, measured as specified in ASTM D4442.
 - e. Concrete Floors: 8%.

3.2 PREPARATION

- A. Section 01700 – Contract Closeout: Requirements for application preparation.
- B. Prepare coatings as follows:
 1. To soft paste consistency, capable of being readily and uniformly dispersed to homogeneous coating.
 2. For smooth flow and brushing properties.
- C. Surface Appurtenances:
 1. Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- D. Defects:
 1. Correct defects and clean surfaces capable of affecting Work of this Section.
- E. Marks:
 1. Seal marks that may bleed through surface finishes with shellac.
- F. Impervious Surfaces:
 1. Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach.
 2. Rinse with clean water and allow surface to dry.

- G. Aluminum Surfaces Scheduled for Paint Finish:
 - 1. Remove surface contamination by steam or high-pressure water.
 - 2. Remove oxidation with acid etch and solvent washing.
 - 3. Apply etching primer immediately following cleaning.
- H. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish:
 - 1. Remove foreign particles to permit adhesion of finishing materials.
 - 2. Apply latex-based sealer or primer.
- I. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- J. Concrete Floors:
 - 1. Remove contamination, acid etch, and rinse floors with clear water.
 - 2. Verify that required acid-alkali balance is achieved.
 - 3. Allow to dry.
- K. Gypsum Board Surfaces:
 - 1. Fill minor defects with filler compound.
 - 2. Spot-prime defects after repair.
- L. Galvanized Surfaces:
 - 1. Remove surface contamination and oils, and wash with solvent.
 - 2. Apply coat of etching primer.
- M. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish:
 - 1. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
 - 2. Remove oil and grease with solution of trisodium phosphate, rinse well, and allow to dry.
 - 3. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water and allow to dry.
- N. Uncoated Steel and Iron Surfaces:
 - 1. Remove grease, mill scale, weld splatter, dirt, and rust.
 - 2. If heavy coatings of scale are evident, remove by hand wire brushing or by sandblasting.
 - 3. Clean by washing with solvent.
 - 4. Apply treatment of phosphoric acid solution, ensuring that weld joints, bolts, and nuts are similarly cleaned.
 - 5. Spot-prime paint after repairs.
- O. Shop-Primed Steel Surfaces:
 - 1. Sand and scrape to remove loose primer and rust.
 - 2. Feather edges to make touchup patches inconspicuous.
 - 3. Clean surfaces with solvent.
 - 4. Prime metal items, including shop-primed items.
- P. Interior Wood Items Scheduled to Receive Paint Finish:
 - 1. Wipe off dust and grit prior to priming.
 - 2. Seal knots, pitch streaks, and sappy sections with sealer.
 - 3. Fill nail holes and cracks after primer has dried.
 - 4. Sand between coats.
- Q. Interior Wood Items Scheduled to Receive Transparent Finish:
 - 1. Wipe off dust and grit prior to sealing.
 - 2. Seal knots, pitch streaks, and sappy sections with sealer.
 - 3. Fill nail holes and cracks after sealer has dried.
 - 4. Sand lightly between coats.

- R. Exterior Wood Scheduled to Receive Paint Finish:
 - 1. Remove dust, grit, and foreign matter.
 - 2. Seal knots, pitch streaks, and sappy sections.
 - 3. Fill nail holes with tinted exterior paintable calking compound after prime coat has been applied.
- S. Exterior Wood Scheduled to Receive Transparent Finish:
 - 1. Remove dust, grit, and foreign matter.
 - 2. Seal knots, pitch streaks, and sappy sections with sealer.
 - 3. Fill nail holes with tinted exterior calking compound after sealer has been applied.
- T. Glued-Laminated Beams:
 - 1. Prior to finishing, wash surfaces with solvent, and remove grease and dirt.
- U. Metal Doors Scheduled for Painting:
 - 1. Prime metal door at top and bottom edge surfaces.
- V. Existing Work:
 - 1. Extend existing paint and coatings installations using materials and methods compatible with existing installations and as specified.

3.3 APPLICATION

- A. See MPI – Architectural Painting Manual.
- B. DO NOT apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform appearance.
- D. Apply each coat of paint slightly darker than preceding coat, unless specified otherwise.
- E. Sand wood and metal surfaces lightly between coats to achieve required finish.
- F. Cleaning:
 - 1. Vacuum surfaces to remove loose particles.
 - 2. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Fillers:
 - 1. If clear finishes are required, tint fillers to match wood.
 - 2. Work fillers into grain before set, and wipe excess from surface.
- H. Concealed Surfaces:
 - 1. Prime concealed surfaces of interior and exterior woodwork with primer paint.
 - 2. Prime concealed surfaces of interior wood surfaces scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with thinner.
- I. Finishing Mechanical and Electrical Equipment:
 - 1. Paint shop-primed equipment.
 - 2. Paint shop-finished items installed in interior areas.
 - 3. Remove unfinished louvers, covers, and access panels on mechanical and electrical components, and paint separately.
 - 4. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, except where these items are shop finished.

5. Paint interior surfaces of air ducts visible through grilles and louvers with one coat of flat black paint to visible surfaces.
6. Paint dampers exposed behind louvers, grilles, to match face panels.
7. Paint exposed conduit and electrical equipment installed in finished areas.
8. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
9. Color-Coding:
 - a. Color-code equipment, piping, conduit, and exposed duct work as specified in indicated requirements.
 - b. Color band and identify with flow arrows, names, and numbering.
10. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings that were removed prior to finishing.

3.4 FIELD QUALITY CONTROL

- A. Section 01700 – Contract Closeout: Requirements for testing, adjusting, and balancing.
- B. Inspecting and Testing:
 1. See MPI – Architectural Painting Manual.

3.5 CLEANING

- A. Section 01700 – Contract Closeout: Requirements for cleaning.
- B. Collect waste material that may constitute fire hazards, place in closed metal containers, and remove daily from Site.

3.6 PAINTING SCHEDULE

- A. Shop-Primed Items for Site Finishing:
 - a. Exposed surfaces of lintels, elevator pit ladders.
 - b. Alkyd System MPI EXT 5.1D:
 - 1) Shop Prime Coat: Primer, alkyd, anticorrosive for metal, MPI #79.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Alkyd, exterior, semigloss (MPI Gloss Level 5), MPI #94.
 - 4) Topcoat: Alkyd, exterior, gloss (MPI Gloss Level 6), MPI #9.
 - 5) Water-Based Light Industrial Coating System MPI EXT 5.1C:
 - 6) Shop Prime Coat: Primer, alkyd, anticorrosive for metal, MPI #79.
 - 7) Intermediate Coat: Matching topcoat.
 - 8) Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.
 - 9) Topcoat: Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.
- B. Exterior Surfaces:
 1. Wood – Painted (Opaque):
 - a. Latex System MPI EXT 6.3L:
 - 1) Prime Coat: Primer, latex for exterior wood, MPI #6.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.
 - 4) Topcoat: Latex, exterior semigloss (MPI Gloss Level 5), MPI #11.
 - b. Latex System, Alkyd Primer MPI EXT 6.3A:
 - 1) Prime Coat: Primer, alkyd for exterior wood, MPI #5.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

- 4) Topcoat: Latex, exterior semigloss (MPI Gloss Level 5), MPI #11.
 - c. Alkyd System MPI EXT 6.3B:
 - 1) Prime Coat: Primer, alkyd for exterior wood[, MPI #5.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Alkyd, exterior, semigloss (MPI Gloss Level 5), MPI #94.
 - 4) Topcoat: Alkyd, exterior, gloss (MPI Gloss Level 6), MPI #9.
2. Wood – Transparent:
 - a. Solid-Color, Water-Based Stain System MPI EXT 6.3K.
 - 1) Prime Coat: Primer, alkyd for exterior wood, MPI #5
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Stain, exterior, water based, solid hide, MPI #16.
 - b. Semitransparent Stain System MPI EXT 6.3D:
 - 1) Prime Coat: Matching topcoat.
 - 2) Topcoat: Stain, exterior, solvent based, semitransparent, MPI #13
3. Glued-Laminated Wood, Wood Timber Members:
 - a. One coat of stain, sealer.
 - b. Two coats of varnish , gloss, or semigloss.
4. Pavement Markings: Two coats of paint, yellow or white.
5. Concrete, Concrete Block:
 - a. One coat of block primer.
 - b. Two coats of latex.
6. Gypsum Board Soffits:
 - a. One coat of primer sealer latex.
 - b. Two coats of latex.
7. Steel – Unprimed:
 - a. Water-Based Light Industrial Coating System MPI EXT 5.1M:
 - 1) Prime Coat: Primer, rust-inhibitive, water based MPI #107.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.
 - 4) Topcoat: Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.
 - b. Water-Based Light Industrial Coating System MPI EXT 5.1C:
 - 1) Prime Coat: Primer, alkyd, anticorrosive for metal, MPI #79
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.
 - 4) Topcoat: Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.
 - c. Alkyd System MPI EXT 5.1D:
 - 1) Prime Coat: Primer, alkyd, anticorrosive, for metal, MPI #79.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163;
 - 4) Topcoat: Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.
8. Steel – Shop Primed:
 - a. Touch up with zinc chromate primer.
 - b. Two coats of alkyd enamel, semigloss.
9. Steel – Galvanized:
 - a. One coat galvanize primer.
 - b. Two coats of alkyd enamel, semigloss.
10. Aluminum – Mill Finish:
 - a. One coat etching primer.
 - b. Two coats of alkyd enamel, gloss.
11. Copper:

- a. One coat etching primer.
 - b. Two coats of alkyd enamel, gloss.
- C. Interior Surfaces:
 - 1. Wood – Painted:
 - a. One coat of latex prime sealer.
 - b. Two coats latex enamel, eggshell.
 - 2. Wood – Transparent:
 - a. Semitransparent Stain System MPI INT 6.4C:
 - 1) Prime Coat: Paste wood filler/stain.
 - 2) Intermediate and Topcoat: Polyurethane varnish, MPI #56 or #57 as required.
 - 3. Concrete:
 - a. Latex System MPI INT 3.1A, MPI INT 3.1E:
 - 1) Prime Coat: Primer, alkali resistant, water based, MPI #3.
 - 2) Prime Coat: Matching topcoat.
 - 3) Intermediate Coat: Matching topcoat.
 - 4) Topcoat: Latex, interior, flat, (MPI Gloss Level 1), MPI #53.
 - 5) Topcoat: Latex, interior, semigloss, (MPI Gloss Level 5), MPI #54.
 - b. Institutional Low-Odor/VOC Latex System MPI INT 3.1M:
 - 1) Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - 4) Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.
 - c. Alkyd System MPI INT 3.1D:
 - 1) Prime Coat: Primer, alkali resistant, water based, MPI #3.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Alkyd, interior, flat (MPI Gloss Level 1), MPI #49.
 - 4) Topcoat: Alkyd, interior, semigloss (MPI Gloss Level 5), MPI #47.
 - 4. Concrete Block:
 - a. Latex System MPI INT 4.2A:
 - 1) Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Latex, interior, flat, (MPI Gloss Level 1), MPI #53.
 - 4) Topcoat: Latex, interior, semigloss, (MPI Gloss Level 5), MPI #54.
 - b. Institutional Low-Odor/VOC Latex System MPI INT 4.2E:
 - 1) Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - 4) Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.
 - c. Alkyd System MPI INT 4.2C:
 - 1) Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Alkyd, interior, flat (MPI Gloss Level 1), MPI #49.
 - 4) Topcoat: Alkyd, interior, semigloss (MPI Gloss Level 5), MPI #47.
 - 5. Steel – Unprimed:
 - a. One coat of alkyd primer.
 - b. Two coats of alkyd enamel, semigloss.
 - 6. Steel – Primed:
 - a. Touch up with alkyd primer.
 - b. Two coats of alkyd enamel, semigloss.
 - 7. Steel – Galvanized:

- a. One coat galvanize primer.
 - b. Two coats of alkyd enamel, semigloss.
- 8. Aluminum – Mill Finish:
 - a. One coat etching primer.
 - b. Two coats of alkyd enamel, gloss.
- 9. Concrete Floors:
 - a. One coat of catalyzed epoxy primer.
 - b. Two coats of catalyzed epoxy enamel, gloss.
- 10. Gypsum Board Walls:
 - a. One coat of alkyd.
 - b. Two coats of latex enamel, eggshell.
- 11. Gypsum Board Ceilings:
 - a. One coat of alkyd primer sealer.
 - b. Two coats latex enamel, eggshell.
- 12. Fire-Retardant Finish:
 - a. Fire-Retardant Coating, Pigmented, Solvent-Based System MPI INT 9.2H:
 - 1) Prime Coat and Intermediate Coat: As recommended by topcoat manufacturer.
 - 2) Topcoat: Fire-retardant coating, alkyd, interior, flat MPI #63.
 - b. Fire-Retardant Coating, Pigmented, Water-Based System MPI INT 9.2J:
 - 1) Prime Coat and Intermediate Coat: As recommended by topcoat manufacturer.
 - 2) Topcoat: Fire-retardant coating, latex, interior, flat MPI #64.
 - 3) Topcoat: Fire-retardant topcoat, latex, interior MPI #67.
- 13. Insulated Coverings – Canvas and Cotton:
 - a. One coat of alkyd primer sealer.
 - b. Two coats of alkyd enamel, eggshell.

D. Colors:

- 1. As indicated on drawings.

END OF SECTION

DIVISION 31
EARTHWORK

SECTION 31 05 19.13 – GEOTEXTILE FILTER FABRIC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. This work shall consist of the installation of a nonwoven geotextile fabric below the riprap.
- B. Related Sections:
 - 1. Section 31 37 00 – Riprap

1.2 REFERENCES

- A. ASTM International:
 - 1. D3786 – Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
 - 2. D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
 - 3. D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
 - 4. D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
 - 5. D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
 - 6. D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile
 - 7. D4886 – Standard Test Method for Abrasion Resistance of Geotextiles (Sandpaper/Sliding block Method)
 - 8. D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles
 - 9. D5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
 - 10. D6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Related Products Using a 50mm Probe

1.3 SUBMITTALS

- A. See Section 01300– Submittals.
- B. Certificates:
 - 1. Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Installation shall be performed as specified in manufacturer's recommendations and by Engineer.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. The nonwoven geotextile fabric shall be an 8 oz fabric, US Fabrics US 205NW or equal. The fabric shall be of nonwoven needle punched construction and consist of long-chain polymeric filaments or fibers composed of polypropylene, polyethylene, or polyamide. The filaments and

fibers shall be oriented whereby they retain their relative positions with each other and allow the passage of water as specified.

- B. The fabric shall be mildew, insect and rodent resistant and shall be inert to chemicals commonly found in soil. The nonwoven fabric shall conform to the physical property requirements below:

Physical Property	Test Method	Test Results
Weight	ASTM D5261	8 oz/sy
Tensile Strength, wet (lbs.)	ASTM D4632	205 lbs.
Elongation, wet, (%)	ASTM D4632	50%
Permittivity	ASTM D4491	1.35 sec-1
Puncture Strength, (lbs.)	ASTM D4833	130 lbs.
CBR Puncture	ASTM D6241	535 lbs.
Mullen Burst Strength, (psi)	ASTM D3786	350 psi
Abrasion Resistance, (% Strength Retained)	ASTM D4886	90
Apparent Opening Size (AOS)	ASTM D4751	80 US Sieve
Ultraviolet Resistance, (% Strength Retention)	ASTM D4355 (After 500 Xenon Weatherometer hrs.)	70%
Trapezoidal Tear	ASTM D4533	85 lbs.
Water Flow Rate	ASTM D4491	90 gal/min/sf

- C. The nonwoven geotextile fabric shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fabric Exposure Following Placement:
- Exposure of the geotextile filter fabric to the elements, particularly the sun, between lay down and cover shall be a maximum of 7 days.
- B. Nonwoven Geotextile Fabric:
- Place in the manner and at the locations shown in Drawings or as directed by Engineer. The surface to receive the fabric shall be prepared to a smooth condition free of obstructions, depressions, and debris. The fabric shall be placed loosely, NOT in a stretched condition.
- C. The Contractor shall anchor the geotextile fabric at outer edges of the riprap courses by embedding the fabric down, across, and up a 1 ft deep by 1 ft wide trench. The fabric shall be centered on the pipe. The anchoring trench shall be backfilled with rock material approved by Engineer. There shall be no separate payment for Geotextile Fabric; it shall be subsidiary to other items.
- D. Where necessary, the fabric shall be placed to provide a minimum 24 in. overlap. The fabric shall be placed transverse to the direction of the flow with the upstream panel overlapping the downstream panel. All installations shall be subject to approval by Engineer.
- E. Repairs:
- A geotextile patch, of the same material, shall be placed over any damaged area and shall extend 12 in. beyond the perimeter of the tear or damaged area. Patch shall be either glued or sewn to the mother fabric or as approved by Engineer.

END OF SECTION

SECTION 31 11 00 – SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for site preparation.

1.2 DEFINITIONS

- A. Interfering or Objectionable Material:
 - 1. Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing:
 - 1. Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing:
 - 1. Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 in. caliper to a depth of 12 in. below subgrade.
- D. Scalping:
 - 1. Removal of sod without removing more than upper 3 in. of topsoil.
- E. Stripping:
 - 1. Removal of topsoil remaining after applicable scalping is completed.
- F. Project Limits:
 - 1. Areas, as shown or specified, within which Work is to be performed.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 – Submittals.
- B. Shop Drawings:
 - 1. Drawings clearly showing clearing, grubbing, and stripping limits.

1.4 QUALITY ASSURANCE

- A. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.5 SCHEDULING AND SEQUENCING

- A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 5 acres.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Clear, grub, and strip areas needed for waste disposal, borrow, or site improvements within limits shown or specified.
- B. DO NOT injure or deface vegetation that is NOT designated for removal.

3.2 LIMITS

- A. DO NOT extend beyond Project limits:
 - 1. Excavation, including trenches, 5 ft beyond top of cut slopes or shored walls.
 - 2. Fill:
 - a. Clearing and Grubbing: 5 ft beyond toe of permanent fill.
 - b. Stripping and Scalping: 2 ft beyond toe of permanent fill.
 - 3. Structures: 15 ft outside of new structures.
 - 4. Roadways: Clearing, grubbing, scalping, and stripping 15 ft from centerline.
 - 5. Other Areas: As shown.
- B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 CLEARING

- A. Clear areas within limits shown or specified.
- B. Fell trees so that they fall away from facilities and vegetation NOT designated for removal.
- C. Cut stumps NOT designated for grubbing to within 6 in. of ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 in. of ground surface.

3.4 GRUBBING

- A. Grub areas within limits shown or specified.

3.5 SCALPING

- A. DO NOT remove sod until after clearing and grubbing is completed and resulting debris is removed.
- B. Scalp areas within limits shown or specified.

3.6 STRIPPING

- A. DO NOT remove topsoil until after scalping is completed.
- B. Strip areas within limits to minimum depths shown or specified. DO NOT remove subsoil with topsoil.
- C. Stockpile strippings, meeting requirements for topsoil, separately from other excavated material.

3.7 TOPSOIL

- A. Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1 1/2 in. maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

3.8 DISPOSAL

- A. Clearing and Grubbing Debris:
 - 1. Dispose of debris
 - 2. Burning of debris shall NOT be allowed.
 - 3. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and NOT support combustion. Maximum dimensions of chipped material used shall be 1/4 in. by 2 in. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
 - 4. Limit disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will NOT be visible from Project.
- B. Scalpings:
 - 1. As specified for clearing and grubbing debris.
- C. Strippings:
 - 1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil.
 - 2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 22 13 – SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Work and testing required for preparing subgrade.
- B. Related Sections:
 - 1. Section 31 11 00 – Site Preparation
 - 2. Section 31 23 16 – Excavation
 - 3. Section 31 23 23.13 – Fill and Backfill

1.2 REFERENCES

- A. ASTM International:
 - 1. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)
 - 2. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)

1.3 DEFINITIONS

- A. Optimum Moisture Content:
 - 1. See Section 31 23 23.13 – Fill and Backfill.
- B. Prepared Ground Surface:
 - 1. Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction:
 - 1. See Section 31 23 23.13 – Fill and Backfill.
- D. Relative Density:
 - 1. See Section 31 23 23.13 – Fill and Backfill.
- E. Subgrade:
 - 1. Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.
- F. Standard Specifications:
 - 1. The latest edition, including supplements of the [insert appropriate State Options:] [Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction] [Oklahoma Department of Transportation Standard Specifications for Highway Construction] or [TxDOT Standard Specifications] [Other].

1.4 SEQUENCING AND SCHEDULING

- A. Prior to preparation, complete applicable Work specified in:
 - 1. Section 31 11 00 – Site Preparation
 - 2. Section 31 23 16 – Excavation

1.5 QUALITY ASSURANCE

- A. Notify Engineer when subgrade is ready for compaction or whenever compaction is resumed after a period of extended inactivity.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. DO NOT use sections of prepared ground surface as haul roads. Protect prepared from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 MOISTURE CONDITIONING

- A. Dry Subgrade:
 - 1. Add water, then mix to make moisture content uniform throughout.
- B. Wet Subgrade:
 - 1. Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.3 TESTING

- A. Test roll subgrade as specified in Standard Specifications to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

3.4 CORRECTION

- A. Soft or Loose Subgrade:
 - 1. Adjust moisture content and recompact,
Or
 - 2. Over excavate as specified in Section 31 23 16 – Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23.13 – Fill and Backfill

END OF SECTION

SECTION 31 22 19 – GRADING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Removal and storage of topsoil.
 - 2. Rough grading the site for site structures, building pads, and drive and parking isles.
 - 3. Finish grading for planting.
- B. Related Sections:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 23 23.13 – Fill and Backfill
 - 3. Section 31 23 16.13 – Trenching for Site Utilities

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01300– Submittals.
- B. Project Record Documents:
 - 1. Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

- A. Perform Work as specified in State of Colorado Highway Department standards.
 - 1. Maintain one copy on site.

1.4 PROJECT CONDITIONS

- A. Protect above – and below – grade utilities that remain.
- B. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.
- C. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving and curbs from grading equipment and vehicular traffic.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil:
 - 1. Shall be soil suitable for sustaining grass and vegetation and shall NOT have any particles larger than 3/4 in. in diameter and shall be free of any trash, debris, or deleterious material. See Section 900 of City of Colorado Springs Standard Specification Manual.
- B. Other Fill Materials:
 - 1. See Section 31 23 23.13 – Fill and Backfill.

PART 3 - EXECUTIONS

3.1 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the Work are as specified.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect utilities that remain from damage.
- D. Notify utility company to remove and relocate utilities.

3.3 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, relandscaped, or regraded without mixing with foreign materials.
- B. DO NOT remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, relandscaped, or regraded.
- D. DO NOT remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with sharp axe.
- F. Stability:
 - 1. Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 SOIL REMOVAL

- A. Stockpile excavated topsoil on site.
- B. Stockpile excavated subsoil on site.
- C. Stockpiles:
 - 1. Use areas designated on site; pile depth NOT to exceed 8 ft; protect from erosion.

3.5 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, more than 1/2 in. in size. Remove soil contaminated with petroleum products.
- C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 in.
- D. Place topsoil in areas where seeding is specified.

- E. Place topsoil in compacted thicknesses:
 - 1. Areas to be Seeded with Grass:
 - a. 6 in.
 - 2. Areas to be Sodded:
 - a. 4 in.
 - 3. Shrub Beds:
 - a. 18 in.
 - 4. Flower Beds:
 - a. 12 in.
 - 5. Planter Boxes:
 - a. To within 3 in. of box rim
- F. Place topsoil during dry weather.
- G. Remove roots, weeds, rocks, and foreign material while spreading.
- H. Near plants spread topsoil manually to prevent damage.
- I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- J. Lightly compact placed topsoil.

3.6 TOLERANCES

- A. Top Surface of Subgrade:
 - 1. Plus or minus 1/10 ft from required elevation.
- B. Top Surface of Finish Grade:
 - 1. Plus or minus 1/2 in.

3.7 FIELD QUALITY REQUIREMENTS

- A. See Section 31 23 23.13 – Fill and Backfill for compaction density testing.

3.8 CLEANING AND PROTECTION

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 23 16 – EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials associated with excavation.
- B. Related Sections:
 - 1. Section 31 11 00 – Site Preparation
 - 2. Section 31 23 19 – Dewatering
 - 3. Section 31 50 00 – Excavation Support Systems

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01300– Submittals.
- B. Shop Drawings:
 - 1. Excavation Plan, Detailing:
 - a. Methods and sequencing of excavation.
 - b. Proposed locations of stockpiled excavated material.
 - c. Proposed and spoil disposal sites.
 - d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.3 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized over-excavation.

1.4 WEATHER LIMITATIONS

- A. Material excavated when frozen or when air temperature is less than 32°F shall NOT be used as fill or backfill until material completely thaws.
- B. Material excavated during inclement weather shall NOT be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.5 SEQUENCING AND SCHEDULING

- A. Clearing, Grubbing, and Stripping:
 - 1. Complete applicable Work as specified in Section 31 11 00 – Site Preparation, prior to excavating.
- B. Dewatering:
 - 1. See Section 31 23 19 – Dewatering, prior to initiating excavation.
- C. Excavation Support:
 - 1. Install and maintain, as specified in Section 31 50 00 – Excavation Support Systems, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Excavate to lines, grades, and dimensions specified and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 ft except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. DO NOT over excavate without written authorization of Engineer.
- C. Remove or protect obstructions as shown and as specified in Section 01560 - Temporary Controls.

3.2 UNCLASSIFIED EXCAVATION

- A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

- A. Minimum Width of Trenches:
 - 1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
 - a. Less than 4 in. Outside Diameter or Width: 18 in.
 - b. Greater than 4 in. and up to 18 in. Outside Diameter or Width: 12 in. greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - c. Greater than 18 in. Diameter or Width: 24 in. greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - 2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 in. greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
 - 3. Increase trench widths by thicknesses of sheeting.
- B. Maximum Trench Width:
 - 1. Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

- A. Semicircular, trapezoidal, or 90-degree-V.
- B. Excavated or plowed into trench bottom. Forming groove by compaction shall NOT be acceptable.

3.5 STOCKPILING EXCAVATED MATERIAL

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

- C. Confine stockpiles to within easements, rights-of-way, and approved work areas. DO NOT obstruct roads or streets.
- D. DO NOT stockpile excavated material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- E. DO NOT stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill.
- B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 11 00 – Site Preparation, for clearing and grubbing debris.

3.7 EXCAVATION SAFETY

- A. See applicable federal, state, and local regulations for requirements.

3.8 SUBGRADE PREPARATION

- A. The excavation for all structures and facilities shall be in dewatered, firm, undisturbed earth. If, in the Engineer's opinion, the subgrade has been disturbed, corrective measures may include:
 - 1. Scarification and recompaction to 95% relative compaction
 - Or,
 - 2. Over-excavation and replacement with compacted granular fill.
- B. If the source of disturbance is determined to be the result of the actions, or inactions of the Contractor, (for example, inadequate dewatering, disturbance by excavating or hauling equipment) the cost of additional subgrade preparation shall be at the Contractor's expense.

END OF SECTION

SECTION 31 23 16.13 – TRENCHING FOR SITE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Backfilling and compacting for utilities outside the building to utility main connections.
- B. Related Sections:
 - 1. Section 31 22 19 – Grading
 - 2. Section 31 23 16 – Excavation
 - 3. Section 31 23 23.13 – Fill and Backfill
 - 4. Section 31 23 23.16 – Trench Backfill
 - 5. Section 33 41 19 – Pipe Laying

1.2 REFERENCES

- A. ASTM International:
 - 1. D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - 2. D2167 – Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
 - 3. D6938 – Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
 - 4. D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 5. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)
 - 6. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)
- B. AASHTO
 - 1. T180 – Standard Method of Test for Moisture–Density Relations of Soils Using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop

1.3 DEFINITIONS

- A. Subgrade Elevations:
 - 1. 4 in. below finish grade elevations specified in Drawings, unless otherwise specified.
- B. Finish Grade Elevations:
 - 1. 4 in. above subgrade elevations specified in Drawings, unless otherwise specified.

1.4 SUBMITTALS

- A. Subject to requirements as specified in Section 01300 - Submittals.
- B. Compaction Density Test Reports.

1.5 PROJECT CONDITIONS

- A. Provide enough fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.

- B. Verify that survey benchmarks and intended elevations for the work are as specified.

1.6 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 UTILITIES

- A. Contractor shall call "COLORADO ONE CALL" two working days before starting excavation. The ONE CALL phone number is 1-800-922-1987.
- B. The location and/or elevation of existing utilities as shown on these plans is based on records of the various utility companies and, where possible, measurements taken in the field. The information is not to be relied upon as being exact or complete. The Contractor must call each utility owner at least two working days before any excavation to request exact field location of utilities.
- C. Protect utilities encountered during excavation.
- D. DO NOT interrupt service in utilities encountered during excavation without approval of the utility owner.
- E. If utilities are damaged or utility service is interrupted by work under this section, the utility owner has the first right to repair. If public health or safety is at risk, Contractor shall take appropriate prudent action to repair damage and service interruption. Costs of utility protection and repair shall be at no additional cost to the Owner.
- F. If existing utilities are found to interfere with the permanent facility being constructed, notify the Engineer for instructions. Do not proceed with permanent relocation of utilities without written instructions from the Engineer.

2.2 FILL MATERIALS

- A. As specified in Section 31 23 23.16 – Trench Backfill.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Notify utility company to remove and relocate utilities.
- D. See Section 31 22 19 – Grading, for additional requirements.

3.2 TRENCHING

- A. Requirements:
 - 1. Provide and install trench bracing and shoring that conforms to the requirements of 29 CFR Part 1926 Subpart P of the OSHA Standards. Bracing shall be so arranged as not to

place any strain on portions of completed work until the construction has proceeded far enough to provide ample strength.

2. Over-excavation, whether by Contractor's negligence or at direction of the Engineer, shall be repaired to required lines and grades.
3. Trenches shall be dug to the alignment and depth required and shall not advance more than 100 ft ahead of the completed pipe, unless otherwise permitted by the Engineer.

B. Notify Owner's Representative of unexpected subsurface conditions and discontinue affected Work in areas until notified to resume work.

C. Slope banks of excavations deeper than 4 ft to angle of repose or less until shored.

D. DO NOT interfere with 45 degree bearing splay of foundations.

E. Cut trenches wide enough to allow inspection of installed utilities.

F. Hand trim excavations. Remove loose matter.

G. Remove excavated material that is unsuitable for reuse from site.

H. Remove excess excavated material from site.

3.3 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade NOT capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.4 BACKFILLING

A. Backfill to contours and elevations specified using unfrozen materials.

B. Employ a placement method that does NOT disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. DO NOT fill over porous, wet, frozen, or spongy subgrade surfaces.

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

E. Slope grade away from building minimum 2 in. in 10 ft. unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Correct areas that are over-excavated:

1. Thrust bearing surfaces: Fill with concrete.
2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97% of maximum dry density.

G. Compaction Density Unless Otherwise Specified.

1. Under paving, slabs-on-grade, and similar construction: 97% of maximum dry density.
2. All other locations: 95% of maximum dry density.

H. Reshape and recompact fills subjected to vehicular traffic.

3.5 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping, Conduits, and Duct Bank:
 - 1. Bedding: Use general fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 in. lifts to 95% of maximum dry density.
- B. At Pipe Culverts:
 - 1. Bedding: use general fill.
 - 2. Place filter fabric specified in Section 31 05 19.13 – Geotextile Filter Fabric, over compacted bedding.
 - 3. Cover with general fill.
 - 4. Fill up to subgrade elevation.
 - 5. Compact in maximum 8 in. lifts to 95% of maximum dry density.

3.6 TOLERANCES

- A. Top Surface of General Backfilling:
 - 1. Plus or minus 1 in. from required elevations.

3.7 FIELD QUALITY REQUIREMENTS

- A. Perform compaction density testing on compacted fill as specified in ASTM D1556, ASTM D2167, ASTM D6938, or ASTM D3017.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material as specified in ASTM D698 (“Standard Proctor”), ASTM D1557 (“Modified Proctor”), or AASHTO T180.
- C. If tests specify work does NOT meet specified requirements, remove work, replace, and retest.
- D. Frequency of Tests; each lift.

3.8 CLEANUP

- A. Leave unused materials in a neat compact stockpile.
- B. Remove unused stockpiled material, leave area in a clean and neat condition. Grade stockpile areas to prevent standing surface water.
- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

WSECTION 31 23 16.16 – TRENCHING FOR WATER AND SEWER LINES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Excavation required for the construction of water and sewer pipes and appurtenances.
- B. Related Sections:
 - 1. Section 31 23 23.16 – Trench Backfill
 - 2. Section 33 41 19 – Pipe Laying

1.2 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 UTILITIES

- A. Contractor shall call "COLORADO ONE CALL" two working days before starting excavation. The ONE CALL phone number is 1-800-922-1987.
- B. The location and/or elevation of existing utilities as shown on these plans is based on records of the various utility companies and, where possible, measurements taken in the field. The information is not to be relied upon as being exact or complete. The Contractor must call each utility owner at least two working days before any excavation to request exact field location of utilities.
- C. Protect utilities encountered during excavation.
- D. DO NOT interrupt service in utilities encountered during excavation without approval of the utility owner.
- E. If utilities are damaged or utility service is interrupted by work under this section, the utility owner has the first right to repair. If public health or safety is at risk, Contractor shall take appropriate prudent action to repair damage and service interruption. Costs of utility protection and repair shall be at no additional cost to the Owner.
- F. If existing utilities are found to interfere with the permanent facility being constructed, notify the Engineer for instructions. Do not proceed with permanent relocation of utilities without written instructions from the Engineer.

2.2 FILL MATERIALS

- A. Shall be as specified in Section 31 23 23.16 – Trench Backfill.

PART 3 - EXECUTION

3.1 GENERAL

- A. Requirements:
 - 1. Provide and install trench bracing and shoring as specified in 29 CFR Part 1926 Subpart P of the OSHA Standards. Bracing shall be so arranged as not to place any strain on

portions of completed work until the construction has proceeded far enough to provide ample strength.

2. Over-excavation, whether by Contractor's negligence or at direction of the Engineer, shall be repaired to required lines and grades.
3. Trenches shall be dug to the alignment and depth required and shall not advance more than 100 ft ahead of the completed pipe, unless otherwise permitted by the Engineer.

- B. Notify property residents two working days prior to beginning excavation on property.
- C. Excavated materials not suitable for backfill or embankment shall not be incorporated into the project but shall be disposed of by Contractor.
- D. Excavate with caution so that structures and underground conduits can be protected.
- E. Excavate every type of material encountered to the lines and elevations necessary to complete the project.
- F. Reroute surface water before excavating and protect excavated trench from entrance of surface water.
- G. In general, the sheeting and bracing shall be removed as the trench or excavation is backfilled, and in such a manner as to avoid the caving in of the bank or disturbance of adjacent areas or structures. The voids left by the withdrawal of sheeting shall be backfilled the same as trench excavations.
- H. Provide "before and after" color photographs of lawns and gardens to Engineer.
- I. Comply with Section 33 41 19 – Pipe Laying.

3.2 TRENCH DEPTH

- A. Excavate to the elevation necessary to provide the depth of bedding material under the barrel of the pipe, noted on the plans or in these specifications, whichever is greater.
- B. All over-excavation up to 2 ft shall be backfilled with bedding material in 6 in. layers and tamped to a bearing capacity equal to the adjacent undisturbed earth. Over excavation greater than 2 ft will require excavation operation to stop until an engineered backfill is determined. Over excavation shall not proceed until approved by Engineer. Contractor shall bear all expense involved if he fails to obtain prior approval from the Engineer.

3.3 TRENCH WIDTH

- A. Excavate to the width shown in detail drawings. Specified width dimensions must be maintained from trench bottom to an elevation 12 in. above barrel of pipe. Over-width excavation will require excavation operation to stop until additional earth loads can be compared to strength of pipe. Costs of unauthorized deviation from the specified width will be borne by the Contractor.

3.4 TRENCH LENGTH

- A. Excavate to a maximum distance of 100 ft from the pipe jointing operation. Longer distances will be considered when conditions warrant.

3.5 EXCAVATION IN ROCK

- A. When rock is encountered, excavate to an elevation 6 in. below the pipe and to the trench width as shown in the details at no additional cost to Owner.

3.6 EXCAVATION IN UNSUITABLE SOIL

- A. Where, in the judgment of the Engineer, the planned bottom of trench is found to be unstable, excavation shall stop until an engineered subgrade stabilization method is determined.

3.7 EXCAVATION IN WET CONDITIONS

- A. Where the planned bottom of trench contains water or the trench bottom is soft from excess water, excavation depth shall increase a minimum of 6 in. or as directed by the Engineer.

3.8 EXCAVATION IN UNFORESEEN STRUCTURE

- A. Preserve unforeseen structures encountered in excavation.
- B. Advise the Engineer when unforeseen structure interferes with planned work. Engineer will determine if plan changes or if structure will be abandoned.

3.9 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavation is removal of materials beyond specified elevations or dimensions without the Engineer or Owner's specific prior approval.

3.10 UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Excavated material not suitable for backfill and excess excavated material shall be disposed of by Contractor in a manner approved by the Engineer and applicable governmental regulations.

3.11 EXCAVATION DEWATERING

- A. Wellpointing or deep wells, where required to keep the excavation dry and the subgrade stable, shall be installed when the excavation extends to within 2 ft of the water table, except as herein provided, and shall be in continuous operation until backfill is completed to this level.
- B. When construction equipment is to be operated in an area that has been excavated, and wellpointing or deep wells are required to keep the excavation dry and the subgrade stable, the wellpointing or deep wells shall be installed when the excavation extends to within 5 ft of the water table.
- C. There shall be sufficient pumping equipment, in good working order, readily available at all times to remove any water that accumulates in excavations to the extent that a stable subgrade is obtained.
- D. Where the excavation crosses natural drainage channels, the work shall be conducted in such a manner that unnecessary damage or delays in the prosecution of the work will be prevented.
- E. Trench dewatering shall discharge to an approved location as specified in the Stormwater Pollution Prevention Plan.
- F. Wellpoint dewatering for the sewer line construction will not be mandatory where a properly stabilized subgrade can be obtained by use of granular bedding. If granular bedding is utilized

by the Contractor for stabilization of the trench bottom in lieu of wellpointing, such bedding material will not be measured for separate payment but will be considered subsidiary to the pipe installation.

- G. Where dewatering might be necessary to properly install the sewer line, such as at drainage channel crossings and tunnel or boring locations, the Contractor shall submit his proposal for this dewatering to the Owner for approval.
- H. Dewatering operations shall continue until pipe has been backfilled and a sufficient cover depth has been reached to prevent flotation of pipe.

END OF SECTION

SECTION 31 23 16.20 – ROCK EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Furnishing all labor, material, and equipment to excavate rock and dispose of rock as specified herein. The following applies to all trenched construction including, but NOT limited to, water mains, sanitary sewer mains, gas mains, and other pipelines.
- B. Requirements of Regulatory Agencies:
 - 1. Observe all municipal ordinances and State and Federal laws relating to the transportation, storage, handling, and use of explosives.
 - 2. Blasters shall be duly licensed and shall always have their license on the work site during blasting activities.

1.2 DEFINITION

- A. At sites of utility relocation projects, rock excavation is hereby defined as material that cannot be removed with the normal excavation equipment used on the project. It is further defined as material requiring drilling and/or blasting prior to its removal from the trench site. The following DO NOT qualify for rock excavation: soft or disintegrated rock that can be removed with a hand pick, power-operated excavator, or shovel; loose, broken, or previously blasted rock or broken stone in rock fills or elsewhere; and rock which has fallen into the excavation from outside of the minimum limits of measurement allowed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavate rock to the lines and grades specified in Drawings. Dispose of excavated material NOT suitable for backfill in a location approved by the Owner.
- B. In rock, excavations shall be carried 6 in. below the bottom of the pipe. Loose earth or gravel NOT larger than 3/4 in. in size shall be used for backfill, tamped thoroughly, and rounded to receive pipe as above.
- C. Excavate rock in structure excavations to 6 in. below the bottom of the foundation.

3.2 MEASUREMENT AND PAYMENT

- A. The Contractor shall notify the Owner when rock measurements can be performed. If backfill commences before measurement is made, the Contractor shall NOT be paid for that portion of the rock removed. Maximum measurement for rock excavation in pipe trenches shall be to 6 in. below bottom of pipe with the width of trench at 2 ft 0 in. plus the interior diameter of pipe, regardless of the excess width excavated. Maximum measurement for precast and cast-in-place structures shall be structure width plus 4 ft; structure length plus 4 ft; and base of structure. Payment shall be the price bid per cubic yard and is to include aggregate fill to bring the ditch to plan grade.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work required to dewater excavations.

1.2 WATER CONTROL PLAN

- A. As a Minimum, Include:
 - 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. Drawings showing locations, dimensions, and relationships of elements of dewatering system.
- B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and control surface and subsurface water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

- A. See Section 01560 – Temporary Controls.
- B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

- A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 ft below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.
- B. Design and Operate Dewatering Systems:
 - 1. To prevent loss of ground as water is removed.
 - 2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
 - 3. To relieve artesian pressures and resultant uplift of excavation bottom.
 - 4. Prevent softening, loosening or otherwise disturbing the excavation subgrade.
- C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
- D. Provide supplemental ditches and sumps only as necessary to collect water from local seeps.

3.4 DISPOSAL OF WATER

- A. Obtain discharge permit for water disposal from authorities having jurisdiction.
- B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.
- C. Discharge water as required by discharge permit and in manner that will NOT cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.
- D. The discharge of ground water into treatment facilities shall NOT be permitted unless specifically authorized by the Owner. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency. If Owner allows groundwater discharge into facilities.

3.5 PROTECTION OF PROPERTY

- A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but NOT limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.
- B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but NOT be limited to, sheeting bracing, underpinning, or compaction grouting.

3.6 REMEDIATION OF GROUNDWATER AFTER DEPLETION

- A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well Owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to the well Owner prior to beginning Work or as satisfactory to each well Owner.

END OF SECTION

SECTION 31 23 23.13 – FILL AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials required for fill and backfill for all excavations other than trench type excavations.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete
 - 2. Section 31 11 00 – Site Preparation
 - 3. Section 31 22 13 – Subgrade Preparation
 - 4. Section 31 23 16 – Excavation
 - 5. Section 31 23 23.16 – Trench Backfill

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Society for Testing and Materials (ASTM):
 - a. C117 – Standard Test Method for Materials Finer Than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. D75 – Standard Practice for Sampling Aggregates.
 - d. D698 – Standard Test Methods for Laboratory Characteristics of Soil Using Modified Effort (12,400 ft-lbf/ft³).
 - e. D1556 – Standard Test Method for Density of Soil in Place by the Sand Cone Method.
 - f. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - g. D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - h. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - i. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 DEFINITIONS

- A. Relative Compaction:
 - 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined as specified in ASTM D698.
 - 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- B. Optimum Moisture Content:
 - 1. Determined as specified in ASTM D698 specified to maximum dry density for relative compaction.
 - 2. Determine field moisture content on basis of fraction passing 3/4 in. sieve.
- C. Relative Density: Calculated as specified in ASTM D4254 based on maximum index density determined as specified in ASTM D4253 and minimum index density determined as specified in ASTM D4254.

- D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and preparation.
- E. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- F. Lift: Loose (uncompacted) layer of material.
- G. Geosynthetics: Geotextiles, geogrids, or geomembranes.
- H. Well-Graded:
 - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
 - 2. Does NOT define numerical value that shall be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- I. Influence Area: Area within planes sloped downward and outward at 60 degrees from horizontal measured from:
 - 1. 1 ft outside outermost edge at base of foundations or slabs.
 - 2. 1 ft outside outermost edge at surface of roadways or shoulder.
 - 3. 0.5 ft outside exterior at spring line of pipes or culverts.
- J. Borrow Material: Material from required excavations or from designated borrow areas on or near site.
- K. Selected Backfill Material/Select Fill: Materials available onsite that Engineer determines to be suitable for specific use.
- L. Imported Material: Materials obtained from sources suitable for specified use.
- M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.
- N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.
- O. Standard Specification: The latest edition, including supplements of the Colorado Department of Transportation Standard Specifications for Highway Construction, El Paso County, and City of Fountain.

1.4 SUBMITTALS

- A. Quality Control Submittals:
 - 1. Catalog and manufacturer's data sheets for compaction equipment.
 - 2. Certified test results from independent testing agency.

1.5 QUALITY ASSURANCE

- A. Notify Engineer when:
 - 1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
 - 2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
 - 3. Fill material appears to be deviating from sections.

1.6 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 23 16, EXCAVATION prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00 – Cast-In-Place Concrete. Obtain acceptance of concrete work and attained strength prior to placing backfill.
- C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00 – Cast-In-Place Concrete.
- D. DO NOT place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 22 13 – Subgrade Preparation.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY REQUIREMENTS

- A. Gradation Tests: It shall be the Contractor's responsibility to conduct testing as necessary to locate acceptable sources of imported material.

2.2 EARTH FILL

- A. Excavated material from required excavations, free from rocks larger than 3 in, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.3 GRANULAR FILL

- A. Structural Backfill Class 1 aggregate meeting all the requirements of Subsection 703.08 (a) of the Colorado Department of Transportation Standard Specifications.

2.4 WATER FOR MOISTURE CONDITIONING

- A. Free of hazardous or toxic contaminants, or contaminants deleterious to proper compaction.

2.5 FOUNDATION STABILIZATION ROCK

- A. Crushed rock or pit run rock.
- B. Uniformly graded from coarse to fine.
- C. Free from excessive dirt and other organic material.
- D. Maximum 2 1/2 in. particle size.

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding

lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. DO NOT place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 ft above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.16 – Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.16 – Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 ft, unless dimensions or grades are specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as specified. Reverse slopes are NOT permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.
- H. Fill and backfill materials shall be conditioned to a water content that is within plus or minus 2% of the optimum required for compaction as determined by ASTM D698.

3.2 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise specified. Place granular fill in lifts of 6 in. maximum thickness and compact each lift to minimum of 95% relative compaction as determined as specified in ASTM D698, Method C.
- B. Subsurface Drainage: Backfill with granular drain material where specified. Place granular drain material in lifts of 6 in. maximum thickness and compact each lift to minimum of 90% relative density.
- C. Other Areas: Backfill with select fill to lines and grades specified, with proper allowance for topsoil thickness where specified. Place in lifts of 6 in. maximum thickness and compact each lift to minimum 95% relative compaction as determined as specified in ASTM D698, Method C.

3.3 FILL

- A. Outside Influence Areas Beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities:
 - 1. Unless otherwise specified, place select fill.
 - 2. Allow for 6 in. thickness of topsoil where required.
 - 3. Maximum 9 in. thick lifts.
 - 4. Place and compact fill across full width of embankment.
 - 5. Compact to minimum 95% relative compaction as determined as specified in ASTM D698, Method C.

6. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.4 SITE TESTING

- A. Gradation:
 1. One sample from each 400 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
 2. If test results specify material does NOT meet section requirements, terminate material placement until corrective measures are taken.
 3. Remove material placed in Work that does NOT meet Specification requirements.
- B. In-Place Density Tests:
 1. As specified in ASTM.
 2. During placement of materials, test:
 - a. One test per every other lift per 200 LF of roadway or trench.
 - b. A minimum of two tests on granular fill beneath structures.
 - c. A minimum of two tests per 300 yds³ during backfilling of walls.
- C. Testing shall be the Contractor's responsibility and conducted by persons experienced in such work.

3.5 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines specified or established by Engineer:
 1. Beneath Footings: Concrete of strength equal to that of respective footing.
 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
 3. Beneath Slabs-On-Grade: Granular fill.
 4. Trenches:
 - a. Unauthorized Over-excavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.16 – Trench Backfill.
 - b. Authorized Over-excavation: Trench stabilization material, as specified in Section 31 23 23.16 – Trench Backfill.
 5. Permanent Cut Slopes (Where Overlying Area is NOT to Receive Fill or Backfill):
 - a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Select Fill.
 - b. Steep Slopes (Steeper than 3:1):
 - 1) Correct over-excavation by transitioning between areas and designed slope adjoining areas, provided such cutting does NOT extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
 - 2) Backfilling over-excavated areas is prohibited unless, in opinion, backfill will remain stable, and over-excavated material is replaced as compacted select fill.
- B. Correct overexcavation by transitioning between areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
- C. Backfilling overexcavated areas is prohibited unless, in opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth fill.

END OF SECTION

SECTION 31 23 23.16 – TRENCH BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Installation materials and Installation methods for open trench installation of utility lines.
 - 2. Trench Excavation Safety Systems.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-in-Place Concrete
 - 2. Section 31 23 23.13 – Fill and Backfill
 - 3. Section 31 23 19 – Dewatering
 - 4. Section 31 50 00 – Excavation Support Systems
 - 5. Section 32 12 16 – Asphalt Concrete Pavement

1.2 REFERENCES

- A. ANSI:
 - 1. 253.1, Safety Color Code.
- B. APWA:
 - 1. Uniform Color Code for Temporary Marking of Underground Utility Locations.
- C. ASTM International:
 - 1. D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - 2. C33 – Standard Specification for Concrete Aggregates
 - 3. C94 – Specification for Ready-Mixed Concrete.
 - 4. C117 – Standard Test Method for Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - 5. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 6. C150 – Standard Specification for Portland Cement.
 - 7. C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - 8. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cubic ft).
 - 9. D1140 – Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve in Soils by Washing.
 - 10. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf).
 - 11. D3776 – Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
 - 12. D3786 – Standard Test Method for Bursting Strength of Textile Fabrics: Diaphragm Bursting Strength Tester Method.
 - 13. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - 14. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 15. D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 16. D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - 17. D4832 – Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - 18. D4991 – Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.

19. D5034 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.3 DEFINITIONS

- A. Base Rock:
1. Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material:
1. Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material:
1. Material obtained by the Contractor from source(s) offsite.
- D. Lift:
1. Loose (uncompacted) layer of material.
- E. Pipe Zone:
1. Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable, or duct bank.
- F. Prepared Trench Bottom:
1. Graded trench bottom after stabilization and installation of bedding material.
- G. Relative Compaction:
1. The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- H. Relative Density:
1. As specified by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material:
1. Material available that the Engineer determines to be suitable for a specific use.
- J. Well-Graded:
1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does NOT define any numerical value that shall be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Shop Drawings:
1. Manufacturer's descriptive literature for marking tapes.
- C. Samples:
1. Trench stabilization material.
 2. Bedding and pipe zone material.
 3. Granular drain.
 4. Granular backfill.

5. Select backfill.
6. Sand(s).
7. Geotextile.

D. Quality requirements Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.

E. Certified Gradation Analysis:

1. Submit NOT less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

F. Controlled Low Strength Material:

1. Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 MARKING TAPE

A. Plastic:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 4 mils.
3. Width: 12 in.
4. Identifying Lettering: Minimum 1 in. high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape.
 - b. Allen Precision Equipment; Markline.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
2. Thickness: Minimum 5 mils.
3. Width: 12 in.
4. Identifying Lettering: Minimum 1 in. high, permanent black lettering imprinted continuously over entire length.
5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
6. Manufacturers and Products:
 - a. Reef Industries; Terra Tape Sentry Line.
 - b. Allen Precision Equipment; Detectatape.

C. Color:

1. As specified in APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color ¹	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials

Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines
Notes:	
1. As specified in ANSI Z53.1, Safety Color Code.	

2.2 TRENCH STABILIZATION MATERIAL

- A. Clean, hard, durable 3 in. minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.
- B. Uniformly graded from coarse to fine, less than 8% by weight passing the 1/4 in. sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Clean or gravelly sand with less than 5% passing No. 200 sieve, as determined as specified in ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
 - 1. Duct Banks: 3/4 in. maximum particle size.
 - 2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8 in. maximum particle size.
 - 3. Pipe Under 18 in. Diameter: 3/4 in. maximum particle size, except 1/4 in. for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 in. diameter.
 - 4. Pipe Greater than 18 in. Diameter: 1 1/2 in. maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe. 3/4 in maximum particle size for PVC, FRP, or HDPE Pipe.
 - 5. Perforated Pipe: Granular drain material.
 - 6. Conduit and Direct-Buried Cable:
 - a. Sand, clean or clean to silty, less than 12% passing the No. 200 sieve.
 - b. Individual Particles: Free of sharp edges.
 - c. Maximum Size Particle: Pass a No. 4 sieve.
 - d. If more than 5% passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined as specified in ASTM D4318.

2.4 SELECT FILL

- A. As specified in Section 31 23 23.13 – Fill and Backfill.

2.5 CONTROLLED LOW STRENGTH FILL

- A. Select and proportion ingredients to obtain compressive strength between 50 psi – 150 psi at 28 days as specified in ASTM D4832.
- B. Materials:
 - 1. Cement: ASTM C150, Type I or II.
 - 2. Aggregate: ASTM C33, Size 7.
 - 3. Fly Ash (if used): ASTM C618, Class C.
 - 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.6 CONCRETE BACKFILL

- A. Provide as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.7 TOPSOIL

- A. Topsoil removed and stockpiled from onsite excavation.

2.8 SOURCE QUALITY REQUIREMENTS

- A. Perform gradation analysis as specified in ASTM C136 for:
 - 1. Select backfill, including specified class(es).
 - 2. Trench stabilization material.
 - 3. Bedding and pipe zone material.
- B. Certify Laboratory Performance of Mix Designs:
 - 1. Controlled low strength fill.
 - 2. Concrete.

PART 3 - EXECUTION

3.1 TRENCH PREPARATION

- A. Water Control:
 - 1. As specified in Section 31 23 19 – Dewatering.
 - 2. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. DO NOT place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
 - 3. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 4. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

- A. Firm Subgrade:
 - 1. Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if specified.
- B. Soft Subgrade:
 - 1. If it is encountered that it may require removal to prevent pipe settlement, notify Engineer. Engineer shall determine the depth of over-excavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place material over full width of trench in 6 in. lifts to required grade, providing allowance for bedding thickness.
- C. Compact each lift to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

- A. Furnish imported bedding material where, in the opinion of the Engineer, excavated material unsuitable for bedding or insufficient in quantity.

- B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 in.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness:
 - 1. Pipe, 15 in. and Smaller:
 - a. 4 in.
 - 2. Pipe, 18 in. – 36 in:
 - a. 6 in.
 - 3. Pipe, 42 in. and Larger:
 - a. 12 in.
 - 4. Conduit:
 - a. 3 in.
 - 5. Direct-Buried Cable:
 - a. 3 in.
 - 6. Duct Banks:
 - a. 3 in.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 in. – 2 in. of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- G. Bell or Coupling Holes:
 - 1. Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

- A. Upper limit of pipe zone shall NOT be less than:
 - 1. Pipe: 12 in. above top of pipe, unless specified otherwise.
 - 2. Conduit: 3 in. above top of conduit, unless specified otherwise.
 - 3. Direct-Buried Cable: 3 in. above top of cable, unless specified otherwise.
 - 4. Duct Bank: 3 in. above top of duct bank, unless specified otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
 - 1. Pipes 10 in. and Smaller Diameter: First lift less than or equal to pipe-diameter.
 - 2. Pipes Over 10 in. Diameter: Maximum 6 in. lifts.
- D. 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 filled before placing each succeeding lift.
- E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.
- F. DO NOT use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of all buried piping, at depth of 2 ft. Coordinate with Piping Installation Drawings.
 - 1. Metallic Marking Tape: Install with nonmetallic piping.
 - 2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

- A. General:
 - 1. Process excavated material to meet specified gradation requirements.
 - 2. Adjust moisture content as necessary to obtain specified compaction.
 - 3. DO NOT allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 ft of backfill has been provided over the top of pipe.
 - 4. DO NOT use power driven impact type compactors for compaction until at least 4 ft of backfill is placed over top of pipe.
 - 5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
 - 6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise specified.
- B. Select Excavated Backfill:
 - 1. Place in lifts NOT exceeding 9 in. thickness.
 - 2. Mechanically compact each lift to a minimum of 95% relative compaction prior to placing succeeding lifts.
- C. Excavated Backfill:
 - 1. Backfill trench above the pipe zone with granular backfill in lifts NOT exceeding 8 in. Compact each lift to a minimum of 95% relative compaction prior to placing succeeding lifts.
- D. Concrete Backfill:
 - 1. Place above bedding.
 - 2. Minimum Concrete Thickness: 6 in. on top and sides of pipe.
 - 3. DO NOT allow dirt or foreign material to become mixed with concrete during placement.
 - 4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
 - 5. Prevent flotation of pipe.
 - 6. Begin and end concrete backfill within 4 in. of a pipe joint on each end.
 - 7. DO NOT encase pipe joints except within the limits of the concrete backfill.
- E. Controlled Low Strength Fill:
 - 1. Discharge from truck mounted drum type mixer into trench.
 - 2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.8 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 in. of backfilled trench.
- B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock:
 - 1. Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Topsoil:
 - 1. Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.
- D. Asphaltic Pavement:
 - 1. Replace settled areas or fill with asphalt as specified in Section 32 12 16 – Asphalt Concrete Pavement.
- E. Other Areas:
 - 1. Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill, shall be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 23 23.19 – TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Materials and work required for placing bedding and backfilling of water and sewer pipelines and appurtenances.
- B. Related Sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines
 - 2. Section 32 12 16 – Asphalt Concrete Pavement
 - 3. Section 33 31 13 – Testing Sanitary Sewer Systems
 - 4. Section 33 34 13 – Ductile Iron Force Main Pipe and Fittings
 - 5. Section 33 34 16 – Solid Wall PVC Force Main Pipe and Fittings
 - 6. Section 33 39 13 – Concrete Manholes
 - 7. Section 33 41 16 – Ductile Iron Gravity Sewer Pipe and Fittings
 - 8. Section 33 41 19 – Pipe Laying
 - 9. Section 33 41 20 – Solid Wall PVC Gravity Sewer Pipe and Fittings

1.2 DEFINITIONS

- A. Base Rock:
 - 1. Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material:
 - 1. Granular material which is used as fill material in the pipe zone of the trench.
- C. Backfill Material:
 - 1. Material used to fill pipe trench from the upper surface of the pipe zone to existing grade or bottom of proposed pavement section.
- D. Imported Material:
 - 1. Material obtained by the Contractor from source(s) offsite.
- E. Lift:
 - 1. Loose (uncompacted) layer of material.
- F. Pipe Zone:
 - 1. Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe or bedding material.
- G. Prepared Trench Bottom:
 - 1. Graded trench bottom after stabilization and installation of bedding material.
- H. Relative Compaction:
 - 1. The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as specified in ASTM D698, Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- I. Relative Density:
 - 1. As defined by ASTM D4253 and ASTM D4254.

- J. Selected Backfill Material:
 - 1. Material available that the Engineer determines to be suitable for a specific use.
- K. Well-Graded:
 - 1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Quality Control Submittals:
 - 1. Catalog and manufacturer's data sheets for compaction equipment.
 - 2. Certified test results from independent testing agency.
 - 3. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

1.4 QUALITY ASSURANCE

- A. Notify Engineer when:
 - 1. Soft or loose subgrade materials are encountered wherever pipe bedding is to be placed.
 - 2. Fill material appears to be deviating from Specifications.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Backfill materials shall be obtained from excavated materials or approved borrow sources.
- B. Backfill material shall be free of trash, debris, cinders, organic matter, or other deleterious materials.
- C. All backfill materials shall be subject to the Engineer's approval.

2.2 TRENCH STABILIZATION MATERIAL

- A. Clean, hard, durable 3 in. minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.
- B. Uniformly graded from coarse to fine, less than 8% by weight passing the 1/4 in. sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Pipe bedding shall be as specified in ASTM D2321, Class IA, manufactured aggregates, open-graded, clean, non-plastic.

1. The gradation shall be:

ASTM D2321, Class IA	
Sieve Size	Percent Passing
1 1/2 in.	100%
No. 4	≤10%
No. 200	<5%

- C. Alternative bedding materials may be considered at the discretion of the Engineer. Alternate bedding materials shall be crushed rock classified as GP as specified in ASTM D2487 with 15% sand or less, a maximum of 25% passing 3/8 in. sieve, and a maximum of 5% fines.

2.4 TRENCH BACKFILL – GENERAL

- A. Excavated material from required excavations, free from rocks larger than 3 in, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.5 TRENCH BACKFILL – GRANULAR

- A. Granular backfill shall be placed under all existing or proposed driving surfaces and/or as specified on the Plans.
- B. Granular backfill shall be Type 1 aggregate meeting all the requirements of Section 703.01 of the Colorado Department of Transportation Standard Specifications.

2.6 TOPSOIL

- A. Topsoil removed and stockpiled from onsite excavation.
- B. Should the Contractor dispose of existing topsoil the Contractor shall acquire and place topsoil to a minimum 6 in. depth at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 GENERAL

- A. All bedding material shall be placed as specified in:
1. Section 31 23 16.16 – Trenching for Water and Sewer Lines.
 2. Section 33 41 19 – Pipe Laying.
- B. Process excavated material to meet specified gradation requirements.
- C. Adjust moisture content as necessary to obtain specified compaction.
- D. DO NOT allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 ft of backfill has been provided over the top of pipe.
- E. DO NOT use power driven impact type compactors for compaction until at least 4 ft of backfill is placed over top of pipe.
- F. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
- G. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise specified.

3.2 TRENCH BACKFILL – GENERAL

- A. Trench backfill shall be placed in a lift not exceeding 9 in. thickness.
- B. Each lift shall be mechanically compacted to a minimum of 95% relative compaction prior to placing succeeding lifts.

3.3 TRENCH BACKFILL – GRANULAR

- A. Granular backfill shall be used under all existing or proposed driving surfaces and at locations specified on the Plans.
- B. Granular backfill shall be placed in lifts not exceeding 8 in. thickness.
- C. Each lift shall be mechanically compacted to 95% relative compaction prior to placing succeeding lifts.

3.4 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 in. of backfilled trench.
- B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.5 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock:
 - 1. Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Topsoil:
 - 1. Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.
- D. Asphaltic Pavement:
 - 1. Replace settled areas or fill with asphalt as specified in Section 32 12 16 – Asphalt Concrete Pavement.
- E. Other Areas:
 - 1. Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.6 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 23 23.33 – FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Controlled low strength concrete flowable fill.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 DEFINITIONS

- A. Flowable Fill:
 - 1. Controlled low strength concrete ready mix.

1.3 SUBMITTALS

- A. As specified in Section 01300 - Submittals.

1.4 QUALITY ASSURANCE

- A. As specified in Section 03 30 00 – Cast-In-Place Concrete.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. As specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. Concrete Mixture for Flowable Fill only:
 - 1. Compressive strength 75 psi – 100 psi.
 - 2. Cement 80 lbs. – 100 lbs. per CY.
 - 3. Fly Ash 200 lbs. – 300 lbs. per CY.
 - 4. Sand variable to equal 1 CY.
 - 5. Water 65 gal – 199 gal per CY.
 - 6. Unit weight approximately 110 lbs/CY.

PART 3 - EXECUTION

3.1 EXECUTION

- A. As specified in Section 03 30 00 – Cast-In-Place Concrete.

END OF SECTION

SECTION 31 32 00 – SOIL EROSION STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials required to minimize erosion and comply with Storm Water Pollution Prevention Plan.

1.2 REFERENCES

- A. ASTM
 - 1. D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
 - 2. D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
 - 3. D5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
 - 4. D3786 – Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
 - 5. D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus
 - 6. D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Shop Drawings/Product Data:
 - 1. Erosion control rock.
 - 2. Fertilizer.
 - 3. Seed.
 - 4. Mulch.
 - 5. Erosion control rock.
 - 6. Soil tackifier.
 - 7. Reinforced plastic covering.
 - 8. Silt fence.
 - 9. Straw bales.
 - 10. Posts for straw bales.
 - 11. Dust controller.
 - 12. Wire mesh.

1.4 STABILIZATION

- A. Soil Erosion Stabilization:
 - 1. Ground surfaces exposed during the wet weather conditions:
 - 2. Areas which shall NOT be subjected to heavy wear by ongoing construction traffic.
 - 3. Temporary and long-term stabilization of new or disturbed ditches, swales, detention ponds, or disturbed ground with intermittence construction traffic.
- B. Permanent Stabilization:
 - 1. Permanently stabilize exposed soil surfaces at finished grades.
 - 2. Permanent stabilization methods include, but are NOT limited to, seeding (permanent), mulching, and landscaping.
 - 3. Immediately perform permanent stabilization at each completed excavation and areas except for areas that are scheduled to be re-disturbed.

4. Incorporate all permanent erosion control features into the project at the earliest practical time.
- C. Buffer Zone:
1. Undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff.
- D. Standard Specification:
1. The latest edition, including supplements of the Colorado Department of Transportation (CDOT) Standard Specifications for Highway Construction, El Paso County, and City of Fountain.
- 1.5 DELIVERY, STORAGE, AND PROTECTION
- A. General:
1. Prevent or reduce the discharge of pollutants to stormwater from all material delivery and storage by minimizing the storage of hazardous materials storing materials in a designated area, installing Secondary containment, conducting regular inspection, and training employees and Subcontractors.
- B. Seed:
1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
 2. Keep dry during storage.
- C. Hydroseeding Mulch:
1. Mark package of wood fiber mulch to show air dry weight.
- 1.6 SEQUENCING AND SCHEDULING
- A. Install erosion and sediment control devices before starting earth disturbance activities and as drainage facilities get constructed.
- B. Complete Soil Preparation:
1. Seeding, fertilizing, mulching, and matting on disturbed areas that shall require stabilization either because the area has reached final grade (permanent landscaping) or because the area shall remain unworked for over 14 days (temporary seeding) during the wet season.
- C. Notify Engineer at least 3 days in advance of:
1. Materials delivery.
 2. Start of stabilization activity.
- D. Seeding:
1. Perform between March 15 and September 15.
- 1.7 MAINTENANCE
- A. Operations:
1. Seeded Areas: Perform during maintenance period to include:
 - a. Watering: Keep seeded surface moist.
 - b. Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
 - c. Mulch: Replace wherever and whenever washed or blown away.

- d. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has NOT been produced.
 - e. Reseed during next planting season if scheduled end of maintenance period falls after September 15.
 - f. Reseed entire area if satisfactory stand does NOT develop by July 1 of the following year.
 - g. Mowing: Mow to 2 in. after grass height reaches 3 in, and mow to maintain grass height from exceeding 3 1/2 in.
 - 2. Inspect, repair, and replace as necessary all erosion control measures during the time period from start of construction to completion of construction.
 - 3. Inspect a minimum of at least once every 7 days or after a 1/2 in. storm event in a 24-hr period.
 - 4. Furnish and install a rain gauge at the project site to monitor rainfall. At no time shall more than 1 ft depth of sediment be allowed to accumulate in any erosion control device.
- B. Sediment Removal:
- 1. Remove sediment from erosion control devices and work into the grading plan at least once a week as required to maintain proper operation of devices. The cleaning operation shall NOT dispose of sediment offsite.
 - 2. Sediment shall be removed, and the controls upgraded or repaired as soon as practicable, but NOT later than 2 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair operations.
 - 3. In the event of continuous rainfall over a 24-hr. period, or other circumstances that preclude equipment operation in the area, hand carry and install additional sediment controls as approved by the Engineer.

1.8 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 FERTILIZER

- A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.
- B. Fertilizer shall have the following minimum percentage of plant food by weight:
 - 1. Summer Hydroseed Mix:
 - a. Nitrogen:
 - 1) 20%.
 - b. Phosphoric Acid:
 - 1) 10%.
 - c. Potash:
 - 1) 10%.
 - 2. Winter Hydroseed Mix:
 - a. Nitrogen:
 - 1) 16%.
 - b. Phosphoric Acid:
 - 1) 8%.
 - c. Potash:
 - 1) 0%.

2.2 SEED

- A. In accordance with the El Paso County Engineering Criteria Manual and Land Development Code.

2.3 MULCH

- A. Wood Cellulose Fiber Mulch:
 - 1. Specially processed wood fiber containing no growth or germination inhibiting factors.
 - 2. Dyed a suitable color to facilitate inspection of material placement.
 - 3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers shall become uniformly suspended to form a homogenous slurry.
 - 4. When hydraulically sprayed on ground, material shall allow absorption and percolation of moisture.
- B. Straw:
 - 1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
 - 2. Average Stalk Length: 6 in.
 - 3. Seasoned before baling or loading.

2.4 EROSION CONTROL MATTING

- A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
- B. Manufacturers and Products:
 - 1. American Excelsior Company,
Arlington, TX;
Curlex Mat.
 - 2. North American Green,
Evansville, IN;
S150 blanket.
 - 3. Other Approved Equal.

2.5 REINFORCED PLASTIC COVERING

- A. Coextruded, copolymer laminate reinforced with a nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.
- B. Black in color and ultraviolet stabilized.
- C. Physical Requirement (Minimum Average Roll Values):
 - 1. Tear Strength: 130 pounds.
 - 2. Elongation: 620%.
 - 3. Minimum Thickness: 6 mil.
- D. Manufacturers:
 - 1. Reef Industries, Inc./Griffolyn Co,
Houston, TX.
 - 2. Other Approved Equal.

2.6 SILT FENCE

- A. Support Posts:

1. As recommended by manufacturer of geotextile.
- B. Fasteners:
 1. Heavy-duty wire staples at least 1 in. long, tie wires, or hog rings, as recommended by manufacturer of geotextile.
- C. Filter Fabric:
 1. Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
 2. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
 3. Material Edges: Finish so that, filaments retain their relative positions under stress.
- D. Filter Fabric Table:

Table No. 1 – Filter Fabric		
Physical Property	Required Value	Test Method
Weight, oz/yd ² , min.	4	ASTM D3776
Equivalent Opening Size, max	50 – 70	U.S. Standard Sieve
Grab Tensile Strength, lb, min. ARV	160	ASTM D4632
Elongation, % max.	25	ASTM D5035
Mullen Burst Strength, psi, min. ARV	200	ASTM D3786
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355
Flow Rate, gpm/sf, min. ARV	30 – 50	ASTM D4491

- E. Manufacturers:
 1. Dupont Co.
Wilmington, DE.
 2. Tencate Mirafi, Inc.
Pendergrass, GA.

2.7 STRAW BALES

- A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

2.8 POSTS FOR STRAW BALES

- A. 2 in. by 2 in. untreated wood or commercially manufactured metal.

2.9 DUST CONTROLLER

- A. Nontoxic materials that DO NOT have an adverse effect on soil structure or establishment and growth of vegetation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Erosion control measures are required during all construction and site disturbance activity and shall remain until permanent site ground covers are in place.
- B. The implementation of the erosion control plan and the construction maintenance, replacement and upgrading the erosion control devices are the responsibility of the Contractor until all construction is completed and landscaping established and approved. During the construction

period, the erosion control devices shall be upgraded for unexpected storm events and to ensure that sediment and sediment laden water DO NOT leave the site.

- C. Maintain existing buffer zones adjacent to project limits. Keep all construction equipment, debris and soils out of the natural buffer zone.

3.2 GRAVEL CONSTRUCTION ENTRANCES

- A. Provide a graveled construction access at each access point between the site and any public or private road or other paved surface.
- B. Place subgrade geotextile, as specified, on the ground prior to erosion control rock placement.
- C. Place erosion control rock over the geotextile to a minimum thickness of 8 in.
- D. Minimum dimensions for construction entrances are 50 ft in length by 16 ft width.
- E. Contractor shall provide a minimum of 4 in. of erosion control rock for each entrance three times during the project at times directed by the Engineer to maintain proper function. More frequent applications of rock may be required, and if so, shall be considered as incidental work.

3.3 SOIL PREPARATION

- A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 in.

3.4 FERTILIZER

- A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 1 in. of soil.
- B. Application Rate:
 - 1. 5 lbs. per 1,000 ft² over areas to be seeded. Use of approved hydraulic equipment to sow seed and distribute fertilizer at the same time shall be acceptable.

3.5 SEEDING

- A. Prepare 1 in. depth seed bed; obtain Engineer's acceptance prior to proceeding.
- B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.
- C. Summer Application:
 - 1. Prepare and apply slurry:

Item	Rate
Seed Mix	200 pounds per acre
Fertilizer	750 pounds per acre
Wood Cellulose Fiber Mulch	As recommended by manufacturer
Water	As necessary

- 2. Irrigation: 1 in. per week to seeded areas.

3.6 MULCHING

- A. Apply uniformly on disturbed areas that shall remain undisturbed for 7 days or more, as requested by Engineer, and on all seeded areas.
- B. Application:
 - 1. Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.
 - 2. Straw: Apply by hand or mechanical means to minimum depth of 2 in.
 - 3. Wood Cellulose Fiber: 1,000 lbs. – 1,500 lbs. per acre.

3.7 EROSION CONTROL MATTING

- A. Place on seeded slopes 4H:1V and steeper.
- B. Apply seed and fertilizer prior to matting.
- C. At top of slope, entrench material in a 6 in. by 6 in. trench and staple at 1 ft intervals. At the bottom of the slope, extend the mat 2 ft beyond the toe of slope, turn material under 4 in. and staple at 1 ft intervals.
- D. Mats shall be stapled in place as they are installed down the slope face. The mat shall have direct contact with the soil surface.
- E. Overlap:
 - 1. Lengthwise: 1 ft minimum.
 - 2. Crosswise: 6 in. minimum.

3.8 REINFORCED PLASTIC COVERING

- A. Place on areas where hydroseeding and erosion control matting have NOT controlled erosion and over all temporary stockpiles.
- B. Install in single thickness, strips parallel to direction of drainage. Anchor plastic in 6 in. by 6 in. trench backfilled with compacted native materials.
- C. Maintain tightly in place by using sandbags on ropes with a maximum 10 ft grid spacing in all directions.
- D. Tape or weight down full length, overlap seams at least 12 in.
- E. Remove at final acceptance unless notified otherwise by Engineer.

3.9 SILT FENCE

- A. Install prior to starting earth disturbing activities upslope of fence.
- B. One-piece filter fabric or continuously sewn to make one-piece filter fabric for full height of the fence, including portion buried in the toe trench.
- C. When joints are necessary, splice filter fabric together only at a support post, with a minimum 6 in. overlap, and securely fasten both ends to support post.

- D. Filter fabric shall NOT extend more than 24 in. above the ground surface. Securely fasten to upslope side of each support post using ties. Filter fabric shall NOT be stapled to existing trees.
- E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 in, and NOT more than 36 in. above the ground surface.
- F. Take precaution NOT to puncture filter fabric during installation. Repair or replace damaged area.
- G. Remove silt fence after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the silt fence has been removed to conform to existing grade. Prepare and seed graded area.

3.10 TEMPORARY SOIL STOCKPILES

- A. Cover with reinforced plastic covering, as directed in Paragraph 2.5 REINFORCED PLASTIC COVERING.
- B. Protect perimeter of stockpile from erosion with ditches.

3.11 STRAW BALES

- A. Embed minimum of 4 in. in flat-bottomed trench. Place across swales or ditches to reduce velocities of concentrated flows. Space bales a minimum of 100 ft spacing.
- B. Place with ends tightly abutting or overlapped. Corner abutment is NOT acceptable.
- C. Install so that bale bindings are oriented around the sides and NOT over the top and bottom of the bale.
- D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.
- E. Wedge loose straws in any gaps between bales.

3.12 DUST CONTROL

- A. Apply appropriate dust control measures on a continuous basis until permanent stabilization measures are in place.
- B. Apply on construction routes and other disturbed areas subject to surface dust movement and where offsite damage may occur if dust is NOT controlled.
- C. Avoid creating erosion when using water as a dust controller.

3.13 CLEANUP

- A. Sediment trapped in erosion control devices shall be regraded into the slopes onsite. DO NOT flush sediment-laden water into the drainage system.
- B. After site restoration is complete and when approved by the Engineer, all temporary erosion control measures shall be completely removed. Immediately shape and permanently stabilize areas affected by the removal process.

- C. Silt fence, straw bales, reinforced plastic covering, and any other erosion control devices shall be disposed of offsite to locations that are approved by federal, state, and local authorities.

END OF SECTION

SECTION 31 37 00 – RIPRAP

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The procurement and installation of riprap.
- B. Related Sections:
 - 1. Section 31 23 16 – Excavation.
 - 2. Section 31 23 23.16 – Trench and Backfill.
 - 3. Section 31 05 19.13 – Geotextile Filter Fabric.

1.2 REFERENCES:

- A. ASTM International:
 - 1. C97 – Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
 - 2. D4992 – Standard Practice for Evaluation of Rock to Be Used for Erosion Control.
 - 3. D5240 – Standard Test Method for Evaluation of Durability of Rock for Erosion Control Using Sodium Sulfate or Magnesium Sulfate.
 - 4. D5312 – Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions.
 - 5. D5313 – Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions.
 - 6. D5779 – Standard Test Method for Field Determination of Apparent Specific Gravity of Rock and Manmade Materials for Erosion Control.

1.3 SUBMITTALS

- A. Provide as specified in Section 01300 - Submittals.
- B. Certificates:
 - 1. Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The riprap shall be hard, sound, and durable. It shall be reasonably free of fines and shall be well graded between the maximum and minimum rock sizes to produce a minimum of voids. No riprap shall be placed on the project until it has been accepted by Engineer.
- B. The minimum density of stone shall be 130 lbs/ft³ and the maximum absorption shall be 6%.
- C. The maximum size shall NOT be greater than 12 in. in any dimension and approximately 50% of the material shall consist of pieces weighing 20 lbs. or more. The stones shall be predominantly angular in shape with NOT more than 25% having a length more than 2.5 times its breadth or thickness and none having a length exceeding 3.0 times its breadth or thickness.
- D. Geotextile fabric shall be as specified or equal.
- E. Contractor shall obtain and submit certification that the proposed rock meets density and absorption requirements specified in this section. Testing for certification shall be as specified in

ASTM C97. Certified test results shall be submitted to Engineer prior to the use of the proposed material as riprap.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The riprap layer shall be a minimum of 24 in. thick when placed over the geotextile fabric.
- B. When placed on the embankment, the smaller stones shall be well distributed throughout the mass. Hand placing may be required to obtain the results specified above.
- C. The areas to be protected with riprap shall be dressed to the lines and grades shown on the Drawings and covered with the geotextile fabric prior to placing the riprap.
- D. Riprap graded so that the smaller stones are uniformly distributed throughout the mass shall then be placed, starting at the toe of the slope, with a maximum vertical drop onto the geotextile fabric of 2 ft. In no case shall stones be allowed to roll down the fabric covered slope. Placement of the riprap over the fabric shall proceed so that the upper boundary of the riprap layer is at essentially the same level for the entire length of the fabric.
- E. Care shall be taken so that the geotextile fabric is NOT damaged during riprap installation. Any rips or tears shall be repaired by Contractor, as specified in Section 31 05 19.13 – Geotextile Filter Fabric, before proceeding with further riprap installation.

END OF SECTION

SECTION 31 50 00 – EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work required to install and remove excavation support systems.
- B. Related Sections:
 - 1. Section 31 23 23.13 – Fill and Backfill.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Shop Drawings:
 - 1. Excavation support plan.
 - 2. Movement monitoring plan.
- C. Quality requirements Submittals:
 - 1. Movement measurement data and reduced results specifying movement trends.

1.3 QUALITY ASSURANCE

- A. Provide surveys to monitor movements of critical facilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Design, provide, and maintain shoring, sheeting, and bracing as necessary and where shown to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.
- B. Minimum areas for shoring, sheeting, and bracing are shown on the Drawings. It shall be the Contractor's responsibility to determine if areas shall require excavation slope retention to protect existing structures and facilities from damage resulting from the Contractor's excavation or excavation methods.
- C. The Contractor shall also be responsible for providing shoring, sheeting, and bracing of excavations as needed for worker safety and as may be required by federal, state, and local regulations.

3.2 EXCAVATION SUPPORT PLAN

- A. Prepare Excavation Support Plan Addressing Following Topics:
 - 1. Details of shoring, bracing, sloping, or other provisions for worker protection of existing structures or facilities.
 - 2. Design assumptions and calculations.
 - 3. Methods and sequencing of installing excavation support.
 - 4. Proposed locations of stockpiled excavated material.

5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.

3.3 MOVEMENT MONITORING PLAN

- A. Prepare Movement Monitoring Plan Addressing Following Topics:
 1. Survey control.
 2. Locations of monitoring points (at least one every 50 ft).
 3. Plots of data trends.
 4. Interval between surveys (not to exceed 5 working days).
- B. Movement monitoring shall be done on every existing structure that is adjacent to the Contractor's excavations.
- C. Results of movement monitoring shall be delivered for the Engineer at least once a week.

3.4 REMOVAL OF EXCAVATION SUPPORT

- A. DO NOT begin to remove excavation support until it can be removed without damage to existing facilities, completed Work, or adjacent property.
- B. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities. Maintain soil wall support as excavation is backfilled.
- C. Fill voids immediately with approved backfill compacted to density specified in Section 31 23 23.13 – Fill and Backfill.

END OF SECTION

SECTION 31 70 19 – BORED EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Boring under streams, highways, roads, and railroads.
 - 2. Casing pipe.
- B. Related Sections:
 - 1. Section 31 22 13 – Subgrade Preparation
 - 2. Section 31 23 23.16 – Trench Backfill

1.2 SUPERVISION AND QUALITY

- A. Contractor's work shall comply with all codes governing and all insurance requirements. Work shall be undertaken only when the construction superintendent is present and supervising the work.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. Crossings shall be completed as specified in applicable federal, state, and local regulations.
- B. In the case of railroad crossings, the project shall be as specified in regulations established by the railroad company.

1.4 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 CASING PIPE

- A. Smooth wall casing pipe shall be of welded steel construction and shall be new material with a minimum yield point of 35,000 psi. The pipe shall have a wall thickness as noted on the plans. The casing pipe shall be cleaned and coated both inside and outside with two coats of coal tar paint, Koppers "Bitumastic Super Service Black," Tnemec "450 Heavy Tnemecol," or USS Chemicals "Pitt Chem 103."
 - 1. Carrier Pipe 16 in.
 - 2. Casing 30 in.
- B. Casing wall thickness shall be 1/4 in. thick for casing pipe 10 in. – 16 in, 3/8 in. thick for casing pipe 18 in. – 24 in, 1/2 in. thick for 30 in. Casing wall thickness for any railroad bores shall be specified by the railroad.

2.2 CARRIER PIPE

- A. Carrier pipe shall be as shown on plans.

2.3 CASING SPACERS

- A. Spacers shall be made of injection molded high density polyethylene. The spacers shall be of a projection type that has a minimum number of projections around the circumference totaling the

number of diameter inches. Spacers shall be spaced a maximum of 10 ft apart. Spacers shall be fastened tightly to the barrel of the carrier pipe to prevent slippage. Spacers shall provide sufficient height to permit clearance between the pipe bell and the casing. Spacers shall be ISO 9002 certified for strength and quality.

2.4 CASING FILL MATERIAL

- A. Sand fill shall be clean pea gravel with uniform gradation of 1/8 in. – 3/8 in. for blowing into casing pipe.

PART 3 - EXECUTION

3.1 GENERAL

- A. Crossings under highways, roads and railroads shall be continuously encased under the through roadways, median, ramps and shoulder area to the limits called for or required by the federal, state, and local regulations. Railroad crossings shall conform to the requirements of the regulations established by the railroad company.
- B. Work shall be performed in a safe and proper manner, with suitable precautions being taken against hazards of every kind. All crossings shall be bored, unless rock formations or other obstructions are encountered that prevents boring or pushing operations. If such conditions are encountered, excavation shall be performed by standard tunneling methods.
- C. Excavations shall provide adequate clearance for installation of and removal of equipment.
- D. Backfilling and construction of fills and embankments during freezing weather shall NOT be done except by permission of the Engineer. No backfill, fill or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill or embankments.
- E. When operating on pavements or walks all equipment shall be rubber tired, except for excavation equipment. Excavating equipment, in such cases, shall NOT have grousers, cleats or lugs on the tracks. The Contractor shall take all reasonable precautions to protect the existing pavements and walks.
- F. No classification of excavated materials shall be made. Boring excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.
- G. Pipelines and other existing underground installations and structures in the vicinity of the work to be done hereunder are specified in the Plans according to the best information available to the Owner. The Owner does NOT guarantee the accuracy of such information. The Contractor shall make every effort to locate all underground pipelines, conduits, and structures by contacting Owners of underground utilities and by prospecting in advance of excavation and boring. Damage to any existing underground installation caused by the Contractor's operation shall be repaired at the Contractor's expense.
- H. Any delays or extra cost to the Contractor caused by pipelines or other underground structures or obstructions NOT shown by the plans, or found in locations different than those specified, shall NOT constitute a claim for extra work, additional payment, or damages.
- I. Erosion control of disturbed areas shall be required during the construction period using check dams, siltation pools, mulching, etc.

- J. The Contractor shall meet the specific requirements of the Highway Department or Railroad. The Contractor shall obtain all necessary permits and insurance.
- K. Operation:
 - 1. Use all means necessary to control dust or mud that may interfere with operation.
- L. Protection:
 - 1. Use all means necessary to protect material and preserve specification requirements.
 - 2. Replace all damaged material or material that has lost specification requirements.

3.2 EXCAVATION

- A. The Contractor shall, during the entire period of construction, provide and maintain any necessary equipment as will, whenever practicable, keep his excavations reasonably free from water pending construction. When necessary to use pumps the Contractor shall dispose of the water without detriment to adjacent properties.

3.3 SHEETING AND SHORING

- A. General:
 - 1. Except where banks may be cut back on a stable slope, excavation for trenches shall be properly and substantially sheeted, braced, and shored, as necessary, to prevent caving or sliding, to provide protection for the workmen and the work, and to provide protection for existing structures and facilities. Sheet piling, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining its shape and position under all circumstances.

3.4 CASING AND CARRIER PIPE INSTALLATION

- A. Casing pipe:
 - 1. Before starting work on borings, complete details of the method of operation and casing to be used shall be submitted to the Engineer for review. All permits shall be obtained by the Contractor.
 - 2. Casing pipes shall have a clear inside diameter NOT smaller than the size specified in schedule.
 - 3. The casing pipe shall be installed by jacking into place. Earth displaced by the casing pipe shall be removed through the interior of the casing by hand, by auger, or by other acceptable means. Sections of the casing pipe shall be welded together to form a continuous casing capable of resisting all stresses, including jacking stresses. The casing pipe in its final position shall be straight and true in alignment and grade. There shall be no space between the earth and the outside of the casing.
- B. Carrier pipe:
 - 1. Polyethylene casing insulators shall be strapped to each end of each piece of pipe. The pipe shall then be pushed into the casing pipe with care being taken to ensure the joints are NOT displaced. The joints in the installed pipe within the casing shall be tested for leakage before the backfill is installed.
- C. Casing Backfill:
 - 1. Following the installation of the carrier pipe in the casing pipe, the entire annular space between the pipe and the casing walls shall be filled. The ends of the casing shall then be closed with a concrete or masonry plug 8 in. thick.
- D. Casing Backfill:

1. Following the installation of the carrier pipe in the casing pipe, the ends of the casing pipe shall then be closed with wrap around or pull-on end seals.

3.5 FINAL GRADING AND DISPOSAL OF EXCESS EXCAVATED MATERIALS

- A. General:
 1. Except as otherwise specified, all excess excavated materials shall be disposed of by the Contractor away from the site of the work.
 2. Excavated rock, junk and debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site of the work.
 3. The disposal of waste and excess excavated materials, including hauling, handling, leveling, and surfacing, shall be at the Contractor's expense.
- B. Restoration of disturbed earth:
 1. The Contractor shall restore all earth areas disturbed from the original condition by his operations. Restoration shall be by seeding, fertilizing, and mulching to obtain an established cover or by appropriate pavement and street repair.

3.6 RESPONSIBILITY OF CONTRACTOR FOR BACKFILL SETTLEMENT

- A. The Contractor shall be responsible financially and otherwise, for:
 1. All settlement of trench and other backfill which may occur from time of original backfilling until the expiration of 1 year after the date of final payment for the entire contract under which the backfilling work was performed.
 2. The refilling and repair of all backfill settlement and the repair or replacement to the original or a better condition of all pavements, top surfacings, driveways, walks, surface structures, utilities, drainage facilities and sod which may have been damaged because of backfill settlement or which have been removed or destroyed in connection with backfill replacement operations.
 3. All damage claims or court actions against the Owner for any damage directly or indirectly caused by backfill settlement.
- B. The Contractor shall make all necessary backfill replacements and repairs, or replacements appurtenant thereto, within 30 days after notification by the Owner or Engineer. Upon the Contractor's failure to do so, the Owner may do, or have done, the necessary work and charge the cost to the Contractor.

3.7 MAINTENANCE OF TRAFFIC

- A. Contractor shall work with minimal interference with public travel, vehicular or pedestrian.
- B. If interference is necessary, Contractor shall, at own expense, provide and maintain suitable detours for accommodation of travel, and shall give reasonable notice to Owners of private drives beforehand.
- C. Maintenance of traffic NOT required where Contractor obtains permission from Owner and tenant of private property, or from authority in charge of residing public property, and shall NOT obstruct traffic beyond designated spot and time agreed upon.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 32 10 00 – CONCRETE SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials required to install concrete sidewalk.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

- A. ASTM International:
 - 1. C94 – Standard Specification for Ready Mixed Concrete
 - 2. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 3. D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
- B. AASHTO:
 - 1. T 99 – The Moisture-Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12 in. (305 mm) Drop.
- C. ACI:
 - 1. 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- D. Standard Specification:
 - 1. The latest edition, including supplements from the Colorado Department of Transportation.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Shop Drawings:
 - 1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
 - 2. Complete data on concrete mix, including aggregate gradations and admixtures as specified in ASTM C94.
- C. Quality Requirements Submittals:
 - 1. Curing Compound: Manufacturer's Certificate of Compliance and application instructions.
 - 2. Ready-mix delivery ticket for each truck as specified in ASTM C94.

1.4 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 EXPANSION JOINT FILLER

- A. 1/2 in. thick, preformed asphalt-impregnated, expansion joint material meeting ASTM D994.

2.2 CONCRETE

- A. As specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. Maximum Aggregate Size:
 - 1. 1 1/2 in.
- C. Slump:
 - 1. 2 in. – 4 in.

2.3 CURING COMPOUND

- A. Liquid membrane-forming, clear or translucent, suitable for and as specified in ASTM C309, Type 1.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Lumber Materials:
 - 1. 2 in. dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed sidewalk.
 - 2. 1 in. dressed lumber or plywood may be used where short-radius forms are required.
- B. Metals:
 - 1. Steel in new undamaged condition.
- C. Setting Forms:
 - 1. Construct forms to shape, lines, grades, and dimensions.
 - 2. Stake securely in place.
- D. Bracing:
 - 1. Brace forms to prevent change of shape or movement resulting from placement.
 - 2. Construct short-radius curved forms to exact radius.
- E. Tolerances:
 - 1. DO NOT vary tops of forms from gradeline more than 1/8 in. when checked with 10 ft straightedge.
 - 2. DO NOT vary alignment of straight sections more than 1/8 in. in 10 ft.

3.2 PLACING CONCRETE

- A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.
- B. Place concrete as soon as possible, and within 1 1/2 hrs. after adding cement to mix without segregation or loss of ingredients, and without splashing.
- C. Place, process, finish, and cure concrete as specified in ACI 304 and in this section. Wherever requirements differ, the more stringent shall govern.
- D. To compact, vibrate until concrete becomes uniformly plastic.

3.3 SIDEWALK CONSTRUCTION

- A. Thickness:
 - 1. 4 in. in walk areas.
 - 2. 6 in. in driveway areas.
- B. Connection to Existing Sidewalk:
 - 1. Remove old concrete back to an existing contraction joint.
 - 2. Clean the surface.
 - 3. Apply a neat cement paste immediately prior to placing new sidewalk.
- C. Expansion Joints:
 - 1. Place at building corners and changes in sidewalk width around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.
- D. Contraction Joints:
 - 1. Provide transversely to walks at locations opposite contraction joints in curb.
 - 2. Dimensions: 3/16 in. by 1 in. weakened plane joints.
 - 3. Construct straight and at right angles to surface of walk.
- E. Finish:
 - 1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
 - 2. Mark walks transversely at 5 ft intervals with jointing tool; finish edges with rounded steel edging tool.
 - 3. Apply curing compound to exposed surfaces upon completion of finishing.
 - 4. Protect sidewalk from damage and allow to cure for at least 7 days.

3.4 SLAB CONSTRUCTION ON GRADE

- A. Thickness:
 - 1. 4 in. or as specified.
- B. Contraction Joints:
 - 1. As specified in Drawings.
 - 2. Dimensions: 3/16 in. by 1 in. weakened plane joints.
 - 3. Construct straight and at right angles to surface of slab.
- C. Finish:
 - 1. Broom surface with fine-hair broom and tool of edges, joints, and markings.
 - 2. Apply curing compound to exposed surfaces upon completion of finishing.
 - 3. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 32 11 00 – BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials required to install base course.
- B. Related Sections:
 - 1. Section 31 22 13 – Subgrade Preparation.

1.2 REFERENCES

- A. AASHTO (American Association of State Highway and Transportation Officials):
 - 1. T 89 – Standard Method for Determining the Liquid Limit of Soils.
 - 2. T 90 – Determining the Plastic Limit and Plasticity Index of Soils.
 - 3. T 96/ASTM C131 – Standard Test Method for Resistance to Degradation of Small Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 4. T 99 – Standard Methods of Test for the Moisture-Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12 in. (305 mm) Drop.
 - 5. T 180 – Standard Methods of Test for the Moisture-Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in. (457 mm) Drop.
 - 6. T 191 – Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.

1.3 DEFINITIONS

- A. Completed Course:
 - 1. Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift:
 - 1. Compacted with uniform surface reasonably true to cross-section.
- C. Standard Specification:
 - 1. The latest edition, including supplements of the [insert appropriate state].

1.4 SUBMITTALS

- A. Quality requirements Submittals:
 - 1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to project.
 - 2. Certified Results of In-Place Density Tests from independent testing agency.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 BASE COURSE ROCK

- A. The aggregate for the base or sub-base course material shall be composed of crushed stone, crushed slag, crushed gravel, or natural gravel which conforms to the quality requirements of

AASHTO M-147 (latest revision). The material shall conform to the requirements set forth in the City of Fountain's Standard Specifications Manual Section 300.

2.2 SOURCE QUALITY REQUIREMENTS

- A. Contractor:
 - 1. Tests necessary to locate acceptable source of materials as specified in requirements.
- B. Final approval of aggregate material shall be based on materials' test results on 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. As specified in Section 31 22 13 – Subgrade Preparation.
- B. Obtain Engineer's acceptance of subgrade before placement of base course rock.
- C. DO NOT place base materials in snow or on soft, muddy, or frozen subgrade.

3.2 EQUIPMENT

- A. Compaction Equipment:
 - 1. Adequate in design and number to provide compaction and obtain the specified density for each layer.

3.3 HAULING AND SPREADING

- A. Hauling Materials:
 - 1. DO NOT haul over surfacing in process of construction.
 - 2. Loads: Of uniform capacity.
 - 3. Measure capacity of truck to determine vehicle load and quantity.
 - 4. Maintain consistent gradation of material delivered; loads of widely varying gradations shall 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 upon roadway without segregation.
 - 3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.4 CONSTRUCTION OF COURSES

- A. General:
 - 1. Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.
- B. Base Course:
 - 1. Maximum Completed Lift Thickness: 6 in.
 - 2. Completed Course Total Thickness: As specified.

3. Spread lift on preceding course to required cross-section.
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:
 - a. Use base 1/4 minus crushed aggregate material as keystone.
 - b. Spread evenly on top of crushed base course, using spreader boxes or chip spreaders.
 - c. Roll surface until keystone is worked into interstices of crushed base course without excessive displacement.
 - d. Continue operation until course has become thoroughly keyed, compacted, and shall NOT creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

3.5 ROLLING AND COMPACTION

- A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.
- B. Commence compaction of each layer of base after spreading operations and continue until density of 100% of maximum density has been achieved as determined by AASHTO T 99.
- C. Commence rolling at outer edges of surfacing and continue toward center; DO NOT roll center of road first.
- D. Apply water as needed to obtain densities.
- E. Place and compact each lift to required density before succeeding lift is placed.
- F. Bind up preceding course before placing leveling course. Remove floating or loose stone from surface.
- G. Blade or otherwise work surfacing as necessary to always maintain grade and cross-section, and to keep surface smooth and thoroughly compacted.
- H. Surface Defects:
 1. Remedy surface defects by loosening and rerolling entire area, including surrounding surface, until thoroughly compacted.
 2. Finished Surface: True to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

- A. Finished Surface of Base Course:
 1. Within plus or minus 0.04 ft of grade specified at any individual point.
- B. Overall Average:
 1. Within plus or minus 0.01 ft from crown and grade specified.

3.7 FIELD QUALITY REQUIREMENTS

- A. In-Place Density Tests:
 1. Construct base course so areas shall be ready for testing.
 2. Allow reasonable length of time for testing laboratory to perform tests and obtain results during normal working hours.
 3. Prove areas meet specified requirements before identifying density test locations.

4. Perform a minimum of 2 tests on completed course per 200 yds³ of material placed as specified in T 191, or T 238 at locations acceptable to Engineer.

B. Cleaning

1. Remove excess material, clean stockpile areas of aggregate.

END OF SECTION

SECTION 32 31 13 – CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Labor, materials, equipment, and incidentals required to furnish and install the chain link fence and gates.
 - 2. The security fencing around the site and access gates to control entry and exit of the facility.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

- A. ASTM International:
 - 1. A121 – Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
 - 2. A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - 3. A491 – Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
 - 4. A1018 – Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 5. A824 – Standard Specification for Metallic-Coated Steel Marcellised Tension Wire for Use with Chain Link Fence.
 - 6. B6 – Standard Specification for Zinc.
 - 7. C94 – Standard Specification for Ready-Mixed Concrete.
 - 8. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - 9. C387 – Standard Specifications for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar.
 - 10. F552 – Standard Terminology Relating to Chain Link Fencing.
 - 11. F567 – Standard Practice for Installation of Chain-Link Fence.
 - 12. F626 – Standard Specification for Fence Fittings.
 - 13. F668 – Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
 - 14. F900 – Standard Specification for Industrial and Commercial Swing Gates.
 - 15. F1043 – Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework.
 - 16. F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
 - 17. F1183 – Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
 - 18. F1184 – Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
 - 19. IEEE, Inc:
 - a. National Electrical Safety Code.
 - 20. NEMA:
 - a. 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Action Submittal:
 - 1. Shop Drawings:
 - a. Detailed information and specifications for materials, finishes, and dimensions.

- b. Card access system serial communication interface card code message format.
 - 2. Samples:
 - a. Approximately 6 in², or 6 in. long of posts, rails, braces, fabric, wire, ties, and fittings.

- C. Informational Submittals:
 - 1. Quality requirements Submittals:
 - a. Manufacturer's recommended installation instructions.
 - b. Evidence of Supplier and installer qualifications.

1.4 SCHEDULING AND SEQUENCING

- A. Complete necessary site preparation and grading before installing chain link fence and gates.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Match style, finish, and color of each fence component with that of other fence components.

2.2 CHAIN LINK FENCE FABRIC

- A. Galvanized fabric as specified in ASTM, Class 1; galvanized after weaving.
- B. Height:
 - 1. 72 in, unless otherwise shown.
- C. Wire Gauge:
 - 1. No. 9, barewire.
- D. Pattern:
 - 1. 2 in. diamond-mesh.
- E. Diamond Count:
 - 1. Manufacturer's standard and consistent for fabric furnished of same height.
- F. Loops of Knuckled Selvages:
 - 1. Closed or nearly closed with space NOT exceeding diameter of wire.
- G. Wires of Twisted Selvages:
 - 1. Twisted in a closed helix three full turns.
 - 2. Cut at an angle to provide sharp barbs that extend minimum 1/4 in. beyond twist.

2.3 POSTS

- A. General:
 - 1. Strength and Stiffness Requirements:
 - a. ASTM F1043, Light Industrial Fence, except as modified in this section.
 - 2. Steel Pipe: ASTM F1083.
 - 3. Roll-Formed Steel Shapes: from ASTM A1018, Grade 45, Steel.

4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 22 in. plus 3 in. for each 1 ft of fence height greater than 4 ft.
5. Protective Coatings:
 - a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:

1. Steel Pipe:
 - a. Outside Diameter: 2.375 in.
 - b. Weight: 3.65 lbs/ft.

C. End, Corner, Angle, and Pull Posts:

1. Steel Pipe:
 - a. Outside Diameter: 2.875 in.
 - b. Weight: 5.79 lbs/ft.

D. Posts for Swing Gates:

1. ASTM F900.
 - a. Outside Dimensions: 4 in. diameter.
 - b. Weight: 6.56 lbs/ft.

2.4 TOP RAILS AND BRACE RAILS

1. Galvanized steel pipe.
2. Protective Coatings: As specified for posts.
3. Strength and Stiffness Requirements: ASTM F1043, Top Rail, Heavy or Light Industrial Fence.
4. Steel Pipe:
 - a. ASTM F1083.
 - b. Outside Diameter: 1.66 in.
 - c. Weight: 2.27 lbs/ft.

2.5 FENCE FITTINGS

A. General:

1. As specified in ASTM F626, except as modified by this article.

B. Post and Line Caps:

1. Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands:

1. No exceptions to ASTM.

D. Tension Bars:

1. One-piece, no exceptions to ASTM F626.
2. Equal in length to full height of fabric.

E. Truss Rod Assembly:

1. 3/8 in. diameter.

F. Barb Arms:

1. 45 degrees arms for supporting three strands of barbed wire.

2.6 TENSION WIRE

- A. Zinc-coated steel marcelled tension wire as specified in ASTM A824, Type II, Class 2.

2.7 BARBED WIRE

- A. Zinc-Coated Barbed Wire:
 - 1. ASTM A121, Chain Link Fence Grade:
 - 2. Line Wire: Two strands of No. 12 GA – 112 GA.
 - 3. Barbs:
 - a. Number of Points: Four.
 - b. Length: 318 in. minimum.
 - c. Shape: Round.
 - d. Diameter: No. 14 GA.
 - e. Spacing: 5 in.

2.8 GATES

- A. General:
 - 1. Gate Operation: Opened and closed easily by one person.
 - 2. Welded Steel Joints: Paint with zinc-based paint.
 - 3. Chain Link Fabric: Attached securely to gate frame at intervals NOT exceeding 15 in.
- B. Swing Gates:
 - 1. ASTM F900.
 - 2. Hinges:
 - a. Furnished with large bearing surfaces for clamping in position.
 - b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and NOT twist or turn under action of gate.
 - 3. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 ft wide may each have forked latch.
 - 4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
 - 5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both gate leaves of double gates.
 - 6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.

2.9 CONCRETE

- A. Provide as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.10 REPAIR AND SALVAGE OF EXISTING FENCE

- A. Non-Salvageable or Nonreusable Parts:
 - 1. Fence posts.
 - 2. Gate posts.
 - 3. End, corner angle, and pull posts.
 - 4. Tension and brace bands.
 - 5. Tension wire.
- B. Salvageable or Reusable Items:
 - 1. Fence fabric.
 - 2. Post caps.
 - 3. Top rails and brace rails.
 - 4. Truss rod assemblies.
 - 5. Barb arms.
 - 6. Barbwire.

- C. All items specified as salvageable shall NOT be bent, twisted, dented, or damaged in any way. Any such items shall NOT be considered for reuse.
- D. All items NOT considered for salvage or reuse shall be disposed of offsite at the Contractor's expense.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install chain link fences and gates as specified in ASTM F567, except as modified in this section, and as specified in fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.
- B. Provide all necessary hardware for a complete fence and gate installation.

3.2 PREPARATION

- A. Establish locations of fence lines, gates, and terminal posts.

3.3 POST SETTING

- A. Driven posts are NOT acceptable.
- B. Post Hole Depth:
 - 1. Minimum 3 ft below finished grade.
 - 2. 2 in. deeper than post embedment depth below finish grade.
- C. Backfill post holes with concrete to 2 in. above finished grade.
- D. Before concrete sets, crown, and finish top of concrete to readily shed water.

3.4 BRACING

- A. Brace gate and corner posts diagonally to adjacent line posts to ensure stability.

3.5 TOP RAILS

- A. Install top rail sleeves with springs at 105 ft maximum spacing to permit expansion in rail.

3.6 CHAIN LINK FABRIC

- A. DO NOT install fabric until concrete has cured minimum 7 days.
- B. Install fabric with twisted and barbed selvage at top.

3.7 BARBED WIRE

- A. Install three strands of barbed wire on brackets, tighten, and secure at each bracket.

3.8 GATES

- A. Hang gates and adjust hardware so gates operate satisfactorily from open or closed position.
- B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.9 FIELD QUALITY REQUIREMENTS

A. Gate Tests:

1. Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition specified.

3.10 REUSE OF EXISTING FENCE MATERIAL

- A. Existing fence material shall be installed on new posts using new tension bars, brace bands, and tension wire.
- B. Existing fence fabric shall NOT be spliced to new fence fabric at mid-length between posts where the existing fence fabric ends. A pull post shall be installed with new brace bands, tension bands, and tension wire. Provide a knuckled selvage at the cut portion of the fence as shown on the Drawings.

END OF SECTION

SECTION 32 92 19 – SEEDING, FERTILIZING, AND MULCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Fertilizer.
 - 2. Mulch.
 - 3. Seed.
 - 4. Preparation.
 - 5. Maintenance.
- B. Related Sections:
 - 1. Section 31 22 19 – Grading
 - 2. Section 31 23 16 – Excavation
 - 3. Section 31 11 00 – Site Preparation
- C. Alternate Methods and Products:
 - 1. Alternate methods from those specified shall be considered for use, provided that in the Engineer's opinion the product shall be equal to or exceed that which would result from the specified methods and products.

1.2 DEFINITIONS

- A. Weeds:
 - 1. Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wold Garlic, Perennial Sorrel, and Brome Grass.

1.3 REGULATORY REQUIREMENTS

- A. See regulatory agencies for fertilizer and herbicide composition.

1.4 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.5 MAINTENANCE DATA

- A. Submit maintenance data for continuing Owner maintenance.
- B. Include maintenance instruction, cutting method, maximum grass height, types, application frequency, and recommended coverage of fertilizer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is NOT acceptable.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.7 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 AGRICULTURAL LIMESTONE

- A. Shall be agricultural limestone with NOT less than 90% passing the No. 4 sieve and containing NOT less than 40% calcium carbonate equivalent. Lime shall be applied at the rate recommended by soil test.

2.2 FERTILIZER, MULCH, & SEED

- A. Shall be in conformance with City of Colorado Springs Standard Specification Section 900.

PART 3 - EXECUTION

3.1 GENERAL

- A. The application of fertilizer, seed, and mulch shall follow each other in successive sequence as closely as possible. Seeding shall be accomplished in the first of the following two periods after completion of earthwork.
 - 1. Spring thaw to June 15th
 - 2. September 1st until consistent ground freeze
- B. Seeding outside the specified seeding periods may be permitted at the Engineer's option, provided the Contractor is willing to make appropriate modifications to his seeding operations, and will guarantee the crop.

3.2 INSPECTION

- A. Contractor shall request that Engineer inspect site grading, cleanup, and surface preparation to determine if site is ready for the seeding, fertilizing and mulching operations.
- B. Upon Engineer's approval operations may begin.

3.3 SURFACE PREPARATION

- A. Immediately in advance of fertilizing, the surface to be seeded shall be repaired, if necessary, to eliminate all damage from erosion or construction operations. The surface shall then be loosened and thoroughly pulverized by discing, harrowing, and raking or other approved methods, to such an extent that it is free from sod, stones, clods, or roots. All growth of vegetation that will seriously interfere with planting operations shall be removed and disposed of as directed. The final surface shall be smooth, uniform, and left in such a condition as to prevent formation of low places and pockets.
- B. Following fertilization and seeding, erosion matting shall be installed as specified in City of Colorado Springs Standard Specification Section 900.

3.4 FERTILIZING

- A. Fertilizer and lime shall be dressed evenly over the areas to be seeded using approved mechanical type spreading equipment.

- B. Fertilizer and lime after spreading shall be immediately incorporated into the soil to a depth of approximately 2 in, by chisel, spike tooth harrow, or other approved methods.

3.5 SEEDING METHODS

- A. General methods:
 - 1. The Contractor shall employ a satisfactory method of sowing by use of either approved mechanical hand seeders or mechanical power-driven drills. When delays in operation carry the work beyond the specified planting seasons, or when conditions are such that by reason of drought, high winds, excessive moisture, or other factors, satisfactory results are NOT likely to be obtained, seeding shall stop. It shall be resumed only where the desired results are probable or when approved alternate procedures have been adopted.
- B. Broadcast seeding:
 - 1. When broadcast seeding is utilized, the seed shall be uniformly broadcast by mechanical hand seeder, in two directions at right-angles to each other and at 1/2 of the specified rate per acre in each direction. After the seed is broadcast it shall be covered by an approved method to a depth of 1/3 in. – 3/4 in. Broadcast seeding shall NOT be done in windy weather.
- C. Drill seeding:
 - 1. When drilling is utilized, it shall be done with approved equipment best suited to perform the work under prevailing conditions. The seed shall be uniformly drilled to a depth of 1/3 in. – 3/4 in. at the rate per acre specified. Drill seeding may be required in windy weather.
- D. Prior to start of seeding, the Contractor shall demonstrate that the application of seed is being made at the specified rate. A final check of the total quantity of seed used shall be made against the area seeded. If the check shows that the Contractor has NOT applied seed at the specified rate, he shall uniformly distribute seed at a rate calculated to meet the shortage.
- E. The Contractor shall maintain the seeded areas until all fertilizing, seeding, and mulching is complete and the work accepted by the Engineer. Areas damaged from the Contractor's own operations shall be repaired at his expense. After acceptance of the work the Contractor shall NOT be held responsible for erosion due to weather, or conditions NOT due to the Contractor's own operations or negligence. The Contractor is NOT required to guarantee a crop, if seeding is done during the specified seeding periods.

3.6 MULCHING

- A. Immediately after seeding, the Contractor shall apply vegetative mulch at a rate of 1.5 tons – 2.5 tons per acre to all seeded areas. Quantity of mulch shall be adjusted within the above limits, as directed by the Engineer, to the area or slope being mulched. Total application of mulch for the project shall average approximately 2 tons per acre. Mulch shall be applied by mechanical mulch spreaders equipped to eject by means of a constant air stream-controlled quantities of the vegetative mulch.
- B. Mulch shall be embedded by a disc type roller having flat serrated discs spaced NOT more than 10 in. apart, with cleaning scrapers for each disc.
- C. Where specified, or in areas of the project where soil conditions are NOT suitable for satisfactory crimping, asphalt emulsion shall be applied with the mulching operation. The normal rate of application shall be 100 gallons per ton of straw; however, this rate may be varied as directed by the Engineer to suit the area or slope conditions.

- D. All mulch shall be distributed evenly over the areas to be mulched within 24 hours after the seeding operation. Following the mulching operation, suitable precautions shall be taken to prohibit traffic over mulched areas. Displaced mulch shall be replaced immediately, including repair of the underlying seed bed, if damaged as well.

3.7 MAINTENANCE

- A. The Contractor shall maintain all seeded areas until the grass is properly established (not less than 90 days) until satisfactory development. Maintenance shall be continued until final acceptance of the work.
- B. Maintenance of seeded areas shall include protecting, watering, mowing, fertilizing, and such other work as may be necessary to establish a permanent lawn. The Contractor shall reseed those seeded areas in which a satisfactory growth is NOT obtained, and shall refill any areas which become eroded prior to final acceptance of the work.
- C. Paved areas shall be kept clean while maintenance operations are in progress.

3.8 REPLACEMENT

- A. The Contractor shall replace all trees, shrubs, and flowers damaged by construction activities in the areas designated on the construction plans. The replacement trees and shrubs shall be equal in size to the damaged or removed specimen.

END OF SECTION

DIVISION 33
UTILITIES

SECTION 33 01 30.71 – PIPE CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Defining machinery used, responsibilities, and results of pipeline cleaning.
 - 2. The Contractor is to remove foreign materials including, but NOT limited to, grease, debris, mud, rock, sand, and other materials that would block accurate inspection of the line or of installation of pipeline rehabilitation materials. Since the success of CCTV inspection and pipeline rehabilitation work depends on the cleanliness of the pipelines, the importance of this phase of the operation is emphasized.
 - 3. High-velocity hydraulic cleaning equipment or mechanically powered equipment may be used to remove the foreign material from the pipeline.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Submit documentation that equipment planned for use on the project as specified in the requirements listed.
- C. Prepare and submit a detailed progress schedule in graphic form showing proposed dates of starting and completing each major division of work, monthly completion percentages, and anticipated monthly payment requests. The schedule shall be consistent with the sequence requirements of the specifications. Submit three copies to the Engineer within 10 days after notice to proceed. Submit a revised schedule with each pay request.
- D. The Contractor shall submit preconstruction photos, either still or video, of the area within a 20 ft radius of any work area and shall submit them to the Engineer prior to the start of construction in any work area. Photo documentation shall NOT be performed more than 7 days prior to the start of construction at any individual work site.

1.3 PROJECT/SITE CONDITIONS

- A. Notify Owner and Engineer no less than 72 hours prior to starting work.
- B. Verify site conditions prior to start of work. Starting work constitutes acceptance of existing conditions.

1.4 PRECAUTIONS

- A. During pipeline cleaning operations, satisfactory precautions shall be taken in the use of cleaning equipment. When using hydraulically propelled cleaning tools (that depend upon water pressure to provide their cleaning force), the Contractor shall take necessary precautions to ensure that damage or flooding of public or private property does NOT occur.
- B. The Contractor shall be responsible for any damage caused by his actions during this project.

1.5 CONTRACTOR RESPONSIBILITIES

- A. The Contractor shall be responsible for any damage to public or private property resulting from his work and shall repair to a condition equivalent to or better than that existing prior to this work or otherwise make whole such damage at no cost to Owner subject to the Engineer's approval.

- B. The Contractor shall be solely responsible for safety during the performance of all Work and shall perform all work as specified in the latest OSHA confined space entry regulations. Contractor shall coordinate his work with local fire, police, and emergency rescue units.
- C. The Contractor shall obtain municipal and other governmental licenses and permits, approvals or consent from utilities or carriers, such as, the telephone companies or other persons or organizations upon whose performance of work under the contract might impinge. The Contractor shall request written release from responsibility for the performance of work under the contract, if and to the extent such work is precluded by the inability to obtain such approvals or consent.
- D. The Contractor shall review all available information pertinent to the site of the project including reports prepared under previous accomplished studies or surveys and any other data relating to the design of the project, including maps, drawings, construction specifications, pipeline system records, etc., as provided by Owner.
- E. The Contractor shall provide all access points as necessary for CCTV and cleaning.
- F. The Contractor shall obtain all fresh water necessary for performance of work under the contract from suitable designated sources approved by the Owner. All costs associated with obtaining fresh water for performance of work are the responsibility of the Contractor.
- G. The Contractor shall notify third parties (such as public utilities and the telephone company) of the Contractor's intent to perform work in an area where such parties may have rights to underground property or facilities and request for maps or other descriptive information as to the nature and location of such underground facilities or property and assurance of the Contractor's ability to enter upon any public or private lands to which access is required for performance of the work under the contract.
- H. The Contractor shall obtain a secure storage area of a size adequate to accommodate the required equipment, vehicles, and materials for the period of performance of the agreement.
- I. The Contractor shall arrange traffic control when the safety of work or the public requires such protection or as may be otherwise specified.
- J. The Contractor shall dispose of all materials removed from the cleaning and TV operations conducted by the Contractor at an approved facility. Costs associated with the removal, transport, and discharge of such materials shall be considered incidental to the project and shall be the responsibility of the Contractor.
- K. The Contractor shall have the ability to always communicate with all crews and the Engineer. The Contractor shall have a cellular telephone and a pager at which the superintendent can be reached at any time while the work is under way.
- L. The Contractor shall provide daily notification of work locations to the Owner and the Engineer. Contractor shall also notify the Owner and Engineer if a point repair is to be made or if equipment becomes lodged.
- M. The Contractor shall maintain a log of incidents and customer complaints. The log shall include date and time of call or incident, nature of complaint and resolution, if any. Logs shall be made available to Owner or Engineer upon request.
- N. The Contractor shall document all cleaning and CCTV inspections on forms approved by the Engineer.

- O. The Contractor shall route all requests for Owner action through the Engineer.
- P. The Contractor shall obtain written permission to cross private property for access to the pipeline segment where easements are inadequate.

1.6 OWNER'S RESPONSIBILITIES

- A. The Owner shall provide any available records for all areas of the project.
- B. The Owner shall provide authorization to perform work that shall be performed during nighttime hours or weekends or on holidays.
- C. The Owner shall review and respond to all submittals and written requests submitted by the Contractor.

1.7 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 CLEANING EQUIPMENT

- A. HIGH-VELOCITY JET (HYDROCLEANING) EQUIPMENT:
 - 1. All high-velocity pipeline cleaning equipment shall be constructed for ease and safety of operation.
 - 2. The Contractor shall have a selection of two or more high-velocity nozzles which shall be capable of producing a scouring action from 10 degrees to 45 degrees in all sizes of pipelines designated to be cleaned.
 - 3. The equipment shall carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel.
 - 4. For pipelines of 18 in. in diameter or greater, a minimum operating pressure of 2,300 psi @ 80 gpm is required.
 - 5. Equipment shall also include a high-velocity gun for washing and scouring designated areas. The gun shall be capable of producing flow from a fine spray to a solid stream.
 - 6. The equipment shall be satisfactory to the Engineer and shall be capable of removing dirt, grease, rocks, sand, and other materials or obstructions from the pipelines.
- B. MECHANICALLY POWERED EQUIPMENT:
 - 1. Bucket machines shall be in pairs with sufficient power to perform the work in an efficient manner.
 - 2. Machines shall be belt operated or have an overload device.
 - 3. Machines with direct drive that could cause damage to the pipe shall NOT be allowed.
 - 4. A power rodding machine shall be either sectional or continuous rod type capable of holding a minimum of 750 ft of rod.
 - 5. The rod shall be specifically heat-treated steel.
 - 6. To ensure safe operation the machine shall be fully enclosed and have an automatic safety clutch or relief valve.
 - 7. Mechanically powered equipment shall only be used when authorized by the Engineer and shall be done only when other cleaning methods are shown to be ineffective.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall locate the to-be-cleaned line by use of Ground Penetrating Radar, radio frequency transmitter located on cleaning equipment, and/or by exposing the line by digging.
- B. The Contractor shall provide to the Engineer records showing horizontal and vertical datum for the exposed pipeline.
- C. The Contractor shall place hunter-orange painted T-posts every 1,000 ft along the center of the pipe and at access points.
- D. The Contractor shall make all provisions for access of cleaning equipment to the individual line access point locations. The number of and the location of the line access points shall be as agreed upon between the Owner, Engineer, and Contractor.

3.2 CLEANING

- A. The pipeline shall be cleaned using approved equipment.
- B. Access points at each end of the line segment shall be constructed as necessary for cleaning and removal of debris.
- C. The Contractor shall provide a mechanism to prevent debris from moving downstream from the line segment being cleaned.
- D. Roots shall be removed where root intrusion is a problem and shall be considered part of cleaning procedures. Procedures may include the use of mechanical equipment, such as rodding machines, bucket machines and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners.
- E. All sludge, dirt, sand, rocks, grease, broken pipe, and other solid or semisolid material shall be removed at either the upstream or downstream access points of the pipeline section being cleaned. Passing material from line segment to line segment shall NOT be permitted.
- F. All solids or semisolids resulting from the cleaning operations shall become the property of Contractor and shall be removed by the Contractor from the pipeline and disposed of at a location approved by the Owner. All materials shall be removed from the site no less often than at the end of each workday. Under NO circumstances shall the Contractor be allowed to accumulate disposal material on the site of work beyond the stated time, except in totally enclosed containers and as approved by the Engineer. The Contractor's trucks shall have permits as specified in all applicable State and Local regulations.
- G. Contractor shall provide Owner and Engineer with a detailed plan for disposal of material removed from the pipeline. This plan shall include, but shall NOT be limited to name and address of disposal site and vehicle permit numbers.

3.3 FINAL ACCEPTANCE

- A. Acceptance of pipeline cleaning shall be made upon the successful completion of cleaning and shall be to the satisfaction of the Engineer. Verification of adequate cleaning shall be obtained by pulling a double squeegee, matching the pipe diameter, through each pipe section.

- B. If later CCTV inspection shows the cleaning to be unsatisfactory, the Contractor shall be required to reclean and reinspect the line segment until the cleaning is shown to be satisfactory. There shall be no additional cost to the Owner because of inadequate cleaning.
- C. The Contractor shall restore access routes and access point locations to a condition equivalent to or better than that initially encountered.

END OF SECTION

SECTION 33 05 23.13 - UTILITY HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Provide and install underground High-Density Polyethylene (HDPE) pipeline using the horizontal directional drilling (HDD) method of installation. This Work shall include all services, equipment, materials, labor, and geotechnical investigation for HDD crossings for the complete and proper installation, testing, restoration of underground utilities and erosion and sedimentation control and restoration.
2. It is acknowledged that the successful design and construction of HDDs of the size shown in the plans requires specialized and proprietary knowledge and skills. Therefore, it is the express intent of this Section to create a singular responsibility for the design and construction of this integrated system required for a successful installation of the pipeline via HDD methods. The design and construction of all aspects, including but not limited to, excavation of entry/exit pits, entry/exit pipe angles, pipe material capable of withstanding the pressures indicated in the contract documents, pipe bending radius, drilling system, guidance system, drilling fluid system plus containment, pipe reaming system, connections to open-cut pipe sections, and backfilling of excavations must be performed by the Installation Contractor and their selected engineer of record to obtain a complete and operational system.

1.2 STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI) / NSF Standards:

ANSI/NSF 6	Drinking Water System Components – Health Effects
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2. American Society for Testing and Materials (ASTM) Standards:

ASTM D1598	Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pressure Pipe
ASTM F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fittings Material

3. American Water Works Associations (AWWA) Standards:

AWWA C901	Standard Specification for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 through 3 Inches, for Water Service
AWWA C906	Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 through 63 inches, for Water Distribution and Transmission

4. Pipeline Research Committee International (PRCI):

PR-277-144507-Z01	Installation of Pipelines by Horizontal Directional Drilling Engineering Design Guide
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1.3 COORDINATION

- A. Section 01040 - Coordination: Requirements for coordination.
- B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 PREINSTALLATION MEETINGS

- A. Section 01040 - Coordination: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

- A. Section 01300 - Submittals.
 - 1. Work Plan: At least 30 days prior to beginning the Work, the HDD Contractor shall submit to the Owner and Engineer a work plan as Record Data detailing the procedure and schedule to be used to execute the Project. Work plan should be comprehensive, specific, and based on actual working conditions for the Project. The work plan should include:
 - a. description of all equipment to be used including years of ownership of drill rig, down-hole tools, drill rod inspection reports, etc.
 - b. list of personnel and their qualifications and experience (including back-up personnel in the event that an individual is unavailable),
 - c. list of Subcontractors including fluid design and management, pipe fusion and steering (if applicable), a schedule of work activity,
 - d. safety plan (including MSDS of any potentially hazardous substances to be used),
 - e. traffic control plan (if applicable),
 - f. all excavation locations,
 - g. interfering utilities,
 - h. source of water to be used for drilling, and flow bypass,
 - i. erosion and sedimentation control plan, and
 - j. contingency plans for possible problems.
 - k. Include drawings and written descriptions identifying details of the method of construction and the sequence of operations to be performed during construction:

- 1) Plan and profile drawing, which includes:
 - a) Details the locations of items of equipment, piping, tanks, pumps, pipe assembly and layout area, materials storage, noise provisions, and other considerations affecting public and private use of lands near the work.
 - b) Depiction of the changing nature of the equipment during the work.
 - c) Both entry and exit locations.
- 2) Detailed description of methods, equipment, and materials to be used for the HDD pipeline installation:
 - a) Descriptions of drilling fluid additives shall be accompanied by Materials Safety Data Sheets (MSDS) and manufacturers' descriptions and warranties.
 - b) Descriptions of equipment shall include manufacturers' specifications, calibrations, appropriate drawings, photographs, and descriptions of modifications since manufacture.
- l. Tracking equipment:
 - 1) Detailed description of the tracking equipment including accuracy and precision of the steering tool.
 - 2) Include records of equipment calibrations and certifications for down-hole surveys and tracking of the drill bit.
 - 3) Describe procedures for operating the down-hole survey tools including measures to verify the accuracy of the equipment readings.
 - 4) Surface monitoring system:
 - a) Tensor Tru Tracker Guidance System.
 - b) Para Track Guidance System.
 - c) Gyroscopic Steering Tool.
- m. Detailed description of the pump and cleaning plant. Include dimensions, manufacturer's specifications, and pump capacity.
- n. Maximum anticipated drilling rates, reaming rates, and drilling fluid weight for the pilot hole and each reaming pass for each soil unit identified in the geotechnical report through which the HDD will traverse. Demonstrate and confirm that pump capacity is adequate for these anticipated drilling rates.
- o. Calculations:
 - 1) Pullback loads for the conditions and operating practices anticipated as per the appropriate methodology: ASTM F1962 and PRCI PR-227-9424. Provide basis for calculations.
 - 2) Pipe stresses expected to result from loads from: the pullback, pipe bending, fluid buckling, earth, and groundwater; break-over stresses during entry into the hole. Provide assumptions used in the calculations.
 - 3) Deflecting and bending loads should be considered when selecting a pipe dimension ratio (DR) using safety factors established under ASTM D1598 and ASTM 2837, which consists of the ratio of the pipe's ultimate strength or resistance applied to the load. The pipe selected shall have the adequate ring stiffness to resist the net external pressure applied to the pipe, without the support of the surrounding soil. Engineer of record shall clearly confirm that the pipe selection is within acceptable loading capacity at depth of final design determined by the Installation Contractor.
 - 4) If buoyancy control will be used, describe how this will be accomplished including how the pipe is to be filled with water during pull back and how this is accounted for in the calculations.
 - 5) Calculations shall be signed sealed by a Professional Engineer licensed in Colorado. Engineer of record must have completed at least 5 (five) projects of similar length, size, diameter, pipe type and geotechnical conditions. Provide references for five most appropriate crossings completed as the Engineer of Record.

- p. Confirm that the project can be completed using the radius of curvature shown on the Drawings along with calculations showing that installation stresses do not exceed allowable pipe stresses.
- q. Waste disposal:
 - 1) Provide plans for disposal of waste materials resulting from the pipeline construction including drilling fluids, cuttings, waste oil, fuel, discharge water, etc.
 - 2) Identify the disposal site and provide a letter indicating authorization and legal authority to accept the described and anticipated waste products.
- r. Noise attenuation (if required by owner or permitting agency): Identify for each piece of equipment the methods and materials required to meet the applicable noise requirements and the noise requirements per the permit conditions or Owner requirements.
- s. Pipe assembly:
 - 1) Identify selected area for pipe assembly.
 - 2) Provide layout drawings showing lengths and number of pipe segments to be stored in pipe assembly area.
 - 3) Provide access diagrams detailing pipe delivery and off-loading.
 - 4) Provide details and layout of equipment to be used in pipe assembly area.
 - 5) Provide layout of rollers and cribbing.
 - 6) Provide estimated time that pipe shall be stored in chosen layout area.
 - 7) Provide estimated time to assemble pipeline, including provisions for welding and installation field coatings & linings.
 - a) Contingency plans: For remediation of problems that may be encountered during the drilling operations. Address both the observations that would lead to the discovery of the problem and the methods that would be used to mitigate the problem. Potential problems to be addressed include:
 - i. Natural and man-made obstructions encountered (such as wood pilings, boulders, etc.).
 - ii. Loss of circulation.
 - iii. Deviation from planned drill path.
 - iv. Inability to advance drill bit or product pipe.
 - v. Drill or product pipe twisted off or broken off in hole.
 - vi. Inadvertent drilling fluid returns.
 - vii. Details on measures to be taken to monitor and protect adjacent utilities, structures, and roadways.
 - viii. Pullback buoyancy modification procedures including method of filling the pipe with clean potable water during pullback.
 - ix. Reports - submit example of daily report form, drilling log form, drilling fluid report, and steering report for review and approval.
 - x. Pilot hole survey and as-built drawing - submit within 24 hrs. of completion of pilot hole for review and approval prior to beginning reaming.
- 2. Equipment: Installation Contractor shall submit specifications on directional drilling equipment as Record Data. Equipment shall include but not be limited to: drilling rig, mud system, mud motors (if applicable), down-hole tools, guidance system, rig safety systems. Calibration records for guidance equipment shall be included. Drill pipe with inspection report (DS-1 Cat. 4) performed immediately prior to project start. Specifications for all drilling fluid additives that Installation Contractor intends to use will be submitted.
- 3. Material: Provide Shop Drawings of the pipe with material specifications, including size, type, diameter and Manufacturer's data and certifications on piping and jointing methods. The shop drawing shall include a Certificate of Adequacy of Design stating the pipe and fittings are satisfactory for the loads which will be imposed during for all loading conditions.

4. Daily Report: Installation Contractor shall maintain a daily project log of drilling operations and a guidance system log along with a fusion report for joints with a copy given to Owner at completion of the Project.
 - a. Complete printout of the down-hole survey data and surface tracking data that includes the calculated 3-dimensional coordinates, inclination measurement, azimuth measurement, type of survey, and corresponding measured drilled radius for each survey point. These items shall be listed as measured distance along the drill path for each survey point and shall be formatted in such a manner as to permit independent calculation of the pilot-hole profile.
 - b. Maximum torque values for each pilot joint run
 - c. Note reasoning for any excessive torque values beyond normal operating conditions.
 - d. The date and start and stop times for each joint drilled.
 - e. Drill fluid data, minimum of three sets of data per shift
 - f. Results of visual inspection for drill fluid emission at the ground surface or into a waterway and times of the inspections, minimum three per shift.
 - g. Any observations and resulting actions relating to inadvertent drill fluid returns
 - h. Include down time of all major equipment that delays project advancement.
5. The following Record Data are required to be submitted prior to the start of drilling operations:
 - a. Signed and sealed construction drawings.
 - b. Construction Process: Provide shop and field welding procedures for all pipe joints on the pipeline.
 - c. Design Data: Provide a summary of the design and design calculations for the HDD geometry and other components sealed and signed by the Installation Contractor or the Installation Contractor's Engineer of Record. Document the codes and standards, methods of analysis, design coefficients, and resultant forces utilized.
6. Key Staff Qualifications
 - a. Provide resumes of key staff that will be assigned to this project. Key staff shall demonstrate on their resumes that they meet the following qualifications:
 - 1) Driller: Minimum 5 years' experience as a horizontal directional driller and have completed at least 5 (five) projects of similar length, diameter, pipe type and conditions.
 - 2) Superintendent: Minimum 10 years' experience in HDD field operations including 3 years as a superintendent and have completed at least 5 (five) projects of similar length, diameter, pipe type and conditions.
 - 3) Drill fluid specialists: Minimum 7 years' experience and training in drill fluid management for HDD applications.
 - 4) Datalogger specialists: Minimum 7 years' experience with the rig and downhole instrumentation installation and maintenance proposed for this project.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01700 - Contract Closeout: Requirements for submittals.
- B. Project Record Documents: Record actual locations of pipe and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- D. Record at least one data point (X, Y, and Z axes) per joint of pipe.

- E. Show depth and location of abandoned bores.
- F. Record depth and location of drill bits and drill stems not removed from bore.

1.7 QUALITY ASSURANCE

- A. Reference Documents
 - 1. NASST - Horizontal Directional Drilling Good Practices Guidelines.
 - 2. ASTM F1962.
- B. Design: Layouts in the Contract Documents are illustrative and intended to provide general guidance for the geometry of the bore. The installation contractor must finalize the HDD design, so it prevents hydraulic fracture and release of drilling fluid. The design must be sealed by a Professional Engineer licensed in the state of Colorado, with a minimum 10 years cumulative experience in the design and construction of HDD installations of similar or greater size for this Project. The sealing engineer shall be in responsible engineering charge of the Work.
- C. The requirements set forth in this document specify a wide range of procedural precautions necessary to provide the very basic, essential aspects of a proper directional drilling installation and are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this Section. Adherence to the specifications contained herein, or the Owner approval of any aspect of any directional drilling operation covered by this Section, shall in no way relieve the Installation Contractor of their ultimate responsibility for the satisfactory completion of the Work authorized under the Contract.
 - 1. Performance Requirements: Lateral or vertical variation in the final position of the carrier pipe from the line and grade established by the Drawings shall be permitted ± 5 feet vertically and horizontally for water lines, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe.
 - 2. Certification: Pipe products shall have been tested and approved by an independent third-party laboratory for continuous use at rated pressures. Pipe and couplings intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF Standard 61 by an acceptable certifying organization.
- D. The Installation Contractor shall not proceed with Work before the Owner approves the list of the engineer, supervisor, driller, mud technician, subcontractors, Drilling Schedule, and a Site-Specific Work Plan.

1.8 QUALIFICATIONS

- A. Installation Contractor's Qualifications: Installation shall be by competent individuals with at least 10 years' experience in similar work of equal scope on water transmission projects. If patented processes are involved based on the pipe selection, the Installer shall be licensed, trained and in good standing with the pipe Manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01320 - Product Delivery, Storage, and Handling: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

- C. Handling:
 - 1. Use shipping braces between layers of stacked pipe.
 - 2. Support pipes with nylon slings during handling.
- D. Storage:
 - 1. According to manufacturer instructions.
 - 2. Stack piping lengths no more than three layers high.
 - 3. Store field joint materials in original shipping containers in dry area indoors.
- E. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations area, if storage is required prior to the start of drilling activities.
 - 2. Protect pipe from entry of foreign materials and water by installing temporary covers, completing sections of Work, and isolating parts of completed system.
 - 3. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

- A. Section 01560 - Temporary Controls: Requirements for ambient condition control facilities for product storage and installation.

1.11 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.
- B. No additional geotechnical information will be provided by the Owner. It will be the complete responsibility of the Installation Contractor to satisfy themselves of the geotechnical conditions at the proposed site(s). If the Installation Contractor deems it necessary for additional geotechnical investigations and analysis, such investigations and analysis must be provided by the Installation Contractor at no additional cost to the Owner and no additional time will be added to the contract for such investigations. All changes to the Installation Contractor's design based on any additional geotechnical information acquired after the project is bid is to be included in the project cost and no additional payment or time is due to the Contractor.

1.12 GEOTECHNICAL INVESTIGATION FOR HDD CROSSINGS

- A. Calculation of formation limit pressure, where applicable, in accordance with HDD Good Practices Guidelines or similar industry standard methodology.
- B. Rate of Penetration for drilling pilot hole and all subsequent ream stages.
- C. Effects of abrasivity on tooling and drill pipe.
- D. Equipment selection sufficient to drill suitable hole for specified pipe, supply adequate drilling fluid to mud motor, drill bits, reamers, hole openers and other tooling.
- E. Develop site specific drilling fluid program for each HDD crossing.
- F. Select fluid cleaning equipment suitable for conditions.

1.13 JOB CONDITIONS; PERMITS AND EASEMENT REQUIREMENTS

- A. Owner will secure the appropriate easements and right-of-way property for the pipeline as shown on the design plans. The Installation Contractor shall observe regulations and instructions of the easement or right-of-way owner as to the methods of performing the Work and take precautions for the safety of the property and the public. The Installation Contractor shall coordinate with the easement or right-of-way owners not less than five (5) days prior to the start of Work within that parcel.
- B. Work within the county road right-of-way must comply with the County's requirements. Acquire a permit, agreement, or work order from the right-of-way owner as required.
- C. Installation Contractor shall obtain Protective Liability Insurance in the amount required by the particular company or other insurance as is specified in the permit at no cost to the Owner.
- D. Perform construction along roads, railroads, and public areas to not interfere with the operations of the roads, driveways, sidewalks, pedestrian traffic and railroads.
- E. Barricades, warning signs, and flagmen, when necessary and specified, shall be provided by the Contractor.
- F. No blasting shall be allowed.
- G. Protect existing pipelines and underground conduits. Verify location and elevation of existing underground facilities and utilities before proceeding with the construction and prevent damage to the existing pipelines or telephone cables. Verification of location (vertical and horizontal) of existing underground facilities and utilities.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The directional drilling equipment shall consist of:
 - 1. directional drilling rig of sufficient capacity to perform all drilling activities and pullback the pipe,
 - 2. drilling fluid mixing,
 - 3. delivery and recovery system of sufficient capacity to successfully complete the crossing,
 - 4. drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be re-used,
 - 5. guidance system to accurately guide boring operations,
 - 6. vacuum truck of sufficient capacity to handle the drilling fluid volume,
 - 7. trained and competent personnel to operate the system.
- B. Equipment must be in good, safe operating condition. Maintain adequate supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this Project.

2.2 DRILLING SYSTEM

- A. Drilling Rig: The directional drilling machine must consist of:
 - 1. hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head,
 - 2. anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing,
 - 3. hydraulic power system must be self-contained with sufficient pressure and volume to power drilling operations,
 - 4. Hydraulic system must be free of leaks,
 - 5. system to monitor and record maximum pull-back pressure and force during pullback operations,
 - 6. grounded during drilling and pull-back operations, and
 - 7. system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.
- B. Drill Bit: The drill bit must be steerable by changing its rotation and must provide the necessary cutting surfaces and drilling fluid jets.
- C. Mud Motors (if required): Mud motors must be of adequate power to turn the required drilling tools.
- D. Drill Pipe: must be premium grade or new and suitable for the anticipated torque, axial forces, and corresponding stresses (bending, tensile, torsional, compression, and hoop). Inspect drill pipe immediately prior to this Project using Standard DS-1 Category 3, 4 or 5 to verify premium grade.

2.3 GUIDANCE SYSTEM

- A. Magnetic Guidance System (MGS) or proven gyroscopic system must be used to provide a continuous and accurate determination of the location of the drill path during the drilling operation. The guidance shall be capable of tracking at all depths up to 100 feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill bit by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to plus or minus 2 percent of the vertical depth of the bore hole.
- B. Use a proven type guidance system operated by personnel trained and experienced with this system. The Installation Contractor's operator must be alerted to magnetic anomalies on the surface of the drill path and shall consider such influences in the operation of the guidance system if using a magnetic system.

2.4 DRILLING FLUID MUD SYSTEM

- A. Mixing System: Provide a self-contained, closed, drilling fluid mixing system of sufficient size to mix and deliver drilling fluid for the proposed length and diameter of the crossing. Mixing system must continually agitate the drilling fluid during drilling operations.
- B. Drilling Fluids: Drilling fluid shall be composed of clean water, bentonite, and appropriate additives based on the soil and rock conditions determined in the geotechnical investigation. Water shall be from an approved source. The pH of the water shall be adjusted in accordance

with the bentonite supplier's requirements. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No potentially hazardous material may be used in drilling fluid.

- C. **Delivery System:** The mud pumping system shall have a minimum capacity to maintain correct drilling alignment and be capable of delivering the drilling fluid at a constant pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, minimum of 12 inches high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.
- D. **Drilling Fluid Recycling System:** The drilling fluid recycling system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid reusable. The system shall be capable of cleaning the fluid, resulting in a sand content of less than 1% and a unit weight in compliance with the approved drilling fluid program. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

2.5 OTHER EQUIPMENT

- A. **Pipe Rammers:** Hydraulic or pneumatic pipe rammers may be used for installation of the carrier pipe.
- B. **Restrictions:** Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Engineer prior to commencement of the Work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the conditions of the Project.

2.6 PIPING MATERIALS

- A. **Water Line Materials:**
 - 1. HDPE pipe shall be AWWA C906 with fused joints.
- B. **Pipe Markings:** Pipe shall be legibly marked in permanent ink with the manufacturer and trade name, nominal size and DR rating/pressure class, hydrostatic proof test pressure, NSF 61 if applicable, manufacturer date code. Pipe and couplings shall also bear the mark of the certifying agency which have tested and approved the product for use in fire protection applications.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Engineer and Owner must be notified 48 hours in advance of starting the Work. The work shall not begin until the Owner's Representative is present at the Site and agrees that proper preparations for the operation have been made, accordance with the contract documents and approved work plan.
- B. The approval for beginning the installation shall in no way relieve the Installation Contractor of the ultimate responsibility for the satisfactory completion of the Work as authorized under the Contract. It shall be the responsibility of Owner to provide inspection personnel at such times as appropriate without causing undue hardship by reason of delay to the Installation Contractor.

3.2 PERSONNEL REQUIREMENTS

- A. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. A responsible representative who is thoroughly familiar with the equipment and type work to be performed, must be always in direct charge and control of the operation. In all cases the supervisor must be continually present at the Site during the actual directional drilling operation. Provide a sufficient number of competent workers on the job at all times to ensure the directional drilling is made in accordance with the contract documents.

3.3 EXAMINATION

- A. Section 01700 - Contract Closeout: Requirements for installation examination.
- B. Verify that connections, sizes, locations, and invert elevations are according to Drawings.

3.4 PREPARATION

- A. Section 01040 - Coordination: Requirements for installation preparation.
- B. Local Utility:
 - 1. Call local utility line information service at 811 not less than three working days before performing Work.
 - 2. Request underground utilities to be located and marked within and surrounding construction areas.
- C. Maintain access to existing facilities indicated to remain; modify pipe installation to maintain access to existing facilities.
- D. Locate and identify utilities indicated to remain and protect from damage.
- E. Identify required lines, levels, contours, and data locations.
- F. Protect plant life, lawns, rock outcroppings, and other features remaining as portion of final landscaping.
- G. Protect benchmarks, such as: existing structures, fences, sidewalks, paving, and survey control points from excavating equipment and vehicular traffic.

- H. Establish pipe elevations with not less than 4-feet of cover.

3.5 DRILLING PROCEDURES

- A. **SITE PREPARATION:** prior to any alterations to work site, installation contractor shall photograph or video tape entire work area, including entry and exit points, one copy of which shall be given to owner and one copy to remain with installation contractor for a period of 1 year following the completion of the project. Work sites shall be within right-of-way and shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. Installation contractor shall confine all activities to designated work areas.
- B. **Drill Path Survey:** Entire drill path shall be accurately surveyed by the Installation Contractor with entry and exit stakes placed in the appropriate locations within the areas determined in the field with the Owner. Locate existing utilities in advance of boring operations. The Installation Contractor shall be responsible for repairing damage to existing utilities at no additional cost to the Owner. Repair of existing utilities shall proceed until complete and the existing utility is back in service. If Installation Contractor is using a magnetic guidance system, drill path will be surveyed by the Installation Contractor for any surface magnetic variations, interference, or anomalies.
- C. **Environmental Protection:** Installation Contractor shall provide environmental protection in accordance with contract documents and all applicable state, federal and local safety requirements.
- D. **Safety:** Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner.
- E. **Pilot Hole:**
 - 1. Pilot hole shall be drilled on drill path with no deviations greater than ± 5 feet horizontal and vertical for the entire crossing. In the event that pilot hole does deviate from drill path more than ± 5 feet, Contractor shall notify Owner immediately and require Installation Contractor to pull-back and re-drill from the location along bore path before the deviation. Installation Contractor shall correct the deviation and resume drilling along the approved drill path. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, Installation Contractor shall cease drilling and follow the approved procedure detailed in the HDD Execution Plan.
 - 2. The Installation Contractor shall expect fluid loss to the formation in shale, limestone, and weathered conditions.
 - 3. If mud fracture or returns loss continues, Contractor will cease operations and notify Owner. Owner, Engineer, and Installation Contractor will discuss additional options and Work will then proceed accordingly.
 - 4. Drill pilot hole along drill path shown on plan and profile drawing to specified tolerances.
 - 5. Design radius - as shown on drawings.
 - 6. Minimum radius - The minimum radius shall be based on a 3-Joint radius that accounts for azimuth and inclination.
 - 7. During pilot hole drilling, reaming, swabbing, and pipe pullback, record the following information for each joint of drill pipe: location of bit or reamer, rate of penetration, torque, thrust/pull force, pumping rate, RPM, annular pressure (pilot hole only), observed circulation, drill pipe length.
- F. **Drilling Obstructions:**
 - 1. If obstructions are encountered during drilling, notify Engineer immediately.

2. Do not proceed around obstruction without approval of Engineer.
 3. For conditions requiring more than 3 feet of deviation in horizontal alignment, submit revised Shop Drawings to Engineer for approval before resuming Work.
 4. Maintain adjusted drill path within easement or right-of-way.
- G. Reaming: Upon successful completion of pilot hole, Installation Contractor will ream pilot hole to a minimum of 12 inches greater than outside diameter of pipe using suitable reamers or hole openers in one or more sizes until the desired diameter hole is drilled. Installation Contractor will not attempt to ream at one time more than the drilling equipment and mud system are designed to safely handle.
- H. Swabbing: After the final ream pass, a swab consisting of a barrel reamer or other reaming tool, will be pulled through the reamed hole to confirm that the hole is suitable for pipe installation.
- I. Pull-Back:
1. After successfully reaming and swabbing bore hole to the required diameter, Installation Contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel and reamer. Pull loads shall not exceed the limits established in the approved submittal. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole.
 2. During pull-back operations, Contractor shall not apply more than the approved tensile load established in the approved submittal, measured at the drill rig, at any time. In the event that pipe becomes stuck, Installation Contractor will cease pulling operations. If pipe remains stuck, Contractor will notify Owner to discuss options and then Work will proceed accordingly.

3.6 HDPE PIPE JOINING

- A. The pipe shall be assembled and joined at the site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of the pipe and/or fusing equipment.
- B. The butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. When cool, all weld beads shall then be removed from the outside and interior surfaces such that the joint surfaces shall be smooth. The fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Engineer prior to pull-back. All defective joints shall be cut out and replaced at no cost to the Owner. Any section of the pipe with a gash, blister, abrasion, nick, scar or other deleterious fault greater in depth than 10 percent of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Engineer shall be discarded and not used.
- C. Terminal sections pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp. The butt gap between pipe ends shall not exceed 1/2 inch.

3.7 SLURRY REMOVAL AND DISPOSAL

- A. Contain excess drilling fluids at entry and exit points until recycled or removed from Site; provide recovery system to remove drilling spoils from access pits.
- B. Drilling Spoils:
 - 1. Remove, transport, and legally dispose of drilling spoils.
 - 2. Do not discharge drilling spoils in sanitary sewers, storm sewers, or other drainage systems.
 - 3. When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.
- C. If drilling fluid leaks to surface, immediately contain leak and barricade area from vehicular and pedestrian travel before resuming drilling operations.
- D. Complete cleanup of drilling fluid at end of each working day.

3.8 SITE RESTORATION

- A. Following drilling operations, Installation Contractor will de-mobilize equipment and restore the work site to original condition. All excavations will be backfilled and compacted to 95 percent of original density. Provide landscaping services from a local professional landscaping company.

3.9 TOLERANCES

- A. Section 01400 - Quality Control: Requirements for tolerances.
 - 1. Pilot drill shall follow the path shown on the Design Drawings within the following tolerances:
 - a. Pilot entry angle: Increase in angle up to 1 degree, no decrease in angle
 - b. Pilot entry location: As specified on the Drawings, no change without Owner permission
 - c. Pilot exit angle: No increase in exit angle. Decrease up to 2 degrees
 - d. Pilot exit location: Up to 25 feet longer or 20 feet shorter than the Drawings
 - e. Pilot depth: Up to 5 feet shallower and 5 feet deeper allowed
 - f. Pilot Alignment: Between 5 feet right or left of design centerline but not within 5 feet of the right of way boundary.
- B. Minimum Horizontal and Vertical Clearance from Other Utilities: 10 feet.
- C. See Paragraph 3.5.E for radius requirements.
- D. Deviation:
 - 1. If pipe installation deviates beyond specified tolerances, abandon bore, remove installed pipe, rebore, and reinstall pipe in correct alignment.
 - 2. Fill abandoned bores greater than 3 inches in diameter with grout or flowable fill material.

3.10 FIELD QUALITY CONTROL

- A. Section 01700 - Contract Closeout: Requirements for testing, adjusting, and balancing.

- B. Following successful pull-back of pipe, Installation Contractor will test pipe in accordance with Section 33 31 23 – Testing Sanitary Sewer Systems. A calibrated pressure recorder will be used to record the pressure during the test period. This record will be presented to Owner.
- C. Before the Owner accepts the installation, the Contractor shall verify the integrity of the HDPE pipe by successfully passing an appropriate standard diameter pig through the pipe and completing a pressure test on the installed pipe. The pig shall be sized accordingly to verify the maximum allowable pipe deflection has not been exceeded.

3.11 CLEANING

- A. Section 01700 - Contract Closeout: Requirements for cleaning.
- B. Upon completion of drilling and pipe installation, remove drilling spoils, debris, and unacceptable material from approach trenches and pits.
- C. Clean up excess slurry from ground.
- D. Restore approach trenches and pits to original condition.
- E. Remove temporary facilities for drilling operations as specified in Section 01560 - Temporary Controls.

END OF SECTION

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SECTION 33 31 13 – STEEL ENCASEMENT PIPE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The Work necessary to provide and install steel encasement pipe for water and sewer lines.
- B. Related Sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines
 - 2. Section 31 23 23.19 – Trenching Bedding and Backfill for Water and Sewer Lines
 - 3. Section 33 41 19 – Pipe Laying

1.2 REFERENCES

- A. ASTM
 - 1. A139 – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Quality Requirements Submittals:
 - 1. Steel encasement diameter, and thickness.
 - 2. End seal shop drawings.
 - 3. Casing spacer shop drawings.
 - 4. Special shipping, storage and protection, and handling instructions.
 - 5. Test procedures.
 - 6. Test results, reports, and certifications.

PART 2 - PRODUCTS

2.1 ENCASEMENT PIPE

- A. Encasement pipe shall be used to provide a conduit for the carrier pipe passing below roadways, railroads, or other surfaces where the encasement pipe shall be installed by jack and boring or at times open cut. Details for steel encasement are specified in the Plans.
- B. Encasement pipe shall also be used to isolate new water lines in the proximity of existing sewer line to prevent possible sewage contamination of the water system. The locations, lengths and diameters are specified in the Plans.
- C. Encasement Pipe Measurements:
 - 1. The encasement pipe shall be new. USED PIPE NOT ALLOWED.
 - 2. Shall be the lengths specified in Drawings and in this section.
 - 3. Shall be a smooth wall, welded steel pipe as specified in :
 - a. ASTM A139, Grade B, ASTM A211 or ASSA C202, Grade B with minimum yield strength of 35,000 psi.
 - 4. Minimum diameter wall thickness for various nominal diameters of carrier pipes:

Carrier Pipe Nominal Diameter (inches)	Steel Encasement Pipe Diameter (inches)	Steel Encasement Pipe Minimum Wall Thickness (inches)
6	12	0.2500
8	16	0.3125
10	20	0.3750
12	20	0.3750
14	24	0.4375
16	24	0.4375
18	30	0.5000
20	30	0.5000
24	36	0.5625

- D. In instances where encasement pipe is being used to isolate the water line, the minimum length of encasement pipe shall be 20 LF. The encasement pipe shall be centered on the crossing water or sewer line.

2.2 CASING SPACERS

- A. Spacers shall be stainless steel.
- B. Manufacturers:
1. Cascade Waterworks Mfg. Co.
 2. Or Approved Equal.
- C. Restrained Joints:
1. Shall have restrained joint type stainless steel casing spacers.
 2. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
Cascade Model CCS-JR
 - b. Or Approved Equal.
- D. Spacers shall be designed to support the carrier within the casing and to maintain a maximum clearance of 1 in. between the casing pipe and runner. Spacers shall be 8 in. wide for carrier pipes up to 14 in. in diameter and 12 in. wide for carrier pipes greater than 14 in. in diameter.
- E. The quantity of runners shall be dependent on the carrier pipe diameter, unless otherwise approved:

Carrier Pipe Nominal Diameter	Quantity of Runners
≤ 14 in.	4
16 in. – 36 in.	6
42 in. – 48 in.	8

- F. Runners shall be abrasion resistant glass-filled polymer or ultrahigh weight molecular polyethylene, with a minimum length of 7 in. and a minimum width of 1 in. Risers, when required, shall be stainless steel and welded to the band. Interior surfaces of the circular stainless-steel band shall be lined with a minimum thickness of 0.09 in. of EPDM or PVC, or approved alternative.

2.3 RUBBER END SEALS

- A. Rubber end seals shall be installed on both ends of the encasement pipe. They shall be the Pull-On type secured to the encasement pipe and the carrier pipe via T-304 stainless steel worm gear bands.
- B. Rubber End Seal Manufacturers:
 - 1. CCI Piping Systems
Model ESC.
 - 2. Cascade Waterworks Mfg. Co.
Model CCES.
 - 3. Or approved equal.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Highway Bore:
 - 1. DO NOT set up equipment or begin excavating pit on state highway Right-of-Way without permission of Colorado Department of Transportation Division Engineer or his authorized representative.
- B. Railroad Bore:
 - 1. DO NOT set up equipment or begin excavating pit on or near railroad property without permission of the respective railroad company.
- C. Highway and railroad permits shall be obtained by the Owner. Contractor shall coordinate with Engineer on obtaining Right-of-Way permit from railroad and shall conform to all requirements there in.

3.2 INSTALLATION, ENCASEMENT PIPE

- A. General:
 - 1. Install encasement pipe at grade and alignment specified in Plans. Allow for height of casement spacers when establishing grade for gravity line encasement pipe.
 - 2. Refer to Standard Details.
- B. Bores:
 - 1. Excavate pits and trenches required at each side of crossing to minimum width and length necessary for boring and jacking operation and carrier pipe installation.
 - 2. Carefully set steel guide rails in pit to attain specified grade and alignment.
 - 3. Keep pit pumped free of standing water. Maintain pit bottom to provide stable base for rails and equipment and firm footing for workmen. Granular material used in bottom of pit shall NOT be paid for as extra work, it is subsidiary to encasement pipe.
 - 4. Provide temporary sheeting and bracing as necessary to prevent earth slides.
 - 5. Bore tunnel and simultaneously jack encasement pipe forward one section at a time. Connect sections by full penetration butt welding performed as specified in AWS D1.1.
 - 6. Remove excavated soil from boring operation as it enters pit and dispose of it offsite.
 - 7. All bored encasement pipe shall be installed by the dry boring and jacking method. Wet boring shall NOT be allowed.
 - 8. Installation of the encasement shall be carried out in such manner that there shall be no settlement of the ground surface above the encasement. The Contractor shall take all precautions to prevent caving of the soils ahead of the pipe. During encasement installation, the Contractor shall use all care to minimize annular space (voids) between the outside of the encasement pipe and the surrounding ground. Therefore, the outside of

encasement pipe installed by boring and jacking shall be pressure grouted to eliminate voids as specified below, unless excepted therein. Only the dry bore method shall be used. WATER JETTING OR SIMILAR METHODS USING WATER ARE STRICTLY PROHIBITED.

9. The Contractor shall inspect the locations where the encasement pipe and bore pits are to be installed and familiarize himself with the conditions under which the work shall be performed and with all necessary details for the orderly prosecution of the work. The omission of any details in the Plans and/or herein for installation of the encasement and carrier pipe shall NOT relieve the Contractor of full responsibility for the proper execution and integrity of the work.
10. The Contractor shall satisfy himself of soils condition by any means he deems necessary, i.e., exploratory boring or exploratory pit excavations at bore ends. Any such exploratory work shall be done in such manner as to NOT jeopardize railroad or highway roadbeds and Rights-of-Way and shall be backfilled and cleaned up to the satisfaction of the Right-of-Way Owner. The Contractor shall be responsible to obtain his own permission and to furnish bonds, etc. as may be required by private landowners or the public authority having jurisdiction at the site of any such exploratory work unless otherwise specified in the Plans or by Owner/Engineer.
11. The Contractor shall perform all excavation required to complete the work regardless of the material encountered. Excavation from the access shafts (bore pits) more than that required to backfill the access shafts and open cut portion of the line shall be disposed of by the Contractor outside the limits of the construction site and at an approved location. Pits and trenches shall be properly shored, sheeted, and braced as specified in Section 31 50 00 – Excavation Support Systems, of these Specifications.
12. Any damage to the encasement pipe coating during shipment or handling shall be repaired by the Contractor. Boring and installation of smooth wall pipe shall be by competent supervisors and workmen specializing in this type of work.
13. IN ORDER TO MAINTAIN THE DESIGNED SLOPE OF THE SEWER GRADIENT, the horizontal and vertical alignment at all points on the encasement pipe shall be held to a tolerance of 0.10 ft of the designed line and grade. encasement pipes not meeting this tolerance shall be subject to removal and replacement at the contractor's expense.

C. Open-Cut:

1. Steel encasement shall be installed in an open-cut trench as specified in Section 31 23 16.16 – Trenching for Water and Sewer Lines and shall be backfilled as specified in Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
2. Steel encasement installed by open-cut shall conform to this specification.
3. When practical, the carrier pipe, the end seals, the casing spacers, and the encasement pipe shall be assembled outside of the trench and shall be installed as a single unit.
4. Extreme care shall be used by the Contractor to assure that the rubber end caps are NOT damaged during installation and backfilling. It is essential that a water-tight seal exist where the rubber end seals contact the carrier pipe and the encasement pipe.

3.3 INSTALLATION, CARRIER PIPE

- A. Installation of the carrier pipe in the encasement shall be accomplished in such manner that neither the pipe nor the encasement is damaged. Care shall be exercised to assure that the joints of the pipe are NOT over-deflected or pulled out during the process. The pipe shall be jointed and pushed or jacked through the encasement. Cables, chains, jacks or other equipment or devices used shall NOT be in direct contact with the pipe unless thoroughly padded.
- B. The carrier pipe barrel, regardless of its diameter, shall be centered diametrically in the encasement pipe by the use of casing spacers compatible with the material of the carrier pipe. Also, all carrier pipe bell/spigot joints inside the encasement shall be restrained from movement in the axial direction by the use restrained casing spacers. There shall be a restrained casing spacer installed at each carrier pipe joint and another casing spacer without axial restraint (non-

restrained) installed at the midpoint of each carrier pipe barrel or at a maximum interval of 10 ft. All casing spacers, whether restrained or non-restrained, shall also function as hold-down jacks to prevent the carrier pipe from floating.

- C. If, after installation of the carrier pipe, adequate stability has NOT been provided, in the opinion of the Owner, the annular space between the carrier pipe and the inside of the encasement pipe shall be filled with sand or other material approved by the Owner.
- D. After the carrier pipe has been installed in the encasement pipe, both ends of the encasement pipe shall be sealed with end seals.

3.4 PRESSURE GROUTING

- A. During installation of bored encasement pipe, care shall be exercised to prevent voids between the encasement and the surrounding ground.
- B. Encasement Pipes:
 - 1. 12 in. and larger nominal diameter, the annular space between the encasement pipe and the ground shall be pressure grouted to eliminate all voids.
 - 2. smaller than 12 in. shall also be grouted if directed by the owner depending on soil conditions at the bore site identified at the time of encasement installation.
- C. When grouting encasement pipes of such diameter that entry by a worker is possible, the grout shall be injected through the encasement pipe wall through 1.5 in. diameter holes from the inside at one location for each 5.0 ft linear interval over the entire length of the encasement pipe. The sequence for grout injection locations shall be:

*Locations (5 ft Spaces)	"Clock" Positions
1 st	12:00
2 nd	3:00
3 rd	12:00
4 th	9:00
5 th	12:00

** Repeat 2nd through 5th locations at 5 ft intervals for each location to the end of the encasement pipe.*

- D. NOTE:
 - 1. The contractor shall be responsible to see that all requirements of OSHA concerning entry of workers into confined spaces are followed as well as any other requirements for this type of work.
- E. For encasement pipes too small to be entered for grouting as addressed above, the annular space may be pressure grouted by means of an external grout pipe attached to the outside of the encasement pipe. After the encasement pipe and the grout pipe are in place, the grout pipe shall be withdrawn as the grout is introduced into the annular space.

3.5 Bore pits excavation and backfill shall be as specified in Sections 31 23 16.16 – Trenching for Water and Sewer Lines and 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.

- A. The bore pits or access shafts for encasement installation shall be rectangular in plain view, approximately 20 ft by 10 ft, with the longer dimension being in the direction of the encasement pipe. The bore pits shall be sheeted, shored, and braced on all sides as addressed herein.

Sheeting shall be timber or steel piling of ample strength to safely withstand all structural loading of whatever nature due to site and soil condition. The top of the sheeting shall be at a minimum elevation equal to the natural ground line as it existed prior to construction.

END OF SECTION

SECTION 33 31 23 – TESTING SANITARY SEWER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The Work necessary to test gravity sewer pipe, force main pipe, manholes and appurtenances.
- B. Related Sections:
 - 1. Section 33 39 13.13 – Pre-Cast Concrete Manholes

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is responsible for supplying all equipment required to conduct testing and all testing shall be conducted by the Contractor.
- B. All testing shall be conducted in the presence of the Engineer.

3.2 GRAVITY SEWER TESTING

- A. The Contractor shall have the option of verifying water tightness by either air testing or water testing. The Engineer shall have the option to require testing by both methods to verify marginal results.
- B. Gravity Sewers – Air Testing:
 - 1. After gravity sanitary sewer and service pipe have been laid, all newly laid sewer main pipe shall be subject to an air pressure test to determine watertightness from air loss.
 - 2. Test Equipment:
 - a. Equipment specified in this section to perform the air test shall be provided by the Contractor. The test gauge shall have incremental divisions of 0.10 psi and have an accuracy of at least plus or minus 0.04 psi. In no case shall a test gauge be used which has incremental divisions of greater than 0.25 psi. The gauge shall be of sufficient size to determine accuracy.
 - 3. Procedure:
 - a. As each section of sewer is completed between manholes, each section shall be air tested. When practical, house connections in each section shall be completed. Air test shall be low pressure air test based on the principle of air pressure loss per period. Contractor shall prepare a log of testing and submit this to the Engineer as each section is completed and tested. All tests shall be accomplished in the presence of the Engineer.
 - b. The test section of the sewer line is plugged at each end. One of the plugs used at the manhole shall be tapped and equipped for air inlet connection for filling the line from the air compressor.
 - c. All service laterals, stubs and fittings into the sewer test section shall be properly capped or plugged, and carefully braced against the internal pressure to prevent air leakage by slippage and blowouts.
 - d. Connect air hose to tapped plug selected for the air inlet. Then connect the other end of the air hose to the portable air control equipment, which consists of valves and pressure gauge used, to:

- 1) Control air entry rate to the sewer test section.
- 2) Monitor the air pressure in the pipeline.
- e. More specifically, the air control equipment includes a shutoff valve, pressure regulating valve, pressure reduction valve and a monitoring pressure gauge having a pressure range from 0 psi – 5 psi. The gauge shall have minimum divisions of 0.10 psi and an accuracy of 0.04 psi.
- f. Connect another air hose between the air compressor (or other source of compressed air) and the air control equipment. This completes the test equipment setup. Test operations may commence.
- g. Supply air to the test section slowly, filling the pipeline until a constant pressure of 4.0 psig is maintained. The air pressure shall be regulated to prevent the pressure inside the pipe from exceeding 5.0 psig.
- h. When constant pressure of 4.0 psig is reached, throttle the air supply to maintain the internal pressure between 3.5 psig – 4.0 psig for at least 5 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall. If leakage is detected at any cap or plug, release the pressure in the line and tighten all leaky caps and plugs.
- i. Then start the test operation again by supplying air. When it is necessary to bleed off the air to tighten or repair a faulty plug, a new 5-minute interval shall be allowed after the pipeline has been refilled.
- j. After the stabilization period, adjust the air pressure to 3.5 psig and shutoff or disconnect the air supply. Observe the gauge until the air pressure reaches 3.5 psig. At 3.5 psig commence timing with a stopwatch which is allowed to run until the line pressure drops to 2.5 psig at which time the stopwatch is stopped. The time required, as shown on the stopwatch for a pressure loss of 1.0 psig, is used to compute the air loss.
- k. If the time in minutes and seconds for the air pressure to drop from 3.5 psig – 2.5 psig is greater than that specified in the table for the designated pipe size, the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued at that time.
- l. If the time in minutes and seconds for the 1.0 psig drop is less than that specified in the table for the designated pipe size, the section of pipe shall NOT have passed the test; therefore, adequate repairs shall be made and the line retested.
- m. Pipe sizes with their respective recommended minimum times, in minutes and seconds, for acceptance by the air test method:

Distance Between Manholes (Feet)	Minimum Time for a 1.0 psig Pressure Drop (Min:Secs)									
	Nominal Diameter (Inches)									
	8	10	12	15	18	21	24	30	36	42
100	7:33	9:26	11:20	14:10	17:00	19:50	22:47	35:37	51:17	69:48
150	7:33	9:26	11:20	14:10	17:00	26:11	34:11	53:25	76:55	104:42
200	7:33	9:26	11:23	17:48	25:38	34:54	45:34	71:13	102:34	139:37
250	7:33	9:53	14:14	22:15	32:03	43:38	56:58	89:02	128:12	174:30
300	7:35	11:52	17:05	26:42	38:27	52:21	68:22	106:50	153:50	209:24
350	8:51	13:51	19:56	31:09	44:52	61:08	79:46	124:38	179:29	244:19
400	10:07	15:49	22:47	35:36	51:17	69:48	91:10	142:26	205:07	279:13
450	11:23	17:48	25:38	40:04	57:41	78:32	102:33	160:15	230:46	314:07
500	12:39	19:47	28:29	44:31	64:06	87:15	113:57	178:03	256:24	349:01

Times for distances NOT listed in the table can be obtained by calculating the straight-line ratio between distances given.

- n. For testing of long sections or sections of larger diameter pipes, or both, a timed-pressure drop of 0.5 psig may be used in lieu of a 1.0 psig timed-pressure drop as

- approved by the Owner or Engineer. If a 0.5 psig pressure drop is used, the appropriate required test time shall be exactly 1/2 the values specified in the table.
- o. An air pressure correction is required when the prevailing ground water is above the sewer line being tested. Under this condition, the air test pressure shall be increased 0.433 psi for each foot the ground water level is above the invert of the pipe.
 - p. Height of ground water above sewer pipe shall be determined by a method approved by the Engineer.
 - q. Any leaks in the system shall be repaired immediately upon discovery. Costs for repairing faulty work, including excavating and re-backfilling and for making tests, shall be paid for by the Contractor.
4. Safety Precautions:
- a. The low-pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is over pressurized or plugs are installed improperly. It is extremely important that the various plugs be installed to prevent the sudden expulsion of a poorly inflated plug. As an example of the hazard, a force of 250 lbs. is exerted on an 8 in. plug by an internal pressure of 5 psi. Observe the following safety precautions.
 - 1) No one shall be allowed in the manholes during the test or when a plugged pipe is under pressure.
 - 2) Gauges, air piping manifolds, and valves shall be located at the top of the ground.
 - 3) Install and brace all plugs securely.
 - 4) DO NOT over pressurize the lines.
- C. Gravity Sewers – Water Testing:
- 1. Water testing shall be by either the infiltration method or by the exfiltration method if approved by the Engineer. Testing for water tightness shall be made by the Contractor in the presence of the Engineer. The Contractor shall provide all equipment, plugs, bulkheads, fittings, water, etc. needed for the testing. The water used for testing shall be paid for by the Contractor.
 - 2. The Engineer shall have the right to direct that either the infiltration or the exfiltration water testing be performed based on groundwater conditions at the time.
 - 3. The tests and measurements of the infiltration method shall be as approved by the Engineer. In all cases, the pipeline shall NOT leak under exterior ground water pressure more than 100 gal/in. of nominal pipe diameter per mile of pipe per 24 hours. Leaks causing any sewer to fail such test shall be repaired until infiltration meets the allowable limit.
 - 4. If, in the opinion of the Engineer, the ground water table at the time of testing is too low to produce dependable infiltration measurement results, the Contractor shall perform the exfiltration method test. The allowable limit shall be as given above including any manholes in the section(s) being tested. Water required for exfiltration test shall be obtained at the Contractor's expense.
 - 5. Where the exfiltration test method is used:
 - a. The downstream end of the pipe section being tested shall be plugged and the plug shall be braced and blocked securely. No one shall be allowed to enter a manhole where a plugged pipe is under pressure. Any other pipe entrances to the upstream manhole shall likewise be securely plugged.
 - b. Only water from a source approved by the Engineer shall be used to perform the test. Wastewater shall NOT be used to perform exfiltration testing.
 - c. Water shall be added through the upstream manhole of the line section being tested to a depth of 2.0 ft above the inside top of the outgoing pipe (or 2.0 ft above the ground water level – see d. below). The water shall be maintained at this level for 24 hours prior to beginning the exfiltration test measurement.
 - d. There shall be a minimum of 2.0 ft positive head above the inside top of the pipe at the high end of the section being tested. This means, if the ground water in the

trench is at (or above) the top of the pipe, then the manhole shall be filled to a point at least 2.0 ft above the ground water level.

- e. The test shall be conducted for two hours. The leakage shall be determined by the calculated change in total volume of water used in the test.

3.3 PIPE DEFLECTION TESTING

A. General:

- 1. All PVC, FRP, and Ductile Iron gravity sewer lines shall be mandrel tested as specified in these sections prior to acceptance.

B. Allowable Deflection:

- 1. The maximum allowable pipe deflection shall NOT exceed 5% of the inside diameter.

C. Mandrel:

- 1. The mandrel shall be hand-pulled by the Contractor through all PVC, FRP, and Ductile Iron gravity sewer lines no earlier than 30 days after the trench has been completely backfilled. Any sections of the sewer NOT passing the mandrel shall be uncovered and the Contractor shall rebed, reround, or replace the sewer to the satisfaction of the Engineer. Any repaired section shall be retested after a sufficient time has elapsed to ensure that trench settlement has stopped. This retest time shall be totally dependent upon method of repair. If the trench has been opened, the retest shall have the same requirements as the original installation. If the pipe has been rerounded, retest shall NOT occur sooner than seven days after rerounding.
- 2. The mandrel (Go/No-Go) device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms shall be rejected as NOT sufficiently accurate. The contact length of the mandrel's arms shall equal or exceed the nominal diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance of plus or minus 0.01 in. The mandrel and all necessary equipment for the mandrel test shall be provided by the Contractor.
- 3. The Owner reserves the right to mandrel test any PVC, FRP, or Ductile Iron sewer pipe before acceptance, and also prior to expiration of the first year of operation. If a previously accepted line fails a mandrel test performed during the first year of operation, the defects shall be corrected at the Contractor's expense.

3.4 TELEVISION INSPECTION

A. The Contractor shall televise all newly installed sewer mains as follows:

B. The Contractor shall clean all lines thoroughly prior to the start of televising. The Contractor shall televise each segment of pipe.

C. The camera shall be moved through the line in either direction at a uniform slow rate NOT to exceed 60 ft/min, by means of cable winches, or similar mechanisms. UNDER NO CIRCUMSTANCES SHALL THE CAMERA BE TETHERED TO A HYDRAULICALLY PROPELLED OR HIGH-VELOCITY JET CLEANING DEVICE WHILE THE CLEANING DEVICE IS ON.

D. The Contractor shall review the video for possible defects in material or workmanship.

E. The Contractor shall correct any defects discovered during the television inspection at the Contractor's expense.

F. The Contractor shall deliver to the Engineer final video in DVD format and logs after all defects have been repaired.

3.5 INSPECTION OF SERVICE LINES

- A. All building sewer lines shall be installed and tested as specified in all state, regional, and local plumbing codes.
- B. All building sewer installations shall be inspected and approved by an authorized local governing agency inspector.
- C. Backfill may only be placed on the completed portions of a building sewer following inspection. No approval certificate shall be issued until all portions of a building sewer from the main connection to the building foundation have been inspected and approved by an authorized inspector. At the time of inspection, the pipe should be in place in the trench and "safed-up", but the top half of the pipe barrel exposed. No approval shall be given for building sewers all or a portion of which are covered at the time of inspection.
- D. All building sewers are subject to testing to insure water tightness. All tests shall be performed in the presence of the Engineer. Tests may be either by:
 - 1. Water Loss Test Procedure; or,
 - 2. Low Pressure Air Loss Procedure.
- E. If, in the opinion of the Engineer, the line in question is properly installed and free from open joints and breaks, building sewers constructed entirely of cast iron soil pipe may be connected to the sewer without testing.
- F. Water Loss Test Procedure
 - 1. Plug the section of line to be tested at the lower end and fill section with water so that at least 4 ft of head is obtained.
 - 2. The maximum acceptable water loss while so filled is NOT more than 100 gal per 24 hrs. per inch of pipe diameter per mile of pipe. This is approximately 3/16 gal for a 100 ft long section of 4 in. pipe tested 30 minutes.
- G. Low Pressure Air Loss Procedure
 - 1. Plug securely both ends of the line to be tested.
 - 2. Charge the line with air to a pressure of 4.5 psig.
 - 3. Allow at least five minutes for the temperature in the pipe to stabilize.
 - 4. Measure the time required for a 1.0 psi drop in pressure.
 - 5. The minimum time for a 1 psi loss is $28.5 \times d$ sec where d = the nominal diameter in inches of the pipe being tested.

3.6 MANHOLE TESTING

- A. Testing, Observations and Guarantee Period:
 - 1. The testing required shall be performed by the Contractor at all manholes and documented to the satisfaction of the Engineer.
 - 2. Testing shall NOT be performed on a specific manhole until all work has been completed for that specific manhole.
 - 3. Any manholes that are observed to be leaking by the Engineer shall be subject to additional repairs and retested by the Contractor at no additional cost to the Owner.
- B. Inflow Testing:
 - 1. All rehabilitated manholes and new manholes shall be dye tested. Manholes shall be dye water tested in the presence of the Engineer. The dye test shall consist of applying a concentrated dye solution around the manhole frame. Dyed water shall be applied for at least ten minutes.

2. Manholes observed to be actively leaking shall have failed the test and shall NOT be acceptable. Manholes failing the test shall require additional rehabilitation by the Contractor at no additional compensation. The manhole shall then be retested as described above until a successful test is made.

C. Vacuum Testing:

1. All new and rehabilitated manholes shall be vacuum tested by the Contractor in the presence of the Engineer for sources of infiltration. Testing shall be made during high groundwater conditions, wherever possible.
2. Manholes shall be tested after installation with all connections (existing and/or proposed) in place. Drop-connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated as specified in manufacturer's recommendations. Plate type test heads that rest on top of the frame are also acceptable. A vacuum of 10 in. of mercury shall be drawn, and the vacuum pump shall be turned off. With the valve closed, the level of vacuum shall be read after the required test time. If the drop in the level is less than 1 in. of mercury (final vacuum greater than 9 in. of mercury), the manhole shall have passed the vacuum test. After a successful test, the temporary plugs shall be removed. The required test time is determined from the table below.

Minimum Time Required for a Vacuum Drop of 1 in. H_g (10 in. H_g – 9 in. H_g) (min:sec)				
Depth of Manhole (feet)	Manhole Inside Diameter (inches)			
	48 in.	60 in.	72 in.	96 in.
8	:20	:26	:32	:45
10	:25	:33	:40	1:00
12	:30	:39	:48	1:07
14	:35	:46	:57	1:18
16	:40	:52	1:05	1:29
18	:45	:59	1:13	1:40
20	:50	1:05	1:21	1:52
22	:55	1:12	1:29	2:03
24	:60	1:19	1:37	2:14
26	1:05	1:25	1:45	2:25
28	1:10	1:32	1:53	2:36
30	1:15	1:38	1:01	2:47
Add for each Additional 2 ft	:05	:07	:08	:11

3. Manhole vacuum levels observed to drop greater than 1 in. of mercury (Final vacuum less than 9 in. of mercury) shall have failed the test and shall require additional rehabilitation. The Contractor shall make the necessary repairs at no additional compensation for only those work items completed by the Contractor. The manhole shall then be retested as described above until a successful test is made.

3.7 PRESSURE TEST FOR FORCE MAINS

- A. Perform hydrostatic leakage tests for force mains by filling the force main with water and increasing the pressure to a testing pressure of 150% of the working pressure with a minimum of 100 psi.

- B. The duration of the leakage test shall be two hours or as specified by the Engineer.
- C. The force main shall NOT be accepted until the actual leakage is equal to or less than the allowable. In addition, all obvious leaks shall be repaired.
- D. The allowable leakage rate per hour for ductile iron, PVC, FRP or concrete pipe shall be calculated by:

$$L = \frac{ND \times P^5}{7400}$$

L = Allowable Leakage (gallons per hour)

N = Number of Joints in Pipeline Tested

D = Nominal Diameter (inches)

P = Test Pressure (psi)

3.8 SYSTEM COORDINATION

- A. Maintain existing sewer flow through new connecting manholes until new sewer is approved by Engineer.
- B. Reshape manhole bottom to divert sewer flow into new sewer after new sewer is approved by Engineer.
- C. Locate sewer services before completing the first manhole downstream from the sewer service.

END OF SECTION

SECTION 33 34 13 – DUCTILE-IRON FORCE MAIN PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The Work necessary to completely furnish and install Ductile-Iron force main pipe and fittings.
- B. Related Sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines.
 - 2. Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
 - 3. Section 33 31 13 – Steel Encasement Pipe.
 - 4. Section 33 31 23 – Testing Sanitary Sewer Systems.
 - 5. Section 33 39 13.13 – Pre-Cast Concrete Manholes.
 - 6. Section 33 41 19 – Pipe Laying.
- C. General Requirements:
 - 1. Like items of ductile-iron pipe provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, and manufacturer's services.
 - 2. All pipes shall be circular and shall be of the sizes shown on the Plans and/or listed in the Unit Price Schedule. All pipes shall be new. Used pipe is prohibited.
 - 3. At the discretion of the Engineer, all pipeline and materials are subject to inspection and approval at the plant of the manufacturer.
 - 4. All materials shall equal or exceed the standards specified herein.
 - 5. During the process of unloading, all pipe materials shall be inspected by the Contractor and any damaged pipe set aside.
 - 6. After pipelines are laid, the Contractor shall test for defects and leakage as specified in Section 33 31 23 – Testing Sanitary Sewer Systems of these specifications.
 - 7. Inspection of pipe at the manufacturer's plant, at the point of delivery, on the job site, or in place shall NOT relieve the Contractor of his responsibility and the material may be subject to rejection until final acceptance of the completed project.

1.2 REFERENCES

- A. ANSI/AWWA:
 - 1. C115/A21.15 – American National Standard for Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
 - 2. C150/A21 – Thickness Design of Ductile-Iron Pipe
 - 3. C151/A21.51 – Ductile-Iron Pipe, Centrifugally-Cast
 - 4. C116/A21.16 – Protective Fusion-Bonded Coatings for The Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
 - 5. C111/A21.11 – Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- B. ANSI/ASME:
 - 1. B16.1 – Gray-Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
- C. AWWA:
 - 1. C153 – Ductile-Iron Compact Fittings

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.

- B. Quality Requirements Submittals:
 - 1. Pipe size, class, and thickness.
 - 2. Special shipping, storage and protection, and handling instructions.
 - 3. Test procedures.
 - 4. Test results, reports, and certifications.

1.4 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ductile-iron force main pipe shall be provided to conform to materials of construction specified in this section.
- B. All force mains shall be installed with tracer wire as specified in Section 33 41 19 – Pipe Laying.
- C. Weights and Marking:
 - 1. Weights of pipe and fittings shall be as specified in ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.
- D. Certification:
 - 1. The Contractor shall upon request furnish the Engineer with certified reports stating that inspection and specified tests have been made and that the results are as specified in ANSI Specifications for each.

2.2 DUCTILE-IRON FORCE MAIN PIPE

- A. All pipe and pipe fittings furnished for underground sewer piping shall have either push-on or mechanical type joints.
- B. Flanges:
 - 1. Flanged DIP and DI fittings shall be used only as specified in the Plans.
 - 2. Flanged pipe and pipe fittings as specified in ANSI/AWWA C115/21.15, Class 250 psi.
 - 3. Flanged drilling as specified in ANSI B16.1, Class 125 flange.
- C. All DIP, 4 in. – 36 in, as specified in:
 - 1. ANSI/AWWA C150/A21.50 (Thickness Design of Ductile-Iron Pipe).
 - 2. ANSI/AWWA C151/A21.51 (Ductile-Iron, Centrifugally-Cast for Water).
- D. Ductile-iron pipe for force mains shall have a minimum Pressure Class of 350.
- E. Standard laying lengths shall be 20 ft plus or minus 1 in, unless otherwise specified.

2.3 FITTINGS FOR DUCTILE-IRON FORCE MAIN

- A. All fittings over 3 in. shall be ductile-iron, mechanical joint fittings and shall be as specified in AWWA C153. All fittings shall have a minimum pressure rating of 350 psi and shall be lightweight (compact) fittings unless otherwise shown on the Plans.

- B. All fittings shall be furnished with gaskets. MJ fittings shall also be furnished with bolts, nuts, and iron glands. All plugs, caps, tees, and bends deflecting 22 1/2 degrees or more shall be provided with reaction backing.
- C. All casting and mating surfaces shall be smooth and of a workmanlike quality, free from cracks, holes, scale, shrinkage, distortion, grooves, scratches, and other defects. Fittings and other castings may be rejected if found to be unacceptable by the Engineer as specified in these sections.
- D. Joints shall be mechanical joint, shall be as specified in AWWA C111, and shall be furnished with Mega-lug type retainer glands and gaskets.
- E. Special fittings shall be as specified in the pipe manufacturer's recommendations and as approved by the Engineer.
- F. All fittings and appurtenances placed on sanitary sewer lines shall meet with the requirements of the type of pipe used and shall be installed as specified in manufacturer's recommendations and as approved by the Engineer.
- G. Connections between different kinds of pipe shall be detailed on the Plans and provide self-cleansing sanitary flow and watertight joints and connections.
- H. All fittings shall be fusion-bonded epoxy coated inside and outside as specified in ANSI/AWWA C116/A21.16.
- I. All valves and fittings (including in-line valves) shall have Megalug style retainer glands or approved equal. Valves, bends, reducers and other hardware near bends shall be positively bolted, all-threaded, or mechanically joined to each other. Bolted includes single and double flanged adapters (such as Foster Adapters or Swivel Adapters) which provide a solid bolted or mechanical joint type connection.

2.4 DUCTILE-IRON PIPE JOINTS

- A. Joints shall be mechanical joints (MJ) or push-on type joints as specified in ANSI/AWWA C111/A21.11 (Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings), unless otherwise specified.
- B. Joints shall have the same pressure rating of the pipe or fittings of which they are a part.
- C. All pipe joints other than those specified herein shall be made as specified in the manufacturer's recommendations and as approved.
- D. All joints shall be made watertight as specified in AWWA and ASTM standards.

2.5 GASKETS FOR DUCTILE-IRON JOINTS AND FITTINGS

- A. Gaskets shall be made of vulcanized styrene butadiene rubber (SBR).
- B. Gaskets shall be marked for nominal pipe size, manufacturer, and year of manufacture.
- C. Gaskets shall be as specified in AWWA C111 (Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings).

2.6 DUCTILE-IRON JOINT AND FITTING LUBRICANT

- A. Lubricant shall be provided by the pipe manufacturer and applied as per the manufacturer's recommendations as specified in ANSI/AWWA C111/A21.11 (Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings).
- B. Lubricant shall be nontoxic and shall NOT support the growth of bacteria and have no deteriorating effects on the gasket or pipe material.
- C. Lubricant containers shall be appropriately identified and labeled with the manufacturer's name.
- D. Each lubricant container shall have printed instructions for usage and joint assembly.

2.7 COATINGS

A. Interior Coatings

- 1. All ductile-iron pipe for force mains shall receive the following interior lining treatment:
 - a. Epoxy Lining:
 - 1) All DIP and DI fittings shall be lined with a high-build, multicomponent amine-cured novalac epoxy lining, containing at least 20% ceramic quartz pigment, by volume.
 - 2) The lining system shall be Protecto 401 Ceramic Epoxy as manufactured by Vulcan Painters, Inc.
 - 3) The lining Applicator shall have a successful history of applying linings to the interior of DIP.
 - b. Condition of Ductile-Iron Prior to Surface Preparation:
 - 1) All DIP and DI fittings shall have a high-build protective lining on the interior. All DIP and DI fittings shall be delivered to the application facility without any lining on the interior surface. As removal of old linings may NOT be possible, the intent of this Specification is that the entire interior of DIP and DI fittings shall NOT have been lined with any substance prior to the application of the lining specified herein.
 - c. Surface Preparation:
 - 1) Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, and other substances. Any areas where oil, grease, or another substance is detected and can be removed by solvent shall be solvent-cleaned using the guidelines outlined in SSPC-SP-1 (Solvent Cleaning).
 - 2) After the surface has been made free of grease, oil, and other substances, all areas to receive the protective compounds shall be abrasive blasted with sand or grit abrasive media.
 - 3) The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, and other sources of roughness shall be removed from the surface. If rust reappears before coating, the affected areas shall be reblasted.
 - d. Lining:
 - 1) Within eight (8) hours after surface preparation, the interior of the pipe shall receive approximately 40 mils dry film thickness of the protective lining.
 - 2) Lining shall NOT occur if the substrate or ambient temperature is below 40°F.
 - 3) The surface shall be dry and dustfree before lining.
 - 4) The linings shall NOT be used on the face of any flanged pipe or fitting, unless otherwise specified.
 - 5) All fittings shall be lined with approximately 40 mils of the protective lining. The 40 mils system shall NOT be applied in the gasket grooves.
 - e. Coating Gasket and End Spigots:

- 1) Due to the tolerances involved, the gasket area and exterior spigot end, up to 6 in. back from the end of the spigot end, shall be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound, or approved equal.
- 2) This coating shall be applied by brush to ensure coverage. Care shall be taken so the coating is smooth, without excess buildup in the gasket groove or on the spigot end.
- 3) All materials for the gasket groove and spigot end shall be applied after the application of the lining.
- f. Number of Coats:
 - 1) The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The time between coats shall never exceed that time recommended by the lining material manufacturer. No material shall be used for lining which is NOT indefinitely recoatable without roughening of the surface.
- g. Touchup and Repair:
 - 1) Protecto Joint Compound, or approved equal, shall be used for touchup or repair. Procedures for touchup and repair shall be as specified in manufacturer's recommendations.
- h. Inspection and Certification:
 - 1) Inspection.
 - 2) All DIP and DI fitting linings shall be checked for thickness using a magnetic film thickness gage. The thickness testing shall be as set forth in SSPC-PA-2 (Measurement of Dry Coating Thickness with Magnetic Gages).
 - 3) The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 V test. Any defects shall be repaired prior to shipment.
 - 4) Each pipe joint and fitting shall be marked with the date of application of the lining system and the numerical sequence of application on that date.
 - 5) Certification.
 - 6) The pipe or fitting manufacturer shall supply a certificate attesting that the Applicator met the requirements of these Specifications, the material used was as specified, and the material was applied as required.

B. Exterior Coatings:

1. All ductile-iron pipe shall have an exterior coating as set forth below.
 - a. Factory Primed Pipe:
 - 1) Unless otherwise shown on the Plans, all exposed pipe and fittings within the limits of structure walls or exposed pipe and fittings located aboveground shall be delivered to the job site factory-blasted, cleaned, and primed with one (1) coat of Tnemec Series N140 Pota-Pox Plus, or approved equal compatible paint system.
 - b. Bituminous Coating:
 - 1) All pipe and fittings specified for buried service shall have a petroleum asphaltic coating approximately 1 mil thick factory-applied to the outside of all pipe and fittings. The finished coating shall be continuous, smooth, neither brittle when exposed to the cold nor sticky when exposed to the sun, and shall be strongly adherent to the pipe or fitting. The bituminous coating shall NOT be applied to the first 6 in. of the exterior of the spigot ends.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe and fittings shall be installed as specified in these sections and the Plans.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials:
 - 1. Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- B. Storage:
 - 1. Products shall be carefully stored in a manner that shall prevent damage and in an area that is protected from the elements.
- C. See Section 01320 - Product Delivery, Storage, and Handling for additional requirements.

3.3 FIELD QUALITY REQUIREMENTS

- A. Contractor shall visually inspect all pipe and fittings upon delivery and set aside and damaged or flawed materials and shall NOT install any damaged or flawed material.
- B. Contractor shall test for defects and leakage as specified in Section 33 31 23 – Testing Sanitary Sewer Systems.

3.4 INSTALLATION

- A. Installation shall be as specified in Section 33 41 19 – Pipe Laying.
- B. Pipe trenching as specified in Section 31 23 16.16 – Trenching for Water and Sewer Lines.
- C. Pipe bedding and backfill as specified in Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
- D. Pipe connections to concrete manholes and other concrete structures as specified in Section 33 39 13.13 – Pre-Cast Concrete Manholes.
- E. Pipe installed within steel encasement as specified Section 33 31 13 – Steel Encasement Pipe.

END OF SECTION

SECTION 33 34 16 – SOLID WALL POLYVINYL CHLORIDE FORCE MAIN PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The Work necessary to completely furnish and install Polyvinyl Chloride (PVC) force main pipe and related fittings.
- B. Related Sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines
 - 2. Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines
 - 3. Section 33 31 23 – Testing Sanitary Sewer Systems
 - 4. Section 33 39 13.13 – Pre-Cast Concrete Manholes
 - 5. Section 33 31 13 – Steel Encasement Pipe
 - 6. Section 33 41 19 – Pipe Laying
- C. GENERAL
 - 1. Like items of PVC pipe provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, and manufacturer's services.
 - 2. All pipes shall be circular and shall be of the sizes shown on the Plans and/or listed in the Unit Price Schedule. All pipes shall be new. Used pipe is prohibited.
 - 3. At the discretion of the Engineer, all pipeline and materials are subject to inspection and approval at the plant of the manufacturer.
 - 4. All materials shall equal or exceed the standards specified herein.
 - 5. During the process of unloading, all pipe materials shall be inspected by the Contractor and any damaged pipe set aside.
 - 6. After pipelines are laid, the Contractor shall test for defects and leakage as specified in Section 33 31 23 – Testing Sanitary Sewer Systems.
 - 7. Inspection of pipe at the manufacturer's plant, at the point of delivery, on the job site, or in place shall NOT relieve the Contractor of his responsibility and the material may be subject to rejection until final acceptance of the completed project.

1.2 REFERENCES

- A. AWWA:
 - 1. C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings
 - 2. C905 – Standard for Polyvinyl Chloride (PVC) Water
- B. ASTM International:
 - 1. D1784 – Standard Classification System and Basis for Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - 2. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Quality Requirements Submittals:
 - 1. Pipe size, class, and thickness.
 - 2. Special shipping, storage and protection, and handling instructions.
 - 3. Test procedures.

- 4. Test results, reports, and certifications.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01320 - Product Delivery, Storage, and Handling.
- B. Delivery of Materials:
 - 1. Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- C. Storage:
 - 1. Products shall be carefully stored in a manner that shall prevent damage and in an area that is protected from the elements.

1.5 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. PVC force main pipe shall be provided as specified in materials of construction and in this section.
- B. All force mains shall be installed with tracer wire as specified in Section 33 41 19 – Pipe Laying.
- C. All plastic pipe and couplings shall bear identification markings as specified in AWWA C-900 or C-905 as applicable, which shall include the National Sanitation Foundation seal of approval. In addition, the plain end of each pipe length shall have two rings, 1 in. apart, painted around the pipe at the proper location to allow field checking of the correct setting depth of the pipe in the bell or coupling.

2.2 PVC FORCE MAIN PIPE

- A. The material used in making the pipe shall be clean, virgin, Cell Classification 12454 PVC compound as specified in ASTM D1784, Standard Specification of Rigid Polyvinyl Chloride Compounds and Chlorinated Polyvinyl Chloride Compounds.
- B. All PVC force main pipe, 4 in. – 48 in, as specified in ANSI/AWWA C900, PVC Pressure Pipe and Fabricated Fitting, 4 in. – 48 in, for Water Distribution.
- C. All PVC force main pipe shall a minimum DR of 14 (Pressure-Rated 305 psi).
- D. Standard laying lengths shall be 20 ft plus or minus 1 in, unless otherwise specified.
- E. Each PVC sewer pipe length shall be clearly marked with the manufacturer's name, nominal pipe size, cell classification, AWWA/ASTM designation, and SDR.

2.3 FITTINGS FOR PVC FORCE MAIN

- A. Shall be as specified in Section 33 34 13 – Ductile Iron Force Main Pipe and Fittings.

2.4 PVC PIPE JOINTS

- A. Joints shall be of the push-on, elastomeric gasket type, as specified in ASTM D3139 (Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals), and/or Uni-Bell UNI-B-01 (Recommended Specification for Thermoplastic Pipe Joints, Pressure and Non-Pressure Applications).
- B. All bells shall be formed integrally with the pipe and shall contain a positively retained, factory installed elastomeric gasket and have a raceway or groove specially formed to accept and retain the gasket.
- C. Wall thickness of the bell at any point shall NOT be less than the required minimum for the pipe barrel. Pipe spigots shall be beveled and have insertion stop marks.
- D. The use of solvent cement or chemically welded joints shall NOT be permitted in field construction, except as specifically authorized by the Engineer.
- E. All pipe joints other than those specified herein shall be made as specified in manufacturer's recommendations and by the Engineer.
- F. All joints shall be made watertight as specified in the latest applicable AWWA and ASTM standards.

2.5 GASKETS FOR PVC JOINTS AND FITTINGS

- A. Gaskets shall be molded or extruded from a high grade, vulcanized, elastomeric compound consisting of either a basic natural or synthetic rubber.
- B. Gaskets shall be marked for nominal pipe size, manufacturer, and year of manufacture.
- C. Gaskets as specified in ASTM F477 (Elastomeric Seals (Gaskets) for Joining Plastic Pipe) and ASTM D3139.

2.6 PVC JOINT AND FITTING LUBRICANT

- A. Lubricant shall be provided by the pipe manufacturer and applied as per the manufacturer's recommendations.
- B. Lubricant shall be nontoxic and shall NOT support the growth of bacteria and have no deteriorating effects on the gasket or pipe material.
- C. Lubricant containers shall be appropriately identified and labeled with the manufacturer's name.
- D. Each lubricant container shall have printed instructions for usage and joint assembly.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe and fittings shall be installed as specified in these sections and the Plans.

3.2 FIELD QUALITY REQUIREMENTS

- A. Contractor shall visually inspect all pipe and fittings upon delivery and set aside and damaged or flawed materials and shall NOT install any damaged or flawed material.

- B. Contractor shall test for defects and leakage as specified in Section 33 31 23 – Testing Sanitary Sewer Systems.

3.3 INSTALLATION

- A. Installation shall be as specified in Section 33 41 13 – Pipe Laying.
- B. Pipe trenching shall be as specified in Section 31 23 16.16 – Trenching for Water and Sewer Lines.
- C. Pipe bedding and backfill shall be as specified in Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
- D. Pipe connections to concrete manholes and other concrete structures shall be as specified in Section 33 39 13.13 – Pre-Cast Concrete Manholes.
- E. Pipe installed within steel encasement as specified in Section 33 31 13 – Steel Encasement Pipe.

END OF SECTION

SECTION 33 39 13.13 – PRECAST CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work for the construction of precast manholes. The Contractor shall be responsible for the correct final elevations and slopes of manholes and the proper setting and elevations of manhole rings and covers.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete
 - 2. Section 03 60 00 – Grout
 - 3. Section 09 97 26.13 – Interior Coatings
 - 4. Section 09 97 26.23 – Exterior Coatings
 - 5. Section 31 23 16 – Excavation
 - 6. Section 31 22 19 – Grading
 - 7. Section 31 23 23.13 – Fill and Backfill
 - 8. Section 33 31 23 – Testing Sanitary Sewer Systems
- C. General Requirements:
 - 1. Manholes of different diameters are required on this project. See the Plans for manhole locations and sizes.
 - 2. The top surface of the barrel shall be constructed truly plumb and level, except where located within roadway limits where it shall match existing slopes and grades, and shall have a light broom finish. There shall be no exposed aggregate on the top edge of the barrel.
 - 3. Manholes where the top elevation is greater than 2 ft above adjacent ground shall use frames and covers as specified in Paragraph 2.5 of this section. Manholes where the top elevation is less than 2 ft above adjacent ground shall use frames and covers as specified in either Paragraph 2.4 or 2.5 of this section, at the Contractor's discretion.

1.2 REFERENCES:

- A. ASTM International:
 - 1. A48 – Standard Specification for Gray Iron Castings
 - 2. C361 – Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
 - 3. C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - 4. C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections
 - 5. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable
 - 6. C990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.3 SUBMITTALS

- A. Section 01300 - Submittals: Procedures for submittals.
- B. Certificates:
 - 1. Certify that products meet or exceed specified requirements.
- C. Submit design calculations supporting reinforcing, thicknesses, and dimensions proposed for use on this project.

1.4 QUALITY ASSURANCE:

- A. Manhole testing is specified in Section 33 31 23 – Testing Sanitary Sewer Systems.
- B. Concrete testing is specified in Section 03 30 00 – Cast-In-Place Concrete.

PART 2 - PRODUCTS

2.1 PRECAST MANHOLES

- A. Precast manholes as specified in ASTM C478 – Standard Specifications for Precast Reinforced Concrete Manhole Sections
- B. The top section shall be an eccentric cone section as specified in ASTM C478.
- C. All manhole joints exposed to soil shall be sealed with an external joint wrap material, six 8 in. minimum width. Manhole joints NOT exposed to soil shall be patched with concrete.
- D. Manufacturer and Product:
 - 1. Sealing Systems Inc.; Infi-Shield Seal Wrap
 - 2. Or Approved Equal.
- E. Integral precast floors shall be allowed, subject to the approval of Engineer. Cast-in-place floors shall be allowed.
- F. Inverts may be precast or field formed into the base section of the manhole, but in either case, shall meet the proper sewer line gradient and alignment shown in the Plans.
- G. Precast concrete manhole sections shall NOT be delivered to the site until the sections are at least ten days old. Two lift holes shall be cast into each cone or riser section for the purpose of handling and placing. The Contractor shall provide and install water plugs into lift holes after laying the sections.
- H. Cutouts in the bottom sections shall be appropriate for the pipe being laid:
 - 1. Bottom sections shall have clear identifying markings to assure they are being used in the right locations.
 - 2. Suitable openings for the inlet and outlet pipe shall be cored into the base section (and into the riser sections for drop or "pass-through" manholes).
 - 3. These openings shall be true size, circular, and located as needed to maintain the proper sewer gradient for each manhole.
- I. Manufactured pipe-to-manhole connectors shall be installed at each opening to assure a flexible watertight seal of the pipe to the manhole.
 - 1. The connector shall be specifically designed for the pipe material and size being used on the project.
 - 2. No adhesives or lubricants shall be employed in the installation of the connector into the manhole.
 - 3. All stainless-steel parts of the connector shall be totally nonmagnetic Series 304 Stainless except the worm screw for tightening the steel band which shall be Series 305 Stainless. The worm screw shall be torqued by a break-away type torque wrench set for 60 – 70 in/lbs.
 - 4. The connector shall be installed in the manhole so that it shall have a minimum cover of 3 in. of concrete at all points and as strictly specified in the manufacturer's recommendations.

- J. Each manhole shall be made up with as few risers as possible. The joints between risers shall be leak proofed with a mechanical water stop seal as approved by the Engineer and meeting the requirements of ASTM C443 and C361. There shall be a suitable spigot cast into the tongue of each component to contain the seal. The seal shall consist of a supporting compression section and a thin sliding flap which has been pre-lubricated. When the sections are fitted together, the edge of the bell shall encounter the flap which then slides towards the compression section.

- K. No more than 8 in. of concentric rings shall be allowed to bring the manhole to finished grade.

2.2 INVERTS

- A. Inverts shall be formed as shown on the detail drawings to the grades specified. Manholes with inverts NOT as specified in these grades may be subject to removal and replacement at the Contractor's expense.
- B. Concrete for inverts shall be Class A as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.3 STEPS

- A. Manhole steps are NOT required and shall NOT be accepted.

2.4 NON-BOLTED FRAMES AND COVERS

- A. Frames:
 - 1. Frame material shall be cast iron or ductile iron as specified in ASTM A48, Class 35 or better. The frame shall exhibit a tensile strength of NOT less than 35,000 psi.
 - 2. Frames for standard manholes shall be Deeter 1266 for nontraffic areas and Deeter 1235 A for traffic areas, or approved equal(s), and shall have 4 3/4 in. diameter holes drilled in the bottom flange. The holes shall be centered in the flange and shall be equally spaced 90 degrees apart.
 - 3. Bearing surfaces between the ring and cover shall be machine finished or ground to assure non-rocking fit in any position, and interchangeability.
- B. Covers:
 - 1. The cover shall form a water-resistant seal between the frame and manhole cover surface. The cover shall have concealed pick holes and a machined bearing surface on the bottom of the casting. As specified in ASTM A48, Class 35 or better, for Gray Iron. The cover shall have a tensile strength of 35,000 psi.
 - 2. A typical standard manhole cover design shall be Deeter 1266 for nontraffic areas and Deeter 1235-A for traffic areas, or approved equal(s).
 - 3. Covers shall set flush with the rim of the frame and shall have no larger than a 1/8 in. gap between the frame and cover.
 - 4. Bearing surfaces shall be machine finished.
 - 5. Lids shall have "SANITARY SEWER" cast on the surface.

2.5 WATERTIGHT MANHOLE INSERTS

- A. This standard covers the furnishing and installation of watertight gasketed manhole inserts in the sanitary sewer collection system.
 - 1. Materials (Stainless Steel)
 - a. Stainless steel inserts shall be installed at locations with outfall pipe diameters greater than 15 in. and as directed by the Engineer.
 - b. Stainless steel inserts:

- 1) TETHERLOK stainless steel Rainstopper
by Southwestern Packing and Seals, Inc.
 - 2) Or Approved Equal.
- c. Insert shall be constructed of 304 stainless steel

2.6 HINGED MANHOLE FRAMES AND COVERS

- A. Covers and frames as specified in ASTM A48, Class 35 or better, for Gray Iron or equivalent ISO standard. Contractor shall provide verification of equivalency.
- B. Covers shall be hinged and incorporate a 90-degree blocking system to prevent accidental closure.
- C. Covers shall be one man operable using standard tools.
- D. Frames shall be circular with a 22 in. clear opening.
- E. The frame depth shall NOT exceed 4 in, and the flange shall incorporate bedding slots, bolt holes and lifting eyes.
- F. Lids shall be lockable and lock/unlock hardware and tools shall be provided with each lid.
- G. Lids shall have "SANITARY SEWER" cast on the surface.

2.7 COATING

- A. The manhole shall be coated as specified in the Owner's Standard Construction Specifications.

2.8 MANHOLE FRAME SEALS:

- A. The material for the seals between the frames and concrete shall be a bitumastic gasket material, meeting, or exceeding ASTM C990. Bitumastic gasket material shall be Ram-Nek, EZ-STIK, or approved equal.

2.9 PIPE CONNECTIONS

- A. Manufactured pipe-to-manhole connectors shall be installed at each opening to assure a flexible watertight seal of the pipe to the manhole.
- B. The connector shall be capable of a 7-degree pipe deflection after installation without loss of sealing.
- C. The connector shall be manufactured expressly for embedment in the wall of concrete manholes and shall be specifically designed for the pipe material and size being utilized on the project.
- D. No adhesives or lubricants shall be employed in the installation of the connector into the manhole.
- E. All stainless-steel parts of the connector shall be totally nonmagnetic Series 304 Stainless except the worm screw for tightening the steel band which shall be Series 305 Stainless. The worm screw shall be torqued by a break-away type torque wrench set for 60 in/lbs. – 70 in/lbs.
- F. The connector shall be installed in the manhole so that it shall have a minimum cover of 3 in. of concrete at all points and as strictly specified in the manufacturer's recommendations.

2.10 STRUCTURAL GROUT

- A. Grout proposed for use to adjust manhole rings to critical grades, such as those located in streets or parking lots, as specified in Section 03 60 00 – Grout.

PART 3 - EXECUTION

3.1 MANHOLE CONSTRUCTION

- A. Excavate to planned depth as specified in Section 31 23 16 – Excavation.
- B. Place and compact 8 in. of Class 7, Type A aggregate.
- C. Place Concrete Base.
- D. Place precast manhole as specified in manufacturer's recommendations, plumb, and to grade.
- E. Plug lifting holes on inside and outside. Grout lift holes on both sides.
- F. Manhole ring may be cast into top section or may be cast-in-place.
- G. Place Concrete and Form Invert.
- H. Bolt manhole frame to manhole as specified in Details.
- I. Install Exterior Manhole Coating.
- J. Backfill as specified in Section 31 23 23.13 – Fill and Backfill.
- K. Test manhole as specified in Section 33 31 23 – Testing Sanitary Sewer Systems.
- L. Install manhole coating as specified in Section 09 97 26.13 – Interior Coatings and in Section 09 97 26.23 – External Coatings.
- M. Clean the manhole frame of all dirt and debris before placing the manhole insert on the rim. The manhole insert shall be fully seated around the manhole frame rim to retard water from seeping between the cover and the manhole frame rim.

END OF SECTION

SECTION 33 39 23.13 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Cleanouts.
 - 4. Floor drains.
 - 5. Mud Valves
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 7. Flashing materials.
- B. Related Sections:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 23 16.13 – Trenching for Site Utilities
 - 3. Section 31 23 23.13 – Fill and Backfill

1.2 REFERENCES

- A. ASTM International:
 - 1. D2665 – Standard Specification for Polyvinyl Chloride Plastic Drain, Waste, and Vent Pipe and Fittings
 - 2. D3311 – Standard Specification for Drain, Waste, and Vent Plastic Fittings Patterns
 - 3. A74 – Standard Specification for Cast-Iron Soil-Pipe and Fittings
 - 4. C564 – Standard Specification for Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings
 - 5. B749 – Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products
 - 6. B152/B152M – Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
 - 7. A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 8. D4068 – Standard Specification for Chlorinated Polyethylene Sheeting for Concealed Water-Containment Membrane
 - 9. B32 – Standard Specification for Solder Metal
- B. AWWA:
 - 1. C110 – Ductile-Iron and Gray-Iron Fittings
 - 2. C153 – Ductile-Iron Compact Fittings
 - 3. C111 – Rubber-Gasket Joints for Ductile-Iron
- C. ASME:
 - 1. A112.36.2M – Cleanouts

1.3 DEFINITIONS

- A. LLDPE: Linear, low-density polyethylene plastic.
- B. PE: Polyethylene plastic.
- C. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.

- B. Product Data:
 - 1. For pipe, tube, fittings, and couplings.
 - 2. Cleanouts
 - 3. Floor Drains
 - 4. Mud Valves
 - 5. Gradation Plan as specified in Drawings
 - 6. Field quality requirements inspection and test reports
- C. Quality Assurance
 - 1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
 - 2. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

1.5 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding a minimum working pressure of, unless otherwise specified:
 - 1. Soil, Waste, and Vent Piping: 10 ft head of water.

1.6 COORDINATION

- A. Coordinate size and location of roof penetrations.

1.7 WARRANTIES

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers are subject to compliance with requirements, provide products by ONE of the manufacturers specified.
- B. Acceptable Manufacturers:
 - 1. Charlotte Pipe
 - 2. Or approved equal.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe:
 - 1. ASTM D2665, drain, waste, and vent.
 - 2. PVC Socket Fittings: ASTM D2665, socket type, made to ASTM D3311, drain, waste, and vent patterns.
- B. Cellular-Core PVC Pipe:
 - 1. ASTM F891, Schedule 40.

2. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated as specified in 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated as specified in 40 CFR 59, Subpart D (EPA Method 24).

2.4 SPECIAL PIPE FITTINGS

A. Wall-Penetration Fittings:

1. Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20 degrees of deflection, gaskets, and restrained-joint ends as specified in AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
2. Manufacturers:
 - a. SIGMA Corp.

2.5 CLEANOUTS

A. Exposed Plastic Cleanouts:

1. Manufacturers:
 - a. Josam Company; Josam Div
 - b. MIFAB, Inc
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc
 - d. Tyler Pipe; Wade Div
 - e. Watts Drainage Products Inc
 - f. Zurn Plumbing Products Group; Specification Drainage Operation
2. Size:
 - a. Same as connected drainage piping.
3. Body Material: PVC to match connected piping.
4. Closure: Countersunk, brass plug.
5. Closure Plug Size: Same as or NOT more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Manufacturers:
 - a. Josam Company; Josam Div.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
 - h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast-iron.
6. Clamping Device: NOT required.
7. Outlet Connection: Threaded.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast-iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

2.6 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Manufacturers:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Floor Drain Design: See Schedule on Drawings

2.7 MUD VALVES

- A. Cast-Iron Mud Valves:
 - 1. Manufacturers:
 - a. Troy Valve
 - 2. Mud Valve Design: Flanged frame style with cast-Iron body, bronze disk ring, resilient seat ring, and non-rising stem.

2.8 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564, rubber gaskets.
 - 2. Size: Same as connected waste piping.
- B. Deep-Seal Traps:
 - 1. Description: With inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4 in. minimum water seal.
 - b. NPS 2 1/2 and Larger: 5 in. minimum water seal.
- C. Floor Drain, Trap-Seal Primer Fittings:
 - 1. Description: With threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Airgap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive airgap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast-iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.9 FLASHING MATERIALS

- A. Lead Sheet:

1. ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise specified:
 2. General Use: 4.0 psi, 0.0625 in. thickness.
 3. Vent Pipe Flashing: 3.0 psi, 0.0469 in. thickness.
 4. Burning: 6 lb. psi, 0.0938 in. thickness.
- B. Copper Sheet:
1. ASTM B152, of the following minimum weights and thicknesses, unless otherwise specified:
 - a. General Applications: 12 oz./ft².
 - b. Vent Pipe Flashing: 8 oz./ft².
- C. Zinc-Coated Steel Sheet:
1. ASTM A653, with 0.20% copper content and 0.04 in. minimum thickness, unless otherwise specified. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if specified.
- D. Elastic Membrane Sheet:
1. ASTM D4068, flexible, chlorinated polyethylene, 40 mil minimum thickness.
- E. Fasteners:
1. Metal compatible with material and substrate being fastened.
- F. Metal Accessories:
1. Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder:
1. ASTM B32, lead-free alloy.
- H. Bituminous Coating:
1. SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 – Earthwork for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise specified.
- B. Aboveground, soil and waste piping shall be any of the following:
1. Cellular-core or Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, vent piping shall be any of the following:
1. Cellular-core or Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground, soil, waste, and vent piping shall be any of the following:
1. Cellular-core or Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 31.

- B. Basic piping installation requirements are specified in Section 23 05 00 – Common Work Results for Mechanical.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Section 23 05 00 – Common Work Results for Mechanical.
- E. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8 bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. DO NOT change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment specified, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets as specified in manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise specified:
 - 1. Horizontal piping NPS 3 and smaller: 1/4 in/ft downward in the direction of flow.
 - 2. Horizontal piping NPS 4 and larger: 1/8 in/ft downward in the direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- I. Install PVC soil and waste drainage and vent piping as specified in ASTM D2665.
- J. Install underground PVC soil and waste drainage piping as specified in ASTM D2321.
- K. DO NOT install PVC piping in return or supply plenums.
- L. DO NOT enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- M. Install cleanouts in aboveground piping and building drain piping, unless otherwise specified:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is specified.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 80 feet for piping NPS 4 and smaller and 200 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- N. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor or as specified in Drawings.

- O. For cleanouts located in concealed piping, install cleanout wall access covers, of types specified, with frame and cover flush with finished wall.
- P. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise specified.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed as specified in drainage area radii:
 - 3. Install floor drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise specified.
- Q. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- R. Install deep-seal traps on floor drains and other waste outlets, if specified.
- S. Install floor drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
- T. Install airgap fittings on draining-type backflow preventers and on indirect waste piping discharge into sanitary and roof drainage systems.
- U. Install treated wood-blocking reinforcement for wall-mounting-type specialties.
- V. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is specified.
- W. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Section 23 05 00 – Common Work Results for Mechanical.
- B. PVC Non-pressure Piping Joints:
 - 1. Join piping as specified in ASTM D2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Install:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs as specified:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if specified: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8 in. minimum rods.

- D. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 1/2 and NPS 2: 48 in. with 3/8 in. rod.
 - 2. NPS 3: 48 in. with 1/2 in. rod.
 - 3. NPS 4 and 5: 48 in. with 5/8 in. rod.
 - 4. NPS 6: 48 in. with 3/4 in. rod.
 - 5. NPS 8 to NPS 12: 48 in. with 7/8 in. rod.
- E. Install supports for vertical PVC piping every 48 in.
- F. Support piping and tubing NOT listed above as specified in MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings specify general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes specified, but NOT smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes specified, but NOT smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes specified, but NOT smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as specified. Provide shutoff valve, if specified, and union for each connection. Use flanges instead of unions for connections NPS 2 1/2 and larger.

3.7 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing as specified, if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0 psi, 0.0938 in. thickness or thicker. Solder joints of lead sheets 4.0 psi., 0.0625 in. thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 in. and skirt or flange extending at least 8 in. around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 in. around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 in. around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement if required.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.8 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.9 FIELD QUALITY REQUIREMENTS

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection shall be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection:
 - 1. If authorities having jurisdiction find that piping shall NOT pass test or inspection, make required corrections, and arrange for reinspection.
- C. Reports:
 - 1. Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping as specified procedures of authorities having jurisdiction or, in absence of published procedures:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but NOT less than 10 ft head of water. From 15 minutes before inspection starts to completion of inspection, water level shall NOT drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 in. wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure shall remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.10 CLEANING

- A. Clean Interior of Piping:
 - 1. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 33 41 19 – PIPE LAYING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. the Work necessary to install gravity sewer, force main pipe, water pipe and appurtenances.
- B. Related Sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines
 - 2. Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines
 - 3. Section 33 31 23 – Testing Sanitary Sewer Systems
 - 4. Section 33 39 13.13 – Pre-Cast Concrete Manholes
 - 5. Section 33 31 13 – Steel Encasement Pipe
 - 6. Section 33 34 13 – Ductile Iron Force Main Pipe and Fittings
 - 7. Section 33 34 16 – Solid Wall PVC Force Main Pipe and Fittings

1.2 WARRANTIES

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All pipe materials shall be as specified on the Plans and conforming to these specifications.

2.2 WARNING TAPE

- A. Nonmetallic sanitary sewer marking tape shall be warning tape.
- B. Acceptable Manufacturer:
 - 1. Rhino Marking and Protection Systems
 - 2. Harris Industries, Inc.
 - 3. Or Approved Equal.
- C. Tape shall have a minimum thickness of 4 mils and manufactured with heavy metal-free polyethylene tape that is impervious to all known alkalis, acids, chemical reagents, and solvents found in soil. The minimum overall width of the tape shall NOT be less than 3 in. Standard rolls shall be 1000' length.
- D. The tape for sewer lines shall be color coded GREEN and imprinted with the message:
 - 1. Caution Buried Sewer Line Below.
- E. The tape for water lines shall be color coded BLUE and imprinted with the message:
 - 1. Caution Buried Water Line Below.

2.3 TRACER WIRE

- A. Tracer wire shall be 12 GA, stranded coated copper for underground burial.
- B. Jacket color shall be GREEN, and made of High Density Polyethylene (HDPE) or High Molecular Weight Polyethylene (HMWPE) designed for direct burial.

- C. Connectors shall be used for all splices or repairs. Connectors shall be moisture displacement style.
- D. Acceptable Manufacturer:
 - 1. 3M Co.; 3M DBR
 - 2. Or Approved Equal.
- E. A locate or conductivity test shall be performed prior to signing off on the project.

2.4 PIPE BEDDING AND BACKFILL

- A. Shall be as specified in 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe, fittings, bedding, backfill, and all other appurtenances shall be installed as specified in these sections and the Plans.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01320 - Product Delivery, Storage, and Handling.
- B. Delivery of Materials:
 - 1. Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- C. Storage:
 - 1. Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
- D. Pipe and accessories shall be handled in such a manner that will ensure their condition after installation to be sound and undamaged. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that they are NOT damaged. Under no circumstances shall loading forks, or other equipment, be inserted into the barrel of the pipe or fitting.
- E. Pipe having pre-molded joint rings shall be handled in such a manner that no weight, including the weight of the pipe itself, will bear on or be supported by the spigot rings at any time. Care shall be taken to avoid dragging the spigot ring on the ground or allowing it to encounter gravel, crushed stone, rocks, or other hard objects. Joint rings which have been damaged in any way will NOT be accepted and shall NOT be incorporated in the work.

3.3 FIELD QUALITY REQUIREMENTS

- A. Provide skilled workmen to insure embedment of pipe.
- B. Contractor shall test for defects and leakage as specified in Section 33 31 23 – Testing Sanitary Sewer Systems.

3.4 TRACE WIRE

- A. Regardless of pipe material, a trace wire shall be laid on top of the pipe and shall be looped around the pipe at least once every 10 ft and connected to all valves and fittings. At valves, the

trace wire shall be brought up into the valve box as specified in the Plans. A tracing test of trace wire will be required prior to final acceptance.

3.5 PIPE DETECTION TAPE

- A. Pipe detection tape shall be provided in all trenches for force main and water line construction. Installation shall be per manufacturer's recommendations and shall be as close as practical to finished grade while maintaining a required minimum of 18 in. between the detection tape and the top of any pipe.

3.6 LAYING PIPE

- A. Proper means and equipment shall be used for lowering pipe into the trenches.
- B. The Contractor shall have full responsibility for any diversion of drainage and for dewatering trenches.
- C. Recesses for the pipe bells are mandatory and shall be hand excavated so that the entire pipe barrel is uniformly supported by the bedding material.
- D. Pipe shall be protected from lateral displacement by means of pipe embedment material installed as provided in this specification. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
- E. When jointed in the trench, the pipe shall form a true and smooth line. Pipe shall NOT be trimmed except for closures, and pipe NOT making a good fit shall be removed.
- F. Unless otherwise approved by the Engineer, the laying of pipe shall begin at the lowest point, and the pipe shall be installed so that the spigot ends point in the direction of flow.
- G. Pipe which is a part of a gravity sewer line shall be aligned and constructed to grades as specified in the plans. Lines NOT conforming to these grades shall be subject to removal and replacement at the Contractor's expense. Force main pipe shall match the horizontal alignment and shall closely match the grades specified in the Plans.
- H. Pipe lines or runs intended to be straight shall be laid straight.
- I. During installation, each pipe and fitting shall be inspected for defects. All defective, damaged, or unsound pipe and fittings shall be rejected and removed from the site of the work.
- J. Dependent on type of application, gravity or pressure, place thrust blocking at all pipe fittings, including bends and reducers, as specified in the Plans.
- K. Prior to joining the pipe, the plain ends of the pipe and the bells of the pipe shall be thoroughly cleaned using a soapy water and cloth, removing all foreign materials from the bells, especially the gasket seats. Any burrs or imperfections in that part of the plain end or bell which will be in contact with the gasket shall be removed.
- L. The clean gasket shall be inserted in the bell and a thin film of lubricant shall be applied to the inside surface of the gasket.
- M. The cleaned plain end shall initially be entered in the bell straight. The plain end shall be forced inside the gasket and bell until the limit mark is just visible. The pipe may then be deflected as allowed by the manufacturer.

- N. Lubricants shall be supplied by the pipe manufacturer in sufficient quantities. No substitutes shall be made.
- O. The Contractor shall furnish such jacks, or other devices as are necessary for forcing the pipe into the bell and gasket. Care shall be exercised to avoid damage to the pipe where the pushing device or machine part contacts the pipe. A wood block or suitable pad shall be placed between the pipe and that part of the pushing device which contacts the pipe.
- P. All plain ends that enter a push on bell shall be beveled at 30 degrees for at least 1/8 in. All cut pieces or ends of pipe of other classifications shall be so beveled.

3.7 PIPE BEDDING NONFERROUS PIPE

- A. Nonferrous pipes include PVC, Polyethylene, and FRP.
- B. Bedding material shall be as specified in Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
- C. Place 6 in, minimum, of bedding between excavated trench bottom or stabilized trench bottom and bottom of pipe or fitting. Provide depression in bedding for joints so that barrel of pipe or fitting rests on bedding. Place bedding in 6 in. maximum layers, compacted to 95% standard maximum density, to 6 in. over the top of pipe and fittings.
- D. Ensure bedding is contacted with the pipe in all directions, and no portion of the bedding is compacted to less than specified density, particularly the area below the springline of the pipe.
- E. Place bedding a minimum of 6 in. over the top of pipe and fittings. Bedding shall be compacted to 95% maximum density.
- F. For areas undercut, whether by Contractor's negligence or by direction of Engineer, provide and place crushed aggregate, compacted to 95% standard maximum density, to bottom elevation of pipe bedding.
- G. When used, the bottom of trench boxes will be above the level of pipe bedding before bedding is compacted. In no case shall pipe bedding be compacted against the trench box or before the trench box is raised to allow compaction of bedding.

3.8 PIPE BEDDING DUCTILE IRON PIPE

- A. Bedding material shall be as specified in Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
- B. Place 6 in, minimum, of bedding between excavated trench bottom or stabilized trench bottom and bottom of pipe or fitting. Provide depression in bedding for joints so that barrel of pipe or fitting rests on bedding. Place bedding in 6 in. maximum layers, compacted to 95% standard maximum density, to a minimum total depth of 3/4 (75%) of the outside diameter of the pipe as specified in Drawings.
- C. Bedding is an integral part of the pipe installation. Therefore, particular care shall be given to insure that bedding is in intimate contact with the pipe in all directions and that no portion of the bedding shall be compacted to less than the specified density, particularly the area below the springline of the pipe.

- D. For areas undercut, whether by Contractor's negligence or by direction of Engineer, provide and place crushed aggregate, compacted to 95% standard maximum density, to bottom elevation of pipe bedding.
- E. When used, the bottom of trench boxes will be above the level of pipe bedding before bedding is compacted. In no case shall pipe bedding be compacted against the trench box or before the trench box is raised to allow compaction of bedding.

3.9 TRENCH BACKFILL

- A. Shall be as specified in Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.

3.10 ALIGNMENT AND GRADE

- A. All pipe shall be laid straight between changes in alignment, except as specified in the Plans, and at a uniform grade between changes in grade. All lines shall be laid so that each section between manholes will lamp.

3.11 JOINTING

- A. Boltless Gasketed Joints:
 - 1. All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be observed and followed by the Contractor. All joint surfaces shall be lubricated as recommended by the manufacturer immediately before the joint is completed.
- B. Mechanical Joints:
 - 1. Mechanical joints shall be carefully assembled as specified in manufacturer's recommendations. If effective sealing is NOT obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Overtightening bolts to compensate for poor installation practice shall NOT be permitted.

3.12 CUTTING PIPE

- A. Cutting of pipe shall be done in a neat manner, without damage to the pipe or to the lining. Pipe cuts shall be smooth, straight and at right angles to the pipe axis. All cutting of pipe shall be done with mechanical pipe cutters of an approved type except that in locations where the use of mechanical cutters would be difficult or impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will cut the pipe without damaging impact or shock.

3.13 CLEANING

- A. The interior of all pipe shall be cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted. All lumps, blisters and excess coating shall be removed from exterior spigot and interior bell surfaces. Such surfaces shall be wire brushed and wiped clean, dry, and free from oil and grease before placing the spigot in the bell. All joint contact surfaces shall be kept clean until the jointing is completed.
- B. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.
- C. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug.

3.14 WATER AND SEWER LINE CROSSINGS

- A. Water and sewer lines crossing one another shall have a minimum 24 in. vertical separation.
- B. In general water lines shall be above sewer lines, however if water line cannot be above sewer line because of cover limitations or other obstructions. The water line may be below the sewer line but either the water or sewer line shall be encased 10 ft either side of the crossing line in steel encasement as specified in Section 33 31 13 – Steel Encasement Pipe.
- C. Water lines shall NOT pass through manholes.

3.15 PARALLEL WATER AND SEWER LINES

- A. Water and sewer line shall have a minimum 10 ft horizontal separation.
- B. Water and sewer lines shall NOT be installed within the same trench.

3.16 TESTING

- A. Acceptance testing for gravity lines and force mains as specified in Section 33 31 23 - Testing Sanitary Sewer Systems.

3.17 CONNECTION OF NEW SEWER PIPELINES TO EXISTING SANITARY SEWERS

- A. Construct, clean, test, and obtain Engineer's approval for pipelines and manholes before connecting new pipeline to the existing sewer.
- B. If, in the opinion of the Engineer, conditions exist which require connection prior to final line acceptance, plug all lines entering the manhole connecting to the existing system until the new system is accepted. In addition, plug the line leaving the first manhole upstream. Never allow water being used to flush the new lines to enter the existing system.
- C. All new pipelines shall connect to the existing system at a new or existing manhole. If a new manhole is built over an existing sewer line, DO NOT break out the top of the existing pipe until the new line is accepted.
 - 1. Flexible pipe couplings may be used to connect existing gravity sewer line to new gravity sewer lines as approved by the Engineer.
 - 2. Acceptable Manufacturers:
 - a. Fernco
 - b. Or Approved Equal.
- D. If a new pipeline is to discharge into an existing manhole, divert the sewage flow around the existing manhole while the tie-in is under construction. Intercept the sewage flow at the existing manhole first upstream from the tie-in construction. Provide suitable pumping equipment and rerouting conduit to pump the sewage around the tie-in construction. Discharge into an appropriate manhole downstream from the construction.
- E. Connection to an existing manhole shall be made by core drilling. A concrete manhole adapter, A-LOK G3 boot system or equal, shall be installed on the sewer pipe, and the annular space grouted.
- F. Connect new pipelines to existing manholes in a neat, workmanlike manner, to ensure a watertight connection.

3.18 TRENCHING

- A. Pipe trenching shall be as specified in Section 31 23 16.16 – Trenching for Water and Sewer Lines.

3.19 CONNECTIONS TO MANHOLES

- A. Pipe connections to concrete manholes and other concrete structures shall be as specified in Section 33 39 13 – Concrete Manholes.

3.20 STEEL ENCASEMENT

- A. Pipe installed within steel encasement shall be as specified in Section 33 31 13 – Steel Encasement Pipe.

END OF SECTION

DIVISION 40
PROCESS INTEGRATION

SECTION 40 05 61 – GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. V140 – General duty gate valves smaller than 3 in.
 - 2. V141 – Buried Resilient-seated gate valves.
 - 3. V142 – Exposed Resilient-seated gate valves.
 - 4. V145 – Resilient Seated Knife Gate Valve, 2 in. – 36 in.
- B. Related Sections:
 - 1. Section 40 05 51 – Common Requirements for Process Valves.
 - 2. Section 40 05 57 – Actuators for Process Valves and Gates.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C500 – Metal-Seated Gate Valves for Water Supply Service.
 - 2. C509 – Resilient-Seated Gate Valves for Water Supply Service.
 - 3. C515 – Resilient-Seated Gate Valves for Water Supply Service.
- B. ASME International:
 - 1. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - 3. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
 - 4. B1.20.1 – Pipe Threads, General Purpose, Inch.
- C. ASTM International:
 - 1. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A536 – Standard Specification for Ductile Iron Castings.
 - 3. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 4. B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 5. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 6. D2000 – Standard Classification System for Rubber Products in Automotive Applications.
- D. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry):
 - 1. SP-70 – Gray Iron Gate Valves, Flanged and Threaded Ends.
 - 2. SP-80 – Bronze Gate, Globe, Angle and Check Valves.
- E. NSF (National Science Foundation):
 - 1. 61 – Health Effects for Drinking Water System Components.
 - 2. 372 – Lead Content for Drinking Water System Components.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01300 - Submittals.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment.

- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation and anchoring requirements, fasteners, and other details.
 - 3. Specify valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
- F. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals:
 - 1. Specify results of factory tests and inspections.
- H. Field Quality-Control Submittals:
 - 1. Specify results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports:
 - 1. Certify that equipment has been installed as specified in manufacturer instructions.
 - 2. Specify activities on Site, adverse findings, and recommendations.
- J. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of installed valve and components.
 - 2. See Section 01 77 00 – Closeout Procedures for additional requirements.

1.4 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water:
 - 1. Certified to NSF Standard 61 and NSF Standard 372.

1.5 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with minimum five years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01320 - Product Delivery, Storage, and Handling for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials as specified in manufacturer instructions.
- D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection as specified in manufacturer instructions.

1.7 WARRANTY

- A. Furnish three-year manufacturer's warranty for valves.
- B. See Section 00610 - Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 TYPE V140: GENERAL-DUTY GATE VALVES – SMALLER THAN 3 IN.

- A. Manufacturers:
 1. M&H/Kennedy Valve Company
 2. Mueller
 3. American
- B. General:
 1. Service: Aboveground, clean water and air.
 2. Comply with MSS SP-80, Class 150.
 3. Maximum Process Fluid Temperature: 150°F.
 4. Body and Trim: Bronze, ASTM B62.
 5. Rising Stem Type
 6. Bonnet: Threaded.
 7. Operation: Handwheel
 8. Wedge Disc:
 - a. Type: Solid.
 - b. Bronze, ASTM B62.
 9. End Connections: threaded.

2.2 TYPE V141: BURIED RESILIENT-SEATED GATE VALVES, 3 IN. AND LARGER

- A. Manufacturers:
 1. Mueller
 2. M&H/Kennedy Valve Company
 3. American
- B. General:
 1. Comply with AWWA C515.
 2. Minimum Working Pressure: 250 psig.
 3. Maximum Process Fluid Temperature: 100°F.
 4. End Connections: Mechanical joint, except tapping valves may be flanged by mechanical joint.
 5. Gear Actuators for Manual Valves: Comply with AWWA C509.
 6. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
 7. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
 8. Valves 14 in. and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.

- C. Operation:
 - 1. Stem: Non-rising.
- D. Materials:
 - 1. Disc: Resilient ASTM A536, ductile iron, fully encapsulated with ASTM D2000, SBR or EPDM.
 - 2. Body: ASTM A536, ductile iron, coated.
 - 3. Stem: Cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem.
 - 4. Connecting Hardware: Type 304 stainless steel.
 - 5. Provide standard AWWA 2 in. operating nut, matching valve key, and valve box for operating stem.
- E. Finishes:
 - 1. NSF 61 & 372 compliant fusion bond epoxy.

2.3 TYPE V142: EXPOSED RESILIENT SEAT GATE VALVE, 3 IN. AND LARGER

- A. Manufacturers and Products:
 - 1. M&H/Kennedy Valve Company.
 - 2. Mueller.
 - 3. American.
- B. General:
 - 1. Comply with AWWA C515.
 - 2. Minimum Working Pressure: 250 psig.
 - 3. Maximum Process Fluid Temperature: 100°F.
 - 4. End Connections: Flanged.
 - 5. Gear Actuators for Manual Valves: Comply with AWWA C509.
 - 6. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
 - 7. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
 - 8. Valves 14 in. and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.
- C. Operation:
 - 1. Stem: Non-rising.
- D. Materials:
 - 1. Disc: Resilient ASTM A536, ductile iron, fully encapsulated with ASTM D2000, SBR or EPDM.
 - 2. Body: ASTM A536, ductile iron, coated.
 - 3. Stem: Cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem.
 - 4. Connecting Hardware: Type 304 stainless steel.
 - 5. Provide handwheel, or chainwheel, unless noted as 2 in. nut, or actuator on the drawings or specified in the valve schedule.
- E. Finishes:
 - 1. NSF 61 & 372 compliant.
 - 2. Finish coat: Match adjoining pipe.

2.4 TYPE V145: KNIFE GATE VALVE, 2 IN. – 36 IN.

- A. Manufacturers and Products:
 - 1. DeZurik.
 - 2. Henry Pratt.
 - 3. Wey Valve.
 - 4. Red Valve.
- B. General:
 - 1. Suitable for service under pressures equal to and less than 150 psi.
 - 2. Full round port, metal seated, raised face design.
 - 3. Flanged wafer design, drilled and tapped to ANSI Class 125/150 standard.
 - 4. Founded gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides.
 - 5. Body to incorporate guides and jams to assist in seating.
- C. Materials:
 - 1. Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel.
 - 2. Wetted Components (including gate): Type 316 stainless steel.
 - 3. Yoke Sleeve: Acid resisting bronze or aluminum bronze.
 - 4. Packing: PTFE.
 - 5. Outside screw and yoke (OS&Y) with handwheel operator.
- D. Finishes:
 - 1. Finish coat: Match adjoining pipe.

2.5 SOURCE QUALITY CONTROL

- A. Section 01400 - Quality Control for testing, inspection, and analysis requirements.
- B. Testing:
 - 1. Test gate valves as specified in AWWA C509.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. As specified in AWWA C509.

3.2 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

3.3 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified in this section shall be present at the jobsite for the minimum person-days listed for the services below, travel time excluded:
 - 1. 2 person-days for installation assistance, inspection, and certification of the installation. Provide certificate.

2. 2 person-days for functional and performance testing.
3. 2 person-days for pre-startup classroom or jobsite training of Owner's personnel.

B. Training of Owner's personnel shall be at such times and locations requested by Owner.

C. See Section 01650 Starting of System– Startup Testing and Training.

3.4 MANUFACTURER'S CERTIFICATE(S)

A. Provide as specified in Section 01650 - Starting of System .

END OF SECTION

SECTION 40 05 62 – PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type V404: Eccentric Plug Valve, 1/2 in. – 3 in.
 - 2. Type V405: Eccentric Plug Valve, 4 in. – 12 in.
 - 3. Type V406: Eccentric Plug Valve, 14 in. and Larger.
- B. Related Sections:
 - 1. Section 40 05 51 – Common Requirements for Process Valves.
 - 2. Section 40 05 57 – Actuators for Process Valves and Gates.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C517 – Resilient-Seated Cast-Iron Eccentric Plug Valves.
 - 2. C550 – Protective Interior Coatings for Valves and Hydrants.
 - 3. C606 – Grooved and Shouldered Joints.
- B. ASME International:
 - 1. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 – NPS 24 Metric/Inch Standard.
 - 3. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
 - 4. B1.20.1 – Pipe Threads, General Purpose, Inch.
- C. ASTM International:
 - 1. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A536 – Standard Specification for Ductile Iron Castings.
 - 3. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
- D. NSF (National Science Foundation):
 - 1. 61 – Health Effects for Drinking Water System Components.
 - 2. 372 – Lead Content for Drinking Water System Components.

1.3 SUBMITTALS

- A. See Section 01300 - Submittals for general submittal requirements.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment.
- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation and anchoring requirements, fasteners, and other details.
 - 3. Specify valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
- F. Manufacturer Instructions:
 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals:
 1. Specify results of factory tests and inspections.
- H. Field Quality-Control Submittals:
 1. Specify results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports:
 1. Certify that equipment has been installed as specified in manufacturer instructions.
 2. Specify activities on Site, adverse findings, and recommendations.
- J. Closeout Submittals
 1. Project Record Documents:
 - a. Record actual locations of installed valves and components.
 2. See Section 01700 - Contract Closeout for additional requirements.
- 1.4 QUALITY ASSURANCE
 - A. Materials in Contact with Potable Water:
 1. Certified to NSF Standard 61 and NSF Standard 372.
- 1.5 QUALIFICATIONS
 - A. Manufacturer:
 1. Company specializing in manufacturing products specified in this section with minimum five years of experience.
- 1.6 DELIVERY, STORAGE, AND HANDLING
 - A. Section 01320 - Product Delivery, Storage, and Handling for transporting, handling, storing, and protecting products.
 - B. Inspection:
 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
 - C. Store materials as specified in manufacturer instructions.
 - D. Protection:
 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 2. Provide additional protection as specified in manufacturer instructions.
- 1.7 WARRANTY
 - A. Furnish three-year manufacturer's warranty for valves.
 - B. See Section 00610 - Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 TYPE V404: ECCENTRIC PLUG VALVE, 1/2 IN. – 3 IN.

- A. Manufacturers:
 - 1. DeZURIK.
 - 2. Henry Pratt.
- B. General:
 - 1. Type:
 - a. Nonlubricated.
 - b. Eccentric.
 - 2. Working Pressure: 175 psig CWP
 - 3. Maximum Process Fluid Temperature: 300°F.
 - 4. Ports:
 - a. Configuration: Rectangular.
 - b. Minimum Port Area: 80% of nominal pipe area.
 - 5. Stem Bearings: Self-lubricating.
 - 6. Stem Seals:
 - a. Type: V-ring.
 - b. Material: Buna-N or NBR.
 - 7. Packing and Gland: Accessible and externally adjustable.
 - 8. End Connections:
 - a. Threaded NPT full size inlets
 - b. Hexagonal for a wrench connection
- C. Operation:
 - 1. Provide valves with wrench level manual operator.
- D. Materials:
 - 1. Body:
 - a. Cast iron, ASTM A126 Class B or stainless steel where specified.
 - b. Lining: Epoxy, as specified in AWWA C550 unless otherwise specified.
 - 2. Plug:
 - a. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar.
 - 3. Seats: Nickel.
 - 4. Stem: Type 316 stainless steel.
 - 5. Stem Bearings: Stainless steel.
 - 6. Seals: PTFE.
 - 7. Connecting Hardware: Type 316 stainless steel.
- E. Finishes:
 - 1. Match adjoining pipe.

2.2 TYPE V405: ECCENTRIC PLUG VALVE, 4 IN. – 12 IN.

- A. Manufacturers:
 - 1. DeZURIK.
 - 2. Val-Matic.
 - 3. Henry Pratt.
- B. General:
 - 1. Type:
 - a. Nonlubricated.

- b. Eccentric.
- 2. Working Pressure: 175 psig CWP
- 3. Maximum Process Fluid Temperature: 300°F.
- 4. Ports:
 - a. Configuration: Rectangular.
 - b. Minimum Port Area: 80% of nominal pipe area.
- 5. Stem Bearings: Self-lubricating.
- 6. Stem Seals:
 - a. Type: V-ring.
 - b. Material: Buna-N or NBR.
- 7. Packing and Gland: Accessible and externally adjustable.
- 8. End Connections:
 - a. Flanged: Comply with ASME B16.1, or
 - b. Grooved ends as specified in AWWA C606 for rigid joints,
 - c. Mechanical joint ends for buried valve.

C. Operation:

- 1. 4 in. valve with wrench lever manual operator and 6 in. – 12 in. valve with totally enclosed, geared, manual operator with hand wheel, 2 in. nut, or chain wheel.

D. Materials:

- 1. Body:
 - a. Cast iron, ASTM A126 Class B or stainless steel where specified.
 - b. Lining: Epoxy, as specified in AWWA C550 unless otherwise specified.
- 2. Plug:
 - a. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar.
- 3. Seats: Nickel.
- 4. Stem: Type 316 stainless steel.
- 5. Stem Bearings: Stainless steel.
- 6. Seals: PTFE.
- 7. Connecting Hardware: Type 316 stainless steel.

E. Finishes:

- 1. Lining: as specified in AWWA C550 unless otherwise specified.
- 2. Coating: Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion boded” epoxy.
- 3. Finish Coat: Match adjoining pipe.

2.3 TYPE V406: ECCENTRIC PLUG VALVE, 14 IN. AND LARGER

A. Manufacturers:

- 1. DeZURIK
- 2. Val-Matic
- 3. Henry Pratt

- B. Nonlubricated type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body with flanged ends or grooved ends as specified in AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.

C. Manufacturers and Products:

- 1. DeZurik.
- 2. Henry Pratt.

3. Val-Matic.

D. General:

1. Type:
 - a. Nonlubricated.
 - b. Eccentric.
2. Working Pressure: 150 psig
3. Maximum Process Fluid Temperature: 300°F.
4. Ports:
 - a. Configuration: Rectangular.
 - b. Minimum Port Area: 80% of nominal pipe area.
5. Stem Bearings: Self-lubricating.
6. Stem Seals:
 - a. Type: V-ring.
 - b. Material: Buna-N or NBR.
7. Packing and Gland: Accessible and externally adjustable.
8. End Connections:
 - a. Mechanical joint ends for buried valve.

E. Operation:

1. Provide with totally enclosed, geared, manual operator with hand wheel, 2 in. nut, or chain wheel.

F. Materials:

1. Body:
 - a. Cast iron, ASTM A126 Class B.
 - b. Lining: Epoxy, as specified in AWWA C550 unless otherwise specified.
2. Plug:
 - a. Ductile iron, ASTM A536.
3. Seats: Nickel.
4. Stem: Type 316 stainless steel.
5. Stem Bearings: Stainless steel.
6. Seals: PTFE.
7. Connecting Hardware: Type 316 stainless steel.

G. Finishes:

1. Lining: As specified in AWWA C550 unless otherwise specified.
2. Coating: Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion boded" epoxy.
3. Finish Coat: Match adjoining pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. As specified in AWWA C517.
- B. Horizontal Piping:
 1. Stem horizontal.
- C. Vertical Piping:
 1. Plug at top when closed.
- D. Plugs:
 1. On top when open and on pressure side when closed.

3.2 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

3.3 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified in this section shall be present at the jobsite for the minimum person-days listed for the services below, travel time excluded:
 - 1. 2 person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
 - 2. 2 person-days for functional and performance testing.
 - 3. 2 person-days for pre-startup classroom or jobsite training of Owner's personnel.
- B. Training of Owner's personnel shall be at times and locations specified by Owner.
- C. See Section 01650 - Starting of System.

3.4 MANUFACTURER'S CERTIFICATE(S)

- A. Provide as specified in Section 01650 – Starting of System.

END OF SECTION

SECTION 40 05 63 – BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. V300 – Metal Body Ball Valve, less than 6 in.
 - 2. V302 – Metal Body Ball Valve, 6 in. and Larger.
 - 3. V303 – Instrumentation Ball Valves.
 - 4. V330 – PVC/CPVC Ball Valves.
 - 5. V331 – 3-Way PVC Ball Valve.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C507 – Ball Valves, 6 in. – 60 in. (150 mm – 1,500 mm).
- B. ASME International:
 - 1. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 – NPS 24 Metric/Inch Standard.
 - 3. B16.11 – Forged Fittings, Socket-Welding and Threaded.
 - 4. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
 - 5. B1.20.1 – Pipe Threads, General Purpose, Inch.
- C. ASTM International:
 - 1. A48 – Standard Specification for Gray Iron Castings.
 - 2. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 3. D3222 – Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
 - 4. D4101 – Standard Specification for Polypropylene Injection and Extrusion Materials.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP-110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- A. See Section 01300 - Submittals for general submittal requirements.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment.
- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation and anchoring requirements, fasteners, and other details.
 - 3. Specify valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
- F. Manufacturer Instructions:
 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals:
 1. Specify results of factory tests and inspections.
- H. Field Quality-Control Submittals:
 1. Specify results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports:
 1. Certify that equipment has been installed as specified in manufacturer instructions.
 2. Specify activities on Site, adverse findings, and recommendations.
- J. Closeout Submittals:
 1. See Section 01700 - Contract Closeout.
 2. Project Record Documents:
 - a. Record actual locations of installed valve and components.
- 1.4 QUALITY ASSURANCE
 - A. Materials in Contact with Potable Water:
 1. Certified to NSF Standard 61 and NSF Standard 372.
- 1.5 QUALIFICATIONS
 - A. Manufacturer:
 1. Company specializing in manufacturing products specified in this Section with minimum five years of experience.
- 1.6 SOURCE QUALITY CONTROL
 - A. See Section 01400 - Quality Control for testing, inspection, and analysis requirements.
 - B. Test and install butterfly valves as specified in AWWA C507.
- 1.7 WARRANTY
 - A. Furnish minimum three-year manufacturer's warranty for valves.
 - B. See Section 00610 - Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as specified in the performance, functions, features, and materials of construction.

- B. Like items of equipment provided in this section shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Design Requirements:
 - 1. Valve class shall meet the connecting line requirements or be as specified in the valve schedule or in Drawings.
 - 2. Bubble-tight at rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
 - 3. Suitable for applications involving frequent throttling and applications requiring valve actuation after long periods of inactivity.

2.2 TYPE V300: METAL BODY BALL VALVE, LESS THAN 6 IN.

- A. Manufacturers:
 - 1. NIBCO:
 - a. T-585-S6-R-66-LL (available in 1/4 in. – 2 in.) for threaded connections.
 - b. F-515-S6-F-66-FS (available in 1/2 in. – 12 in.) for flanged connections.
 - 2. Apollo – 76 Series.
 - 3. Milwaukee Valve – F20 Series (available in 1 in. – 12 in.) for flanged connections.
- B. Typical Service:
 - 1. Water
 - 2. Drain
 - 3. Sample locations
 - 4. Compressed Air
 - 5. RO Sample Panel
- C. General:
 - 1. See MSS SP 110 (threaded or socket-welded valves)
 - 2. Type: Nonlubricated and capable of sealing in either flow direction.
 - 3. Minimum Working Pressure: As specified in Section 40 23 39.1 – Process Piping Schedule.
 - 4. Port: Full.
 - 5. End Connections:
 - a. Threaded or socket weld for 2 in. and smaller.
 - b. Class 150 flanged for sizes 3 in. and larger. Flanges shall be as specified ANSI/ASME B16.1 standards.
- D. Operation:
 - 1. Operator: Hand lever
- E. Materials:
 - 1. Body:
 - a. Type: Two piece.
 - b. Materials:
 - 1) All 316 Stainless steel compatible with service designated.
 - 2) Ball: Type 316 Stainless steel.
 - 2. Seats: PTFE.
 - 3. Stem: [Stainless steel].
 - 4. Stem Seals: PTFE or Viton
 - 5. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
- F. Finishes:
 - 1. Finish coat: Match adjoining pipe

2.3 TYPE V302: METAL BODY BALL VALVE, 6 IN. AND LARGER

- A. Manufacturers and Products:
 - 1. Henry Pratt - AWWA Rubber Seated Ball Valve (available in 4" - 60")
 - 2. Val-Matic - Ener-G (available in 4" - 60")
 - 3. McCANNA/MARPAC
- B. General:
 - 1. Type: Nonlubricated and capable of sealing in either flow direction.
 - 2. See AWWA C507.
 - 3. Stem packing: Manually adjustable while valve is under pressure.
 - a. End Connections:
 - 1) Flanged ends.
 - 2) Flanges shall be as specified ANSI/ASME B16.1 standards.
- C. Operation:
 - 1. Manually operated ball valves shall have self-locking worm gear type actuator with position indicator. Gearing shall be permanently lubricated. Provide adjustable screws to stop travel at both Open and Closed positions.
 - 2. Operator: Hand lever
- D. Materials:
 - 1. Body: ASTM A48 cast iron and integrally cast bronze bushed trunnions.
 - 2. Ball: [Stainless steel].
 - 3. Seats: TFE
 - 4. Stem Seals: TFE or Viton.
- E. Finishes:
 - 1. Finish coat: Match adjoining pipe.

2.4 TYPE V303: INSTRUMENTATION BALL VALVES

- A. Manufacturers and Products:
 - 1. Swagelok – 40G Series (available in 1/8 in. – 3/4 in.)
 - 2. Parker – B Series (available in 1/16 in. – 1/2 in.)
- B. General:
 - 1. Stainless steel body ball valve, nylon handle.

2.5 TYPE V330: PVC/CPVC BALL VALVES

- A. Manufacturers:
 - 1. Georg Fischer – 546 Pro (available in 3/8 in. – 4 in.)
 - 2. Asahi/America, Inc.
 - 3. NIBCO/Chemtrol –
 - a. PVC – U-45TB-V (available in 1/2 in. – 2 in.)
or
S-45TB-V (available in 3 in. – 6 in.)
 - b. CPVC – U-51TB-V (available in 1/2 in. – 2 in.)
or
S-51TB-V (available in 3 in. – 6 in.)
 - 4. Hayward Flow Control – TBH Series True Union (available in 1/4 in. – 6 in.)
 - 5. Spears – True Union 2000 (available in 1/2 in. – 8 in.)
- B. Typical Service:

1. Water
2. Chemicals
3. Drain
4. Sample locations

C. General:

1. Type: Nonlubricated and capable of sealing in either flow direction.
2. Working Pressure:
 - a. 1/2 in. – 2 in. – 250 psi.
 - b. 2 1/2 in. – 6 in. – 150 psi.
3. Ports: Full size.
4. All ball valves on sodium hypochlorite lines and/or chlorine dioxide lines shall be venting type valves.
5. End Connections:
 - a. True Union:
 - 1) Solvent or heat welded to piping.
 - 2) Defer to manufacturer's recommendation for installation.

D. Operation:

1. Operator: Hand lever

E. Materials:

1. Body and Ball:
 - a. PVC, ASTM D1784 when adjoining to PVC pipe.
 - b. CPVC, ASTM D1784 when adjoining to CPVC pipe.
2. Seats: PTFE.
3. O-rings: Viton (FKM)

2.6 TYPE V331: 3-WAY PVC/CPVC BALL VALVES

A. Manufacturers:

1. Georg Fischer – 543 Pro (available in 3/8 in. – 2 in.)
2. Asahi/America, Inc.
3. NIBCO/Chemtrol –
 - a. S45M3-V for PVC (available in 1/2 in. – 2 in.)
 - b. S51M3-V for CPVC (available in 1/2 in. – 2 in.)
4. Hayward Flow Control – TW Series True Union (available in 1/2 in. – 2 in.)
5. Spears – True Union 2000 (available in 1/2 in. – 4 in.)

B. Typical Service:

1. Water
2. RO Permeate Probing Connections
3. Chemicals

C. General:

1. Type: Nonlubricated and capable of sealing in either flow direction.
2. Working Pressure:
 - a. 1/2 in. – 2 in. – 150 psi.
 - b. 2 1/2 in. – 4 in. – 235 psi.
3. Ports: Full size.
4. End Connections:
 - a. True union: solvent or heat welded to piping.

D. Operation:

1. Operator: Hand lever

- E. Materials:
 - 1. Body and Ball:
 - a. PVC, ASTM D1784 when adjoining to PVC pipe.
 - b. CPVC, ASTM D1784 when adjoining to CPVC pipe.
 - 2. Seats: PTFE.
 - 3. O-rings: Viton (FKM)

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Section 01320 - Product Delivery, Storage, and Handling for transporting, handling, storing, and protecting products requirements.
- B. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials as specified in manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing them in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection as specified in manufacturer instructions.

3.2 INSTALLATION

- A. Install valves as specified in AWWA C507.

3.3 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Count and record number of turns to open and close valve, account for any discrepancies with Manufacturer's data.

3.4 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified in this section shall be present at the jobsite for the minimum person-days listed for the services below, travel time excluded:
 - 1. 1 person-day for installation assistance, inspection, and certification of the installation. Provide certificate.
 - 2. 1/2 person-day for functional and performance testing.
 - 3. 1 person-day for pre-startup classroom or jobsite training of Owner's personnel.
- B. Training of Owner's personnel shall be at times and locations specified by Owner.
- C. See Section 01650 Starting of System – Startup Testing and Training.

3.5 MANUFACTURER'S CERTIFICATE(S)

- A. Provide as specified in Section 01650 - Starting of System.

END OF SECTION

SECTION 40 05 78 – AIR RELEASE VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Type V750: Well Service Air Valve, 1/2 in. and Larger.
 - 2. Type V752: Wastewater Combination Air Valves, 1 in. and Larger.
 - 3. Type V755: Clean Water Combination Air Valve, 1 in. and Larger.
 - 4. Type V757: Air Release Valves for Water Service.
 - 5. Type V780: Safety Relief Valve for Air Service, 1 1/2 in. – 3 in.
 - 6. Type V785: Safety Relief Valve for Air Service, 3 in. And Larger.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C512 – Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
- B. NSF International:
 - 1. 61 – Drinking Water System Components – Health Effects.
 - 2. 372 – Drinking Water System Components – Lead Content.

1.3 SUBMITTALS

- A. See Section 01300 - Submittals for general submittal requirements.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment.
- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation and anchoring requirements, fasteners, and other details.
 - 3. Specify valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
- F. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals:
 - 1. Specify results of factory tests and inspections.
- H. Field Quality-Control Submittals:
 - 1. Specify results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports:
 - 1. Certify that equipment has been installed as specified in manufacturer instructions.

2. Specify activities on Site, adverse findings, and recommendations.

J. Closeout Submittals:

1. Project Record Documents:
 - a. Record actual locations of installed valve and components.
2. See Section 01700 - Contract Closeout for additional requirements.

1.4 COORDINATION

- A. Coordinate Work of this Section with installation of process piping.

1.5 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water:
1. Certified to NSF Standard 61 and NSF Standard 372.

1.6 QUALIFICATIONS

- A. Manufacturer:
1. Company specializing in manufacturing products specified in this section with minimum five years of experience.

1.7 SOURCE QUALITY CONTROL

- A. See Section 01400 - Quality Control for testing, inspection, and analysis requirements.
- B. Test and install valves as specified in AWWA C512.

1.8 WARRANTY

- A. See Section 00610 - Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified in this section.
- B. Like items of equipment provided in this section shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Design Requirements:
1. Valve class shall meet the requirements of the connecting line or as specified in the valve schedule or in Drawings.

2.2 TYPE V750: WELL SERVICE AIR VALVE, 1/2 IN. AND LARGER

- A. Manufacturers:
1. Val-Matic - Well Service Air Valve (1/2 in. – 20 in.)
 2. DeZurik.
- B. General:

1. Fully automatic float operated valve,
2. Suitable for vertical turbine pump discharge service,
3. Designed to exhaust air which is present in pump column on pump startup and allow air to re-enter the column on pump shutdown, should a negative pressure occur.
4. NSF/ANSI 61 certified.
5. Valves 3 in. and smaller shall be equipped with a dual port throttling device to provide adjustable control of the exhaust rate and allow free air to flow into the valve through a separate inlet port.
6. Valves 4 in. larger shall be equipped with a regulated exhaust device, which shall allow free airflow in and out of the valve, close upon rapid air exchange, and control the air exhaust rate to reduce pressure surges.
7. Connections:
 - a. Inlet:
 - 1) Valve sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection.
 - 2) Valve sizes 4 in. and larger shall have bolted flange inlets equal to the valve size. Flanges shall be as specified in ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 300 ductile iron flanges.
 - b. Outlets:
 - 1) Valve sizes 6 in. and smaller shall have NPT outlets;
 - 2) Valves 8 in. and larger shall have ANSI B16.1 Class 125 outlet flanges.
 - 3) The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
8. Working Pressure: As specified in pipe schedule.

C. Materials:

1. Body, cover, and baffle:
 - a. Class 125 and 250 Valves: ASTM A126 Class B cast iron.
 - b. Class 300 Valves: Ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 cast ductile iron.
2. Float, guide shafts, and bushings: Type 316 stainless steel. Nonmetallic guides and bushings are not acceptable.
3. Seats: Buna-N.

D. Finish:

1. NSF/ANSI 61 certified fusion bonded epoxy as specified in AWWA C550.

2.3 TYPE V752: WASTEWATER COMBINATION AIR VALVES, 1 IN. AND LARGER

A. Manufacturers:

1. Val-Matic - Combination Wastewater Valve (1 in. – 8 in.)
2. DeZurik - APCO High Performance Combination Air Valve (1 in. - 6 in.)
3. ARI

B. General:

1. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry.
2. The valve shall open during draining or if a negative pressure occurs.
3. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure.
4. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
5. Valve shall be suitable for use with domestic sewage
6. Connections:
 - a. Inlet:

- 1) Valve sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection.
 - 2) Valve sizes 4 in. and larger shall have bolted flange inlets equal to the valve size. Flanges shall be as specified in ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 300 ductile iron flanges.
 - b. Outlets:
 - 1) Valve sizes 6 in. and smaller shall have NPT outlets;
 - 2) Valves 8 in. and larger shall have ANSI B16.1 Class 125 outlet flanges.
 - 3) The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
 7. Working Pressure: As specified in pipe schedule.
- C. Materials:
1. Body: [Cast iron or ductile iron or Stainless Steel]
 2. Float, guide shafts and bushings: Type 316 stainless steel.
- D. Finish: NSF/ANSI 61 certified fusion bonded epoxy as specified in AWWA C550.
- 2.4 TYPE V755: CLEAN WATER COMBINATION AIR VALVE, 1 IN. AND LARGER
- A. Manufacturers:
1. Val-Matic - Combination Clean Water Valve (1 in. – 20 in.)
 2. DeZurik - APCO Single Body Combination Air Valve (1 in. - 8 in.)
- B. General:
1. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry.
 2. Valve shall open during draining or if negative pressures occur.
 3. Valve shall also release accumulated air from a piping system while system is in operation and under pressure.
 4. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
 5. Valves used in potable water shall be NSF/ANSI certified.
 6. Connections:
 - a. Inlet:
 - 1) Valve sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection.
 - 2) Valve sizes 4 in. and larger shall have bolted flange inlets equal to the valve size. Flanges shall be as specified in ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 300 ductile iron flanges.
 - b. Outlets:
 - 1) Valve sizes 6 in. and smaller shall have NPT outlets;
 - 2) Valves 8 in. and larger shall have ANSI B16.1 Class 125 outlet flanges.
 - 3) The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
 7. Working Pressure: As specified in pipe schedule.
- C. Materials:
1. Body: Constructed of cast iron or ductile iron.
 2. Float, guide shafts and bushings: Type 316 stainless steel.
- D. Finish:
1. NSF/ANSI 61 certified fusion bonded epoxy as specified in AWWA C550.

2.5 TYPE V757: AIR RELEASE VALVES FOR WATER SERVICE

- A. Manufacturers:
 - 1. Val-Matic - Air Release Clean Water Valve (1/2 in. – 6 in.)
 - 2. Dezurik - APCO Clean Water Air Release Valve (1/2 in. – 6 in.)
- B. Description:
 - 1. Valve shall be automatic float operated valve designed to release accumulated air from a piping system while system is in operation and under pressure.
 - 2. Comply with AWWA C512.
 - 3. Furnish blowoff valve, quick-disconnect couplings, and minimum 6 ft of hose.
 - 4. End Connections:
 - a. Inlet Valve End Connections Size 1/2 to 3 in.: NPT.
 - b. Inlet Valve End Connections Size 4 in. and Larger: Flanged. ANSI B16.1 for Class 150 and ANSI B16.42 for Class 300.
 - c. Outlet Valve End Connections Size 6 in. and smaller: NPT.
 - d. Outlet Valve End Connections Size 8 in. and Larger: Flanged ANSI B16.1
 - 5. Working Pressure: As specified in pipe schedule.
 - 6. Size: As specified in Drawings.
- C. Materials:
 - 1. Body and Cover: Cast iron or Ductile iron.
 - 2. Float, Seat, and Trim: Type 316 stainless steel.
 - 3. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy as specified in AWWA C550.

2.6 TYPE V780: SAFETY RELIEF VALVE FOR AIR SERVICE, 1/2 IN. – 3 IN.

- A. Manufacturers:
 - 1. Kunkle – 900 Series (1/2 in. – 2 in.)
 - 2. Apollo Valve
- B. Description:
 - 1. Spring loaded, adjustable pressure relief valve for process air service
 - 2. Test pull ring or lever.
- C. Materials:
 - 1. Trim: Stainless Steel
 - 2. Seat: Material suitable for elevated temperatures above 300°F.

2.7 TYPE V785: SAFETY RELIEF VALVE FOR AIR SERVICE, 3 IN. AND LARGER

- A. Manufacturers:
 - 1. Kunkle – 300/600 Series (1.25 in. – 6 in.)
- B. Description:
 - 1. Exposed spring, full nozzle design
- C. Materials:
 - 1. Body: Cast Steel
 - 2. Trim: Stainless Steel
 - 3. Seat: Material suitable for elevated temperatures above 300°F.

2.8 INSULATION

- A. As specified in pipe schedule.

2.9 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Section 01320 - Product Storage, Delivery, and Handling for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials on site in manufacturer's original packaging and inspect for damage.
- C. Store materials as specified in manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection as specified in manufacturer instructions.

3.2 EXAMINATION

- A. Verify that field dimensions are as specified in Shop Drawings.
- B. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

3.3 PREPARATION

- A. Section 01040 - Coordination for installation preparation requirements.
- B. Thoroughly clean end connections before installation.
- C. Close pipe and equipment openings with caps or plugs during installation.
- D. Cleaning:
 - 1. Clean surfaces to remove foreign substances.

3.4 INSTALLATION

- A. As specified in manufacturer instructions.
- B. Provide access for operation, removal, and maintenance, and to avoid discharge to occupied areas or other equipment.
- C. Installation Standards:
 - 1. Install Work as specified in AWWA C512 standards.

3.5 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Control for inspection and testing requirements.
- B. Inspect for interferences and proper supports.
- C. Testing:
 - 1. Demonstrate operation without undue noise or vibration.
- D. Manufacturer Services:
 - 1. Furnish services of manufacturer's representative experienced in installation of products furnished under this section for not less than 2 days onsite for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- E. Equipment Acceptance:
 - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 - 2. Make final adjustments to equipment under direction of manufacturer's representative.
 - 3. Repair damaged coatings with material equal to original coating.
- F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.6 CLEANING

- A. Keep interior of air release valves clean as installation progresses.

3.7 DEMONSTRATION

- A. Section 01650 - Starting of System for demonstration and training requirements.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION