

Fort Campbell/Fort Irwin Water, Wastewater And Recycled Water Design and Construction Standards

U.S. Army Directorate of Contracting (DOC)
Fort Campbell/Fort Irwin

Parts Include:

Part A: Water Distribution System Design Standards

Part B: Wastewater Collection System Design Standards

Part C: Recycled Water Distribution System Design Standards

Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction

Part E: Standard Details for Water, Wastewater and Recycled Water Construction

December 2016



Fort Campbell, KY

Fort Irwin, CA

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FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

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END OF SECTION

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

PART 00
GENERAL REQUIREMENTS FOR WATER AND WASTEWATER
CONNECTIONS AT FORT CAMPBELL, KENTUCKY

PART 1 GENERAL

1.01 GENERAL

- A. These requirements apply to all users of the water and sewer utility systems at Fort Campbell, Kentucky including but not limited to the U.S. Army, AAFES, NAF activities, private contractors, and any and all tenants of the Post. These requirements are subject to the terms and conditions of the utility privatization contract (DACA87-00-D-0043) between the U.S. Army and CH2M.
- B. It is Fort Campbell and CH2M policy that connecting facilities to the water and wastewater utilities must be performed safely and in compliance with all applicable regulations and standards. As such, no water or wastewater connections may be made without prior coordination and approval by CH2M, the Fort Campbell water and wastewater service provider.

1.02 DESIGN AND CONSTRUCTION

- A. Effective August 31, 2003, CH2M is the privatization contractor and operator of the water and sewer systems at Fort Campbell, up to and including a point of demarcation not closer than 5 feet from the exterior of each facility on Post. Typical demarcations occur at a shutoff valve, water meter, or backflow preventer on the water line, or a clean-out on the sewer line. For specific points of demarcation at each facility, contact CH2M directly. Existing and new exterior oil-water separators and grease traps are included in CH2M's system.
- B. It is the policy of CH2M to design and construct any and all improvements to the existing water and sewer infrastructure. CH2M may allow new service lines or laterals from the existing water or sewer infrastructure to be designed and constructed by others, if no changes to the existing infrastructure are required. In all cases, the contractor is responsible to bear the cost of connection of the new facility plumbing pipes to the existing exterior utility piping. It is within CH2M's exclusive right to make the final determination as to who will design and construct new service lines or laterals. Regardless of whether the new service lines or laterals are constructed by CH2M or the customer, the responsibility for connecting the utility piping to the building plumbing will rest with the entity constructing the utility piping.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

1.03 REQUESTS FOR CONNECTION

- A. All requests for connection to the water or sewer systems must be submitted to CH2M as early as possible, but not later than 180 days for CH2M to construct or 60 days for others to construct. The request form *Fort Campbell Application for Water/Wastewater Utilities Service* is available from the CH2M on-site engineer.

Essential information needed with the completed request form includes:

1. date the service is required;
2. location of the facility;
3. building site plan with existing and final topography;
4. finish floor elevation of all floors in all structures;
5. interior plumbing plan;
6. water fixture units, and;
7. special requirements for water service such as fire sprinkler systems, lawn irrigation systems, and industrial or manufacturing processes.

Additional information related to wastewater services includes whether food preparation facilities will be included in any of the structures and whether wastes with characteristics differing from typical domestic wastes will be discharged to the sewer.

- B. CH2M shall submit a letter of commitment to provide service, determining that either the contractor or CH2M will design and construct the service. The letter will include an agreement between the parties for the establishment of new water or sewer service. A fee schedule will also be included, outlining the cost of services by CH2M including permit fees, and design and construction (if applicable).
- C. Charges for all new water or sewer service or improvements are the responsibility of the requesting party. Payment for services must be paid in advance, unless other terms are determined by CH2M.

1.04 DESIGN AND CONSTRUCTION STANDARDS

- A. Design and construction by others shall be in accordance with the latest version of Fort Campbell/Fort Irwin Water, Wastewater and Recycled Water Design and Construction Standards. Water and wastewater utility designs shall be reviewed and approved by CH2M before construction can begin. The customer shall coordinate construction activities with CH2M for inspection. In no case shall water service be turned on until construction has been inspected and approved by CH2M, and record drawings received.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

1.05 CONSERVATION STANDARDS

- A. Fort Campbell has adopted conservation standards for utilities on the Post. The standards dictate the use of low flow plumbing fixtures. The CH2M design standards reflect the use of low flow fixtures in new facilities to be connected to the system.

1.06 WATER METERS/BACKFLOW PREVENTERS/LINE TAPS

- A. CH2M requires water meters on individual facilities.
- B. CH2M requires the customer installation of a backflow preventer on each water service or fire protection service line to each facility per Army and/or state regulations, and requires access for regular inspection. The new backflow preventer must be installed and tested by a licensed interior plumber, and must be inspected and accepted by CH2M.
- C. CH2M will make or inspect all taps to the existing water and sewer lines, for service to new facilities.
- D. CH2M requires detector check valves and vaults on all fire protection lines.

1.07 CONSTRUCTION COMPLETE

- A. At the completion of construction, record drawings must be provided to CH2M along with a completed Form 1354. Final payment to the subcontractor shall be withheld by the Army until such drawings are provided.

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FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

PART 00
GENERAL REQUIREMENTS FOR WATER, WASTEWATER AND RECYCLED
WATER CONNECTIONS AT FORT IRWIN, CALIFORNIA

PART 1 GENERAL

1.01 GENERAL

- A. These requirements apply to all users of the water, sewer and recycled water utility systems at Fort Irwin, California, including but not limited to the U.S. Army, AAFES, NAF activities, private contractors, and any and all tenants of the Post. These requirements are subject to the terms and conditions of the utility privatization contract (DACA87-02-D-0037) between the U.S. Army and CH2M.
- B. It is Fort Irwin and CH2M policy that connecting facilities to the water, wastewater and recycled water utilities must be performed safely and in compliance with all applicable regulations and standards. As such, no water or wastewater or recycled water connections may be made without prior coordination and approval by CH2M, the Fort Irwin service provider.

1.02 DESIGN AND CONSTRUCTION

- A. Effective April 1, 2005, CH2M is the privatization contractor and operator of the water, sewer and recycled water systems at Fort Irwin, up to and including a point of demarcation not closer than 5 feet from the exterior of each facility on Post. Typical demarcations occur at a shutoff valve, water meter, backflow preventer, post indicator valve on the water line, or a clean-out on the sewer line. For specific points of demarcation for each facility, contact CH2M directly.
- B. It is the policy of CH2M to design and construct any and all improvements to the existing water, sewer and recycled water infrastructure. CH2M may allow new services lines or laterals from the existing infrastructure to be designed and constructed by others, if no changes to the existing infrastructure are required. In all cases, the subcontractor is responsible to bear the cost of connection of the new facility plumbing pipes to the existing exterior piping. It is within CH2M's exclusive right to make the final determination as to who will design and construct new service lines or laterals. Regardless of whether the new service lines or laterals are constructed by CH2M or the customer, the responsibility for connecting the utility piping to the building plumbing will rest with the entity constructing the utility piping.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

1.03 REQUESTS FOR CONNECTION

- A. All requests for connection to the water, sewer or recycled water systems must be submitted to CH2M as early as possible, but not later than 180 days for CH2M to construct or 60 days for others to construct. The request form *Fort Irwin Application for Water/Wastewater Utilities Service* is available from the CH2M on-site engineer.

Essential information needed with the completed request form includes:

1. date the service is required;
2. location of the facility;
3. building site plan with existing and final topography;
4. required water pressure at each utility connection;
5. peak and average water demand and wastewater load at each connection;
6. finished floor elevation of all floors in all structures;
7. interior plumbing plan (optional);
8. water fixture units, and;
9. special requirements for water service such as fire sprinkler systems, lawn irrigation systems, and industrial or manufacturing processes.

Additional information related to wastewater services includes whether food preparation facilities will be included in any of the structures and whether wastes with characteristics differing from typical domestic wastes will be discharged to the sewer. If so, a wastewater characterization report must be submitted including BOD, COD, TDS, TSS, pH, TKN, nitrate as N, ammonia as N, temperature, MBAS, phenols, TRPH, oil and grease, trihalomethanes, priority pollutants, volatile and semi-volatile organics, inorganics, pesticides, and any other constituent of concern.

- B. CH2M shall submit a letter of commitment to provide service, determining that either the contractor or CH2M will design and construct the service. The letter will include an agreement between the parties for the establishment of new water or sewer or recycled water service. A fee schedule will also be included, outlining the cost of services by CH2M including permit fees, and design and construction (if applicable).
- C. Charges for all new water or sewer or recycled water service or improvements are the responsibility of the requesting party. Payment for services must be paid in advance, unless other terms are determined by CH2M.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

1.04 DESIGN AND CONSTRUCTION STANDARDS

- A. Design and construction by others shall be in accordance with the latest version of Fort Campbell/Fort Irwin Water, Wastewater and Recycled Water Design and Construction Standards. Water, wastewater and recycled water utility designs shall be reviewed and approved by CH2M before construction can begin. The requestor shall coordinate construction activities with CH2M for inspection. In no case shall service be turned on until construction has been inspected and approved by CH2M and record drawings submitted.

1.05 WATER METERS/BACKFLOW PREVENTERS/LINE TAPS

- A. CH2M does not require water meters on individual connections. However, under certain circumstances, the Directorate of Public Works may require a water meter. In those cases, the cost associated with any meters, including installation, maintenance, and reading shall be borne by the requestor.
- B. CH2M requires the installation of a backflow preventer on each water service or fire protection service line to each facility, excluding housing, per Army and/or state regulations, and requires access for regular inspection. The new backflow preventer must be installed and tested by an American Water Works Association (AWWA) or County of San Bernardino certified backflow prevention assembly tester, and must be inspected and accepted by CH2M.
- C. CH2M will make or inspect all connections to the existing water, sewer and recycled lines, for service to new facilities.

1.06 CONSTRUCTION COMPLETE

- A. At the completion of construction, record drawings must be provided to CH2M. Final payment to the subcontractor shall be withheld by the Army until such drawings are provided.

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Part A

Water Distribution System

Design Standards

U.S. Army Directorate of Contracting (DOC)
Fort Campbell/Fort Irwin

Parts Include:

Part A: Water Distribution System Design Standards

Part B: Wastewater Collection System Design Standards

Part C: Recycled Water Distribution System Design Standards

Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction

Part E: Standard Details for Water, Wastewater and Recycled Water Construction

December 2016



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Fort Irwin, CA

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FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

PART A
WATER DESIGN STANDARDS

PART 1 GENERAL

1.01 GENERAL

- A. CH2M shall review for approval all plans for new potable water systems, potable water extensions to new areas, or replacement potable water pipelines.
- B. Water distribution systems shall be designed to maintain treated water quality. Special consideration shall be given to distribution system main sizing, providing for design of multidirectional flow, adequate valving for distribution system control, and provisions for adequate flushing. Systems shall be designed to maximize turnover and to minimize residence times.

PART 2 SYSTEM DESIGN

2.01 PRESSURE

- A. All water mains, including those not designed to provide fire protection, shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow. The normal working pressure in the distribution system shall be approximately 60 to 80 psi, and not less than 35 psi under peak flow conditions.

2.02 DIAMETER

- A. The minimum size of water main that provides for fire protection and serving fire hydrants shall be 8 inches in diameter. Larger size mains will be required if necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure specified in Article Pressure.
- B. The minimum size of water main in the distribution system where fire protection is not provided shall be 6 inches in diameter, minimum. Any departure from minimum requirements shall be justified by hydraulic analysis and future water use, and shall be reviewed for approval by CH2M in situations of special circumstances.

2.03 DEPTH OF PIPELINE COVER

- A. The top of all water distribution pipelines must be a minimum of 3 feet below finished grade, unless otherwise approved by CH2M. Cover shall not exceed

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

6 feet below finished grade within 10 feet of buildings, roads, structures and constructed surface features. Cover shall not exceed 10 feet below finished grade at all locations, unless reviewed for approval by CH2M in situations of special circumstances.

2.04 FIRE PROTECTION

- A. When fire protection is to be provided, system designer shall provide fire flows and facilities that are in accordance with the current, relevant requirements of the National Fire Protection Association (NFPA).
- B. When fire protection is to be provided, final fire protection system design elements including hydrant spacing and post indicator valve locations shall be as approved by Post Public Safety and Fire Marshal.
- C. CH2M upon written request, will conduct hydrant tests. CH2M is required to provide 20 psi at 500 gpm for design. Should additional pressure be required, CH2M may require the design and construction of a booster pump station.

2.05 DEAD ENDS

- A. Dead ends shall be minimized by making appropriate tie-ins whenever practical, to provide increased reliability of service and reduced head loss. Dead ends shall only be installed with CH2M approval, and only under special circumstances.
- B. Dead end mains shall be equipped with a means to provide adequate flushing. Flushing devices shall be sized to provide flows which will give a velocity of at least 2.5 feet per second in the water main being flushed. The flushing device may be provided with a fire hydrant if flow and pressure are sufficient. No flushing device shall be directly connected to any sewer. Coordinate discharge of flows with CH2M.

2.06 MATERIALS

- A. Materials Specifications are in Part D, "Standard Specifications for Water, Wastewater and Recycled Water Construction," Section 33 05 01, Conveyance Piping – General; Section 33 05 01.02, Ductile Iron Pipe and Fittings; and Section 33 05 01.09, Polyvinyl Chloride (PVC) Pressure Pipe and Fittings.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

2.07 CAPACITY

- A. For residential areas, the average daily flow shall be 100 gallons/capita/day. Peak flow shall be calculated using the following formula:

$$\frac{38.2}{(AverageDailyFlow)^{0.167}}$$

where *AverageDailyFlow* is the total cumulative flow in gallons per day.

- B. For other areas, the average daily flow shall be calculated based on an acceptable population equivalent and utilizing the same peaking formula shown above.
- C. The velocity in distribution mains shall typically be between 5 and 10 feet per second. A lower velocity indicates the pipe could be oversized, leading to added pipe costs and sediment problems; a higher velocity implies added head loss adversely affecting flow capability and residual pressures. Velocity is determined by dividing peak domestic flow by cross-sectional area of the pipe selected. If the velocity falls within the given range, the pipe size is acceptable.
- D. Design criteria is taken from U.S. Army Corps of Engineer's Engineering Manual EM 1110-3-160, "Water Supply, General Considerations," April 1984.

PART 3 VALVES

3.01 GENERAL

- A. A sufficient number of valves shall be provided on water mains to minimize inconvenience and sanitary hazards during repairs. Valves shall be located at not more than 500-foot intervals in commercial districts, and at not more than one block, or 800-foot intervals, in other districts. Valve specifications are in Part D: Standards Specifications for Water, Wastewater and Recycled Water Construction.
- B. All service connections shall have corporation stops, curb stops, angle valves, and meter couplings/yokes sized to match adjacent piping.
- C. Post Indicating Valve Locations: Post indicating valves shall be located within CH2M's point of demarcation. Each building with fire protection will require an individual post indicating valve, unless approved otherwise by CH2M. The Post Fire Chief shall have final authority on location of all post indicating valves before construction.

PART 4 HYDRANTS

4.01 LOCATION AND SPACING

- A. Fire hydrants shall be provided at each street intersection and at intermediate points between intersections as recommended by the Post Fire Chief. Generally, fire hydrant spacing shall range from 350 to a maximum 500 feet depending on the area being served.
- B. Consideration shall be given to placing hydrants in locations where traffic disruption is minimized when hoses are lying across the roadway. The Post Fire Chief shall have final authority on number, spacing, and location of all fire hydrants prior to commencing construction.
- C. Water mains not designed to carry fire-flows shall not have fire hydrants connected to them. It is recommended that flushing hydrants be provided on these systems. Flushing devices shall be sized to provide flows which will give a velocity of at least 2.5 feet per second in the water main being flushed. No flushing device shall be directly connected to any sewer.
- D. Hydrant Specifications are in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction,” Section 33 12 19, Water Utility Distribution Fire Hydrants.

4.02 HYDRANT LEADS

- A. The hydrant lead shall be a minimum of 6 inches in diameter. Auxiliary valves shall be installed on all hydrant leads.
- B. Hydrant Drainage:
 - 1. Hydrant drains should be plugged. When the drains are plugged the barrels must be pumped dry after use during freezing weather.
 - 2. Where hydrant drains are not plugged, a gravel pocket or dry well shall be provided unless the natural soils will provide adequate drainage.
 - 3. Hydrant drains shall not be connected to or located within 10 feet of sanitary sewers, storm sewers, or storm drains.
 - 4. Hydrant drains, where allowed, must be above the seasonal groundwater table.

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DESIGN AND CONSTRUCTION STANDARDS

PART 5 AIR RELIEF VALVES

5.01 AIR RELIEF VALVES AND PIPING

- A. At high points in water mains where air can accumulate provisions shall be made to remove the air by means of air relief valves, combination air relief valves or air/vacuum valve.
 - 1. The open end of an air relief pipe from automatic valves shall be extended to at least 1 foot above grade and provided with a screened, downward facing elbow.
 - 2. Discharge piping from air relief valves shall not connect directly to any storm drain, storm sewer, or sanitary sewer.

PART 6 VALVE, METER AND BLOW-OFF CHAMBERS

6.01 GENERAL

- A. Chambers, pits or manholes containing valves, blow-offs, meters, or other such appurtenances to a distribution system, shall not be located in areas subject to flooding or in areas of high groundwater. Such chambers or pits shall drain to the ground surface, or to absorption pits underground. The chambers, pits and manholes shall not connect directly to any storm drain or sanitary sewer.

PART 7 CROSS-CONNECTIONS AND INTERCONNECTIONS

7.01 CROSS CONNECTIONS

- A. There shall be no connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby non-potable water or other contaminating materials may be discharged or drawn into the system. CH2M maintains and enforces a program conforming to state requirements to detect and eliminate cross connections.

7.02 COOLING WATER

- A. Neither steam condensate, cooling water from engine jackets, nor water used in conjunction with heat exchange devices shall be returned to the potable water supply.

7.03 INTERCONNECTIONS

- A. The approval of CH2M shall be obtained for interconnections between potable water supplies. Consideration shall be given to differences in water quality.

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DESIGN AND CONSTRUCTION STANDARDS

7.04 SEPARATION FROM OTHER UTILITY PIPELINES

- A. A 10-foot horizontal separation from outside of pipe to outside of pipe shall be maintained when a new potable water pipeline is built in parallel to a new or existing recycled water pipeline or sanitary sewer. If a 10-foot horizontal separation is not possible, the potable water pipeline shall be concrete encased to prevent cross-contamination from recycled water pipelines and sanitary sewers. Concrete encasement shall not be controlled low-strength material (CLSM). Concrete encasement shall be in accordance with Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction Section 03 30 10, Reinforced Concrete.
- B. At crossings with recycled water pipelines and sanitary sewers, the potable water pipelines shall be located from the ground surface in the order of descending quality, with potable water above recycled water and recycled water above sanitary sewers. The minimum vertical separation shall be 18-inches between top of recycled water pipeline and bottom surface of potable water pipeline. The minimum vertical separation shall be 18-inches between top of sanitary sewers and bottom of recycled water pipeline. If the minimum vertical spacing is not possible, the potable water pipeline shall be concrete encased to prevent cross-contamination from recycled water pipelines and sanitary sewers. Concrete encasement shall not be controlled low-strength material (CLSM). Concrete encasement shall be in accordance with Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction Section 03 30 10, Reinforced Concrete.

PART 8 WATER SERVICES AND PLUMBING

8.01 PLUMBING

- A. Water services and plumbing shall conform to relevant local and/or state plumbing codes, or to the applicable National Plumbing Code. Solders and flux containing more than 0.2 percent lead, and pipe fittings containing more than 8 percent lead, shall not be used. Plumbing Specifications are in Part D, "Standard Specifications for Water, Wastewater and Recycled Water Construction," Section 33 12 13 (FCP) Water Service Connections and 33 12 13 (FIR) Water Service Connections.

8.02 BACKFLOW PREVENTER

- A. A customer-supplied backflow preventer shall be installed by a certified plumber, according to national plumbing codes, at each service connection to the water main to protect potable water supplies from health hazard contamination by preventing back siphonage and backpressure backflow. Each backflow preventer shall have access for regular inspections, and must

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

be inspected and accepted by CH2M at the time of construction. All new backflow preventers shall be located outside of buildings unless otherwise approved by CH2M.

8.03 BOOSTER PUMPS

- A. Individual booster pumps shall not be allowed for any individual residential service from the public water supply mains without prior written approval from CH2M. If additional pressure is required to operate sprinkler systems as provided in Article Fire Protection, the designer shall notify CH2M in advance.

8.04 WATER SERVICES

- A. Water service lines shall not conflict with existing utilities. Water service lines shall not be located under buildings, ponds, stormwater basins, or other permanent structures.
- B. Material: Material shall be as specified in Part D, "Standard Specifications for Water, Wastewater and Recycled Water Construction," 33 12 13, Water Service Connections.

PART 9 SERVICE METERS

9.01 GENERAL

- A. Each service connection shall be individually metered, unless otherwise approved by CH2M. Meter Specifications are in Part D, "Standard Specifications for Water, Wastewater and Recycled Water Construction," Section 33 12 13 (FCP) Water Service Connections and 33 12 13 (FIR) Water Service Connections.

END OF SECTION

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Part B

Wastewater Collection System Design Standards

U.S. Army Directorate of Contracting (DOC)
Fort Campbell/Fort Irwin

Parts Include:

Part A: Water Distribution System Design Standards

Part B: Wastewater Collection System Design Standards

Part C: Recycled Water Distribution System Design Standards

Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction

Part E: Standard Details for Water, Wastewater and Recycled Water Construction

December 2016



Fort Campbell, KY

Fort Irwin, CA

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FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

PART B
WASTEWATER SYSTEM DESIGN STANDARDS

PART 1 GENERAL

1.01 GENERAL

- A. CH2M shall review for approval all plans for new sanitary sewer systems, sewer extensions to new areas, or replacement separate sanitary sewers in which rainwater from roofs, streets, and other impervious areas as well as groundwater from foundation drains is excluded.
- B. CH2M shall review for approval all plans for sanitary lift/pump stations and force mains.

PART 2 DESIGN CAPACITY AND DESIGN FLOW

2.01 GENERAL

- A. Sewer capacities shall be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, considerations shall be given to the maximum anticipated capacity of institutions, industrial parks, etc.

PART 3 DETAILS OF DESIGN AND CONSTRUCTION

3.01 MINIMUM SIZE

- A. No gravity main line sewer conveying raw wastewater shall be less than 8 inches in diameter. Residential laterals shall not be less than 4 inches in diameter. All other laterals shall be no less than 6 inches in diameter.
- B. Residential duplex buildings may combine the two laterals to one, and temporary buildings may combine two laterals into one before connecting to the main line. All other structures require an individual lateral, unless approved otherwise by CH2M.

3.02 DEPTH

- A. Adequate cover must be provided for frost protection. Generally, a minimum of 24 inches of earth will be required to protect the sewer from freezing. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

3.03 BUOYANCY

- A. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where high groundwater conditions are anticipated.

3.04 SLOPE

- A. Recommended Minimum Slopes: All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Manning’s formula using an “n” value of 0.013. The following are the recommended minimum slopes which should be provided; however, slopes greater than these are desirable. Minimum service lateral slopes shall be 1/4 inch per foot as specified in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction,” Section 33 05 01.12, Gravity Sewer Pipe and Fittings.

Nominal Sewer Size	Minimum Slope in Feet * (per 100 feet)
8-inch	0.40
10-inch	0.28
12-inch	0.22
14-inch	0.17
15-inch	0.15
16-inch	0.14
18-inch	0.12
21-inch	0.10
24-inch	0.08
27-inch	0.067
30-inch	0.058
* For sewers greater than 30-inch diameter, obtain minimum slope requirements from CH2M.	

B. Capacity:

1. Contributing Population: Domestic wastewater quantities normally are to be computed on a contributing population basis, except as noted in Paragraphs Average Daily Flow, and Average Hourly Flow Rate, which

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

follow. The population to be used in design depends upon the type of area which the sewer serves. If the area is strictly residential, the design population is based on full occupancy of all housing and quarters served. If the area served is entirely industrial, the design population is the greatest number, employed in the area at any time, even though some of these persons may also be included in the design of sewers in the residential area. For sewers serving both residential and industrial areas, the design population includes residents and nonresidents, but no person should be counted more than once. For design purposes, one-third of the nonresident population will be added to the resident population.

2. Average Daily Flow: Average daily flow will be computed by multiplying the resident and nonresident contributing populations by 100 gallons per capita per day plus admissible daily flows from commercial and industrial operations. The average daily flow will be used only for designing sewers to serve the entire installation, or large sections of the installation, and where a major portion of the wastewater is generated by residents over a 24-hour period.
3. Average Hourly Flow Rate: When designing sewers to serve small areas of the installation where several buildings or a group of buildings are under construction, and where the majority of wastewater is generated by nonresidents or other short term occupants, the average hourly flow rate will be used. The average hourly flow rate will be computed based on the actual period of waste generation. For example, 1,000 nonresidents at 30 gallons per capita per day would generate 30,000 gallons in 8 hours for an average hourly flow rate of 3,750 gph (90,000 gpd). Note that the average daily flow would still be 30,000 gpd, or 30,000 gallons in 24 hours, but the sewer must be designed hydraulically to carry the 30,000 gallons in 8 hours, not 24 hours.
4. Infiltration: Extraneous flows from ground water infiltration will enter the sewer system and are to be accounted for by adding 500 to 1,000 gpd per inch per mile of pipe as established by CH2M, to the peak rate of flow. Tests required for newly constructed sewers limit leakage to 500 gpd per inch per mile.
5. Gravity Sewer Design: Sewers will be designed to discharge the wastewater flows as required by Paragraph Contributing Population. Generally, it is not desirable to design sewers for full flow, even at peak rates. Trunk and interceptor sewers will be designed to flow at depths not exceeding 90 percent of full depth; laterals and main sewers, 80 percent; and building connections, 70 percent. The minimum sizes to

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DESIGN AND CONSTRUCTION STANDARDS

be used are those required by Paragraph, Minimum Size. The following formula, charts, procedures, and criteria will be used for design.

- a. Design Formula: The Manning formula will be used for design of gravity flow sewers as follows:

$$V = \frac{1.486 R^{2/3} S^{1/2}}{n}$$

Where:

V = velocity in fps

n = coefficient of pipe roughness

R = hydraulic radius in feet, and

S = slope of energy grade line in feet per foot

6. Roughness Coefficient: The roughness coefficient (n) for use in the Manning formula will be 0.013 for pipe sizes 12 inches and larger, and 0.014 for pipe sizes 10 inches and smaller. Variation of “n” with depth of flow has been shown experimentally, and may be considered in designing sewers to flow partially full.
7. Velocity: Sewers will be designed to provide a minimum velocity of 2.0 fps based on the “n” value as defined in Paragraph, Roughness Coefficient at the average daily flow. Maximum velocity is set at 10.0 fps.
8. Slope: Assuming uniform flow, the value “S” in the Manning formula is equivalent to the sewer invert slope. Pipe slopes must be sufficient to provide the required minimum velocities and depths of cover on the pipe as detailed in Paragraph Recommended Minimum Slopes.
9. Minimum Flow Depths: Slopes less than those recommended for the 2.0 feet per second velocity, when flowing full, shall not be permitted.
10. Slope Between Manholes: Sewers shall be laid with uniform slope between manholes.
11. High Velocity Protection: Where velocities greater than 10 feet per second are attained, special provision shall be made to protect against displacement by erosion and impact.
12. Steep Slope Protection: Sewers on 20 percent slopes or greater shall be anchored securely with concrete, or equal, anchors spaced as follows:
 - a. Not over 36 feet, center-to-center, on grades 20 percent and up to 35 percent;
 - b. Not over 24 feet, center-to-center, on grades 35 percent and up to 50 percent;
 - c. Not over 16 feet, center-to-center, on grades 50 percent and over.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

3.05 ALIGNMENT

- A. Sewers 24 inches in diameter or less shall be laid with straight alignment between manholes. Straight alignment shall be checked by using a laser level or lamping. In special cases for critical sewer reaches, CH2M may require that each joint be surveyed by a Professional Land Surveyor.

3.06 CHANGES IN PIPE SIZE

- A. When a smaller sewer transitions to a larger sewer at a manhole, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for maintaining the same energy gradient is to place the 0.8 depth point of both sewers at the same elevation.

3.07 MATERIALS AND INSTALLATION

- A. Materials and Installation Specifications are in Part, D, “Standard Specifications for Water, Wastewater and Recycled Water Construction”.

PART 4 MANHOLES

4.01 LOCATION

- A. Manholes shall be installed as follows:
 - 1. at the end of each line;
 - 2. at all changes in grade, size, or alignment;
 - 3. at intersections;
 - 4. at distances not greater than 400 feet for sewers 15 inches or less; and
 - 5. at distances not greater than 500 feet for sewers 18 to 24 inches;
 - 6. at distances as determined by CH2M for sewers 27 inches and greater.

Cleanouts may be used only for special conditions and shall not be substituted for manholes nor installed at the end of laterals greater than 150 feet in length.

4.02 DROP TYPE

- A. An outside drop pipe shall be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert.

4.03 MATERIALS AND INSTALLATIONS

- A. Materials and Installation Specifications are in Part, D, “Standard Specifications for Water, Wastewater and Recycled Water Construction”.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

- B. Section 33 05 13, Manholes. Installation details for manholes are in Part E, Standard Details for Water, Wastewater and Recycled Water Construction.

PART 5 GREASE TRAPS/INTERCEPTORS

5.01 GENERAL

- A. The Fort Campbell/Fort Irwin Environmental Division states that The Clean Water Act and the NPDES Permit require that certain contaminants be removed from wastewater before it is discharged to the wastewater collection system. Under this pretreatment requirement, wastewater contaminated with grease or oils must be treated to remove the grease or oil before the water can be discharged to the wastewater collection system.

5.02 LOCATION

- A. Grease traps shall be located to provide ease of accessibility for cleaning and servicing. In new construction or renovation, grease traps shall be located outside of the building.

5.03 SIZING

- A. The Uniform Plumbing Code shall be used for sizing grease traps at Fort Campbell. This formula, shown below, takes the number of meals of a restaurant per peak hour and multiplies it by waste flow rate, retention time, and storage factor to get the size requirement. This formulas includes a safety factor, which could yield a seemingly large grease trap capacity. The customer is required to provide the facility seating capacity to calculate the number of meals per peak hour. This information should be readily available to determine grease trap/interceptor size. This process is clarified on the Uniform Plumbing Code's *Grease Interceptor Sizing Worksheet*, which can be made available by the CH2M on-site engineer.

1. Uniform Plumbing Code Formula:
$$\frac{\# \text{ of meals} \times \text{waste flow rate} \times \text{retention time} \times \text{storage factor}}{\text{requirement peak hour}} = \text{size}$$
- a. Number of meals served at peak operating hour (Seating Capacity) x Peak Factor:
 - 1) Where Peak Factor for fast food restaurant is 1.33.
 - 2) Peak Factor for all other food service types is 1.00.
- b. Waste Flow Rate:
 - 1) With Dishwasher: 6-gallon flow.
 - 2) Without Dishwasher: 5-gallon flow.
 - 3) Single Service Kitchen: 2-gallon flow.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

- 4) Food Waste Disposer: 1-gallon flow.
- c. Retention Times:
 - 1) Commercial Kitchen Waste/Dishwasher: 2.5 hours.
 - 2) Single Service Kitchen/Single Serving: 1.5 hours.
- d. Storage Factors:
 - 1) Fully-Equipped Commercial Kitchen/8-Hr. Operation: 1.
 - 2) Fully-Equipped Commercial Kitchen/16-Hr. Operation: 2.
 - 3) Fully-Equipped Commercial Kitchen/24-Hr. Operation: 3.
 - 4) Single Service Kitchen: 1.5.

PART 6 SEWERS IN RELATION TO STREAMS

6.01 LOCATION OF SEWERS IN STREAMS

A. Cover Depth:

1. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. The depth shall be established based upon a stream scour analysis performed by the designer. In all cases, the following minimum cover requirements shall be met:
 - a. 1 foot of cover where the sewer is located in rock.
 - b. 3 feet of cover in other material (in major streams, more than 3 feet of cover may be required).
 - c. In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.
 - d. Less cover will be approved by CH2M and other authorities having jurisdiction only if the proposed sewer crossing will not interfere with the future improvements to the stream channel. Justification for requesting less cover shall be provided in the project design report.

B. Horizontal Location: Sewers located along streams shall be located outside of the stream bed and sufficiently removed from the stream embankment to provide for future possible stream widening and to prevent pollution by siltation during construction.

C. Structures: The sewer outfalls, headwalls, manholes, gate boxes, or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream. Structures shall be located a minimum of 10 feet from stormwater basins. If disturbance is made to surfaces, structures shall be adjusted to match grade.

D. Alignment: Sewers crossing streams shall be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be free from

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DESIGN AND CONSTRUCTION STANDARDS

change in grade. Sewer systems shall be designed to minimize the number of stream crossings.

6.02 CONSTRUCTION

- A. Materials: Sewers entering or crossing streams shall be constructed of ductile iron pipe with restrained mechanical joints; specified in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction”, Section 33 05 01.02, Ductile Iron Pipe and Fittings. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.
- B. Siltation and Erosion: Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods shall provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbance or uprooting of trees and vegetation, dumping of soil or debris, or pumping of silt-laden water into the stream. Specifications shall require that cleanup, grading, seeding, and planting or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than 7 days.

PART 7 AERIAL CROSSINGS

7.01 GENERAL

- A. Support shall be provided for all joints of pipe used for aerial crossings. The supports shall be designed to prevent frost heave, overturning, and settlement. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between aboveground and belowground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize frost heaving. For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the 50-year flood elevation. Pipeline supports for aerial crossings shall not be attached or affixed to bridges or walkways, unless the authority having jurisdiction grants approval.
- B. Ductile iron pipe with restrained mechanical joints shall be required for aerial crossings as specified in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction”, Section 33 05 01.02, Ductile Iron Pipe and Fittings.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

PART 8 PROTECTION OF WATER SUPPLIES

8.01 GENERAL

- A. When wastewater sewers are proposed in the vicinity of any water supply facilities, requirements of Part A “Water Distribution System Design Standards” should be used to confirm acceptable separation distances in addition to the following requirements.
- B. Cross-Connections Prohibited: There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No potable water pipe shall pass through or come into contact with any part of a sewer manhole.

8.02 RELATION TO POTABLE AND RECYCLED WATER MAINS

- A. Horizontal and Vertical Separation Specifications are located in Part D, Standard Specifications for Water, Wastewater and Recycled Water Construction, Section 33 05 01.12, Gravity Sewer Pipe and Fittings. Standard Drawings are in Part E, Standard Details for Water, Wastewater and Recycled Water Construction.
- B. Crossing Specifications are located in Part D, Standard Specifications for Water, Wastewater and Recycled Water Construction, Section 33 05 01.12, Gravity Sewer Pipe and Fittings. Standard Drawings are in Part E, Standard Details for Water, Wastewater and Recycled Water Construction.

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Part C

Recycled Water Distribution System Design Standards

U.S. Army Directorate of Contracting (DOC)
Fort Irwin

Parts Include:

Part A: Water Distribution System Design Standards

Part B: Wastewater Collection System Design Standards

Part C: Recycled Water Distribution System Design Standards

Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction

Part E: Standard Details for Water, Wastewater and Recycled Water Construction

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PART C
RECYCLED WATER DISTRIBUTION SYSTEM DESIGN
STANDARDS FOR FORT IRWIN

PART 1 GENERAL

1.01 GENERAL

- A. This Part C Recycled Water Distribution System Design is only applicable to Fort Irwin, CA.
- B. CH2M shall review for approval all plans for new recycled water systems, recycled water extensions to new areas, or replacement recycled water pipelines.
- C. Recycled water distribution systems shall be designed to maintain separation from any potable water system and to preserve potable water quality. Special consideration should be given to recycled water distribution system main sizing, providing for design of multidirectional flow, adequate valving for distribution system control, and provisions for adequate flushing.

PART 2 SYSTEM DESIGN

2.01 PRESSURE

- A. All recycled water mains, shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The recycled water system shall be designed to maintain a normal working pressure in the recycled water distribution system pressure should be approximately 60 to 80 psi, and not less than 35 psi under peak flow conditions.

2.02 DIAMETER

- A. The minimum size of recycled water main in the distribution system shall be 6 inches in diameter, minimum. Any departure from minimum requirements shall be justified by hydraulic analysis and future water use, and shall be reviewed for approval by CH2M.

2.03 DEPTH OF PIPELINE COVER

- A. The top of all recycled water distribution pipelines shall be a minimum of 4 feet below finished grade to locate generally below potable water pipelines. Design consideration must be given to utility crossings. See Part 7, Cross-Connections and Interconnections.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

2.04 DEAD ENDS

- A. Dead ends shall be minimized by making appropriate tie-ins whenever practical, in order to provide increased reliability of service and reduce head loss.

2.05 MATERIALS

- A. Materials Specifications are in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction,” Section 33 05 01, Conveyance Piping – General; Section 33 05 01.02, Ductile Iron Pipe and Fittings; and Section 33 05 01.09, Polyvinyl Chloride (PVC) Pressure Pipe and Fittings.
- B. Pipe materials used for recycled water pipelines shall be color coded and/or marked to indicate recycled water as specified.

PART 3 VALVES

3.01 GENERAL

- A. A sufficient number of valves shall be provided on recycled water mains to minimize inconvenience and sanitary hazards during repairs. Valves should be located at not more than 500-foot intervals. Valve Specifications are in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction,” Section 33 12 13 (FIR), Water Service Connections.
- B. Valve castings are standard steel castings with a special heavy-duty cover. All valve covers on recycled water transmission pipelines are non-interchangeable with potable water covers. Covers must be painted purple by using Pantone 522.

PART 4 FLUSHING HYDRANTS

4.01 LOCATION AND SPACING

- A. Flushing hydrants may be provided as needed throughout the recycled water system.
- B. Flushing devices should be sized to provide flows which will give a Velocity of at least 2.5 feet per second in the water main being flushed. No flushing device shall be directly connected to any sewer. Coordinate discharge of flows with CH2M.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

4.02 VALVES AND NOZZLES

- A. Recycled Water Post Type Drain Hydrant requirements are in Part E, Standard Details for Water, Wastewater, and Recycled Water Construction, Detail 3312-961.

PART 5 AIR RELIEF VALVES

5.01 AIR RELIEF VALVES AND PIPING

- A. At high points in recycled water mains where air can accumulate provisions shall be made to remove the air by means of air relief valves, combination air relief valves, or air/vacuum valves. Automatic air relief valves shall not be used in situations where flooding of the manhole or chamber may occur.
 - 1. The open end of an air relief pipe from automatic valves shall be extended to at least 1 foot above grade and provided with a screened, downward facing elbow.
 - 2. Discharge piping from air relief valves shall not connect directly to any storm drain, storm sewer, or sanitary sewer.

PART 6 VALVE, METER, AND BLOW-OFF VAULTS

6.01 GENERAL

- A. Wherever possible, vaults, pits or manholes containing valves, blow-offs, meters, or other such appurtenances to the recycled water distribution system, shall not be located in areas subject to flooding or in areas of high groundwater. Such vaults or pits should drain to the ground surface, or to absorption pits underground. The vaults, pits, and manholes shall not connect directly to any storm drain or sanitary sewer.

PART 7 CROSS-CONNECTIONS AND INTERCONNECTIONS

7.01 CROSS CONNECTIONS

- A. There shall be no connection between the recycled water distribution system and any pipes, pumps, hydrants, or tanks whereby a connection to the potable water system may occur. Also, there should be no connection to any pipes or pumps where a connection to the sanitary sewer may occur. CH2M maintains and enforces a program conforming to state requirements to detect and eliminate cross connections.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

7.02 SEPARATION FROM OTHER UTILITY PIPELINES

- A. A 10-foot horizontal separation from outside of pipe to outside of pipe shall be maintained when a new recycled water pipeline is built in parallel to an existing potable water pipeline or sanitary sewer. If a 10-foot horizontal separation is not possible, the potable water pipeline shall be concrete encased to prevent cross-contamination of the potable water service or from a recycled water or sanitary sewer pipeline. Concrete encasement shall not be controlled low-strength material (CLSM). Concrete encasement shall be in accordance with Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction Section 03 30 10, Reinforced Concrete.
- B. At crossings with potable water and sanitary sewer pipelines, recycled water pipelines should be located from the ground surface in the order of descending water quality, with potable water above recycled water and recycled water above sanitary and storm sewers. The minimum vertical separation shall be 18-inches between top of recycled water pipe and bottom surface of potable water pipelines. The minimum vertical separation shall be 18-inches between top of sewers and bottom surfaces of recycled water pipelines. If the minimum vertical spacing is not possible, the potable water pipeline shall be concrete encased to prevent cross-contamination from recycled water pipelines and sanitary sewers. Concrete encasement shall be in accordance with Standard Specifications for Water, Wastewater, and Recycled Water Construction, Section 03 30 10, Reinforced Concrete. Concrete encasement shall not be controlled low-strength material (CLSM). Concrete encasement shall be in accordance with Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction Section 03 30 10, Reinforced Concrete.

PART 8 RECYCLED WATER SERVICES AND PLUMBING

8.01 GENERAL

- A. Recycled water services and plumbing shall conform to relevant local and/or state plumbing codes, or to the applicable National Plumbing Code. Plumbing Specifications are in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction,” Section 33 12 13 (FIR), Water Service Connections.
- B. Material: Material shall be as specified in Part D, “Standard Specifications for Water, Wastewater and Recycled Water Construction,” 33 12 13 (FIR), Water Service Connections. HDPE shall not be allowed.
- C. All service connections shall have corporation stops, curb stops, angle valves, and meter couplings/yokes sized to match adjacent piping.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

- D. Recycled water service lines shall not conflict with existing utilities. Recycled water service lines shall not be located under buildings, ponds, storm water basins, or other permanent structures.

8.02 BACKFLOW PREVENTER

- A. A customer-supplied backflow preventer shall be installed by a certified plumber, according to national plumbing codes, at each service connection from a cooling tower to the recycled water main pipeline to protect recycled water supplies from contamination by preventing back siphonage and backpressure backflow. Each backflow preventer shall have access for regular inspections, and must be inspected and accepted by CH2M at the time of construction.

8.03 BOOSTER PUMPS

- A. Individual recycled water booster pumps shall not be allowed for any individual service from the recycled water supply mains without prior written approval from CH2M. If additional pressure is required to operate an irrigation sprinkler system, the designer shall notify CH2M HILL in advance.

PART 9 RECYCLED SERVICE METERS

9.01 GENERAL

- A. Each recycled service connection should be individually metered, unless otherwise approved in advance by CH2M. Meter Specifications are in Part D, "Standard Specifications for Water, Wastewater and Recycled Water Construction," Section 33 12 13 (FIR), Water Service Connections.

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Part D

Standard Specifications for Water, Wastewater and Recycled Water Construction

U.S. Army Directorate of Contracting (DOC)
Fort Campbell/Fort Irwin

Parts Include:

Part A: Water Distribution System Design Standards

Part B: Wastewater Collection System Design Standards

Part C: Recycled Water Distribution System Design Standards

Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction

Part E: Standard Details for Water, Wastewater and Recycled Water Construction

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DESIGN AND CONSTRUCTION STANDARDS

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3311-824A	3/4, 1, 1-1/2, and 2-Inch Water Service Connection
3311-825-FCP	Outside Installation of Backflow Preventers
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Detail No.	Description
3311-826	Water Service for 2-1/2 Inch and Larger Installations
3311-827-FIR	Outside Installation of Recycled Water Y-Strainer
3311-828	Recycled Water Meter Installation
3312-650	Type A Combination Air Release Valve Assembly up to 2-Inch
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3312-652	Sewage Air and Vacuum Assembly
3312-653-A	Water Blowoff Assembly/Manhole
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4027-645	Section A-A Pressure Reducing Valve
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4027-648	Recycled Water Valve Box Detail

END OF SECTION

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SECTION 01 57 28
TEMPORARY FLOW CONTROL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. Institute of Inspection, Cleaning, and Restoration Certification (IICRC): S500, Standard and Reference Guide for Professional Water Damage Restoration.

1.02 DEFINITIONS

- A. Bypass Pumping: Temporary flow control accomplished by diverting flow away from the Work area using one or more pumps.
- B. Temporary Flow Control: Reducing, limiting, or excluding flow in or to a sanitary sewer, storm sewer, pump station, force main, or other facility as required for performing the Work under the Contract. Draining, handling, and disposal of sanitary sewage and stormwater from pipelines and other facilities as required for performing the Work under the Contract is also part of temporary flow control.
- C. Temporary Flow Control Plan: Plan prepared by Subcontractor containing complete information on how Subcontractor proposes to perform temporary flow control in accordance with specified requirements.

1.03 SYSTEM DESCRIPTION

- A. Provide facilities and controls required to intercept, convey, and discharge flow to be controlled. Include standby and emergency equipment.
- B. Conform to regulatory requirements.
- C. Protect water resources, wetlands, and other natural resources.
- D. Temporary flow control shall be done in a manner that will not damage private or public property, or create a nuisance or public menace. Flow shall be conveyed in enclosed pipes that are adequately protected from traffic or other hazards.

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E. Discharge:

1. As directed by CH2M.
2. Dumping or free flow on private or public property, gutters, streets, or sidewalks is prohibited.
3. Discharge of sanitary sewage to storm sewers, to surface waters or wetlands, or into the ground, is prohibited.

1.04 SITE CONDITIONS

- A. Obtain approval and secure permits for placement of temporary flow control facilities within public right-of-ways.

1.05 SUBMITTALS

A. Informational Submittals:

1. Temporary Flow Control Plan.
2. Emergency Cleanup Plan.
3. Special permits required for temporary flow control.
4. Names and qualifications of industrial hygienist and standby cleanup Subcontractor, including but not limited to, certification by IICRC.
5. Information describing equipment and materials to be used and showing conformance with specified requirements.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Industrial Hygienist and Cleanup Subcontractor: Certified by IICRC.
2. Temporary Flow Control System Designer: Registered Professional Engineer who has at least 5 years' experience in design of such systems and who is registered in the state where the Work is being conducted.

B. Regulatory Requirements:

1. As required by federal state and local government agencies and all authorities having jurisdiction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Install temporary flow control facilities only within CH2M's point of demarcation or easement obtained with approval of CH2M.

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- B. Operate and maintain temporary flow control 24 hours per day, 7 days per week, including without limitation, holidays, as required to control flows.
- C. Promptly remove temporary flow control facilities as soon as they are no longer needed.

3.02 REQUIRED TEMPORARY FLOW CONTROL

- A. Except at pipe sags, depth of flow during television inspection and joint testing shall not exceed that shown below for respective pipe sizes:

Maximum Depth of Flow in Inches	
Pipe Size (Inches)	Television Inspection and Joint Testing
6	1.20
8	1.60
10	2.00
12	3.00
15	3.75
18	4.50
21	5.25
24	6.00
27	8.00
30	9.00
33 and up	30% of Pipe Diameter

- B. Eliminate flow from sewer manhole to manhole segments during manhole construction and sewer pipe replacement or lining within that segment.
- C. If flow reaches peak estimated flow that flow control system was designed for, stop all Work that requires flow control, secure work area, and restore flow until flow recedes.

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3.03 EQUIPMENT AND MATERIALS

A. General:

1. Provide materials and equipment that will ensure continuous and successful operation of temporary flow control systems.
2. Repair or modify systems as necessary.
3. Unless otherwise shown or specified, materials and equipment may be new or used at Subcontractor's option.

B. Plugs:

1. Provide with taps for connection of pressure gauges and air hoses, and flow-through capability.
2. Pipe Diameters 24 Inches and Smaller: Use mechanical plugs with rubber gaskets or pneumatic plugs with rubber boots.
3. Pipe Diameters Larger than 24 Inches:
 - a. Use inflatable bag stoppers made in two or more pieces.
 - b. Manufacturers:
 - 1) Lansas.
 - 2) Cherne Industries.

C. Pumps:

1. Fully automatic, self-priming units that do not require use of foot valves or vacuum pumps in priming system.
2. Solids handling design with ability to pump minimum 3-inch diameter sphere.
3. Able to run dry for long periods of time to accommodate cyclical nature of flows.
4. Engine: Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from source.

D. Electric Power Generators:

1. Be able to simultaneously start and run electric powered pumps required for flow to be controlled.
2. Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from source.
3. Include automatic transfer switch if flow control system is to operate unattended.

E. Standby Equipment:

1. Standby Pump: One of each size to be available onsite.

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2. Electric Power Generators: Minimum of one if temporary flow control system contains electric powered pump. Able to simultaneously start and run electric powered pumps required for flow to be controlled.

3.04 TEMPORARY FLOW CONTROL PLAN

- A. Prepare and submit Temporary Flow Control Plan at least 60 days before starting the Work requiring temporary flow control. Include the following information:
 1. Drawings indicating location of temporary sewer plugs, bypass discharge lines, roadway crossings, and staging areas.
 2. Traffic Control Plan specifically applicable to temporary flow control adhering to requirements of applicable agencies and as may be specified in Contract Documents.
 3. Locations where flow will be intercepted and discharged, and protection of discharge structure.
 4. If trucks are to be employed include the following:
 - a. Numbers and sizes of trucks.
 - b. Configuration of facilities to be used to load trucks at each interception location.
 - c. Locations where trucks will unload.
 - d. Time for loading, unloading, and travel.
 5. Complete descriptions, noise control, and performance characteristics of pumps, electric power generators, and standby equipment.
 6. Details of temporary force mains, including horizontal and vertical alignments, pipe materials, protection of existing buried and aboveground facilities and improvements, maintenance of traffic and access to properties.
 7. Design calculations proving adequacy of temporary system and selected equipment to convey all flows.
 8. Drawings showing layouts and configurations of temporary flow control facilities and also showing locations relative to CH2M points of demarcation.
 9. Drawings and design calculations of temporary bulkheads and plugs.
 10. Drawings and design calculations for thrust restraint of temporary piping.
 11. Details of system controls and control logic; include diagrams and narrative.
 12. Anticipated schedule for the Work.
 13. Other information to completely describe temporary flow control facilities and conformance to specified requirements.
 14. Details of contingency plan.
 15. Anticipate coordination needs with CH2M.

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DESIGN AND CONSTRUCTION STANDARDS

3.05 EMERGENCY CLEANUP PLAN

- A. Prepare and submit not less than 60 days before scheduled date of temporary flow control activities. As a minimum plan shall include the following:
 - 1. Procedures for removal of water.
 - 2. Procedures for determining nature and extent of damage and required restoration where restoration is possible.
 - 3. Provide for industrial hygienist and standby Subcontractor for cleanup of exterior and building interior spaces that might be affected by a spill, backup, or overflow. Industrial hygienist and cleanup Subcontractor shall be certified by IICRC and follow IICRC S500 for cleanup of Category 3 water.
- B. Implement for Full Scale Test and during temporary flow control.

3.06 BLOCKING FLOW

- A. Flow control may consist of blocking flow with mechanical or pneumatic plugs if only small amount of flow needs to be controlled and adequate storage is available.
- B. Use primary and secondary plugs for each flow control location.
- C. When blocking flow is no longer needed for performance and acceptance of the Work, remove plugs in a manner that permits sewage flow to slowly return to normal without surcharging or causing other major disturbances downstream.
- D. Remove temporary plugs at end of each working day and restore normal flow. If downstream work is not or cannot be completed during workday provide, operate, and maintain bypass pumping system or other method of flow control to accommodate flows.

3.07 PIPING

- A. Minimize disturbance of existing utilities.
- B. Where temporary flow control pipelines cross streets and private driveways, install pipeline in trench and cover with temporary pavement. Requests to lay temporary pipe at grade with crossover ramps shall be submitted to CH2M and Directorate of Public Works for approval. Note that approval may not be granted.
- C. Installation of bypass pipelines is prohibited in salt marsh/wetland areas.

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3.08 TEMPORARY SANITARY SEWAGE FLOW REDUCTION

- A. Subcontractor may request through CH2M sewer service customers upstream of the Work area to reduce or curtail sewer flow.
 - 1. First Notice: Not less than 1 week nor more than 2 weeks prior to when sewer flow reduction or curtailment is requested.
 - 2. Second Notice: Not more than 24 hours nor less than 12 hours prior to when sewer flow reduction or curtailment is requested.
- B. When service lateral must be disconnected from main for more than 1 day, lateral shall be positively drained or pumped a minimum of four times per day at regular intervals. Monitor status of flow and storage. Pump lateral more frequently where flows exceed storage capacity of lateral, or additional temporary storage may be provided by Subcontractor.
- C. Temporarily restore full flow services in uncompleted sections during nonwork hours.
- D. Promptly notify sewer service customers that were requested to reduce or curtail sewer flow when the Work is complete and full uninterrupted service restored.
- E. Subcontractor shall be responsible for control of sewage flows and under no circumstances be entitled to rely on flow reduction or curtailment by upstream sewer service customers.

3.09 DRAINING EXISTING PIPELINE

- A. Before initiating shutdown, ensure required materials, equipment, and labor are available onsite. Excavate and expose portions of existing pipeline to be removed.
- B. Provide tap and piping in place to drain sewage from existing pipeline before it is cut and to capture contents that may drain out when pipe is cut.
- C. Sewage drained shall be conveyed and discharged as directed by CH2M.

3.10 FIELD QUALITY CONTROL

- A. Hydrostatic Pressure Test for Pump Bypass Systems:
 - 1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times maximum operating pressure of system.
 - 2. Notify CH2M 24 hours prior to testing.

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B. Full Scale Test:

1. At least 14 days prior to test, notify CH2M of date and time of test.
2. Do not begin temporary flow control activities until successful test has been completed.
3. Conduct on proposed temporary flow control at least 14 days before scheduled date of actual proposed temporary flow control.
4. Purpose of test is to demonstrate capability, function, and reliability of Subcontractor's proposed method of temporary flow control.
5. Duration: Minimum of 4 hours.
6. Conduct between 8:00 a.m. and 4:00 p.m. Do not conduct test on Saturday, Sunday, or holiday.
7. If electric pumps are being used, provide standby generators to ensure continuity of pumping operation in event of power failure.
8. Demonstrate system controls and operation, reliability, and transfer to standby equipment during test.
9. Conduct until flow is accommodated for minimum specified test duration.
10. Failure:
 - a. Test shall be deemed to have failed if during test flows are not accommodated for whatever reason and for whatever length of time.
 - b. If test fails, determine and correct deficiencies that caused test to fail and conduct another Full Scale Test.
11. Determination by CH2M of a successful test, permission by Engineer to proceed with the Work requiring temporary flow control, or anything else shall not relieve Subcontractor from responsibility to provide temporary flow control.

END OF SECTION

SECTION 03 30 10
REINFORCED CONCRETE

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
 - a. 117/117R, Standard Tolerances for Concrete Construction and Materials.
 - b. 301, Specifications for Structural Concrete.
 - c. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - d. 305.1, Specification for Hot Weather Concreting.
 - e. 306.1, Specification for Cold Weather Concreting.
 - f. 309R, Guide for Consolidation of Concrete.
 - g. 318M, Building Code Requirements for Structural Concrete.
 - h. 347, Guide to Formwork for Concrete.
 - i. SP-66, Detailing Manual.
 2. ASTM International (ASTM):
 - a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - e. C33, Standard Specification for Concrete Aggregates.
 - f. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - g. C78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Three-Point Loading).
 - h. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - i. C94, Standard Specification for Ready-Mixed Concrete.
 - j. C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
 - k. C150, Standard Specification for Portland Cement.
 - l. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.

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- m. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - n. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - o. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
 - p. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - q. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
 - r. C452, Standard Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate.
 - s. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
 - t. C494, Standard Specification for Chemical Admixtures for Concrete.
 - u. C595, Standard Specification for Blended Hydraulic Cements.
 - v. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - w. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
 - x. C1042, Standard Test Method for Bond Strength of Latex Systems Used with Concrete by Slant Shear.
 - y. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion penetration.
 - z. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - aa. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- 3. Concrete Reinforcing Steel Institute (CRSI):
 - a. Placing Reinforcing Bars.
 - b. Manual of Standard Practice.
 - 4. International Code Council (ICC): Evaluation Services Report.
 - 5. Wire Reinforcement Institute (WRI): WWR-500, Manual of Standard Practice, Structural Welded Wire Reinforcement.
 - 6. National Institute of Standards and Technology (NIST): Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices.
 - 7. National Ready Mixed Concrete Association (NRMCA).

1.02 DEFINITIONS

- A. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16 inch deep, surface voids

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greater than 3/4 inch in diameter, cracks in liquid containment structures and below-grade habitable spaces that are 0.005 inch wide and wider, and cracks in other structures that are 0.010 inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

- B. Exposed Concrete: Concrete surfaces that can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.
- C. Hydraulic Structures: Liquid containment facilities.
- D. New Concrete: Less than 60 days old.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings:
 - a. Product Data: Admixtures, bonding agent, bond breaker, plastic and hydrophilic waterstops, and patching materials.
 - b. Design Data: Concrete mix designs including aggregate gradations and admixtures, in accordance with ASTM C94.
 - c. Reinforcement Detail and Placement: Prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66, including bend lists and placement drawings and details.
 - d. Detailed plan for placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F (hot weather) and below 40 degrees F (cold weather), if applicable to the conditions at the time of concrete pour.
 - e. Concrete repair methods and materials when required.
 - f. Manufacturer's data for formwork materials and system, form ties and form release agent.

B. Informational Submittals:

- 1. Manufacturer's application instructions for bonding agent and bond breaker.
- 2. Manufacturers' Certificate of Compliance:
 - a. Portland cement.
 - b. Admixtures.
 - c. Fly ash.
 - d. Aggregates.

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- e. Bonding agent.
- f. Bond breaker.
- g. Patching materials.
- h. Admixtures: Manufacturers' Certificate of Proper Installation.

1.04 QUALITY ASSURANCE

- A. Concrete: Meet the requirements of ACI 318.
- B. Qualifications:
 - 1. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.
- C. Hot Weather Concreting: Conform to ACI 305.1.
- D. Cold Weather Concreting: Conform to ACI 306.1.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not use concrete curing compounds where solvents in the curing compounds are prohibited by state and federal laws and regulations. Use only water-based curing compounds.

1.06 REINFORCEMENT DELIVERY, STORAGE AND HANDLING

- A. Unload, store and handle reinforcing bars in accordance with CRSI publication "Placing Reinforcing Bars."

1.07 FORMWORK DESIGN REQUIREMENTS

- A. Design formwork in accordance with ACI 347 and ACI 318 to provide concrete finishes specified.
- B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure in accordance with ACI 347.
- C. Make joints in forms watertight.
- D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

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DESIGN AND CONSTRUCTION STANDARDS

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wall and Miscellaneous Forms:

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.

B. 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. 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.
2. Form release agents certified to be NSF 61 approved shall be used for concrete that will be in contact with potable drinking water. Manufacturers with NSF 61 certified products:
 - a. Unitex Chemicals; Farm Fresh.
 - b. Atlas Construction Supply, Inc.; Bio-Guard.
 - c. Or approved equal.
3. Non-NSF 61 certified form release agents can be used for concrete that that does not contact potable drinking water. Manufacturers and Products:
 - a. BASF, Shakopee MN; MBT, Rheofinish 211.
 - b. Cresset Chemical Company; Crete-Lease 20-VOC.
 - c. Or approved equal.

C. 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 will leave no metal closer than 1.5 inches 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 1.5-inch depth and sufficient dimensions to permit patching of tie hole.
5. Through-Bolts: Tapered minimum 1-inch diameter at smallest end.

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2.02 CONCRETE AND ADMIXTURES

A. Cement: Furnish from one source.

1. Portland Cement: Type I or Type II:
 - a. Meet ASTM C150.
 - b. Alkalis: Maximum 0.60 percent.
 - c. Tricalcium Aluminate Content of Type I Cement: Maximum 12 percent.
 - d. Nonhydraulic Abovegrade Structures: Type I or Type II cement.
 - e. Hydraulic Structures: Type II cement or combination of Type I mixed with fly ash.
 - f. Combine fly ash with cement at batch plant or during production of cement in accordance with ASTM C595, Type IP cement.
2. Ready-Mixed Cement: Conforming to ASTM C94, Option A.
3. Admixtures:
 - a. Characteristics: Compatible with each other and free of chlorides or other corrosive chemicals.
 - b. Air Entraining: Conforming to ASTM C260, nontoxic after 30 days and contains no chlorides. Concrete with air-entrainment admixture added shall maintain air percentage as batched, within plus or minus 2 percent for time required for placement into structure or slab.
 - c. Water Reducing: Conforming to ASTM C494, Type A or D.
 - 1) Manufacturers and Products:
 - a) BASF Admixtures Inc., Shakopee, MN; Pozzolith or Polyheed.
 - b) Euclid Chemical Co., Cleveland, OH; Eucon WR-91.
 - c) W. R. Grace & Co., Cambridge, MA; WRDA with HYCOL.
 - d) Or approved equal.
 - d. Superplasticizers: Conforming to ASTM C494, Type F or G. Hold slump of 5 inches or greater for time required for placement. Furnish type as recommended by manufacturer for allowed temperature ranges.
 - 1) Manufacturers and Products:
 - a) BASF Admixtures Inc., Shakopee, MN; Rheobuild or Polyheed at dosage greater than 10 ounces per 100 pounds of cement.
 - b) Euclid Chemical Co., Cleveland, OH; Eucon 537.
 - c) W. R. Grace & Co., Cambridge, MA; Daracem 100.
 - d) Or approved equal.

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- e. Fly Ash: Conforming to C618, Class C or F, except as modified herein:
 - 1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
 - 2) ASTM C618, Table 1, Loss of Ignition: Maximum 3 percent.
 - 3) ASTM C618, Table 2, Water Requirement: Maximum 100 percent of control.

B. Aggregates: Furnish from one source.

- 1. Natural Aggregates:
 - a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
 - b. Free from deleterious coatings and substances in accordance with ASTM C33, except as modified herein.
 - c. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
- 2. Nonpotentially Reactive: In accordance with ASTM C33, Appendix XI, Paragraph X1.1.
- 3. Aggregate Soundness: Test for fine and coarse aggregates in accordance with ASTM C33 and ASTM C88 using sodium sulfate solution.
- 4. Aggregate Size: 1 inch, or smaller.

C. Water: Clean and potable containing less than 500 ppm of chlorides.

2.03 ANCILLARY CONCRETE MATERIALS

A. Expansion Joint Filler: Conform to ASTM D994, 1/2-inch thick, or as otherwise indicated.

B. Non-Shrink Grout:

- 1. Color: To match concrete.
- 2. Nonmetallic, nongas-liberating.
- 3. Prepackaged natural aggregate grout requiring only the addition of water.
- 4. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
- 5. Test in accordance with ASTM C1107/C1107M:
 - a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
 - b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.

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6. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
7. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
8. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
9. Manufacturers and Products:
 - a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 928.
 - b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
 - c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
 - d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
 - e. Or approved equal.

C. Curing Compound:

1. Water-based, high solids content non-yellowing curing compound meeting the requirements of ASTM C309 and ASTM C1315.
2. Moisture Loss: 0.40 kg per square meter per 72 hours maximum.
3. Capable of meeting moisture retention requirements at manufacturer's recommended application rate.
4. Manufacturers and Products:
 - a. Chemrex Inc., Shakopee, MN; Masterkure.
 - b. Euclid Chemical Company, Cleveland, OH; Super Diamond Clear VOX.
 - c. WR meadows, Inc., Hampshire, IL; VOCOMP-30.
 - d. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
 - e. Dayton Superior; Safe Cure and Seal, 30 percent.
 - f. Or approved equal.

D. Evaporation Retardant:

1. Optional: Fluorescent color tint that disappears completely upon drying.
2. Manufacturers and Products:
 - a. Master Builders Co., Cleveland, OH; Confilm.
 - b. Euclid Chemical Co., Cleveland, OH; Eucobar.
 - c. Or approved equal.

E. Bonding Agent:

1. Furnish two-component epoxy.
2. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
3. Manufacturers and Products:
 - a. BASF Building Systems Inc., Shakopee, MN; Concreative.

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- b. Euclid Chemical Co., Cleveland, OH; Euco Epoxy System.
- c. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32.
- d. Or approved equal.

F. Bond Breaker:

- 1. Nonstaining type, providing positive bond prevention.
- 2. Manufacturers and Products:
 - a. Burke Co., San Mateo, CA; Burke Clean Lift Bond Breaker or Burke Tilt Free Bond Breaker.
 - b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.
 - c. Williams Distributors, Inc., Seattle, WA; Williams Tilt-Up Compound.
 - d. Or approved equal.

G. Concrete Surface Repair Mortar System:

- 1. One component cement-based, rheoplastic, flowable mortar repair system.
- 2. Shear bond strength in accordance with ASTM C1042, with 7 day minimum strength of 2,150 psi.
- 3. Application temperature range of 40 to 100 degrees F.
- 4. Compressive strength: ASTM C109, 6,000 psi at 7 days.
- 5. Resistant to freeze-thaw cycles and deicing chemicals.
- 6. Flexural strength of 770 psi at 28 days in accordance with ASTM C78.
- 7. High slump design for improved placement, 4 to 6 inches.
- 8. Rapid chloride permeability in accordance with ASTM C1202, 1,000 coulombs maximum.
- 9. Sulfate resistance in accordance with ASTM C1012, maximum 0.006 percent length change after 8 months.
- 10. Modulus of Elasticity: 4.8×10^6 at 28 days in accordance with ASTM C469.
- 11. Manufacturer and Product:
 - a. Master Builder Technologies; EMACO S66-CR.
 - b. Or approved equal.

2.04 REINFORCING STEEL

A. Deformed Bars:

- 1. Includes stirrups, ties and spirals.
- 2. ASTM A615, Grade 60.
- 3. Welding of reinforcing bars is not permitted.

B. Welded Wire Fabric: Conforming to ASTM A185, or ASTM A497 and ACI 318, using ASTM A82 wire with 75 ksi minimum tensile strength. Furnish flat sheets only, rolled sheets are not permitted.

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C. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
 - a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
 - b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.
2. Mechanical Threaded Connections:
 - a. Furnish metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
 - b. Manufacturers and Products:
 - 1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
 - 2) Richmond Screw Anchor Co., Inc., Fort Worth, TX; Richmond DB-SAE Dowel Bar Splicers.
 - 3) Or approved equal.

D. Accessories:

1. Tie Wire: Black, soft-annealed 16-gauge wire.
2. Bar Supports and Spacers:
 - a. Use precast concrete bar supports and side form spacers, unless otherwise noted. Do not use other types of supports or spacers.
 - b. Precast concrete supports shall have the same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use, and shall have a wire or other device cast into each block for the purpose of attaching them to the reinforcing steel bars.
 - c. Space bar supports so minimum concrete cover is maintained for reinforcing bars between supports.

E. Fabrication: Follow CRSI Manual of Practice. Bend the reinforcing bars cold.

2.05 CONCRETE MIX DESIGN

- A. Design: Select and proportion ingredients using trial batches; sample, cure and test concrete mix through approved independent testing laboratory in accordance with ACI 211.1.
 1. Concrete Compressive Strength, F'_c :
 - a. 4,000 psi at 28 days for structures and structural slabs.
 - b. Concrete compressive strength when concrete is cured and tested in accordance with ASTM C31 and ASTM C39.
 - c. Design lab-cured trial mix cylinders.

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- d. Use additional cement or cement plus fly ash above minimum specified if required to meet average compressive strength, F'_{cr} .
 - e. Use F'_{cr} as basis for selection of concrete proportions as set forth in ACI 301.
 - f. F'_{cr} : Equal to F'_c plus 1,200 when data are not available to establish standard deviation.
2. Slump Range: 3 to 5 inches.
 3. Air Entrainment: 4 to 6 percent, when tested in accordance with ASTM C231.
 4. Fly Ash: Maximum 25 percent, minimum 15 percent of total weight of fly ash plus cement.
 5. Water Reducers: Use in concrete without plasticizers.
 - a. Water-Cement (W-C) ratio (or W-C plus fly ash ratio) shall control the amount of total water added to the concrete. With maximum aggregate size of 1 inch, the maximum W-C ratio with plasticizer shall be 0.45. The maximum W-C ratio without plasticizer shall be 0.50.

B. Proportions:

1. Design mix to meet aesthetic and structural concrete requirements.
2. In accordance with ACI 211.1, unless specified otherwise.

2.06 CONCRETE MIXING

A. General: In accordance with ACI 304R.

B. Mixing: Minimum 70 and maximum 270 revolutions of the mixing drum. Nonagitating equipment shall not be used.

C. Truck Mixers:

1. Equip with electrically actuated counters to readily verify number of revolutions of drum or blades.
2. Counter:
 - a. Resettable, recording type, mounted in driver's cab.
 - b. Actuated at time of starting mixers at mixing speeds.
3. Truck mixer operation shall furnish concrete batch as discharged that is homogeneous with respect to consistency, mix, and grading.
4. If slump tests taken at approximately 1/4 point and 3/4 point of load during discharge give slumps differing by more than 2 inches when specified, slump is more than 4 inches, discontinue use of truck mixer unless causing condition is corrected and satisfactory performance is verified by additional slump tests.
5. Before attempting to reuse unit, check mechanical details of mixer, such as water measuring, and discharge apparatus, condition of blades, speed

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- of rotation, general mechanical condition of unit, admixture dispensing equipment, and clearance of drum.
6. Do not use nonagitating or combination truck and trailer equipment for transporting ready-mixed concrete.
 7. Concrete Volume in Truck:
 - a. Limit to 63 percent of total volume capacity in accordance with ASTM C94 when truck mixed.
 - b. Limit to 80 percent of total volume capacity when central mixed.
 8. Mix each batch of concrete in truck mixer for minimum 70 revolutions of drum or blades at rate of rotation designated by equipment manufacturer.
 9. Perform additional mixing, if required, at speed designated by equipment manufacturer as agitating speed.
 10. Place materials, including mixing water, in mixer drum before actuating revolution counter for determining number of mixing revolutions.
- D. Aggregates: Thoroughly and uniformly wash before use.
- E. Admixtures:
1. Air-Entraining Admixture: Add at plant through manufacturer-approved dispensing equipment.
 2. Water Reducers: Add prior to addition of high range water-reducing admixture (superplasticizers).
 3. High Range Water-Reducing Admixture (Superplasticizers) and Air-Entraining Admixtures:
 - a. Add at concrete plant only through equipment furnished or approved by admixture manufacturer.
 - b. Accomplish variations in slump, working time, and air content for flowable mixes by increasing or reducing high range water reducing admixture (superplasticizers) dose or air-entraining admixture dose at ready-mix plant only.
 - c. Equipment shall provide for easy and quick visual verification of admixture amount used for each dose.
 - d. Add discharge amount to each load of concrete into separate dispensing container, verify amount is correct, and add to concrete.
 - e. Additional dosage of high range water reducing admixture (superplasticizers) may be added in field using manufacturer-approved dispensing when unexpected delays cause too great of slump loss.

2.07 CONCRETE SOURCE QUALITY CONTROL

- A. Cement: Test for total chloride content.

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- B. Fly Ash: Test in accordance with ASTM C311.

2.08 PLASTIC WATERSTOP

- A. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
- B. Specific Gravity: Approximately 1.37.
- C. Shore Durometer Type A Hardness: Approximately 80.
- D. Performance Requirements: COE Specification CRD-C-572.
- E. Type: Center bulb with parallel ribs or protrusions on each side of strip center.
- F. Corrugated or tapered type waterstops are not acceptable.
- G. Thickness: Constant from bulb edge to outside stop edge.
- H. Minimum Weight per Foot of Waterstop: 1.60 pounds for 3/8 inch by 6 inches.
- I. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.
- J. Manufacturers and Products:
 - 1. Vynlex Corp., Knoxville, TN; Catalog No. 03250/VIN: No. RB6-38H (6 inches by 3/8 inch) and No. RB9-38H (9 inches by 3/8 inch).
 - 2. Greenstreak Plastic Products, St. Louis, MO; Catalog No. 03150/GRD: Style 732 (6 inches by 3/8 inch) and Style 735 (9 inches by 3/8 inch).
 - 3. Four Seasons Industries Durajoint, Garrettsville, OH; Catalog No. CSP-162: Type 9 (6 inches by 3/8 inch), and Type 10 (9 inches by 3/8 inch).

2.09 HYDROPHILIC WATERSTOP

- A. For use at construction joints only, where new concrete is placed against existing concrete and as shown on Drawings.
- B. Material shall be a nonbentonite hydrophilic rubber compound.
- C. Manufacturers and Products:
 - 1. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.

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2. Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

- A. Thoroughly clean form surfaces that will 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: Apply form release agent as recommended by the manufacturer.
- C. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.02 ERECTION OF FORMS

- A. General: Unless specified otherwise, follow applicable recommendations of ACI 347.
- B. Beveled Edges (Chamfer):
 1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
 2. Where beveled edges on existing adjacent structures are other than 3/4 inch, match to adjacent beveled edge.
- C. Form Tolerances: Provide forms in accordance with ACI 117, ACI 347, and ACI 318.
- D. Earth cuts may be used for forming footings.

3.03 FORM REMOVAL

- A. Non-supporting forms (sides of beams, walls, columns, and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
 1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 2. Curing and protection operations are maintained.
- B. Remove forms with care to prevent scarring and damaging the surface of the concrete.

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3.04 REINFORCING BAR PREPARATION

- A. Notify Engineer and CH2M when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.
- B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.
- C. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.05 REINFORCING BAR INSTALLATION

- A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.
- B. Spacing and Positioning: Conform to ACI 318.
- C. Location Tolerances: In accordance with CRSI publication, "Placing Reinforcing Bars."
- D. Splicing:
 - 1. Follow ACI 318.
 - 2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
 - 3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
 - 4. Stagger splices in adjacent bars where indicated.
- E. Mechanical Splices and Connections:
 - 1. Use only in areas specifically approved in writing by Engineer.
 - 2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
 - 3. For metal sleeve splice, follow manufacturer's installation recommendations.
 - 4. Maintain minimum edge distance and concrete cover.
- F. Tying Reinforcing Bars:
 - 1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
 - 2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

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- G. Reinforcement around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.
- H. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.
- I. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.06 PLACING CONCRETE

- A. Preparation: Meet requirements and recommendations of ACI 304R and ACI 301, except as modified herein.
- B. Inspection: Notify Engineer and CH2M at least one full working day in advance before starting to place concrete.
- C. Discharge Time:
 - 1. As determined by set time, do not exceed 1-1/2 hours after adding cement to water unless special approved time delay admixtures are used. Coordinate time delay admixture information with manufacturer and Engineer prior to placing concrete.
 - 2. Adjust slump or air content at Site by adding admixtures for particular load when approved by Engineer. Then, adjust plant dosage for remainder of placement. Additional dosage at Site shall be through approved dispenser supplied by admixture manufacturer.
 - 3. Maintain required slump throughout time of concrete placement and consolidation. Discontinue use of high range water reducing admixture (superplasticizers) and provide new mix design if it fails to maintain slump between 4 and 8 inches and produce good consolidation for length of time required. Redesign mix adjusting set control admixtures to maintain setting time in range required.
- D. Placement into Formwork:
 - 1. Before depositing concrete, remove debris and foreign material from space to be occupied by concrete.
 - 2. Prior to placement of concrete, dampen fill under slabs on ground, dampen sand where vapor retarder is specified, and dampen wood forms.
 - 3. Reinforcement: Check for proper placement and clearances, and correct deficiencies. Secure in position before placing concrete.
 - 4. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel

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- above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
5. Use placement devices, for example, chutes, pouring spouts, and pumps.
 6. Vertical Free Fall Drop to Final Placement: 5 feet in forms 8 inches or less wide and 8 feet in forms wider than 8 inches, except as specified.
 - a. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
 - b. Limit free fall to prevent segregation caused by aggregates hitting reinforcing steel.
 7. Do not use aluminum conveying devices.
 8. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
 9. Joints in Footings and Slabs:
 - a. Ensure space beneath plastic water stop completely fills with concrete.
 - b. During concrete placement, make visual inspection of entire water stop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, place remaining concrete to full height of slab.
 - d. Apply procedure to full length of waterstops.
 10. If reinforcement is in direct sunlight or is more than 20 degrees F higher in temperature than concrete temperature before placement, wet reinforcement with water fog spray before placing concrete to cool reinforcement.
 11. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
- E. Conveyor Belts and Chutes:
1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
 2. Do not use chutes longer than 50 feet.
 3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
 4. Conveyor Belts:
 - a. Approved by Engineer.
 - b. Wipe clean with device that does not allow mortar to adhere to belt.
 - c. Cover conveyor belts and chutes.

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- F. Retempering: Not permitted for concrete where cement has partially hydrated.
- G. Pumping of Concrete:
1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to assure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
 2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
 3. Replace pumping equipment and hoses (conduits) that are not functioning properly.
- H. Maximum Size of Concrete Placements:
1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
 2. Joints:
 - a. Locate expansion, control, contraction, and construction joints where shown.
 - b. When expansion or control joints are not shown, provide construction joints at maximum spacing of 40 feet in each direction.
 - c. When expansion or control joint spacing exceeds 60 feet, provide intermediate construction joints at maximum spacing of 40 feet.
 - d. Uniformly space construction joints.
 3. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
 4. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.
- I. Consolidation and Visual Observation:
1. Consolidate concrete with internal vibrators with minimum frequency of 8,000 cycles per minute and amplitude as required to consolidate concrete in section being placed.
 2. Provide at least one standby vibrator in operable condition at placement Site prior to placing concrete.
 3. Consolidation Equipment and Methods: ACI 309R.
 4. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
 5. Vibration consolidation shall not exceed distance of 3 feet from point of placement.
 6. Vibrate concrete in vicinity of joints to obtain impervious concrete.

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7. Vibrate until concrete becomes uniformly plastic.
8. Vibrator must penetrate freshly-placed concrete into previous layer of fresh concrete below.

J. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 305.1.
2. Placement frequency shall be such that lift lines will not be visible in exposed or architectural concrete finishes.
3. Maintain concrete temperature below 90 degrees F at time of placement, or furnish test data or provide other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
4. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
5. Prevent differential temperature between reinforcing steel and concrete.

K. Cold Weather Placement:

1. Do not place concrete when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
2. Do not place concrete against frozen earth or ice, or against forms and reinforcement with frost or ice present.
3. Provide heated enclosures when air temperatures are below 40 degrees F.
4. Maintain surface temperature of concrete above 40 degrees F and cure concrete for minimum of 7 days.
5. Provide maximum and minimum thermometers placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work.
6. In accordance with ACI 306.1 and ACI 301.
7. External Heating Units:
 - a. Vent heating units to atmosphere and do not locally heat or dry concrete. Where water cure is specified, maintain wet condition.
 - b. Do not exhaust heater flue gases (causes concrete carbonation as a result of concentrated carbon dioxide) directly into enclosed area.

3.07 CONCRETE BONDING

A. To Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 1/4 inch.

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2. Saturate surface with water for 24 hours prior to placing new concrete.

3.08 CONSTRUCTION JOINTS

- A. Locate as shown, or as approved.

3.09 REPAIRING CONCRETE – HORIZONTAL CONCRETE REPAIR SYSTEM

- A. Installation:

1. Remove standing water.
2. Apply bond coat slurry to prepare surface.
3. Immediately place mixed repair mortar into prepared area from one side to the other.
4. Work material firmly into bottom and sides of patch to assure a good bond.
5. Level mortar and screed to elevation of existing concrete.
6. Finish to same texture as existing concrete around patch.

- B. Curing:

1. Provide water-based wax, emulsion in accordance with moisture retention requirements of ASTM C309, Type 1, when applied at one gallon to 250 square feet. Apply in accordance with Federal Air Quality Regulation 40 CFR 52.254.
2. Apply membrane forming curing compound at no more than one gallon per 250 square feet, as soon as finishing operation is complete.
3. Apply a second coat of curing compound at no more than one gallon per 250 square feet, after 3 hours, or when first coat is not tacky to the touch.

3.10 CURING OF CONCRETE

- A. General:

1. Protect fresh concrete from direct rays of sunlight, drying winds and wash by rain.
2. Use only water curing on walls and slabs that will be in contact with potable water.
3. Use only water curing where additional finishes, such as painting, cementitious material or other special coatings, are required.
4. Keep concrete slabs continuously wet for a 7-day period. Intermittent wetting is not acceptable.
5. Use curing compound and evaporation retardant only where approved by Engineer. Curing compound and evaporation retardant are to be applied in accordance with the manufacturer's instructions and

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recommendations as soon as the forms are removed and finishing is completed.

6. Remove and replace concrete damaged by freezing.
- B. Use one of the following methods as approved by Engineer:
1. Slabs and Curbs:
 - a. Method 1: Protect surface by water ponding for 7 days.
 - b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
 - c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
 - d. Method 4: Continuously sprinkle exposed surface for 7 days.
 - e. Other agreed upon method that will keep moisture present and uniform at all times on surface of slabs. Do not use curing compounds.
 - f. Where water curing for slabs during cold weather is not possible, use Engineer-approved curing compound at manufacturer's recommended coverage per gallon.
 - g. Where curing compound cannot be used, special methods using moisture shall be agreed upon prior to placing the concrete slabs.
 - h. Protect slabs during cold weather with plastic sheets or other material inside required heated enclosure if foot traffic is permitted on slabs.

3.11 EVAPORATION RETARDANT APPLICATION

- A. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.
- B. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.12 CONCRETE SLAB FINISHES

- A. General:
 1. Finish slab concrete per the requirements of ACI 302.1R.
 2. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
 3. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
 4. Do not dust surfaces with dry materials.
 5. Use evaporation retardant.

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6. Round off edges of slabs with steel edging tool. Steel edging tool radius shall be 1/4 inch for slabs subject to wheeled traffic.
- B. Type S-1 (Steel Troweled Finish to be Used on All New Slabs and Pads in the Project):
1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation. Use evaporation retardant.
 2. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.
 3. Use sufficient pressure on wood floats to bring moisture to surface.
 4. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
 5. Burnish surface with an additional troweling. Final troweling shall produce ringing sound from trowel.
 6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
 7. Power Finishing:
 - a. Approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
 - b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.
 - c. Do first steel troweling for slab S-1 finish by hand.

3.13 INSTALLATION OF WATERSTOPS

- A. Hydrophilic Waterstop:
1. Install in accordance with manufacturer's written instructions.
 2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of reinforcing steel, locate centered between layers of steel or as shown.
 3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
 4. Butt ends of waterstop strip together at splices and corners and join with sealant.
 5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.

3.14 BACKFILL AGAINST WALLS

- A. Do not backfill against walls until wall concrete obtains 100 percent and top supporting slab concrete obtains 80 percent of the specified 28-day compressive strength.

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- B. Place backfill simultaneously on both sides of structure where required, to prevent differential pressures.

3.15 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Provide concrete for testing of slump, air content, and for making cylinders from the point of discharge into forms. When concrete is pumped, Samples used shall be taken from discharge end of pump hose.
3. Evaluation will be in accordance with ACI 301 and Specifications.
4. Specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
5. Frequency of testing may be changed at request of Engineer and approval by CH2M.
6. Pumped Concrete: Take concrete samples for slump (ASTM C143) and test cylinders (ASTM C31 and ASTM C39) at placement (discharge) end of line.
7. Reject concrete represented by cylinders failing to meet strength and air content.

3.16 PROTECTION OF INSTALLED WORK

- A. After curing and after applying final floor finish, cover slabs with plywood, particle board, plastic sheeting or other material, as approved by Engineer, to keep floor clean and protect it from material and damage as a result of other construction work.
- B. Repair defective areas and areas damaged by construction.

END OF SECTION

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SECTION 03 40 00
PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C150, Standard Specification for Portland Cement.
 - b. C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - e. C858, Standard Specification for Underground Precast Concrete Utility Structures.

1.02 SUBMITTALS

A. Action Submittals:

1. Experience record on production of precast structures, indicating the capability to satisfactorily perform the work.
2. Drawings showing precast structure including layouts of top slab hatch and all pipe penetrations.
3. Manufacturer's catalog data on precast concrete items. Show dimensions of structures and locations of openings including thicknesses of walls, floor, and top slab with their reinforcing steel. Show materials of construction by ASTM reference and grade.
4. Manufacturer's design structural calculations and certification signed and sealed by a licensed civil or structural engineer currently registered in the state work is being performed that structure design complies with the specified design load conditions in accordance with the Drawing General Structural Notes and the referenced ASTM specifications (e.g., ASTM C857 and C858).
5. Manufacturer's catalog data, descriptive literature, and installation instructions for the water proofing material.

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PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Precast Concrete Structures specified in this section shall be products of:
1. Jensen Precast.
 2. Utility Vault/Oldcastle.
 3. Brooks Products Inc.
 4. Associated Concrete Products Inc.
 5. Or approved equal.

2.02 PRECAST CONCRETE STRUCTURES

- A. Comply with ASTM C858 and C478 except as modified herein.
- B. Design Live and Dead Loads: In accordance with ASTM C857. Design precast concrete structures to withstand site gravity and lateral soil design criteria as noted on Drawing General Structural Notes.
- C. Minimum Wall and Slab Thickness: 6 inches.
- D. Design and construct structures to be watertight.
- E. Provide openings in precast structures for piping and access in accordance with the Drawings.

2.03 SEALANTS AND MORTAR

- A. Fill joints between precast sections with a double layer of plastic sealing compound to make watertight. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C387, Type S.

2.04 CONCRETE AND STEEL REINFORCEMENT

- A. As specified in Section 03 30 10, Reinforced Concrete.

2.05 WATERPROOFING

- A. Waterproofing Material: Black bituminous compound of brush or spray consistency for application on below grade concrete surfaces.
- B. Manufacturers and Product:
1. Horn, Dehydratine 4.

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2. Select Shield, 301-A.
3. Or approved equal.

2.06 APPURTENANCES

- A. Provide ladders, sidewalk doors, vents, supports, inserts, and other miscellaneous metalwork as shown on the Drawings.

2.07 FABRICATION

- A. Reinforcing Steel:
 1. Place in position before concrete is cast.
 2. Keep clean and free from form oil or other substances harmful to bond.
- B. Forms: Produce smooth surfaces.
- C. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of ACI 304R. Steam curing is permitted.
- D. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

2.08 SOURCE QUALITY CONTROL

- A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.
- B. Test and record concrete strengths.

PART 3 EXECUTION

3.01 EXCAVATING AND BACKFILLING

- A. Provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend horizontally 12 inches beyond the outside faces of the vault and foundation.

3.02 ERECTION

- A. Verify that anchorage inserts are in correct locations.
- B. Handle and erect concrete with care as recommended by manufacturer.

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- C. Erect precast units plumb, straight, level, square, and in proper alignment.
- D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.
- E. Field Cutting: Not allowed without prior approval of Engineer.

3.03 INSTALLING STRUCTURE SECTIONS

- A. Set each precast concrete structure section plumb on a double layer bed of sealant to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

3.04 WATERPROOFING

- A. Waterproofing shall be factory applied to all exterior surfaces of structure sections and risers per manufacturer's recommendations. Prior to backfilling, field-apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

3.05 FIELD QUALITY CONTROL

- A. Inspection:
 - 1. With Engineer and CH2M, inspect precast members for chips, cracks, discoloration, and other damage.
 - 2. Record location and condition of damaged.
- B. Resolution:
 - 1. Repair damage to satisfaction of Engineer and CH2M.
 - 2. Remove members with damage or repairs not acceptable to Engineer and CH2M.
 - 3. Install new acceptable members in place of those removed.
 - 4. Perform reinsertion and obtain acceptance by Engineer and CH2M.

3.06 PROTECTION

- A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to the Site.
- B. After erection, protect units from damage.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.
- D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.
- E. Stripping: Removal of topsoil remaining after applicable scalping is completed.
- F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 QUALITY ASSURANCE

- A. Obtain CH2M's approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.03 SCHEDULING AND SEQUENCING

- A. Prepare Site only after adequate erosion and sediment controls are in place.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Clear, grub, and strip areas actually 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.

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3.02 LIMITS

- A. As follows, but not to extend beyond Project/Construction limits.
 - 1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
 - 2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
 - 3. Waste Disposal:
 - a. Clearing: 5 feet beyond perimeter.
 - b. Scalping and Stripping: Not required.
 - c. Grubbing: Around perimeter as necessary for neat finished appearance.
 - 4. Structures: 10 feet outside of new structures.
 - 5. Roadways: Clearing, grubbing, scalping, and stripping 8 feet from roadway shoulders.
- B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 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 off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

- A. Grub areas within limits shown or specified.

3.05 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.

3.06 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.

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3.07 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite unless otherwise approved by CH2M.
2. Burning of debris onsite will not be allowed.
3. Woody debris may be chipped. Chips may be sold to Subcontractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used onsite shall be 1/4 inch by 2 inches. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
4. Limit offsite 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. Provide certificates of proper disposal.

B. Scalpings: 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 offsite or as approved by CH2M.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

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SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
 - a. Methods and sequencing of excavation.
 - b. Proposed locations of stockpiled excavated material.
 - c. Proposed onsite and offsite spoil disposal sites.
 - d. Numbers, types, and sizes of equipment proposed to perform excavations.
 - e. Anticipated difficulties and proposed resolutions.
 - f. Reclamation of onsite spoil disposal areas.

1.02 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized overexcavation.

1.03 WEATHER LIMITATIONS

- A. Material excavated when frozen or when air temperature is less than 32 degrees 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.

1.04 SEQUENCING AND SCHEDULING

- A. Demolition: Complete demolition prior to excavating.
- B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.
- C. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.
- D. Excavation Support: Install and maintain, as specified in Section 31 41 00, Shoring, as necessary to support sides of excavations and prevent detrimental

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settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, 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 overexcavate without written authorization of Engineer and CH2M.
- C. Remove or protect obstructions encountered.
- D. Use of explosives shall not be allowed.

3.02 UNCLASSIFIED EXCAVATION

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

3.03 TRENCH WIDTH

- A. Minimum Width of Trenches:
 - 1. Construct trenches of sufficient width to meet trench backfill requirements shown on Drawings.
 - 2. Increase trench widths by thicknesses of sheeting or shoring.
- B. Maximum Trench Width: As shown on Drawings. Pipe of greater strength or superior pipe bedding, when approved in writing by Engineer, may be used in lieu of maintaining the pipe trench widths shown or specified.

3.04 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 will not be acceptable.

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3.05 EMBANKMENT AND CUT SLOPES

- A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.
- B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.
- C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.06 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.

3.07 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite within 28 days of excavation unless otherwise directed by CH2M.
- B. Dispose of debris resulting from removal of underground facilities as specified. If not specified dispose of offsite unless otherwise directed by CH2M.

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- C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

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DESIGN AND CONSTRUCTION STANDARDS

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Well permits.
3. Discharge permits.
4. Water Level Elevations Observed in Observation Wells: Submit same day measured.
5. Settlement Benchmark Elevations: Submit weekly record.
6. Inflow Measurements: Submit weekly record.

1.02 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 each system.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.

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

3.01 GENERAL

- A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

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- B. Remove and control water during periods when necessary to properly accomplish Work.

3.02 SURFACE WATER CONTROL

- A. Remove groundwater and surface runoff controls when no longer needed.

3.03 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 25 feet 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.
- C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
- D. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.
- E. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 MONITORING WELLS

- A. Monitoring Groundwater Levels: Install and monitor observation wells at locations shown or selected by Engineer. Measure water levels observed in each observation well at least weekly or frequency stated in Subcontractor's Dewatering Plan and whenever system or component failures are discovered and whenever any event, including but not limited to flood, storms, changes in water surface elevation of nearby water bodies, may have caused a change in the groundwater elevation.
- B. After groundwater level observation wells are no longer needed for monitoring groundwater levels, abandon observation wells, as required by regulations.

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3.05 SETTLEMENT

- A. Monitoring Dewatering-Induced Settlement: Establish monuments for monitoring settlement at locations shown or selected by Engineer. Monitor vertical movement of each settlement monument, relative to remote benchmark selected by Engineer, at least weekly or frequency stated in Subcontractor's Dewatering Plan.

3.06 MONITORING FLOWS

- A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.07 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. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.08 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, bracing, underpinning, or compaction grouting.

3.09 REMEDIATION OF GROUNDWATER 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

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water of a quality and quantity equal to or exceeding the quality and quantity available to well owner prior to beginning the Work or as satisfactory to each well owner.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. D75, Standard Practice for Sampling Aggregates.
 - d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - i. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - j. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

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- B. Optimum Moisture Content:
 - 1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
 - 2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.
- C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with 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 subgrade 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: 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. Satisfying both of the following requirements, as defined in ASTM D2487:
 - 1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
 - 2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.
- I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - 1. 1 foot outside outermost edge at base of foundations or slabs.
 - 2. 1 foot outside outermost edge at surface of roadways or shoulder.
 - 3. 0.5 foot 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.

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- K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.
- L. Imported Material: Materials obtained from sources offsite, 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.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings: Tank manufacturer's recommendations for backfill around each buried tank.
 - 2. Samples:
 - a. Imported material taken at source.
 - b. Geotextile.
- B. Informational Submittals:
 - 1. 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.

1.04 QUALITY ASSURANCE

- A. Notify Engineer when:
 - 1. Structure or tank 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 Specifications.

1.05 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 10 00, Site Clearing and Section 31 23 16, Excavation prior to placing fill or backfill.

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- B. Backfill against concrete structures only after concrete has attained 70 percent of design strength. Obtain Engineer's 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 10, Reinforced Concrete.
- D. Backfill around buried tanks only after tank is set in position, securely anchored, and ready to be backfilled, and Engineer provides authorization to backfill.
- E. Do not place granular base, subbase, or surfacing until after subgrade has been prepared.

PART 2 PRODUCTS

2.01 EARTHFILL

- A. Excavated material from required excavations and designated borrow sites, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.
- B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.
- C. Provide imported material of equivalent quality, if required to accomplish Work.

2.02 GRANULAR FILL

- A. 1-inch minus crushed gravel or crushed rock.
- B. Free from dirt, clay balls, and organic material.
- C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.03 SAND

- A. Free from clay, organic matter, or other deleterious material.
- B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

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<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

2.04 BACKFILL AROUND BURIED TANKS

A. As recommended by tank manufacturer.

2.05 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.06 GRANULAR FILTER MATERIAL

A. Clean, hard, durable gravel, free from foreign materials and washed.

2.07 WATER FOR MOISTURE CONDITIONING

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

2.08 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FCP) or Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FIR).

2.09 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-inch particle size.

2.10 CRUSHED ROCK FOR SUBSTATIONS

- A. Clean, hard, durable crushed rock, free from foreign materials and washed.
- B. Gradation as determined in accordance with ASTM C117 and ASTM C136.

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C. Base Course:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2 inches	100
1-1/2 inches	95 - 100
3/4 inch	55 - 75
1/4 inch	35 - 50
No. 10	4 - 60

D. Finish Grade Rock:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2 inches	100
1-1/2 inches	90 - 100
1 inch	30 - 65
3/4 inch	0 - 15

2.11 SOIL COVER OVER GEOTEXTILES

- A. Particle Size: Maximum 1 inch.
- B. Free of sharp angular pieces that may damage geotextile.

2.12 SOIL COVER OVER GEOMEMBRANES

- A. Granular material.
- B. Particle Size: Maximum 1/4 inch.
- C. Particle Shape: Rounded.

PART 3 EXECUTION

3.01 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

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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 feet 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 23.15, Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. 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.

3.02 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 shown. Place granular fill in lifts of 8-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557 or D698.
- B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 8-inch maximum thickness and compact each lift to minimum of 90 percent relative density.
- C. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch

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maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.

3.03 BACKFILL AROUND TANKS

- A. Backfill to top of tank, unless otherwise shown, with granular fill and thoroughly water settle by saturating backfill and vibrating saturated backfill with a concrete vibrator inserted through full depth of backfill on 1-foot maximum centers.
- B. Backfill above top of tank with earthfill placed in 8-inch lifts. Compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557 or D698 Method.

3.04 FILL

- A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
 - 1. Allow for 6-inch thickness of topsoil where required.
 - 2. Maximum 8-inch thick lifts.
 - 3. Place and compact fill across full width of embankment.
 - 4. Compact to 95 percent relative compaction as determined in accordance with ASTM D1557, based on average of most recent four tests on like material. If any two of the four most recent tests falls below 94 percent or any one of the four preceding tests falls below 94 percent, additional compactive effort will be required.
 - 5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.05 SITE TESTING

- A. Gradation:
 - 1. One sample from each 1,500 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 indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
 - 3. Remove material placed in Work that does not meet Specification requirements.

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B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Earthfill: The testing shall be done at a minimum frequency defined by the minimum of the following:
 - a. One test each 750 cubic yards.
 - b. Three tests for each 2 feet lift of fill placement.
 - c. Three tests per day.

3.06 SAND BLANKET OVER VAPOR RETARDER

A. Place sand in manner that avoids damage to underlying vapor retarder.

B. Moisten sand and thoroughly compact it with a vibratory plate compactor.

3.07 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FCP) or Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FIR).

3.08 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Granular fill.
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 Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
 - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, 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): Earthfill.
 - b. Steep Slopes (Steeper than 3:1):
 - 1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and

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- right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
- 2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.09 SUBSTATION SITE SURFACING

A. Base Course:

1. Installed after Site grading and substation construction is complete.
2. Compact to at least 95 percent of maximum dry density as determined by ASTM D698.

B. Finish Grade:

1. Installed over base course.
2. Finish grade layer shall not be compacted.

3.10 PLACING FILL OVER GEOSYNTHETICS

A. General:

1. Place fill over geosynthetics with sufficient care so as not to damage them.
2. Place fill only by back dumping and spreading only.
3. Dump fill only on previously placed fill.
4. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.

B. Hauling: Operate hauling equipment on minimum of 3 feet of covering.

C. Spreading:

1. Spreading equipment shall be track mounted, low ground pressure, D-6 or lighter.
2. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
3. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
4. Never push fill downslope. Spread fill over sideslopes by pushing up from slope bottom. If access to bottom of slope is unavailable, progressively place fill, beginning at toe of slope and working upslope, with backhoe or dragline operated from top of slope. Limit distance material falls onto the geosynthetics to maximum of 2 feet.

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5. Correct wrinkles in geotextiles.
 6. Maintain proper overlap of unseamed geosynthetics.
 7. Avoid overstressing geosynthetics and seams.
- D. Compaction: Compact fill only after uniformly spread to full thickness shown.
- E. Geosynthetic Damage:
1. Mark punctures, tears, or other damage to geosynthetics, so repairs may be made.
 2. Clear overlying fill as necessary to repair damage.
 3. Repairs to geosynthetics shall be made by certified installers of respective geosynthetics.

3.11 ACCESS ROAD SURFACING

- A. Place and compact as specified in Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FCP) or Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FIR).

END OF SECTION

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SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Public Works Association (APWA): Uniform Color Code.
 2. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - e. C150/C150M, Standard Specification for Portland Cement.
 - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
 - h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
 - j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

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1.02 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material: Material obtained by Subcontractor from source(s) offsite.
- D. Lift: Loose (uncompacted) layer of material.
- E. Pipe Zone: 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: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.
- G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- H. Relative Density: As defined by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.
- J. Well-Graded: 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. Satisfying both of the following requirements, as defined in ASTM D2487:
 - 1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
 - 2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

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1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tape/tracer wire.
2. Samples: Geotextile.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. 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.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 6 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape.
 - b. Mutual Industries; Non-detectable Tape.
 - c. Presco; Non-detectable Tape.

B. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 6 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

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- 6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
- 7. Manufacturers and Products:
 - a. Reef Industries; Terra Tape, Sentry Line Detectable.
 - b. Mutual Industries; Detectable Tape.
 - c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code.

Color*	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	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.02 TRACER WIRE

- A. Material: Minimum 12-gauge solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.
- B. Splices: Use wire nut or lug suitable for direct burial as recommended by tracer wire manufacturer.
- C. Manufacturers:
 - 1. Copperhead Industries, LLC.
 - 2. Performance Wire & Cable Inc.
 - 3. Pro-line Safety Products Company.

2.03 TRENCH STABILIZATION MATERIAL

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

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B. Granular Backfill:

1. Clean gravel or crushed rock, reasonably well-graded from coarse to fine.
2. Maximum Particle Size: 1-inch.
3. Dry sand, accepted by Engineer, may be provided for trenches above maximum groundwater level.

2.04 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 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
5. Conduit and Direct-Buried Cable:
 - a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
 - b. Individual Particles: Free of sharp edges.
 - c. Maximum Size Particle: Pass a No. 4 sieve.
 - d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.05 EARTH BACKFILL

A. As specified in Section 31 23 23, Fill and Backfill.

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2.06 PROCESSED EARTH BACKFILL

- A. Class A Backfill: Earth backfill, meeting the following additional requirement.
 - 1. Cohesionless, free-draining material with 100 percent passing 3-inch sieve, at least 70 percent passing 1-1/2-inch sieve, and less than 10 percent passing No. 200 sieve.

2.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials:
 - 1. Cement: ASTM C150/C150M, Type I or Type II.
 - 2. Aggregate: ASTM C33/C33M, Size 7.
 - 3. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
 - a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
 - 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.08 CONCRETE BACKFILL

- A. Provide as specified in Section 03 30 10, Reinforced Concrete.

2.09 GRAVEL SURFACING ROCK

- A. As specified in Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FCP) or Section 32 11 23, Aggregate Base Courses and Gravel Surfacing (FIR).

2.10 TOPSOIL

- A. Minimum 6-inch lift consistent with adjacent topsoil and capable of supporting vegetative cover growth requirements.

2.11 SOURCE QUALITY CONTROL

- A. Perform gradation analysis in accordance with ASTM C136 for:
 - 1. Earth backfill, including specified class.
 - 2. Trench stabilization material.
 - 3. Bedding and pipe zone material.

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- B. Certify Laboratory Performance of Mix Designs: Controlled low strength material.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

- A. Water Control:
 - 1. 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.
 - 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 3. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

- A. Firm Subgrade: 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 shown or specified.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 GEOTEXTILE INSTALLATION

- A. Where shown on Drawings or standard details, except as follows:
 - 1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
 - 2. Anchor geotextile trench walls prior to placing trench stabilization or bedding material.
 - 3. Provide 24-inch minimum overlap at joints.

3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.

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

3.05 BEDDING

- A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.
- B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness: As follows:
 - 1. Pipe 15 Inches and Smaller: 4 inches.
 - 2. Pipe 18 Inches to 36 Inches: 6 inches.
 - 3. Pipe 42 Inches and Larger: 8 inches.
 - 4. Conduit: 3 inches.
 - 5. Direct-Buried Cable: 3 inches.
 - 6. Duct Banks: 3 inches.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches 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: 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.

3.06 BACKFILL PIPE ZONE

- A. Upper limit of pipe zone shall not be less than following:
 - 1. Pipe: 12 inches, unless shown otherwise.
 - 2. Conduit: 3 inches, unless shown otherwise.
 - 3. Direct-Buried Cable: 3 inches, unless shown otherwise.
 - 4. Duct Bank: 3 inches, unless shown otherwise.

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- 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. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
 - 2. Pipe Over 10-Inch Diameter: Maximum 6-inch 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 voids are completely filled before placing each succeeding lift.
- E. Each lift shall be compacted with a minimum of two passes by either a vibratory plate compactor or a power-driven impact compactor. Take care to avoid damaging pipe and pipe coating.

3.07 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of buried piping, shown on Drawings. Coordinate with piping installation drawings.
 - 1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
 - 2. Nondetectable Marking Tape: Install with metallic piping.

3.08 TRACER WIRE INSTALLATION AND TESTING

- A. Install tracer wire continuously along centerline of nonmetallic buried piping.
- B. Attach wire to top of pipe using tape at maximum of 10-foot intervals. In areas where depth of cover is excessive for allowing detection of tracer wire with electronic pipe locator, install tracer wire within pipe backfill directly above pipe centerline at a minimum depth of 3 feet.
- C. Install splices in accordance with manufacturer’s instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.
- D. Bring tracer wire to surface at each valve box, curb box, vault, air valve, blowoff valve, hydrant, and pipeline marker. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Mark valve

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box cover with the word "TRACER". Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.

- E. Test continuity of tracer wire using electronic pipe locator in presence of Engineer and CH2M prior to paving.

3.09 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 trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet 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 shown or specified.

B. Class A Backfill:

1. Place in lifts not exceeding thickness of 9 inches.
2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Controlled Low Strength Material:

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. In other areas, fill trench section as shown on Drawings.

3.10 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow. Comply with the requirements of Section 32 11 23, Aggregate Base

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Courses and Gravel Surfacing (FCP) or Section 32 11 23, Aggregate Base
Courses and Gravel Surfacing (FIR).

- C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.
- D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16 (FCP) Asphalt Paving or 32 12 16 (FIR) Asphalt Paving.
- E. Asphaltic Pavement: Replace settled slabs as specified in Section 32 12 16 (FCP) Asphalt Paving or 32 12 16 (FIR) Asphalt Paving.
- F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.11 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

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SECTION 31 32 00
SOIL STABILIZATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Official Seed Analysts of North America.

1.02 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after planting until requirements of this section are completed.

B. Satisfactory Stand: Grass or section of grass of 10,000 square feet or larger that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.03 SUBMITTALS

A. Action Submittals: Product data for commercial products; seed, fertilizer, and lime.

B. Informational Submittals:

1. Seed certifications.
2. Copies of delivery invoices or other proof of quantities of mulch, lime, and fertilizer.
3. Manufacturer's Installation Instructions: Commercial products.

1.04 DELIVERY, STORAGE, AND PROTECTION

A. 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.

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2. Keep dry during storage.
- B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.05 SEQUENCING AND SCHEDULING

- A. Complete soil preparation, seeding, liming, fertilizing, and mulching within 10 days after final grades have been reached.
- B. Notify CH2M at least 3 days in advance of:
 1. Materials delivery.
 2. Start of planting/seeding activity.
- C. Seeding: Perform under favorable weather conditions during seasons that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE

- A. Operations:
 1. 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 end of 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.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

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- B. Fertilizer shall have the following minimum percentage of plant food by weight:
 - 1. Summer Mix:
 - a. Nitrogen: 10 percent.
 - b. Phosphoric Acid: 10 percent.
 - c. Potash: 10 percent.

2.02 SEED

- A. Fresh, clean new-crop seed that complies with tolerance for purity and germination established by Official Seed Analysts of North America.
- B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer's instructions.
- C. Seed Mix: Kentucky 31 Tall Fescue.
- D. Winter Protective Mix: 50/50 mix of Kentucky 31 Tall Fescue and Winter Rye.

2.03 MULCH

- A. Wood Cellulose Fiber Mulch:
 - 1. Specially processed wood fiber containing no growth or germination inhibiting factors.
 - 2. Dyed suitable color to facilitate inspection of material placement.
 - 3. Manufactured such that after addition and agitation in slurry tanks with water, material fibers become uniformly suspended to form homogenous slurry.
 - 4. When hydraulically sprayed on ground, material will 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 inches.
 - 3. Seasoned before baling or loading.

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2.04 EROSION CONTROL MATTING

- A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
- B. Manufacturers and Products:
 - 1. Akzo Industries, Asheville, NC; Curlex Mat.
 - 2. North American Green, Evansville, IN; S150 blanket.

2.05 S150 BLANKET TACKIFIER

- A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.
- B. Capable of hydrating in water, and to readily blend with other slurry materials.
- C. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.
- D. Manufacturers and Products:
 - 1. Chevron Asphalt Co.; CSS-1.
 - 2. Terra; Tack AR.
 - 3. J-Tack; Reclamare.

2.06 REINFORCED PLASTIC COVERING

- A. Co-extruded, copolymer laminate reinforced with 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 percent.
- D. Manufacturers:
 - 1. Reef Industries, Inc., Houston, TX.
 - 2. Griffolyn Co., Houston, TX.

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PART 3 EXECUTION

3.01 SOIL PREPARATION

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

3.02 SEEDING

- A. Prepare 1-inch-deep seed bed; obtain Engineer's acceptance prior to proceeding.
- B. Apply on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.
- C. Hydroseed slopes steeper than 3:1. Flatter slopes may be mechanically seeded.
- D. Mechanical: Broadcast seed in two different directions, compact with cultipactor or roller.
 - 1. Sow seed at uniform rate of 14 pounds per 1,000 square feet.
 - 2. Use Brillion type seeder.
 - 3. Broadcasting allowed only in areas too small to use Brillion type seeder.
 - 4. Roll with ring roller to cover seed and water with fine spray.
- E. Hydroseeding:
 - 1. Application rate: 21 pounds per 1,000 square feet.
 - 2. Apply on moist soil only after free surface water has drained away.
 - 3. Prevent drift and displacement of mixture into other areas.
 - 4. Upon application, allow absorption and percolation of moisture into ground.
 - 5. Mixtures: Seed and fertilizer may be mixed together. Apply within 30 minutes of mixing to prevent fertilizer from burning seed.

3.03 MULCHING

- A. Apply uniformly on seeded areas.
- B. Application: 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.
 - 1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.

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2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.04 EROSION CONTROL MATTING

- A. Place on seeded slopes 3H:1V and steeper, staple/stake in place and with the appropriate overlap in accordance with manufacturer's instruction.

3.05 TACKIFIER

- A. Apply on areas mulched with manufacturer's recommended requirements.
- B. Spray on after mulch is in place.
- C. Apply at rate of 5 gallons per 1,000 square feet.

3.06 REINFORCED PLASTIC COVERING

- A. Place on areas where hydroseeding and erosion control matting have not controlled erosion.
- B. Install in single thickness, strips parallel to direction of drainage.
- C. Maintain tightly in place by using sandbags on ropes with a maximum 10-foot grid spacing in all directions.
- D. Tape or weight down full length, overlap seams at least 12 inches.
- E. Remove at final acceptance, unless notified otherwise by CH2M.

3.07 FIELD QUALITY CONTROL

- A. Upon completion of maintenance period CH2M will within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, CH2M will make another determination following the next growing season.

END OF SECTION

SECTION 31 41 00
SHORING

PART 1 GENERAL

1.01 SUBMITTALS

- A. Informational Submittals: Excavation support plan.

1.02 QUALITY ASSURANCE

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

3.02 EXCAVATION SUPPORT PLAN

- A. Prepare excavation support plan addressing following topics:
 1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
 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.
 6. Anticipated difficulties and proposed resolutions.

3.03 REMOVAL OF EXCAVATION SUPPORT

- A. Remove excavation support in a manner that will maintain support as excavation is backfilled.
- B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

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- C. Remove excavation support in a manner that does not leave voids in the backfill.

3.04 TRENCHES

- A. Within the State of California: For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of California Labor Code Section 6707, applicable local construction safety orders, and federal requirements.
- B. Outside the State of California: For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements.

END OF SECTION

SECTION 32 11 23 (FIR)
AGGREGATE BASE COURSES AND GRAVEL SURFACING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T11, Standard Method of Test for Materials Finer Than 75 μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
 - c. T89, Standard Specification for Determining the Liquid Limit of Soils.
 - d. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.
 - e. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - f. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.
 - g. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
 - h. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
 - i. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
 - j. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 2. ASTM International (ASTM):
 - a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - b. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - c. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

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- d. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.02 DEFINITIONS

- A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift: Compacted with uniform cross-section thickness.
- C. Standard Specifications: When referenced in this section, shall mean 2010 California Department of Transportation Standard Specifications (Caltrans).

1.03 SUBMITTALS

- A. Informational Submittals:
 - 1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
 - 2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 BASE COURSE

- A. As specified for Class 2 Aggregate Base in Section 26-1.02B, of the Standard Specifications.
- B. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.
- C. Maximum Size: 3/4 inch.

2.02 GRAVEL SURFACING

- A. As specified for Base Course.
- B. Physical Qualities: As specified for Base Course.

2.03 SOURCE QUALITY CONTROL

- A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

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- B. Final approval of aggregate material will be based on test results of installed materials.
- C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. As specified in Section 26, of the Standard Specifications.
- B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.
- C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

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

3.03 HAULING AND SPREADING

- A. Hauling Materials:
 - 1. Do not haul over surfacing in process of construction.
 - 2. Loads: Of uniform capacity.
 - 3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.
- B. Spreading Materials:
 - 1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
 - 2. Produce even distribution of material upon roadway or prepared surface without segregation.
 - 3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

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3.04 CONSTRUCTION OF COURSES

A. Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown on Drawings.
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, as follows:
 - a. Use leveling course or surfacing material as keystone.
 - b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
 - c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
 - d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 9 inches.
2. Completed Course Total Thickness: As shown on Drawings.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

- A. Commence compaction of each layer of base after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by California Test 231.
- B. Commence rolling at outer edges and continue toward center; do not roll center of road first.
- C. Apply water as needed to obtain specified densities.
- D. Place and compact each lift to required density before succeeding lift is placed.
- E. Remove floating or loose stone from surface of preceding course before placing leveling course.

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- F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.
- G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

- A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.
- B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.
- C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.
- D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 DRIVEWAY RESURFACING

- A. Replace gravel surfacing on driveways that were gravel surfaced prior to construction.
- B. Provide compacted gravel surfacing to depth equal to original, but not less than 6 inches.
- C. Leave each driveway in as good or better condition as it was before start of construction.

3.08 FIELD QUALITY CONTROL

- A. In-Place Density Tests:
 - 1. Show proof that areas meet specified requirements before requesting that CH2M identify density test locations.

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2. Refer to Table 1 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 1 Minimum Sampling and Testing Requirements			
Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T180, Method D	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	AASHTO T310 and AASHTO T265 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

3.09 CLEANING

- A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

**SECTION 32 12 16 (FCP)
ASPHALT PAVING**

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
 - b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
 - c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
 - d. M140, Standard Specification for Emulsified Asphalt.
 - e. M208, Standard Specification for Cationic Emulsified Asphalt.
 - f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
 - g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
 - h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
 - i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
 - j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
 - k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
 - l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
 - m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
2. Asphalt Institute (AI):
 - a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
 - b. Superpave Series No. 2 (SP-2), Superpave Mix Design.

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3. ASTM International (ASTM):
 - a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
 - d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
 - e. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

- A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. RAP: Reclaimed asphalt pavement.
- C. Standard Specifications: Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

1.03 SUBMITTALS

- A. Informational Submittals:
 1. Manufacturer's Certificate of Compliance for the following materials:
 - a. Aggregate: Gradation, source test results as defined in this Section.
 - b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
 - c. Prime Coat: Type and grade of asphalt.
 - d. Tack Coat: Type and grade of asphalt.
 - e. Additives.
 - f. Mix: Conforms to job-mix formula.
 2. Statement of qualification for independent testing laboratory.
 3. Test Results:
 - a. Mix design.
 - b. Asphalt concrete core.
 - c. Gradation and asphalt content of uncompacted mix.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

B. Compaction Control Strip:

1. General:
 - a. Construct to approximately 400 square meters in area and at location that will become a portion of completed paved area.
 - b. Thickness: Typical of thickness to be paved on Project.
2. Rollers Used for Compaction:
 - a. Steel Wheel Rollers: Minimum static weight 9 Mg (10 tons).
 - b. Pneumatic Rollers: Capable of exerting pressure of 550 Kpa (80 psi) on bituminous surface.
 - c. Vibratory Rollers: Static weight minimum 5.5 Mg (6 tons), capable of applying a 9-Mg (10-ton) impact force equipped with amplitude and frequency control specifically designed for compaction of bituminous mixtures.
3. Compaction:
 - a. Compact bituminous mat, using a standard rolling pattern that covers entire control strip. Request that CH2M witnesses final density test.
 - b. Continue rolling until no further compaction can be obtained as determined by field density testing.
 - c. Temperature and condition of bituminous mat shall be considered workable when further compaction can no longer be obtained.
4. Target Density Determination:
 - a. Select test point near center of normal roller pass, but no closer than 600 millimeters (2 feet) from edge of mat and 15 meters (50 feet) from either end of control strip. Mat thickness at this point shall be at least depth of finished pavement.
 - b. Point at which no further densification can be obtained.
5. Establish new target density if change is made in mix design, nominal depth of mat being placed, aggregate source, or material properties.

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1.05 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 10 degrees C (50 degrees F) or air temperature is lower than 4 degrees C (40 degrees F). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.
- B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Prime Coat: Cut-back asphalt, conform to Section 806 of the Standard Specifications for Primer-L.
- B. Tack Coat: Emulsified asphalt, conform to Section 806 of the Standard Specifications for SS-1, SS-1h, or RS-1.
- C. Sand (Blotter Material): Clean, dry, with 100 percent passing 4.75-millimeter (No. 4) sieve, and a maximum of 10 percent passing 75 μ m (No. 200) sieve.

2.02 ASPHALT CONCRETE MIX

- A. General:
 - 1. Mix formula shall not be modified except with written approval of Engineer.
 - 2. Source Changes:
 - a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
 - b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by CH2M to confirm that properties are in compliance with design criteria.
 - c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.
- B. Surface and binder course to match existing or as approved by Engineer and as specified in Division 400 of the Standard Specifications unless otherwise shown on Drawings.
- C. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized,

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uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

- D. Aggregate:
 - 1. General: As specified in Section 403 of the Standard Specifications; RAP material may be used up to a maximum of 15 percent by total weight.
- E. Mineral Filler: In accordance with AASHTO M17.
- F. Asphalt Cement: Paving Grade as specified in Section 400 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.
- B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

- A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.
- B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 PREPARATION

- A. Prepare subgrade as specified in Section 403 of the Standard Specifications.
- B. Existing Roadway:
 - 1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
 - 2. Remove existing material to a minimum depth of 25 millimeters (1 inch).
 - 3. Paint edges of meet line with tack coat prior to placing new pavement.

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- C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.04 PAVEMENT APPLICATION

- A. General: Place asphalt concrete mixture on approved, prepared base in conformance with this section.
- B. Prime Coat:
 - 1. Heat cut-back asphalt as specified in Section 806 of the Standard Specifications, prior to application.
 - 2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
 - 3. Do not apply when moisture content of upper 75 millimeters (3 inches) of base exceeds optimum moisture content of base, or if free moisture is present.
 - 4. Application Rate: Minimum 0.68 to maximum 2.28 liters per square meter of surface area (0.15 to 0.50 gallons per square yard).
 - 5. Remove or redistribute excess material.
 - 6. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.
- C. Tack Coat:
 - 1. Prepare material, as specified in Section 806 of the Standard Specifications, prior to application.
 - 2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
 - 3. Do not apply more tack coat than necessary for the day's paving operation.
 - 4. Touch up missed or lightly coated surfaces and remove excess material.
 - 5. Application Rate:
 - a. Minimum 0.25 liter to maximum 0.70 liter of asphalt (residual if diluted emulsified asphalt) per square meter (0.05 to 0.15 gallon per square yard) of surface area.
 - b. Apply at rate, within range specified, sufficient to assure good bonding, but not so heavy that surplus asphalt flushes into asphalt concrete being placed.
- D. Pavement Mix:
 - 1. Prior to Paving:
 - a. Sweep primed surface free of dirt, dust, or other foreign matter.

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- b. Patch holes in primed surface with asphalt concrete pavement mix.
 - c. Blot excess prime material with sand.
 2. Place asphalt concrete pavement mix in one single lift.
 3. Compacted Lift Thickness:
 - a. Minimum: Twice maximum aggregate size, but in no case less than 25 millimeters (1 inch).
 - b. Maximum: 100 millimeters (4 inches).
 4. Total Compacted Thickness: Match existing pavement.
 5. Apply such that meet lines are straight and edges are vertical.
 6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
 7. Joints:
 - a. Offset edge of each layer a minimum of 150 millimeters (6 inches) so joints are not directly over those in underlying layer.
 - b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
 - c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
 8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
 9. After placement of pavement, seal meet line by painting a minimum of 150 millimeters (6 inches) on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.
- E. Compaction: Uniformly compact each course to target density arrived at in compaction control strip.
- F. Tolerances:
 1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
 2. Completed Surface or Wearing Layer Smoothness:
 - a. Uniform texture, smooth, and uniform to crown and grade.
 - b. Maximum Deviation: 3 millimeters (1/8 inch) from lower edge of a 3.6-meter (12-foot) straightedge, measured continuously parallel and at right angle to centerline.
 - c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.
 3. Transverse Slope Maximum Deviation: 6 millimeters (1/4 inch) in 3.6 meters (12 feet) from rate of slope shown.

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4. Finished Grade:
 - a. Perform field differential level survey on maximum 15-meter (50-foot) meter grid and along grade breaks.
 - b. Maximum Deviation: 6 millimeters (0.02 foot) from grade shown.

G. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by CH2M.
2. Preparation:
 - a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
 - b. Seal in dry weather and when temperature is above 2 degrees C (35 degrees F).
3. Application:
 - a. Fill cracks over 1.5 millimeters (1/16 inch) in width with asphalt-sand slurry or approved crack sealer prior to sealing.
 - b. When sealing patched surfaces and joints with existing pavements, extend minimum 150 millimeters (6 inches) beyond edges of patches.

3.05 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.
2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.
3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
4. Portland Cement Concrete Joints: Remove joint filler to minimum 12 millimeters (1/2 inch) below surface.

B. Application:

1. Tack Coat: As specified in this Section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.
3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.

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4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 50 millimeters (2 inches).
5. Actual compacted thickness of intermittent areas of 100 square meters (120 square yards) or less may exceed 50 millimeters (2 inches), but not 100 millimeters (4 inches).
6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 403 of the Standard Specifications.

B. Application:

1. Patch Thickness: 75 millimeters (3 inches) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 350 to 525 Newtons per linear centimeter (200 to 300 pounds per linear inch). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 6 millimeters (1/4 inch) or minus 0 millimeter when straightedge is laid

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across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

- A. General: Provide services of approved certified independent testing laboratory to conduct tests.
- B. Field Density Tests:
 - 1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
 - 2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
 - 3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.
- C. Testing Frequency:
 - 1. Quality Control Tests:
 - a. Asphalt Content, Aggregate Gradation: Once per every 400 mg (500 tons) of mix or once every 4 hours, whichever is greater.
 - b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 900 mg (1,000 tons) or once every 8 hours, whichever is greater.
 - 2. Density Tests: Once every 450 mg (500 tons) of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 12 16 (FIR)
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
 - b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
 - c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
 - d. M140, Standard Specification for Emulsified Asphalt.
 - e. M208, Standard Specification for Cationic Emulsified Asphalt.
 - f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
 - g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
 - h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
 - i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
 - j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
 - k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
 - l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
 - m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
 2. Asphalt Institute (AI):
 - a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
 - b. Superpave Series No. 2 (SP-2), Superpave Mix Design.

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3. ASTM International (ASTM):
 - a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
 - d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
 - e. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

- A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. RAP: Reclaimed asphalt pavement.
- C. Standard Specifications: When referenced in this Section shall mean 2010 California Department of Transportation Standard Specifications (Caltrans).

1.03 SUBMITTALS

- A. Informational Submittals:
 1. Asphalt Concrete Mix Formula:
 - a. Submit minimum of 15 days prior to start of production.
 - b. Submittal to include the following information:
 - 1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
 - 2) Bulk specific gravity for each aggregate constituent.
 - 3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
 - 4) Properties as stated in Section 39 of the Standard Specifications for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
 - 5) Percent of asphalt lost due to absorption by aggregate.
 - 6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.

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- 7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
 - 8) Optimum mixing temperature.
 - 9) Optimum compaction temperature.
 - 10) Temperature-viscosity curve of asphalt cement to be used.
 - 11) Brand name of any additive to be used and percentage added to mixture.
2. Test Report for Asphalt Cement:
 - a. Submit minimum 10 days prior to start of production.
 - b. Show appropriate test method(s) for each material and the test results.
 3. Manufacturer's Certificate of Compliance for the following materials:
 - a. Aggregate: Gradation, source test results as defined in Section 39 of the Standard Specifications.
 - b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
 - c. Prime Coat: Type and grade of asphalt.
 - d. Tack Coat: Type and grade of asphalt.
 - e. Additives.
 - f. Mix: Conforms to job-mix formula.
 4. Statement of qualification for independent testing laboratory.
 5. Test Results:
 - a. Mix design.
 - b. Asphalt concrete core.
 - c. Gradation and asphalt content of uncompacted mix.
 - d. Field density.
 - e. Quality control.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.05 ENVIRONMENTAL REQUIREMENTS

- #### A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 10 degrees C (50 degrees F) or air temperature is lower than 4 degrees C (40 degrees F). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

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- B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Tack Coat: Emulsified asphalt, Grade SS-1, SS-1h conforming to Section 94 of the Standard Specifications.

2.02 ASPHALT CONCRETE MIX

- A. General:
 - 1. Mix formula shall not be modified except with written approval of Engineer.
 - 2. Source Changes:
 - a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
 - b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by CH2M to confirm that properties are in compliance with design criteria.
 - c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.
- B. Asphalt Concrete: Type A, 3/4-inch maximum course, as specified in Section 39 of the Standard Specifications.
- C. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.
- D. Aggregate:
 - 1. General: As specified in Section 39 of the Standard Specifications.
- E. Mineral Filler: In accordance with AASHTO M17.
- F. Asphalt Cement: Paving Grade PG 70-10 as specified in Section 92 of the Standard Specifications.

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PART 3 EXECUTION

3.01 GENERAL

- A. Traffic Control:
 - 1. In accordance with an approved traffic control plan.
 - 2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.
- B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

- A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.
- B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

- A. In accordance with Section 39 of the Standard Specifications.

3.04 PREPARATION

- A. Prepare subgrade as specified in Section 39 of the Standard Specifications.
- B. Existing Roadway:
 - 1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
 - 2. Remove existing material to a minimum depth of 25 millimeters (1 inch).
 - 3. Paint edges of meet line with tack coat prior to placing new pavement.
- C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

- A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Section 32 11 23 (FIR), Aggregate Base Courses and Gravel Surfacing.

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B. Tack Coat:

1. Prepare material, as specified in Section 94 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply more tack coat than necessary for the day's paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.
5. Application Rate:
 - a. Minimum 0.25 liter to maximum 0.70 liter of asphalt (residual if diluted emulsified asphalt) per square meter (0.05 to 0.15 gallon per square yard) of surface area.

C. Pavement Mix:

1. Prior to Paving:
 - a. Sweep primed surface free of dirt, dust, or other foreign matter.
 - b. Patch holes in primed surface with asphalt concrete pavement mix.
 - c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in a minimum of two lifts of equal thickness.
3. Compacted Lift Thickness:
 - a. Minimum: Twice maximum aggregate size, but in no case less than 25 millimeters (1 inch).
 - b. Maximum: 100 millimeters (4 inches).
4. Total Compacted Thickness: As shown.
5. Apply such that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
 - a. Offset edge of each layer a minimum of 150 millimeters (6 inches) so joints are not directly over those in underlying layer.
 - b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
 - c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 150 millimeters (6 inches) on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.

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D. Compaction:

1. Roll until roller marks are eliminated and minimum density of 95 percent of mix design unit weight at optimum asphalt content is obtained
2. Joint Compaction:
 - a. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
 - b. Cut away waste material and lay new mix against fresh cut.

E. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
 - a. Uniform texture, smooth, and uniform to crown and grade.
 - b. Maximum Deviation: 1/8 inch from lower edge of a 12-foot straightedge, measured continuously parallel and at right angle to centerline.
 - c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.
3. Transverse Slope Maximum Deviation: 1/4 inch in 12 feet from rate of slope shown.
4. Finished Grade:
 - a. Perform field differential level survey on maximum 50-foot grid and along grade breaks.
 - b. Maximum Deviation: 0.02 foot from grade shown.

F. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by CH2M.
2. Preparation:
 - a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
 - b. Seal in dry weather and when temperature is above 2 degrees C (35 degrees F).
3. Application:
 - a. Fill cracks over 1.5 millimeters (1/16 inch) in width with asphalt-sand slurry or approved crack sealer prior to sealing.

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- b. When sealing patched surfaces and joints with existing pavements, extend minimum 150 millimeters (6 inches) beyond edges of patches.

3.06 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.
2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.
3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
4. Portland Cement Concrete Joints: Remove joint filler to minimum 12 millimeters (1/2 inch) below surface.

B. Application:

1. Tack Coat: As specified in this section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.
3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.
4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 50 millimeters (2 inches).
5. Actual compacted thickness of intermittent areas of 100 square meters (120 square yards) or less may exceed 50 millimeters (2 inches), but not 100 millimeters (4 inches).
6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.07 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 39 of the Standard Specifications.

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B. Application:

1. Patch Thickness: 75 millimeters (3 inches) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 350 to 525 Newtons per linear centimeter (200 to 300 pounds per linear inch). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 6 millimeters (1/4 inch) or minus 0 millimeter when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.08 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

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C. Testing Frequency:

1. Quality Control Tests:
 - a. Asphalt Content, Aggregate Gradation: Once per every 400 mg (500 tons) of mix or once every 4 hours, whichever is greater.
 - b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 900 mg (1,000 tons) or once every 8 hours, whichever is greater.
2. Density Tests: Once every 450 mg (500 tons) of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 16 00 (FCP)
CURBS AND GUTTERS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in.) Drop.
 2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 3. ASTM International (ASTM):
 - a. C94, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 4. Standard Specification: Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

1.02 SUBMITTALS

- A. Action Submittals:
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 in accordance with requirements of ASTM C94.
- B. Informational Submittals:
1. Curing Compound: Manufacturer's Certificate of Compliance and application instructions.
 2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Conform to Standard Specifications.

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PART 2 PRODUCTS

2.01 MATERIALS

- A. Conform to the requirements of the referenced Standard Specification.

2.02 EXPANSION JOINT FILLER

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

2.03 CONCRETE

- A. As specified in Section 03 30 10, Reinforced Concrete.
- B. Maximum Aggregate Size: 1-1/2 inch.
- C. Slump: 2 inches to 4 inches.

2.04 CURING COMPOUND

- A. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform Work in accordance with the referenced Standard Specification.

3.02 FORMWORK

- A. Lumber Materials:
 - 1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.
 - 2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.
- B. Metals: Steel in new undamaged condition.
- C. Setting Forms:
 - 1. Construct forms to shape, lines, grades, and dimensions.
 - 2. Stake securely in place.

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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 inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.03 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 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.
- C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.
- D. To compact, vibrate until concrete becomes uniformly plastic.

3.04 CURB CONSTRUCTION

- A. Construct ramps at pedestrian crossings.
- B. Expansion Joints: Place at maximum 45-foot intervals, and at the beginning and end of curved portions of curb, and at connections to existing curbs. Install expansion joint filler at each joint.
- C. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.
- D. Contraction Joints:
 1. Maximum 15-foot intervals in curb.
 2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
 3. Insert steel sheet to full depth of curb.
 4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
 5. Finish top of curb with steel trowel and finish edges with steel edging tool.

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- E. Front Face:
1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
 2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
 3. Remove and replace defective concrete.
 4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
 5. Continue curing for minimum of 5 days.
- F. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.
1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
 2. Compact backfill firmly.

3.05 SIDEWALK CONSTRUCTION

- A. Thickness:
1. 4 inches in walk areas.
 2. 6 inches 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: Place in adjacent curb, where sidewalk ends at curb, and 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-inch by 1-inch weakened plane joints.
 3. Construct straight and at right angles to surface of walk.

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DESIGN AND CONSTRUCTION STANDARDS

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-foot intervals, or in pattern shown on Drawings, 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.

END OF SECTION

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SECTION 32 16 00 (FIR)
CURBS AND GUTTERS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in.) Drop.
 2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 3. ASTM International (ASTM):
 - a. C94, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 4. Standard Specification: When referenced in this section, shall mean 2010 California Department of Transportation Standard Specifications (Caltrans).

1.02 SUBMITTALS

- A. Action Submittals:
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 in accordance with requirements of ASTM C94.
- B. Informational Submittals:
1. Curing Compound: Manufacturer's Certificate of Compliance and application instructions.
 2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

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DESIGN AND CONSTRUCTION STANDARDS

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Conform to the State of California Standard Specifications for Highway Construction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Conform to the requirements of Section 73-1.02A and 73-1.02B of the referenced Standard Specification.

2.02 CONCRETE

- A. As specified in Section 03 30 10, Reinforced Concrete.
- B. Maximum Aggregate Size: 1-1/2 inch.
- C. Slump: 2 inches to 4 inches.

2.03 CURING COMPOUND

- A. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform Work in accordance with Section 73-1.03A through 73-1.03F of the referenced Standard Specification.

3.02 FORMWORK

- A. Lumber Materials:
 - 1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.
 - 2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.
- B. Metals: Steel in new undamaged condition.

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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 inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.03 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 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.
- C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.
- D. To compact, vibrate until concrete becomes uniformly plastic.

3.04 CURB CONSTRUCTION

- A. Construct ramps at pedestrian crossings.
- B. Expansion Joints: Place at maximum 45 foot intervals and at the beginning and end of curved portions of curb and at connections to existing curbs. Install expansion joint filler at each joint.
- C. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.
- D. Contraction Joints:
 1. Maximum 15-foot intervals in curb.
 2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.

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3. Insert steel sheet to full depth of curb.
4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
5. Finish top of curb with steel trowel and finish edges with steel edging tool.

E. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
3. Remove and replace defective concrete.
4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
5. Continue curing for minimum of 5 days.

F. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.

1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
2. Compact backfill firmly.

3.05 SIDEWALK CONSTRUCTION

A. Thickness:

1. 4 inches in walk areas.
2. 6 inches 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: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

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D. Contraction Joints:

1. Provide transversely to walks at locations opposite contraction joints in curb.
2. Dimensions: 3/16-inch by 1-inch 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-foot intervals or in pattern shown on Drawings, 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.

END OF SECTION

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SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
 - b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
 - c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
 - e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
 - h. A824, Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence.
 - i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - k. C150, Standard Specification for Portland Cement.
 - l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - m. F552, Standard Terminology Relating to Chain Link Fencing.
 - n. F567, Standard Practice for Installation of Chain-Link Fence.
 - o. F626, Standard Specification for Fence Fittings.
 - p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
 - q. F900, Standard Specification for Industrial and Commercial Swing Gates.
 - r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.

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DESIGN AND CONSTRUCTION STANDARDS

- s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
 - t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
 - u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
 - v. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
 - w. F1379, Standard Terminology Relating to Barbed Tape.
 - x. F1911, Standard Practice for Installation of Barbed Tape.
 - y. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.
- 2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
 - 3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.02 DEFINITIONS

- A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

- A. Action Submittals:

- 1. Shop Drawings:
 - a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
 - 1) Fence, gate posts, rails, and fittings.
 - 2) Chain link fabric.
 - 3) Gates and hardware.
 - 4) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
 - 5) Gate access system, including access control features, power and control wiring diagrams, and operating instructions.
 - 6) Accessories: Barbed wire.
- 2. Samples:
 - a. Chain Link Fabric: Approximately 6 inches square.
 - b. Posts, Rails, Braces, Wire, and Ties: Approximately 6 inches long.
 - c. Fittings: 1 each.

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3. Test Reports: Field test result for compliance of installation of chain link fence, gates, and gate operators.

B. Informational Submittals:

1. Manufacturer's recommended installation instructions.
2. Evidence of Supplier and installer qualifications.
3. Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Automatic Gate Operator System Supplier: 5 years' experience in gate operator systems.
2. Automatic Gate Operator System Installer: Experienced installer who has completed chain link fences and gates similar in material, design, and extent to those indicated for Project and whose work has resulted with a record of successful in-service performance with a minimum 3 years' experience.

- ### B. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

- ### C. Preinstallation Conference: Conduct conference at project Site with gate installer to verify layout and operations of automatic gate operating system.

1.05 DELIVERY, STORAGE, AND HANDLING

- ### A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.06 SCHEDULING AND SEQUENCING

- ### A. Complete necessary Site preparation and grading before installing chain link fence and gates.
- ### B. Interruption of Existing Utility Service: Notify CH2M 72 hours prior to intended interruption of any utility services. Do not proceed with interruption of utility service without written permission from CH2M and utility provider.

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DESIGN AND CONSTRUCTION STANDARDS

1.07 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with CH2M named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of CH2M, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
 - 1. Faulty operations of gate operators and controls.
 - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 3. Deflection of fence fabric beyond limits.

PART 2 PRODUCTS

2.01 GENERAL

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

2.02 CHAIN LINK FENCE FABRIC

- A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot.
- B. Height: 72 inches, unless otherwise shown.
- C. Core Wire Gauge: No. 9.
- D. Pattern: 2-inch diamond-mesh.
- E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.
- F. Loops of Knuckled Selvages: 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 inch beyond twist.

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DESIGN AND CONSTRUCTION STANDARDS

2.03 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence, except as modified in this section.
2. Round Steel Pipe, Schedule 40: ASTM F1083.
3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
5. Protective Coatings:
 - a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:

1. Round Steel Pipe:
 - a. Outside Diameter: 2.375 inches.
 - b. Weight: 3.65 pounds per foot.

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

1. Round Steel Pipe:
 - a. Outside Diameter: 2.875 inches.
 - b. Weight: 5.79 pounds per foot.

D. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

E. Posts for Swing Gates 8 Feet High and Under:

1. ASTM F900.
2. Round Steel Pipe:
 - a. Outside Diameter: 3.5 inches.
 - b. Weight: 4.85 pounds per foot.

F. Posts for Swing Gates Over 8 Feet High: As recommended by fence manufacturer.

G. Posts for Horizontal Sliding Gates:

1. ASTM F1184, Type I, Class 1.
2. Round Steel Pipe:
 - a. Outside Diameter: 3.5 inches.

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- b. Weight: 4.85 pounds per foot.
3. Guide posts for Class 1 horizontal-slide gates, equal gate post height, one size smaller, but weight is not less than 3.11 pounds per foot, installed adjacent to gate post to permit gate to slide in space between.

2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.
2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

B. Galvanized Roll-Formed Steel C Shapes:

1. Roll formed from ASTM A1011/A1011M, Grade 45.
2. Outside Dimensions: 1.625 inches by 1.25 inches.
3. Weight: 1.40 pounds per foot.

C. Protective Coatings: As specified for posts.

D. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy industrial fence.

2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this Article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:

1. One-piece.
2. Length not less than 2 inches shorter than full height of chain link fabric.
3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

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- F. Tie Wires, Clips, and Fasteners: According to ASTM F626.
- G. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with single 45-degree arms for supporting three strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.06 TENSION WIRE

- A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.07 BARBED WIRE

- A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade:
 - 1. Line Wire: Two strands of No. 12-1/2 gauge.
 - 2. Barbs:
 - a. Number of Points: Two.
 - b. Length: 3/8 inch minimum.
 - c. Shape: Round.
 - d. Diameter: No. 14 gauge.
 - e. Spacing: 5 inches.

2.08 GATES

- A. General:
 - 1. Gate Operation: Opened and closed easily by one person.
 - 2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
 - 3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
 - 4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
 - 5. Gate Fabric Height: Same as for adjacent fence height.
 - 6. Welded Steel Joints: Paint with zinc-based paint.
 - 7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
 - 8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.

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9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.
- B. Swing Gates: Comply with ASTM F900 for single or double swing gate types.
1. Leaf Width: As shown.
 2. Hinges: Offset type, malleable iron.
 - 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 feet 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 leaves of double gate.
 6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.
- C. Cantilever Horizontal Sliding Gates:
1. Comply with ASTM F1184 for single slide gate Type II, Class 1 with external roller assemblies.
 2. Cantilever Gate Support Posts: Spaced on maximum 10-foot centers.
 3. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, designed to support size, weight, width, operation, and design of gate and roller assemblies.
 4. Roller Guards: As required per ASTM F1184 for Type II, Class 1 gate.
 5. Hangers, roller assemblies, and stops fabricated from galvanized malleable iron.
- D. Rolling Gate:
1. Track Rollers: Malleable iron or heavy pressed steel with provision for grease lubrication.
 2. Ground Rollers: Malleable iron or heavy pressed steel with provision for grease lubrication.
 3. Support Posts: Spaced on maximum 7-foot centers.
 4. Gates more than 8 feet in height shall have three tracks.
 5. Frames: ASTM F1184, Type I.
 6. Gate Accessories: ASTM F1184.

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2.09 CONCRETE

- A. Materials: ASTM C387, packaged, dry, combined ingredients with Type I cement.
- B. Mixing: In a clean metal container, mix package of dry materials by hand or machine. Following manufacturer's instructions, add clean water in sufficient quantity to produce a slump of 2 inches to 3 inches.

2.10 FENCE GROUNDING

- A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
 - 1. Material above Finished Grade: Copper.
 - 2. Material on or below Finished Grade: Copper.
 - 3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Connectors and Grounding Rods: Comply with UL 467.
 - 1. Connectors for Below-Grade Use: Exothermic welded type.
 - 2. Grounding Rods: Copper-clad steel.

PART 3 EXECUTION

3.01 GENERAL

- A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by CH2M. Erect fencing in straight lines between angle points.
- B. Provide necessary hardware for a complete fence and gate installation.
- C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.
- D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.
 - 1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.

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DESIGN AND CONSTRUCTION STANDARDS

2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.
3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.02 PREPARATION

- A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.
- B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

- A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.
- B. Posthole Depth:
 1. Minimum 3 feet below finished grade.
 2. 2 inches deeper than post embedment depth below finish grade.
- C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.
- D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.
- E. Before concrete sets, crown and finish top of concrete to readily shed water.

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- F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

- A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.
 - 1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

- A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

- A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

- A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.
- B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

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DESIGN AND CONSTRUCTION STANDARDS

3.08 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.
- C. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- D. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.
- E. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.
- F. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.
- G. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.09 BARBED WIRE

- A. Install barbed wire uniformly in configurations of three strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.10 GATES

- A. Install gates according to manufacturer's written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.
- B. Set gate stops in concrete to engage center drop rod or plunger bar.

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3.11 ELECTRICAL GROUNDING

- A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.12 FIELD QUALITY CONTROL

- A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.
- B. Gate Tests:
 - 1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
 - 2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
 - 3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.13 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site to train CH2M's personnel to adjust, operate, and maintain gates.

3.14 CLEANUP

- A. Remove excess fencing materials and other debris from Site.

END OF SECTION

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SECTION 33 01 30.16
TELEVISION INSPECTION OF SEWER PIPELINES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. National Association of Sewer Service Companies (NASSCO): Pipeline Assessment Certification Program (PACP), latest version.
 2. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

- A. Action Submittals:
1. Catalog and manufacturer's data sheets for television equipment.
 2. Acceptance Standard closed-circuit television (CCTV) video copy.
- B. Informational Submittals:
1. References: Contact names and telephone numbers.
 2. List of staff and equipment to be used on Project.
 3. Crew chief qualifications.
 4. Crew chief contact information: name, mobile telephone number.
 5. Certification that staff to be used for the Work is properly trained in confined space entry and hazardous atmospheres.
 6. Training and inspection plan, 7 days prior to manual inspection.
 7. Traffic control plan.
 8. Schedule: 7-day look-ahead; weekly.
 9. CCTV Inspection:
 - a. Initial first day's CCTV inspection external hard drive within 24 hours after first day's work is completed.
 - b. Subsequent work products/documentation deliverables on routine basis every week.
 - c. Include the following with each inspection submitted:
 - 1) Inspection media.
 - 2) Inspection database (PACP Standard Exchange Database) updated weekly.
 - 3) Inspection reports.
 10. Log of cable footage counter calibration checks.

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1.03 QUALITY ASSURANCE

A. Qualifications:

1. Subcontractor: Performed NASSCO PACP type work successfully for at least three other projects, within last 5 years, with pipe lengths and pipe diameters similar to this Project.
2. Crew Chief: Minimum of 2 years' experience on projects similar to this Project and experienced using proposed equipment for this Project. If experience level cannot be met because of new equipment or technology proposed for Project, submit training and experience information for CH2M's consideration.

B. Prestartup Meeting: At least 5 days prior to beginning CCTV inspection work, schedule with CH2M to review proposed temporary sewer flow diversion plan, traffic control plans, cleaning, and inspection methods.

C. Acceptance Standard CCTV Video:

1. External hard drive format showing example quality of work that Subcontractor proposes for Project.
2. Submittal shall also include examples that demonstrate camera advancement speeds, picture clarity, environment condition, lighting, panning as well as focus on defects, title frame, and screen labels for images, and sample stills.
3. Examples shall include a minimum of four manhole to manhole segments and combinations of sizes.
4. Picture quality and definition shall be to satisfaction of CH2M.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Complete closed-circuit television (CCTV) inspection for pipe segments as indicated on Drawings.

1. Label assets and structures in their inspection records using same identification nomenclature as shown on Drawings.
2. If pipe or structure is not shown or listed, identify by downstream structure with letter designation added starting with "A" for each unidentified structure on each pipe segment. Subsequent upstream structures will be identified by adding "B", "C", and so on; include revisions on corrected field map.

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- B. Complete applicable Work specified in Section 01 57 28, Temporary Flow Control, and Section 33 01 33, Gravity Sewer Pipeline Cleaning, prior to starting CCTV inspection work.
- C. Use CH2M's CCTV Inspection Manual for completion of CCTV inspection form and defect coding.
- D. Record GPS latitude and longitude (decimal degrees) coordinates using portable global positioning system (GPS) device in field for manholes and pipeline access locations used during inspection; include them in inspection information in database and summary report.
- E. Subcontractor's Project Manager and Crew Chief shall attend regular progress meetings as scheduled by CH2M.
- F. Look-Ahead Schedule: Prepare and submit at least 7 days in advance, identifying areas to be investigated during coming week. Schedules shall include structure numbers, street locations, and dates.
- G. Traffic Control:
 - 1. Traffic Control Plan specific to television inspection, adhering to requirements of applicable agencies and as may be specified in Contract Documents.
 - 2. Notify CH2M at least 7 days in advance of Work starting, of areas where Work will be conducted, and submit traffic control plan.
- H. Measure and record flow depths and times of measurement at a sufficient number of locations to indicate flow depths that could be expected during inspection work. A minimum of one flow depth measurement shall be recorded for each line section.

3.02 EQUIPMENT

- A. Inspection Vehicle:
 - 1. Equipped with monitoring equipment specifically compatible with sewer inspection equipment.
 - 2. Equipped with a safety backup alarm and traffic warning flashers.
 - 3. Clearly marked with the inspection company name and phone number.
- B. Inspection Equipment:
 - 1. Inspection equipment that fails to produce satisfactory inspection quality shall be removed from the Work.

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2. Monitoring Studio:
 - a. Equipped with independent power source.
 - b. Equipped with lights.
 - c. Temperature controlled.
 - d. Size: Sufficient to allow seating for a minimum of two people in addition to operating technician.
 - e. Television Monitor:
 - 1) Locate in monitoring studio.
 - 2) Capable of producing high quality color picture.
 - 3) Resolution: No less than 500 lines.
 - 4) Continuous display during survey.
3. Transport Platform:
 - a. Self-propelled, mounted on skid, or mounted on float.
 - b. Sized for each pipe diameter in accordance with manufacturer's recommendations.
 - c. Cables: 1,500 feet long, minimum.
 - d. Equipped with tag line suitable for pulling camera backwards.
 - e. Equipped with winch, power winch, TV cable, powered rewind, or other devices used to move camera through pipe.
 - 1) When powered and controlled winches are used to pull television camera through line, provide telephones, radios, or other means of communication between the two manholes to ensure communications exist between crewmembers.
 - f. Remote Reading Footage Counter:
 - 1) Accuracy: 0.20 feet over length of section being inspected.
 - 2) Counter display located in monitoring studio.
 - 3) Marking on cable will not be allowed.
 - 4) Calibration: Perform each day prior to setup.
 - g. Secure cable, chains, and other devices used with camera so as not to obstruct camera view or otherwise interfere with proper documentation of sewer conditions.
4. Television Camera:
 - a. Closed-circuit color television camera.
 - b. Sufficient for 6-inch through 60-inch diameters and in accordance with manufacturer's recommendations.
 - c. Mounted on transport platform.
 - d. Self-leveling.
 - e. Operative in waterproof and 100 percent humidity conditions without lens fogging.
 - f. Operative in hazardous and corrosive environment and specifically designed for pipeline inspection.
 - g. Camera Lighting:
 - 1) Mounted on and turned in direction of camera head.

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- 2) Light Sensitivity: Greater than 1.5 lux minimum.
- 3) Minimize reflective glare.
- 4) Remote variable intensity control.
- 5) Provide clear, in-focus picture of entire inside periphery of pipe.
- 6) Ability to achieve proper balance of tint and brightness.
- h. Resolution:
 - 1) Horizontal Resolution: 460 lines minimum.
 - 2) Vertical Resolution: 400 lines minimum.
 - 3) Meet or exceed monitor resolution.
- i. Rotation: 360 degrees.
- j. Pan and Tilt: 270 degrees, with adjustable supports designed for operation in connection with pipe inspection.
- k. Viewing Angle: 65 degrees, minimum.
- l. Focus and Iris Controls:
 - 1) Automatic or remote.
 - 2) Remote control adjustment for focus and iris shall be located in monitoring studio.
- m. Focal Distance: Adjustable through range from 6 inches to infinity.
- n. Zoom: Capable of 40:1 (10x optical, 4 times digital).

C. Inspection Software:

1. Inspection equipment shall utilize software capable of providing complete survey reports, inspection database, and linked media files.
2. Coding system shall be certified by NASSCO in accordance with their Pipeline Assessment and Certification Program (PACP).

3.03 INSPECTION

A. Video Recording:

1. CCTV inspection is represented by one manhole-to-manhole pipe segment or other access-to-access point; not multiple manhole-to-manhole segments.
2. Prior to beginning CCTV inspection, complete initial screen text step and position camera at center of manhole and with axis at centerline of pipe.
3. Before camera enters pipe, inspection shall provide internal video of manhole. Video recording shall begin by facing pipe segment to be televised and then pan/tilt/zoom as necessary to point camera up towards manhole opening.

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4. Show continuous footage reading on inspection image. Place on screen where it is clearly visible (if black font, do not place on dark background, if white font, do not place on light background).
5. Viewing shall be in direction of flow, except while camera is being used in a reverse setup. Inspection shall proceed from upstream to downstream, unless prohibited by obstruction.
6. If during inspection operation television camera will not pass through entire line segment due to obstruction, set up equipment so inspection can be performed from opposite manhole.
7. If upstream (reverse) setup, is required, establish new inspection run separate from downstream (normal) setup.
8. Keep camera lens clean and clear. If material or debris obscures image or causes reduced visibility, clean or replace lens prior to proceeding with recording operation.
9. Camera lens shall remain above visible water level and may submerge only while passing through clearly identifiable line sags or vertical misalignments. If flow exceeds 25 percent of diameter, such that camera lens becomes obscured, stop inspection until flow subsides. If necessary, reschedule CCTV operation. Surcharging and flooding of camera lens is not an excusable condition if it has been artificially created upstream (for example, placement of flow plugs or freshwater flushing in pipe).
10. Record inside of each lateral and connection of lateral to pipeline.
11. Recordings shall clearly show defects and observations, and their severity, in addition to obvious features (such as, laterals and joints).
12. Immediately report to CH2M obstructions that restrict flow and cause inspection to be interrupted. Document condition with still photographs, and begin inspections of other pipelines.
13. Camera Operation:
 - a. Speed: 30 feet per minute, maximum, during inspection.
 - b. Stop, for a minimum of 5 seconds, at every lateral, or other defect or adversity.
 - c. Pan entire diameter or area of pipe at each defect and lateral connection.
 - d. Readjust lens, lighting, and focus in order to ensure clear, distinct, and properly lighted image of defect.
14. Loss of color or severe red or green color will be cause for rejection of inspection.
15. Recordings shall be without distortion or outside interference.
16. Televisé line segments from structure-to-structure on same external hard drive in continuous run.
 - a. Video shall clearly show camera starting and ending at structure, unless defects do not allow it.

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- b. Do not perform partial televising on one external hard drive and then complete run on another external hard drive.
 - c. If line is partially televised, as a result of an excusable condition, (for example, collapsed line), televised length shall be viewed by CH2M for acceptability.
 - d. If portion of line is unacceptable, entire segment shall be deemed unacceptable and shall be retelevised.
17. CH2M may accept physical inspection that does not adhere to minimum standards if adverse conditions are encountered and re-inspection is not advised. In such a case, enough data shall be provided to permit accurate assessment.

B. Measurement:

1. Record in English units.
2. Obtain pipe diameter by physical measurement in upstream (or downstream) access structure.
3. Verify pipe material (such as, RCP, VCP, CMP) and surface lengths between manholes.
4. Use calipers or measuring rod to determine diameter of inlet and outlet pipe.
5. Footage measurements shall begin at centerline of upstream manhole, unless CH2M approves otherwise.
6. Continuous Footage Readings:
 - a. Use to identify location of defects.
 - b. Accurate to within plus or minus 0.20 foot tolerance.
 - c. Defect identifications are to be called out and recorded to nearest 0.10 foot.
 - d. Line segment recording will be unacceptable if continuous footage meter is inaccurate, or identified defects or features leave doubt as to accuracy of locations or total length.
7. Measurement shall be zeroed after each segment inspected.
8. Check accuracy of measurement meters daily by use of walking meter, roll-a-tape, or other suitable device.

3.04 RECORDING OF DOCUMENTATION

- A. Upon completion of CCTV inspection, transfer inspection data to DVD of sufficient capacity and compatibility with CH2M's equipment; include code required for proper playback of video file.

1. Labeling:
 - a. Provide printed label on outside of DVD that indicates the following:

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- 1) Name of Contractor.
- 2) Project title.
- 3) Date of inspection.
- 4) Inspection company.
- 5) Deliverable number.

B. Media:

1. Video:

- a. Inspections completed, with a unique filename per inspection.
- b. Encoded in .MPG or other format approved by CH2M.
- c. Opening Screen: The following is an example of required on-screen text display fields:
 - 1) Date and Time: (YYYY/MM/DD), (military time hh:mm).
 - 2) Surveyor's Name/Company: John Doe/ABC Company.
 - 3) Project Name: XYZ project.
 - 4) Location: 1 Example Street.
 - 5) Location Code: B – Example Highway.
 - 6) Upstream MH No: ### (Feature_ID or Facility_ID).
 - 7) Upstream MH depth: ##.# (nearest tenth of a foot).
 - 8) Downstream MH No: ### (Feature_ID or Facility_ID).
 - 9) Pipe Segment Ref. ##### (Feature_IDs).
 - 10) Starting Footage: ### (nearest tenth of foot).
 - 11) Inspection Direction: Downstream or upstream.
 - 12) Pipe Material: Example, ductile iron.
 - 13) Pipe Diameter/Height/Width: Diameter: ##/Height: ##/Width: ## (as measured in field).
 - 14) Weather: Example, snow.
 - 15) Precleaning: Example, jetting.
 - 16) Additional Information: Additional important information/comments.
- d. Continuous View: Following is list of required on-screen text display fields:
 - 1) Inspection date and time.
 - 2) Continuous forward and reverse readout of camera distance from center of manhole reference (tape counter footage).
 - 3) Pipe structure identification number.
 - 4) Defect/observation code(s) (when encountered).

2. Audio:

- a. Embedded in video file.
- b. Operator shall include description of inspection setup, including related information from log form and unusual conditions.
- c. Operation changes (for example, remove roots and restart inspection at footage prior to root removal).

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- d. Verbal description and location of each defect.
 - e. Verbal description and location of each service connection.
 3. Still Photographs:
 - a. Provide digital photographs showing inspection image whenever observation or defect is recorded.
 - b. Each with unique filename.
 - c. Encoded in .JPEG format.
 - d. Minimum 640 by 480 resolution.
 - e. Provide label on front of photograph with structure identification number, footage (if not visible on photograph), and defect code.
- C. Database:
1. Include all inspections. Creating a database per inspection is not acceptable.
 2. Provide database of collected data including:
 - a. Asset information.
 - b. Inspection information, where each inspection includes no more than one manhole-to-manhole segment.
 - c. Defect codes and scores.
 - d. Start and stop footages for continuous defects.
 3. File Type: MSAccess, .MDB, .ACCDB.
 4. Database Format: NASSCO PACP data shall be exported into standard PACP Exchange database.
 5. List inspection media names in corresponding asset/inspection/defect information field within database.
- D. Inspection Reports:
1. Provide .PDF inspection reports including:
 - a. Summary of inspections completed. An example summary inspection report is shown as a Supplement at the end of this section.
 - b. Pipe graphs of each inspection showing asset information and defects/observations.
 2. Field Maps:
 - a. Corrected to reflect actual field conditions.
 - b. Illustrate changes in pipe routing that differ from anticipated network. Are not necessary for pipe segments whose routing is as indicated on Drawings.
 - c. Neatly strike out wrong data using green pencil and clearly mark in correct data, using red pencil. Show notes that clarify changes in blue pencil.

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3.05 FIELD QUALITY CONTROL

- A. Review videos and reports to resolve inconsistent and conflicting data and to improve accuracy of data prior to submittal.
- B. If minimum level of accuracy is not met between videos and reports after review by CH2M, perform re-inspection of pipes that do not meet requirements.
- C. Quality control procedures shall be in accordance with method attached as a supplement at the end of this section.

3.06 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification.
 - 1. Inspection Summary Sheet.
 - 2. NASSCO PACP Quality Control Procedure.

END OF SECTION

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INSPECTION SUMMARY SHEET

SAMPLE—CUSTOMIZE FOR CH2M

Deliverable ID	Basin	Pipe ID	US MH	DS MH	Pipe Mat'l	Pipe Size	Length	Date Insp.	Insp. Length	Reverse (Y/N)	Condition Score

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NASSCO PACP QUALITY CONTROL PROCEDURE

General Method

CCTV contracting companies shall have a Random Number Quality Control procedure in place that is then audited by CH2M. A random number is one of a series of numbers that have no detectable pattern, so that each and every item in a known population has an equal chance of being selected based upon random number. A minimum of 5 percent of CCTV Subcontractor's data shall be checked using a Random Number Quality Control procedure as basis of selecting inspections for review. Intent is for CH2M to actually audit CCTV Subcontractor's QC procedure rather than performing their own QC. If there is doubt about results then CH2M can ask for another differing set of Random Numbers to be created and be applied to CCTV operator in question, thereby generating another different set of inspections to be checked. Create QC history for each CCTV operator and not for each contract.

Generating Random Numbers

A Random Number list, based upon population and selection percentage, is available from many web sites. This site generates a list of random numbers that can be sorted in numerical order and printed. Each CCTV operator shall have a different set of Random Numbers.

Selection of Inspections to be Checked

In the field, CCTV operator inspects each sewer segment and enters PACP information into a computer database. In the office, QC employee/operator counts through inspections, for each separate CCTV operator, in the order in which they were inspected. When inspection coincides with a Random Number a copy of inspection is made from HD/DVD onto CCTV operator's master QC HD/DVD. A copy of corresponding CCTV report is also printed from computer. These are then kept in CCTV operator's QC folder until QC is carried out by qualified QC employee/operator. By using the Random Number sampling system CCTV operator will not be able to "abuse" system. CH2M can ask for the set of Random Numbers for each CCTV operator at start of Project, or CH2M can provide a set of Random Numbers to be used for each operator associated with Project.

Quality Control of Inspection

It is expected that accuracy of Header record exceeds 90 percent as most field contents are based upon facts. The simplest method for QC of Header record is as follows:

Each field completed, and those that are not but should have been, is counted, producing a "number of fields checked", say 32 (ignoring unused fields).

Then fields with mistakes are counted, irrelevant of level of the mistake, creating an "error count" say for this example, 2.

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Therefore, calculation is:

$(\text{error count}/\text{number of fields checked}) * 100 = \text{percentage error}$
 $100 - \text{percentage error} = \text{accuracy percentage}$

$(2 / 32) * 100 = 6.25\%$

$100\% - 6.25\% = 93.75\%$ accuracy level

This percentage accuracy level is then entered onto a graph so that ongoing accuracy can easily be seen, again, for each CCTV operator.

Detail Information

It is expected that accuracy of Observation/Defect codes exceed 90 percent.

As with Header records, each field that has been completed in the Detail records is added up, irrelevant of whether it is a Clock At/To, the Continuous Defect field or Distance/Video digits. Each entry is treated as equally important. From this number of entries made in the Detail section, a figure is arrived. A qualified QC employee/operator then looks through the same inspection and checks accuracy of each field and reaches two values, the number of entries that should have been made and an error count. No attempt should be made to create a new inspection from scratch, just check what has already been reported on. If a defect is not recorded then number of fields that support the missed defect is added to Error Count, for instance, if CCTV operator misses an EMJ then error count increases by at least five errors:

Video Digit, Distance, Code, Clock At and To and the percent

The five errors must also be added to number of entries that should have been made as well as any other errors to reach a total number of entries. Therefore at the end each inspection there are two values, the number of entries that should have been made and the error count. Calculation for Quality Control of each inspection is as follows:

$(\text{Error Count} / \text{Number of entries that should have been made}) * 100 = \text{Percentage Error}$

$100 - \text{Percentage Error} = \text{Accuracy Level}$

Assume Number of entries made should have been 122 Assume Error Count is 8:

$(8 / 122) * 100 = 6.5\%$

$100\% - 6.5\% = 93.5\%$ Accuracy Level

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This percentage Accuracy Level is then entered onto a graph so that ongoing level can be easily seen for each CCTV Operator.

Summary

QC inspection information for each sewer segment checked is entered into QC forms so that an Audit trail can be established. There must be hard copies of each inspection checked with Errors and Omissions clearly marked. Accuracy Level calculations must also be entered into QC logs. Random Number must be entered against each aspect of QC procedure. A continuing Accuracy Level Graph must be kept up to date for each CCTV operator; it is acknowledged that results could be as much as 1 month behind time of inspection.

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SECTION 33 01 33
GRAVITY SEWER PIPELINE CLEANING

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals:

1. Catalog and manufacturer's data sheets for cleaning equipment.
2. Root Herbicide: Product data.

B. Informational Submittals:

1. Root Herbicide: Material Safety Data Sheet and application method.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. Subcontractor: Performed work successfully for at least three other projects, within last 5 years, with pipe lengths and pipe diameters similar to this Project.
2. Crew Chief: Minimum of 2 years' experience on projects similar to this Project and experienced using proposed equipment for this Project. If experience level cannot be met because of new equipment or technology proposed for Project, submit training and experience information for CH2M's consideration.

PART 2 PRODUCTS

2.01 CLEANING EQUIPMENT

A. Equipment shall be capable of removing dirt, grease, rocks, sand, roots, and obstructions from lines and manholes.

B. High-Velocity, Hydro Cleaning Equipment:

1. High-Pressure Hose: 700 feet, minimum.
2. Hydraulically driven hose reel.
3. High-Velocity Nozzle:
 - a. Two, minimum.
 - b. Capable of producing scouring action from 10 degrees to 45 degrees in lines to be cleaned.

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4. High-Velocity Gun: Capable of producing flows ranging from fine spray to long distance solid stream.
5. Water Tank: 1,000 gallon, minimum.
6. Single engine drive or auxiliary engine.
7. Equipment Operating Controls: Locate above ground.
8. Working Pressure: 2,000 pounds per square inch at 65 gpm, minimum.
9. Vacuum System:
 - a. Minimum 6-inch suction line.
 - b. Equipped with fluidizing nozzle capable of removing material from beneath water surface at depths from the ground surface to the sewer invert of at least 35 feet.
10. High-Volume Water and Solids Separation System: Capable of cleaning liquid vacuumed from sewer to the degree that it can be reused for continuous high-pressure sewer cleaning.

C. Mechanically Powered Cleaning Equipment:

1. Use either power bucket or power rodder.
 - a. Bucket Machine:
 - 1) Furnish with buckets in pairs, and with sufficient dragging power to perform Work efficiently.
 - 2) Use V-belts for power transmission or have overload device. No direct drive machines permitted.
 - 3) Equip with take-up drum, and minimum 500 feet of cable.
 - b. Rodding Machine:
 - 1) Fully enclosed, and with automatic safety throwout clutch or relief valve.
 - 2) Either sectional or continuous.
 - 3) 750 feet of rod, minimum.
 - 4) Rod shall be heat-treated steel.

2.02 ROOT REMOVAL EQUIPMENT

- A. Use tools and accessories designed for removing roots, such as hydraulic root cutters, porcupines, or high-velocity hydro cleaners.

2.03 ROOT HERBICIDE

- A. Herbicide with foaming agent similar or equal to:

1. RootX® supplied by General Chemical Company; Salem, Oregon.
2. Vaporooter® supplied by Douglas Products; Rancho Cordova, California.

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DESIGN AND CONSTRUCTION STANDARDS

PART 3 EXECUTION

3.01 PREPARATION

- A. When hydraulically propelled cleaning tools that depend upon water pressure to provide cleaning force or tools that retard flow are used, take precautions to ensure water pressure created does not damage or cause flooding of public or private property.

3.02 PIPELINE CLEANING

- A. Perform cleaning prior to closed-circuit television (CCTV) inspection.
- B. Cleaning shall restore pipe to a minimum of 95 percent of original carrying capacity. No more than 5 percent debris, based on visual observation provided by CCTV inspection, shall remain in pipe.
- C. Clean using hydraulically propelled, high-velocity hydro, or mechanically powered equipment supplemented with additional equipment as required based on conditions of lines at time Work commences and suitable to obtain a clean sewer line free from dirt, sand, rocks, gravel, grease, sludge, roots, and other debris.
- D. If using high velocity hydro-cleaning equipment, make minimum of two passes through pipe segment.
- E. Begin cleaning at upstream end of system and proceed in downstream direction. Unless otherwise permitted by CH2M, cleaning of pipeline segments upstream of a section of pipe already cleaned will not be allowed. If entire section cannot be cleaned from upstream manhole, it will be assumed that a major blockage exists. Subcontractor shall, with CH2M's approval, abandon effort and document what was completed to point of blockage.
- F. Supply water for performing high-velocity hydro cleaning or flushing. Water may be obtained from the Post's water system. Obtain approval from CH2M prior to commencement of Work.
- G. Remove debris at downstream manhole of pipe segment being cleaned with vacuum system.

3.03 ROOT REMOVAL AND TREATMENT

- A. Remove roots from pipe being cleaned.

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- B. Treat pipeline segments that have root intrusion with herbicide. Apply herbicide to roots within one hour of root removal and in accordance with manufacturer's recommendations and in such a manner to preclude damage to surrounding vegetation.

3.04 HIGH-VOLUME WATER AND SOLIDS SEPARATION SYSTEM

- A. Use to separate and capture solids and filter water for cleaning. Provide continuous operation until cleaning of a pipe segment is complete.

3.05 MATERIAL REMOVAL AND DISPOSAL

- A. Sludge, dirt, sand, rocks, grease, and other solid or semisolid material resulting from cleaning operation shall be removed at adjoining downstream manhole. Passing material to downstream pipe will not be permitted.
- B. Solids or semisolids resulting from cleaning operations shall be removed from site and disposed of in accordance with provisions of local, state, and federal requirements. Do not accumulate debris onsite beyond a single workday, except in totally enclosed containers and as approved by CH2M.

3.06 VERIFICATION OF CLEANING AND ROOT REMOVAL

- A. Inspect cleaned pipe segment by CCTV inspection, as specified in Section 33 01 30.16, Television Inspection of Sewer Pipelines, to verify results of cleaning and root removal and treatment effort. Reclean and remove and retreat roots in pipe segment if CH2M determines section has not been adequately cleaned or roots properly removed and treated.

END OF SECTION

SECTION 33 05 01
CONVEYANCE PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.
 2. American Water Works Association (AWWA):
 - a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - b. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - c. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm).
 - d. C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - e. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - f. C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
 - g. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - h. C221, Fabricated Steel Mechanical Slip-Type Expansion Joints.
 - i. C606, Grooved and Shouldered Joints.
 3. ASTM International (ASTM):
 - a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - d. C150/C150M, Standard Specification for Portland Cement.
 - e. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 4. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

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1.02 DESIGN REQUIREMENTS

- A. Where pipe class or wall thickness is not indicated, design piping system for maximum stress based on the following pressures and loads:
1. Operating Pressure: 150 psi.
 2. Field Hydrostatic Test Pressure: 200 psi.
 3. Earth Loads: In accordance with field conditions, as approved by Engineer.
 4. Soil Density: In accordance with field conditions, as approved by Engineer.
 5. Traffic Loads: H-20.

1.03 SUBMITTALS

- A. Action Submittals:
1. Detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information.
 2. Layout drawing showing location of each pipe section and each special length.
 3. Pipe pressure class.
 4. Wall thickness, reinforcing, and strength calculations.
 5. Product Data: Manufacturer's data for couplings, saddles, gaskets, and other pipe accessories. Indicate maximum rated working pressure and test pressure for each item.
- B. Informational Submittals: Manufacturer's Certificate of Compliance.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with manufacturer's recommendations and as specified in individual Specification(s) following this section.
- B. Marking at Plant: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, diameter of pipe dimension ratio, pipe class, pipe number for laying purposes, and other information required for type of pipe.
- C. Pipe, specials, and fittings received at Project Site in damaged condition will not be accepted.
- D. Gasket Storage: Store rubber gaskets in cool, well ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

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- E. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
- F. Handling:
 - 1. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.
 - 2. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.
 - 3. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe. Pipe shall not be rolled off or dropped from delivery truck onto ground.
 - 4. Pipe and fittings shall not be stored on rocks or gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPE

- A. As specified in the individual specification(s) following this section.

2.03 JOINTS

- A. As specified in the individual specification(s) following this section.

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2.04 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for appropriate operating pressure and hydrostatic test pressure.
3. Exposed, bolted, sleeve-type couplings shall be lined and coated with fusion bonded epoxy in accordance with AWWA C213.
4. Buried, bolted, sleeve-type couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

B. For Pipe with Flanged Ends:

1. Flanged coupling adapters, in accordance with AWWA C219.
2. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.
3. Rubber expansion joints shall allow compression, extension, and lateral deflection of the pipes being joined.

C. Bolting Materials for Couplings: Stainless steel in accordance with AWWA C219.

2.05 SERVICE SADDLES

- A. Double strap design rated for 150 psi minimum working pressure.

2.06 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Assemble interconnected rubber links with Type 316 stainless steel bolts, nuts, and pressure plates.
3. Size modular mechanical seals according to manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.
4. Manufacturers and Products:
 - a. Thunderline/LinkSeal, Div. of PSI, Houston, TX; Link Seal.
 - b. Calpico, Inc., South San Francisco, California; Sealing Linx.
 - c. Advance Products and Systems, Lafayette, Louisiana; Innerlynx.

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B. Wall Sleeves:

1. Diameter, ends, and length shall be as shown on Drawings.
2. Shall include integral seep ring to minimize seepage between metal sleeve and concrete.

C. Wall Couplings:

1. Diameter, ends, and length shall be as shown on Drawings.
2. Wall couplings shall provide flexible mechanical joint.
3. Body and end rings shall be coated with fusion bonded epoxy.
4. Body shall include integral seep ring.
5. Shall comply with AWWA C219.

- D. If core drilling is required for penetrations of existing concrete walls or slabs, locations of drilling shall be determined by radiograph to avoid damage to reinforcing steel and conduits.

2.07 FLANGES, FLANGE GASKETS, AND BOLTING MATERIALS

- A. As specified in individual specifications following this section.
- B. Flanges, bolting materials, and flange gaskets for steel flanges shall conform to AWWA C207.
- C. Flanges, bolting materials, and flange gaskets for ductile iron flanges shall conform to AWWA C110 and AWWA C115.
- D. Stainless steel bolting material shall conform to ASTM F593, Type 304 stainless steel, Group 1, Condition SH1, 2, 3 or 4.
- E. If the flanges are coated, provide two washers for each bolt on each side of the flange to minimize damage to the coating as the nuts are tightened. Provide bolts of the proper length to accommodate the washers.

2.08 CONCRETE FOR THRUST BLOCKS

- A. Thrust Block Concrete: As specified in Section 03 30 10, Reinforced Concrete.
- B. Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.
- C. Welded Wire Fabric: ASTM A497/A497M.
- D. Formwork: Plywood.

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2.09 PIPE LOCATING TAPE

- A. As specified in Section 31 23 23.15, Trench Backfill.

2.10 PIPE BEDDING AND PIPE ZONE MATERIAL

- A. As specified in Section 31 23 23.15, Trench Backfill.

2.11 TRENCH STABILIZATION MATERIAL

- A. As specified in Section 31 23 23.15, Trench Backfill.

PART 3 EXECUTION

3.01 GENERAL

- A. Notify CH2M at least 2 weeks prior to field fabrication of pipe or fittings.
- B. Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished.
- C. Distributing Materials: Place materials along trench only as will be used each day, unless otherwise approved by CH2M. Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area.

3.02 EXAMINATION

- A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.
- C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer's instructions.

3.03 PREPARATION OF TRENCH

- A. Prepare trench as specified in Section 31 23 16, Excavation.
- B. Unless otherwise permitted by CH2M, maximum length of open trench shall not exceed 300 feet.

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3.04 INSTALLATION

A. General:

1. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
2. Install individual pipe lengths in accordance with approved lay diagram. Misplaced pipe shall be removed and replaced.
3. Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.
4. Flanged Joints:
 - a. Install perpendicular to pipe centerline.
 - b. Bolt Holes: Straddle vertical centerline, aligned with connecting equipment flanges or as shown on Drawings.
 - c. Use torque-limiting wrenches to provide uniform bearing and proper bolt tightness.
 - d. Flange Type: Use flat-faced flange when joining with flat-faced ductile or cast iron flange.
5. Couplings:
 - a. Install in accordance with manufacturer's written instructions.
 - b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
 - c. Remove pipe coating, if necessary, to obtain smooth surface.
 - d. Clean gaskets before installation.
 - e. If necessary, lubricate with gasket lubricant for installation on pipe ends.
 - f. Tighten coupling bolts progressively, drawing up bolts on opposite sides gradually until bolts have uniform tightness.

B. Buried Pressure Pipe:

1. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown on Drawings.
2. Placement:
 - a. Keep trench dry until pipe laying and joining is completed.
 - b. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
 - c. Measure for grade at pipe invert, not at top of pipe.
 - d. Excavate trench bottom and sides of ample dimensions to permit proper joining, welding, visual inspection, and testing of entire joint.
 - e. Prevent foreign material from entering pipe during placement.
 - f. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

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- g. In general, lay pipe upgrade with bell ends pointing in direction of laying.
 - h. Deflect ductile iron pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
 - 1) Shorter pipe lengths.
 - 2) Special mitered joints.
 - 3) Standard or special fabricated bends.
 - i. Check gasket position with feeler gauge to assure proper seating.
 - j. After joint has been made, check pipe alignment and grade.
 - k. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
 - l. Prevent uplift and floating of pipe prior to backfilling.
3. Tolerances:
- a. Deflection From Horizontal Line: Maximum 2 inches.
 - b. Deflection From Vertical Line: Maximum 1 inch.
 - c. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
 - d. Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.
- 4. Cover Over Top of Pipe: Minimum 3 feet, unless otherwise shown.
 - 5. Disposal of Excess Excavated Material: As specified in Section 31 23 16, Excavation.

3.05 THRUST RESTRAINT

- A. Location: At pipeline tees, plugs, caps, bends, and locations where unbalanced forces exist.
- B. Thrust Blocking:
 - 1. Place only where shown on Drawings.
 - 2. Quantity of Concrete: Sufficient to cover bearing area of pipe and provide required soil bearing area as shown on Drawings.
 - 3. Place blocking so pipe and fitting joints are accessible for repairs.
 - 4. Place concrete in accordance with Section 03 30 10, Reinforced Concrete.

3.06 CORROSION PROTECTION

- A. Buried Pipe: As specified in the individual specifications following this section.

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- B. Notify CH2M at least 3 days prior to start of surface preparation, coating application, and corrosion protection work.

3.07 PLACEMENT OF PIPE LOCATING TAPE

- A. Place pipe locating tape in accordance with Section 31 23 23.15, Trench Backfill.

3.08 PIPE BEDDING AND ZONE MATERIAL

- A. Place pipe bedding and pipe zone material in accordance with Section 31 23 23.15, Trench Backfill.

3.09 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in the individual specification(s) following this section.

3.10 CLEANING AND DISINFECTION

- A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. Dispose of water and flushed foreign matter.
- B. If impractical to flush large diameter pipe at 2.5 fps, clean pipe in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.
- C. Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.
- D. Disinfection: As specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

END OF SECTION

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SECTION 33 05 01.02
DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): T99, Standard Method of Test for the Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
 2. American Society of Mechanical Engineers (ASME):
 - a. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
 - b. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
 3. American Water Works Association (AWWA):
 - a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Fittings.
 - f. C116/A21.16, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
 - g. C150/A21.50, Thickness Design of Ductile-Iron Pipe.
 - h. C151/A21.51, Ductile-Iron Pipe. Centrifugally Cast, for Water.
 - i. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
 - j. C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - k. C606, Grooved and Shouldered Joints.
 4. ASTM International (ASTM):
 - a. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - b. A563, Standard Specification for Carbons and Alloy Steel Nuts.
 - c. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
 - d. D1330, Standard Specification for Rubber Sheet Gaskets.

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- e. D1922, Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method.
 - f. D2000, Standard Classification System for Rubber Products in Automotive Applications.
 - g. D4976, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
5. International Organization for Standardization (ISO): 9001, Quality Management Systems – Requirements.

1.02 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings: Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating and lining data.

B. Informational Submittals:

- 1. Manufacturer's Certificate of Compliance stating that inspections and specified tests have been made and that results thereby comply with requirements of Article Source Quality Control.
- 2. Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
 - a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Method of isolation.
 - d. Method of conveying water from source to system being tested.
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested.
- 3. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
- 4. Test documentation form and results.

1.03 QUALITY ASSURANCE

- A. Pipe manufacturer shall be ISO 9001 registered or provide the services of an independent inspection agency.

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- B. Prior to start of manufacturing, manufacturer not meeting or having ISO registration requirements shall submit name of at least two independent inspection agencies for approval.
 - 1. Independent inspection agency shall be responsible, on a daily basis, for sample monitoring of chemical and mechanical tests, sample visual inspection of quality assurance tests performed on in-process pipe and fittings, and sample visual and dimensional inspection on finished products.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General:
 - 1. Ductile iron pipe shall be manufactured, lined, coated, and tested domestically in the United States of America.
 - 2. Ductile iron fittings shall be manufactured, lined, coated, and tested domestically or for fittings produced outside of the United States of America they shall bear the name of the domestic manufacturer supplying the pipe.
 - 3. Pipe manufacturer shall certify source manufacturing facility has been producing ductile iron pipe of the specified diameters, pressure, dimensions and standards for a period of not less than 10 years.
- B. Pipe:
 - 1. General:
 - a. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.
 - b. Lined and coated as specified.
 - 2. Meet requirements of AWWA C150/A21.50, AWWA C151/A21.51, and AWWA C111/A21.11.
 - 3. Centrifugally cast, grade 60-42-10 iron.
 - 4. Pressure rating of pipe from 4 inches to 24 inches in diameter shall be 250 psi.
 - 5. Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 12-inch to 54-inch diameter pipe in accordance with AWWA C115/A21.15.
 - 6. Grooved end pipe shall be minimum Special Class 53.

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C. Joints:

1. Push-On Joint: Rated at minimum working pressure equal to pipe material design.
2. Restrained Joint:
 - a. Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.
 - b. Manufacturers and Products:
 - 1) American Cast Iron Pipe; Flex-Ring, Field Flex-Ring, and Lok-Ring.
 - 2) Pacific States Pipe; Thrust-Lock.
 - 3) U.S. Pipe; TR Flex and HP Lok.
3. Mechanical Wedge Action Type Joint:
 - a. Use only in areas where adjoining to fixed points where laying length is determined in field.
 - b. Prior to purchase and installation, type and application of this joint shall be approved by Engineer and CH2M.
4. Use of set screws for restraint or field-lock gaskets shall not be allowed.
5. Grooved Joint:
 - a. Rigid type radius cut grooved, conforming to AWWA C606.
 - b. Manufacturer: Victaulic Company of America.
6. Ball Joint:
 - a. Meet requirements of AWWA C151/A21.51.
 - b. Minimum Working Pressure:
 - 1) 4-inch through 12-inch Diameter: 350 psi.
 - 2) Larger than 12-inch Diameter: 250 psi.
 - c. Manufacturers and Products:
 - 1) American Cast Iron Pipe; Flex-Lock.
 - 2) U.S. Pipe; USIFLEX.

D. Fittings:

1. Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted.

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2. Mechanical, Push-On, Flanged, or Restrained Joint: In accordance with the following table:

Minimum Pressure Ratings for AWWA C110/A21.10 and C115/A21.15 Ductile Iron Fittings		
Diameter (inches)	Rubber Gasket Joints (Push-on, Mechanical, Restrained) (psi)	Flanged Joints (psi)
3 to 24	350	250
30 to 48	250	250

Minimum Pressure Ratings for AWWA C153/A21.53 Ductile Iron Fittings		
Diameter (inches)	Rubber Gasket Joints (Push-on, Mechanical, Restrained) (psi)	Flanged Joints
3 to 24	350	Not included in C153/A21.53 (refer to the C110/A21.10 Standard)
30 to 48	250	Not included in C153/A21.53 (refer to the C110/A21.10 Standard)
54 to 64	150	150 psi

3. Rubber Gasket Joints Including Mechanical Joints, Push-On Joints, and Flanged Joints: In accordance with AWWA C111/A21.11.
4. Mechanical Joint Fittings: In accordance with AWWA C110/A21.10 and AWWA C153/A21.53.
5. Grooved End Fittings:
- a. Radius cut grooved, rigid type conforming to AWWA C110/A21.10 and AWWA C153/A21.53.
 - b. Manufacturers:
 - 1) Victaulic Company of America.
 - 2) Gustin-Bacon.

- E. Welded Outlet: Only weld to pipe in manufacturer's shop.

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F. Lining:

1. Pipe and fittings for clean water applications shall be cement-lined and asphaltic seal coated in accordance with AWWA C104/A21.4.
2. Pipe and fittings for wastewater applications shall be lined with 40-mil ceramic epoxy, as manufactured by Induron.
3. Pipe and fitting lining for domestic water service shall comply with requirements of AWWA C116/A21.16.

G. Coating: Asphaltic type, 1 mil thick, in accordance with AWWA C151/A21.51, AWWA C115/A21.15, AWWA C110/A21.10, and AWWA C153/A21.53.

H. Polyethylene Encasement:

1. Virgin polyethylene raw material conforming to requirements of ASTM D4976.
2. Elongation: 800 percent, minimum, in machine and transverse direction (ASTM D882).
3. Tensile Strength: 3,600 psi, minimum.
4. Dielectric Strength: 800V per mil-thickness, minimum.
5. Propagation Tear Resistance: 2,550-gram force (gf), minimum, in machine and transverse direction (ASTM D1922).
6. Tube Form: Conform to AWWA C105/A21.5.
7. Film: 0.008 inch (8 mil) thick, minimum.
8. Number of Film Layers: One.

I. Bolting:

1. Flanged Connection Bolts: Carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.
2. Grooved End Connections Bolts: Manufacturer's standard.

J. Gaskets:

1. Flat Faced Flange Gaskets:
 - a. Pipe Smaller Than 54 Inches: Rated for working pressure 150 psi to 250 psi, 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ASME B16.21, AWWA C207, and ASTM D1330, Grade 1 and Grade 2.
 - b. Pipe 54 Inches and Larger: Rated for working pressure greater than 250 psi; shall be Toruseal gaskets as manufactured by American Ductile Iron Pipe or Flange-Tyte gaskets as manufactured by U.S. Pipe.

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2. Grooved End Joint Gaskets: Halogenated butyl, conforming to ASTM D2000 and AWWA C606.

2.02 SOURCE QUALITY CONTROL

A. Factory Tests:

1. General:
 - a. Tests shall be performed on pipe with metal thickness equal to that specified.
 - b. Only pipe that passes leak test shall be shipped.
2. Hydrostatic Proof Test:
 - a. All Pipe: Perform at 500 psi for a minimum duration of 10 seconds.
 - b. Pipe 30 Inches and Larger: Additionally test to 75 percent of minimum yield strength during test duration which shall not be less than 15 seconds.
 - c. Record each test cycle on a strip chart.
 - d. Each test cycle for 30-inch and larger pipe shall be marked by pipe number.
 - e. Inspect each pipe during testing for leaks.
 - f. Pipe which shows evidence of leaks shall be scrapped.
 - g. Repair welding of leaks is not permitted.
3. Perform a 15-psi air test on welded-on outlet pipe.
4. Pipe ends (spigot end, bell and socket) shall be gauged with suitable gauges at sufficiently frequent intervals to ensure compliance to standard dimensions of AWWA C151/A21.51.
 - a. In addition, each socket and spigot shall be inspected in a well lighted area for injurious defects which could affect the joint performance.
 - b. Remove defects by cutting of pipe ends.
 - c. Pipe with injurious defects in the bell shall be scrapped.
 - d. Manufacturer shall have a recommended ovality tolerance for pipes 18 inches inch and larger.
 - e. Each end of each 18-inch and larger pipe shall be measured and approved by manufacturer's quality assurance inspector to meet tolerances.
5. Submit a certified inspection report from the independent agency of witnessed tests within 10 days of the inspection.
 - a. Test results shall show restrained joints in the sizes specified have been successfully tested to at least twice the specified pressure rating of the joint without leakage or failure.
6. In accordance with AWWA C104/A21.4.

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PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

3.02 PREPARATION

- A. Trench Grade:
 - 1. When specified, grade bottom of trench by hand to specified line and grade with proper allowance for pipe thickness and pipe base. Trench bottom shall form a continuous and uniform bearing and support for pipe between bell holes.
 - 2. Before laying each section of pipe, check grade and correct irregularities found. Grade may be disturbed for removal of lifting tackle.
- B. Bell (Joint) Holes: At each joint, dig bell holes of ample dimensions in bottom of trench, and at sides where necessary, to permit joint to be made properly and to permit easy visual inspection of entire joint.

3.03 INSTALLATION

- A. General:
 - 1. Provide and use proper implements, tools, and facilities for safe and proper prosecution of the Work.
 - 2. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings.
 - 3. Do not drop or dump pipe materials into trench.
- B. Cleaning Pipe and Fittings:
 - 1. Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
 - 2. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

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C. Laying Pipe:

1. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of CH2M.
2. Mechanical Joint, Push-On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement.
3. Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.
4. When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.
5. Do not allow foreign material to enter pipe while it is being placed in trench.
6. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from job.

D. Joining Push-On Joint Pipe and Mechanical Joint Fittings:

1. Join pipe with push-on joints and mechanical joint fittings in accordance with manufacturer's recommendations.
2. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.
3. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.
4. Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

E. Ball Joint Pipe:

1. Assemble and install in accordance with manufacturer's recommendations.
2. Hydrostatic Test:
 - a. Conduct on ball joint pipe independent of other pipe systems/type being installed.
 - b. Conduct test in accordance with requirements of these Specifications and manufacturer's recommendations.

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F. Cutting Pipe:

1. General: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
2. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
3. Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

G. Field Welding:

1. Use of field welded outlets will not be allowed. Welding for outlets shall be performed only in pipe manufacturer's shop.
2. Field installed outlets may be installed with saddle approved by Engineer and CH2M. Opening in pipe shall be machined cut and not with cutting torch.
3. Field welding of bars for restrained joint systems will not be allowed. Welding shall be performed in pipe manufacturer's shop.

H. Line and Grade:

1. Minimum Pipe Cover: 3 feet, unless otherwise indicated.
2. No high points will be allowed between air valves.
3. Maintain pipe grade between invert elevations to provide minimum clearance at air valve locations of 4 feet from existing ground surface to top of pipe.
4. Install air valves as shown and field verify intervening low points. When field conditions warrant, exceptions may be made upon approval of Engineer and CH2M.
5. Deviations exceeding 6 inches from specified line or 1 inch from specified grade will not be allowed without express approval of Engineer and CH2M.
6. Pipeline sections that are not installed to elevations shown or installed as approved by Engineer and CH2M shall be reinstalled to proper elevation.

- I. Thrust Restraint: Primary method of restraint shall be through use of restrained joint pipe. Thrust blocking shall be used where detailed on Drawings and as approved by Engineer and CH2M.

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J. Polyethylene Encasement:

1. Encase pipe, fittings, and valves where specified in accordance with AWWA C105/A21.5, Method A.
2. Cut polyethylene tube approximately 2 feet longer than pipe length.
3. Slip tube around pipe, centering to provide 1-foot overlap on each adjacent section.
4. Pull encasement to take out slack and wrap snug around pipe.
5. Secure overlap in place and fold at quarter points of pipe length.
6. Wrap and tape encasement snug around fittings and valves.

3.04 HYDROSTATIC TESTING

A. Pipeline Hydrostatic Test:

1. General:
 - a. Notify CH2M in writing 5 days in advance of testing. Perform testing in presence of CH2M.
 - b. Test newly installed pipelines. Using water as test medium, pipes shall successfully pass a leakage test prior to acceptance.
 - c. Furnish testing equipment and perform tests in manner satisfactory to CH2M. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions.
 - d. Isolate new pipelines that are connected to existing pipelines.
 - e. Conduct tests on entire pipeline after trench has been backfilled. Testing may be done prior to placement of asphaltic concrete or roadway structural section.
 - f. Subcontractor may, if field conditions permit and as determined by Engineer and accepted by CH2M, partially backfill trench and leave joints open for inspection and conduct an initial service leak test. Hydrostatic test shall not, however, be conducted until backfilling has been completed.
 - g. Supply of temporary water for testing shall be provided by CH2M.
 - h. Dispose of water used in testing.
2. Procedure:
 - a. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.
 - b. Expel air from pipe system during filling. Expel air through air release valve or through corporation stop installed at high points and other strategic points.
 - c. Test pressure shall be 200 psi as measured at low point of pipeline.

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- d. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 - e. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional make-up water only as necessary to restore test pressure.
 - f. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
 - g. If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.
3. Allowable Leakage: Maximum allowable leakage shall not exceed amount stated in AWWA C600.

END OF SECTION

SECTION 33 05 01.09
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
 - a. C110, Ductile-Iron and Gray-Iron Fittings.
 - b. C153, Ductile-Iron Compact Fittings, for Water Service.
 - c. C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 - d. C900-16, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 12 In. (100 mm through 300 mm), for Water Distribution.
 - e. C905-10, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
 - f. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. through 12 In. (100 mm through 300 mm), for Water Distribution.
 2. ASTM International (ASTM):
 - a. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - b. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - c. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - d. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - e. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
 - f. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
 - g. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 3. NSF International (NSF).

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1.02 SUBMITTALS

- A. Action Submittals: Drawings showing pipe diameter, pipe class, and fitting details.
- B. Informational Submittals:
 - 1. Manufacturer's Certificate of Compliance.
 - 2. Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
 - a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Method of isolation.
 - d. Method of conveying water from source to system being tested.
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested.
 - 3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
 - 4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 PRODUCTS

2.01 MATERIALS

DR 18

- A. Pipe:
 - 1. PVC, conforming to requirements of AWWA C900.
 - 2. SDR shall be 200 psi rating.
 - 3. Pipe to be used for potable water conveyance shall be manufactured from National Sanitation Foundation (NSF) approved compounds.
- B. Joints:
 - 1. Rubber gasketed.
 - 2. Conform to AWWA C900.
- C. Fittings: Ductile iron, conforming to AWWA C153 or AWWA C110.
- D. Service Saddles:
 - 1. Double strap type with minimum strap width of 2 inches.

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2. Straps shall be Type 304 stainless steel. Saddles shall be ductile iron, epoxy-coated, 10 mils minimum thickness.
3. Minimum Pressure Rating: 200 psi.

E. Restrained Joints:

1. Pipe restraint, where indicated on Drawings, shall be provided by system using wedges. System shall be specifically recommended for use on PVC pipe. Systems with set screws, gripper rings, or gripper gaskets shall not be used.
2. Minimum Pressure Rating: 200 psi.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with AWWA C605.
- B. Solvent cement used for joints as recommended by pipe manufacturer.
- C. Joints:
 1. Rubber Gasketed: In accordance with manufacturer's written instructions.
 2. Solvent Cemented: In accordance with ASTM D2855.
 3. Restrained Joint Systems: In accordance with manufacturer's written instructions.
- D. Pipe Bending for Horizontal or Vertical Curves:
 1. Bending of pipe barrels larger than 12 inches in diameter is not allowed.
 2. Radius of curves shall not exceed 75 percent of manufacturer's recommended values.
 3. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.
- E. Maximum Joint Deflection: 75 percent of manufacturer's recommended values.

3.02 INSPECTION AND HYDROSTATIC TESTING

- A. General:
 1. Notify CH2M in writing at least 5 days in advance of testing. Perform testing in presence of CH2M.

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2. Using water as test medium, all newly installed pipelines shall successfully pass hydrostatic leakage test prior to acceptance.
3. Conduct field hydrostatic test on buried piping after trench has been completely backfilled and compacted. Testing may, as approved by CH2M, be done prior to placement of asphaltic concrete or roadway structural section.
4. Subcontractor may, if field conditions permit and as approved by CH2M, partially backfill trench and leave joints open for inspection and conduct an initial informal service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.
5. Supply of temporary water for testing shall be provided by CH2M.
6. Dispose of water used in testing.
7. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
8. Wait a minimum of 5 days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
9. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
10. New Piping Connected to Existing Piping:
 - a. Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to CH2M.
 - b. Provide appropriate thrust blocking.

B. Hydrostatic Testing Procedure:

1. Furnish testing equipment, as approved by CH2M, which provides observable and accurate measurements of leakage under specified conditions.
2. Maximum Filling Velocity: 0.25 foot per second calculated based on full area of pipe.
3. Expel air from piping system during filling.
4. Test Pressure: 200 psi as measured at low point of pipeline.
5. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
6. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding make-up water only as necessary to restore test pressure to within 5 psi of specified hydrostatic test pressure.
7. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

C. Maximum Allowable Leakage:

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$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour.

N = Number of joints in tested line.

D = Nominal diameter of pipe, in inches.

P = Average test pressure during leakage test, in pounds per square
inch.

END OF SECTION

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SECTION 33 05 01.12
GRAVITY SEWER PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
 - a. C105, Polyethylene Encasement for Ductile Iron Pipe Systems.
 - b. C110, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm), for Water.
 - c. C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger - Shop Applied.
 - e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
 - f. C302, Reinforced Concrete Pressure Pipe, Noncylinder Type.
 - g. C900-16, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. (100 mm Through 300 mm), for Water Distribution.
 2. ASTM International (ASTM):
 - a. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - b. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
 - c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - d. C150, Standard Specification for Portland Cement.
 - e. C151, Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
 - g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
 - h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 - i. C596, Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
 - j. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
 - k. D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.

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- l. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- m. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- n. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- o. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- p. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- q. D3212, Standard Specification for Joints For Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- r. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- s. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- t. F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.02 DEFINITIONS

- A. CCTV: Closed Circuit Television.
- B. SDR: Standard Dimension Ratio.

1.03 SUBMITTALS

- A. Action Submittals: Complete Shop Drawings and laying diagrams showing location of each pipe section.
- B. Informational Submittals:
 - 1. Certificates:
 - a. Manufacturer's Certificate of Compliance that products furnished meet requirements of this section.
 - b. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
 - c. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe, AWWA C111 for ductile iron pipe, ASTM C361 for reinforced concrete pipe.

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PART 2 PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

A. 15-Inch Diameter and Smaller:

1. In accordance with ASTM D3034.
2. Joints: Integral bell and spigot, in accordance with ASTM D3212.
3. Minimum SDR: 26.
4. Cell Classification: 12454-B or 12454-C, as defined by ASTM D1784.
5. Fittings: SDR 35 minimum wall thickness.
6. Gaskets: Factory fabricated rubber compression type with solid cross section in accordance with ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.

B. 18-Inch through 36-Inch Diameter:

1. In accordance with ASTM F679.
2. Joints: Integral bell and spigot, in accordance with ASTM D3212.
3. Minimum Pipe Stiffness: 46 psi when tested in accordance with ASTM D2412.
4. Cell Classification: Minimum 12454-C, as defined by ASTM D1784.
5. Fittings: Wall thickness no less than wall thickness of equivalent size of pipe.
6. Gaskets: Factory fabricated rubber compression type with solid cross section conforming to ASTM F477.

2.02 VITRIFIED CLAY PIPE (VCP)

A. ASTM C700, extra strength.

B. Joints: ASTM C425, bell and spigot.

C. Gaskets: Factory fabricated, compression type, conforming to ASTM C425. Lubricant for joining pipe as approved by pipe manufacturer.

2.03 DUCTILE IRON PIPE (DIP)

A. Pipe:

1. Conform to ASTM A746.
2. Thickness Class: 51.
3. Joints: Push-on with rubber gaskets conforming to AWWA C111. Lubricant for joining pipe as approved by pipe manufacturer.

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4. Fittings: Ductile iron conforming to AWWA C110, lined and coated same as pipe.

B. Polyethylene Wrap and Tape for Ductile Iron Pipe:

1. Polyethylene Wrap: 8 mils, minimum thickness, conforming to AWWA C105.
2. Adhesive Tape: Thermoplastic pressure sensitive; minimum thickness of 8 mils; minimum width of 1 inch.

2.04 REINFORCED CONCRETE PIPE (RCP)

- A. Conform to requirements of this section and of ASTM C76 for Class III unless otherwise shown on Drawings.
- B. Minimum Wall Thickness: Wall B.
- C. Modified and special designs are not permitted.
- D. Joints:
 1. General:
 - a. Use rubber-gasket type with “captive gasket in groove” design.
 - b. Joint mating length shall provide allowance for manufacturer’s allowable joint deflection, preset joint opening to allow for joint deflection, and allowances as necessary to ensure positive gasket sealing during joint movement.
 - c. Joints shall be manufactured either with or without steel joint rings.
 2. Concrete Joints:
 - a. Push-on, self-centering bell and spigot type, using rubber gaskets.
 - b. Joints and gaskets shall conform to ASTM C443. Lubricant for joining pipe as approved by pipe manufacturer.
 - c. Flared bell type joints that provide full wall thickness at both bell and spigot.
 - d. Shall form watertight seal capable of resisting internal or external water head of minimum 30 feet.
 3. Joints Made with Steel Joint Rings:
 - a. Push-on, self-centering bell and spigot type, using steel bell and spigot rings, conforming to requirements of ASTM C361. Lubricant for joining pipe as approved by pipe manufacturer.
 - b. Flared bell type joints that provide full wall thickness at both bell and spigot, except for pipe wall more than 6 inches thick. Flush bells with steel joint rings conforming to requirements of ASTM A361 may be used.

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- c. Steel joint rings shall extend beyond bell or spigot at least 2 inches.
- d. Shall form watertight seal capable of resisting internal or external water head of minimum 30 feet.

E. Fabrication:

- 1. Pipe: Manufacture using centrifugal spun process or wet-cast in stationary vertical forms with concrete compacted by high-frequency vibration. Rotating packer or platform methods will not be allowed.
- 2. Concrete Pipe Fittings and Specials:
 - a. Shop fabricate as shown and designed for same internal and external pressures as adjoining pipe.
 - b. Mitered pipe ends with maximum deflection angle of 10 degrees are acceptable.
 - c. Maximum bend angle for bends shall be 22.5 degrees.
- 3. Steel Plate Fittings and Specials:
 - a. Fabricated from steel plate, cement-mortar lined, and coated.
 - b. Steel plate fittings shall conform to dimensional requirements of AWWA C208.
 - c. Minimum Steel Plate Thickness:
 - 1) Pipe 48-Inch Diameter and Smaller: 3/16 inch, minimum.
 - 2) Pipe Larger Than 48-Inch Diameter: 3/8 inch, minimum.
 - d. Line and coat steel fittings in accordance with AWWA C205.
- 4. Cement:
 - a. ASTM C150, Type II.
 - b. Fly ash or other cement substitutes will not be allowed.
 - c. Minimum Cement Content: 564 pounds per cubic yard of concrete.
 - d. Maximum Water-Cement Ratio: 0.49, by weight of concrete.
- 5. Circumferential Reinforcing:
 - a. Only circular reinforcing shall be used. Elliptical, quadrant, and triple cage reinforcing arrangements shall not be permitted.
 - b. In no case shall areas of reinforcement in each cage be less than that required by standard designs given in ASTM C76.
 - c. Modifications of required areas of reinforcing based on elliptical design shall not be used to reduce required reinforcing in either cage.
 - d. Design of concrete protective covering over reinforcing shall be 1 inch, minimum. In no case, shall placement tolerances permit less than 3/4 inch of protective cover.
 - 1) Increase wall thickness to provide required cover and to accommodate tolerances used in fabrication.

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- e. Wire fabric reinforcing shall be permitted for only single inner cage reinforcing patterns.
- f. Provide firm and positive support of reinforcing to prevent movement during concrete placement.
6. Longitudinal Reinforcing:
 - a. Equally spaced ASTM A615/A615M, Grade 40 bars.
 - b. Maximum Spacing: 12 inches or 3 times wall thickness, whichever is less, but in no case less than a total of four bars.
 - c. Provide a minimum total cross-sectional area of reinforcing equal to 0.004 times gross concrete area of pipe wall.
7. Sand and Aggregate: Nonreactive and shall conform to requirements of AWWA C302.
8. Water: Clean, potable, and free of objectionable quantities of organic matter, alkali, salts, and other impurities. Agricultural water with total dissolved solids exceeding 1,000 milligrams per liter or plant recycle water shall not be used.
9. Curing shall be in accordance with requirements of AWWA C302.
10. Pipe Laying Length: Maximum pipe laying lengths shall be in accordance with AWWA C302.
11. Marking: Each pipe section shall be marked in accordance with requirements of ASTM C76.

2.05 SERVICE CONNECTION PIPE AND FITTINGS

- A. Acceptable Pipe Materials: Polyvinyl chloride.
- B. Use one type of service connection pipe material throughout, no interchanging of pipe and fittings allowed. Long-radius bends shall be used for changes in direction, unless approved otherwise by CH2M.
- C. Size shall be 6-inch services.

2.06 PIPE FOR WATERLINE CROSSINGS

- A. PVC pressure pipe conforming to AWWA C900 or ASTM D2241; SDR 26, maximum.
- B. Class 51 ductile iron pipe conforming to AWWA C151.

2.07 PIPE TO MANHOLE CONNECTOR

- A. Manufacturers and Products:
 1. Uniseal, Evansville, Indiana; Pipeconx, Universal Pipe Connector.
 2. NPC Inc., Milford, NH; Kor-N-Seal.

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2.08 FLEXIBLE COMPRESSION COLLAR

- A. Mechanical joint coupling with No. 305 stainless steel bands.
- B. Manufacturers:
 - 1. Calder, Inc. , Bellflower, CA.
 - 2. Fernco Inc., Davison, MI.

2.09 CONCRETE

- A. Compressive Strength: Minimum 2,500 psi at 28 days.

2.10 JOINT CEMENT MORTAR

- A. Mixture: 1 part cement and 2 parts of clean sand well graded of such size that will pass No. 8 sieve.
- B. Combine cement and sand in proper proportions and thoroughly mix with water.
- C. Quantity of water used in preparation of mortar shall be minimum required to produce mixture sufficiently workable for purpose intended.
- D. No admixtures shall be used, unless otherwise specified or acceptable to Engineer.

2.11 QUICK SETTING GROUT

- A. High strength, nonstaining grout.
- B. Reach initial set within 90 minutes at 70 degrees F and minimum compressive strength of 2,500 psi within 24 hours.
- C. Shrinkage shall be less than 0.01 percent when tested in accordance with ASTM C596.

2.12 SOURCE QUALITY CONTROL

- A. Reinforced Concrete Pipe:
 - 1. Inspection of Pipe Fabrication Procedure: Select and provide independent testing agency to observe pipe fabrication. Agency staff shall have experience in observation of prestressed concrete cylinder pipe fabrication in accordance with ASTM E329. Representative of the agency shall be present full time while pipe is being fabricated. Provide

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a letter to CH2M certifying that pipe furnished meets requirements of this section.

2. Plant Testing:
 - a. General: Pipe shall not be coated internally or externally with any substance in an attempt to improve its performance when it is air or hydrostatically tested. Use of coating will be cause for rejection of pipe. This requirement does not apply to minor repair work on occasional imperfections resulting from manufacture or minor damage during handling.
 - b. Three-Edge Bearing Test:
 - 1) As required by ASTM C76 for each diameter and class.
 - 2) Tests shall determine load to produce 0.01-inch wide crack.
 - c. Hydrostatic Test:
 - 1) Minimum of 10 percent of pipe sections to 10 psi in plant prior to delivery to Job Site.
 - 2) Testing and basis of rejection shall be in accordance with ASTM C361.
 - 3) Sections to be tested shall be selected at random by CH2M's representative.
 - 4) Hydrostatic tests shall be made on two assembled sections of pipe and shall include joint. Bulkheads shall be installed in outer ends of joined pipe sections.
 - 5) Sections that fail hydrostatic test shall be marked as failed sections and removed from production and storage area.
 - d. Manufacturing Quality Testing:
 - 1) Sawcut one pipe joint, randomly selected from every 100 joints of pipe manufactured, in half with a saw that will cleanly cut concrete and reinforcing steel.
 - 2) Cut will be inspected for voids adjacent to circumferential bars. Voids will be considered continuous and failing if a 1/16-inch diameter pin can be inserted 1/4 inch deep. If voids exist adjacent to more than 10 percent of circumferential bars, test two additional pipe sections.
 - 3) If either of the two additional pipe sections fail, entire lot will be rejected.

B. Pipe Fittings:

1. Tees:
 - a. Shop fabricated by pipe manufacturer.
 - b. Tee stubs shall not protrude inside sewer pipe.
 - c. Joints: Same as joints used on sewer pipe.
 - d. Insert-a-tee PVC fitting.
2. Caps and Plugs:

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- a. Gasket and Joint: Same as pipe specified.
- b. Banded or otherwise secured to withstand test pressures involved without leakage.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Notify CH2M immediately of manufacturing imperfections or damage caused by improper handling.
- B. Verify size, pipe condition, and pipe class prior to installation of pipe.
- C. Repairs to RCP pipe section will be allowed, only if approved in writing by CH2M. Damaged pipe which, in opinion of CH2M, cannot be repaired, will be rejected and shall be removed from the Project Site.

3.02 PREPARATION

- A. Pipe Distribution: Do not distribute more than 1 week's supply of materials in advance of laying, unless otherwise approved by CH2M.
- B. Inspect pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used.
- C. Remove foreign matter and dirt from inside of pipe and fittings and keep clean during and after laying. Wash ends of section clean with wet brush prior to joining sections of pipe.

3.03 INSTALLATION

- A. General:
 1. Install pipe sections in accordance with manufacturer's recommendations.
 2. Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.
 3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings. Do not drop or dump pipe into trenches.
- B. Line and Grade:
 1. Establish line and grade for pipe by use of lasers.
 2. Measure for grade at pipe invert, not at top of pipe.

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3. Do not deviate from line or grade, as shown on Drawings, more than 1/2 inch, provided that such variation does not result in a level or reverse sloping invert.

C. Laying and Jointing:

1. Use gasket lubricant as recommended by gasket manufacturer.
2. Lay pipe upgrade with bell ends pointing in direction of laying.
3. When field cutting or machining pipe is necessary, use only tools and methods recommended by pipe manufacturer and approved by Engineer and CH2M.
4. After section of pipe has been placed in its approximate position for jointing, clean end of pipe to be joined, inside of joint, and rubber ring immediately before joining pipe.
5. Assemble joint in accordance with recommendations of manufacturer.
6. Apply sufficient pressure in making joint to assure that joint is "home" as defined in standard installation instructions provided by pipe manufacturer. Inside joint space shall not exceed 50 percent of pipe manufacturer's recommended maximum allowance.
7. Place pipe to specified line and grade to form smooth flow line.
8. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section.
9. Check for alignment and grade after joint has been made.
10. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed.
11. When pipe is laid within movable trench shield, take precautions to prevent pipe joints from pulling apart when moving shield ahead.
12. When laying operations are not in progress, and at close of day's work close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints.
13. Take precautions to prevent "uplift" or floating of line prior to completion of backfill operation.
14. Connections between one pipe material and another shall be by means of flexible compression collar, installed in accordance with the manufacture's recommendations, or concrete closure collar.

D. Gasketed Joint Protection:

1. Point (fill with joint cement mortar) 360 degrees of circumference. Quick setting grout may be substituted for joint cement mortar when approved by Engineer.
 - a. Thoroughly clean joint of lubricant materials and dirt.
 - b. Prewet joint before applying mortar.

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- c. Pointing shall be done in such a manner that there are no bulges, ridges, or other irregularities.
 - d. Pointing shall be flush with interior of pipe.
 - e. Do not point joints closer than three pipe joints from next pipe section to be placed.
 - f. Pointing Mortar:
 - 1) 1 part cement to 1.5 parts sand, unless otherwise approved by Engineer.
 - 2) Plastic and of such consistency that it will readily adhere to pipe.
- E. Connection to Structure or Manhole:
- 1. Locate standard pipe joint within 1.5 feet of outside face of structure for pipe 18 inches and smaller and within one pipe diameter for pipe 21 inches and larger.
 - 2. Plug or close off pipe stubbed with watertight plug.
 - 3. Connect PVC pipe to manhole with pipe to manhole connector in accordance with manufacturer's recommendations.
- F. Crossing Waterlines: Where sewer crosses less than 18 inches below waterline, use ductile iron or PVC pressure pipe for crossing or encase in concrete envelope for a minimum distance of 9 feet on each side of waterline.
- G. Ductile Iron Pipe:
- 1. Cutting and Dressing of Ductile Iron Pipe Ends:
 - a. Cut at right angles to centerline of pipe to leave smooth end, without damage to pipe.
 - b. Use only approved mechanical cutter.
 - c. Taper cut end of pipe to be used with rubber gasket joints by grinding or filing 1/8 inch back at an angle of approximately 30 degrees with centerline of pipe.
 - d. Remove sharp or rough edges.
 - e. Abrade cut ends with grinding wheel and apply lining repair material. Use only compatible repair materials provided by pipe lining manufacturer. Allow repair lining to harden and cure before installation.
 - 2. Polyethylene Wrap:
 - a. Before installing wrap, clean pipe exterior of foreign material.
 - b. Cut wrap approximately 2 feet longer than pipe section.
 - c. Overlap wrap approximately 1 foot; seal joints with adhesive tape.
 - d. Tape entire circumference of pipe at 3-foot intervals along pipe.

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- e. Repair rips, punctures, or other damage to polyethylene with adhesive tape.
- f. When fittings cannot be practically wrapped in a tube, use a flat sheet or split tube of polyethylene. Securely tape seams.

3.04 CONCRETE CLOSURE COLLAR

- A. Use only when approved by Engineer, and then only to make connections between dissimilar pipe or where standard rubber gasketed joints or flexible compression collars are impractical or unavailable.
- B. Procedure:
 - 1. Remove water from excavation; placement of concrete in standing water will not be allowed.
 - 2. Wash pipe to remove loose material.
 - 3. Wrap and securely fasten light gauge sheet metal or building felt around pipe joint to ensure that concrete does not enter line.
 - 4. Wet nonmetallic pipe thoroughly prior to concrete placement.
 - 5. Placement shall be monolithic for each collar.
 - 6. Place to minimum 6 inch thickness around outside diameter of pipe.
 - 7. Extend concrete minimum of 12 inches on each side of joint.
 - 8. Cure concrete, after initial set, by covering with well moistened earth.

3.05 SERVICE CONNECTION TEES

- A. Install as shown on Drawings.
- B. Install caps or plugs on tees.
- C. Furnish tee outlets with gasketed type joint or approved adapter to join service connection pipe.
- D. Concrete encase tees in trenches deeper than 12 feet. Do not encase joints at ends of tee fitting.

3.06 SERVICE CONNECTION INSTALLATION

- A. In general, service connections shall extend to demarcation line, or as directed by CH2M.
- B. Minimum Slope: 1/4 inch per foot.
- C. Minimum Trench Depth: 4 feet at demarcation line. CH2M will determine required depth at end of line in each case.

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- D. Progress of Construction: Unless otherwise approved by CH2M, install service connection not more than 5 days after backfilling of sewer trench in block or equivalent 400-foot section of sewer.
- E. Laying and Jointing of Service Connection Pipe and Fittings:
1. Maximum deflection permissible with any one fitting shall not exceed 45 degrees and shall be accomplished with long-radius curves or bends. Short-radius elbows or curves will not be permitted, except by permission of CH2M.
 2. Make service connection to sewer system at manhole when directed by CH2M. Where service connection pipe is connected to manhole or concrete structure, make connection so standard pipe joint is located not more than 1.5 feet from structure.
 3. Provide end of service connection line and fittings with standard watertight plug, cap, and stopper, suitably braced to prevent blow-off during hydrostatic or air testing.
- F. First length of pipe out from tee on lateral or main shall not be greater than 3 feet in length.
- G. Line and Grade for Service Connection Pipe and Fittings:
1. Install sewer tee so as to locate connection pipe within horizontal distance of 1 foot either side of staked location.
 2. Lay pipe uniformly between tee or top of riser section and end of service connection. Where minimum slopes are used, lay pipe by means of good quality builder's level not less than 24 inches long.
- H. Service Connection Marker:
1. Place at end of service connection as shown on Drawings.
 2. Paint top portion of marker immediately after its installation with high-quality, white, quick-drying enamel.
 3. If marker is broken or knocked out of vertical alignment during backfilling operation, reopen trench and replace marker.
- I. Existing Service Connections:
1. Locate prior to constructing tee in new sewer pipeline.
 2. Disconnect from existing pipelines to be abandoned and reconnect them to new sewer pipeline.

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3.07 CLEANING

- A. Clean each section of completed sewer pipeline prior to testing.
- B. Place screen or dam in downstream manhole of section being cleaned to catch debris.
- C. Remove material from each manhole section before cleaning the next section downstream.
- D. Method: High velocity hydro-cleaning equipment.
- E. Cleaning water may be discharged into existing sewer system after screening and removal of debris.

3.08 GASKET FIELD SPLICE TESTS

- A. Perform field splice test on 20 percent of each lot of delivered gaskets, in accordance with ASTM C361 in presence of CH2M.
- B. Furnish feeler gauges of proper size, type, and shape to verify proper placement of gasket.
- C. Test section of gasket shall be at point where ends of gasket are joined together.
- D. If gasket joints separate during test, entire lot will be rejected and shall immediately be removed from Site.

3.09 HYDROSTATIC AND PNEUMATIC TESTS

- A. General:
 - 1. Notify CH2M in writing 5 days in advance of testing. Perform testing in presence of CH2M.
 - 2. Pipe 18 inches in diameter and smaller shall be tested for leakage using Hydrostatic Exfiltration or Pneumatic Test Methods at Subcontractor's option.
 - 3. Pipe over 18 inches in diameter shall be tested for leakage using Hydrostatic Exfiltration Test Method.
 - 4. Individual joints may be tested on pipe 36 inches in diameter and larger at Subcontractor's option.
 - 5. Pipe shall successfully pass leakage test prior to acceptance
 - 6. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed. Testing may be

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- done prior to placement of asphaltic concrete or roadway structural section.
7. Isolate new pipelines that are connected to existing pipelines. Install pipe plugs as required to allow section of new pipe to be pressure tested.
 8. Plug wyes, tees, stubs, and service connections with gasketed caps or plugs securely fastened or blocked to withstand internal test pressure. Such plugs or caps shall be removable, and their removal shall provide socket suitable for making flexible jointed lateral connection or extension.
 9. Furnish testing equipment and perform tests as approved by CH2M. Testing equipment shall provide observable and accurate measurement of leakage under specified conditions.
 10. Supply of temporary water for testing shall be provided by CH2M.
 11. Dispose of water used in testing.
 12. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed. Testing may be done prior to placement of asphaltic concrete or roadway structural section.

B. Hydrostatic Exfiltration Test:

1. Fill pipe test section 24 hours prior to time of testing, if desired, to permit normal absorption into VCP and RCP pipe walls.
2. Procedure:
 - a. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on full area of pipe.
 - b. Expel air from piping system during filling.
 - c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 - d. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional make-up water only as necessary to restore test pressure.
 - e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
3. Measurement Accuracy: Plus or minus 1/8 gallon of water leakage under specified conditions
4. PVC and ductile iron pipe and joints shall sustain maximum water loss limit of 0.8 gallon per inch diameter per 1,000 feet of pipe, including service connections within test section per 2 hours. Allowable leakage shall be modified as stated below if hydrostatic head is other than 6 feet.
5. Concrete pipe and joints shall sustain maximum water loss limit of 1.5 gallons per inch diameter per 1,000 feet of pipe, including service connections within test section per 2 hours. Allowable leakage shall be modified as stated below if hydrostatic head is other than 6 feet.

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6. Hydrostatic Head:
 - a. At least 6 feet above maximum estimated groundwater level in section being tested, but no less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 - b. In every case, determine height of water table at time of test by exploratory holes or such other methods approved by CH2M. CH2M will make final decision regarding test height for water in pipe section being tested.
 - c. If hydrostatic head is other than 6 feet, allowable leakage as computed by criteria above shall be adjusted by the square root of actual head divided by square root of 6.
 7. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 16 feet of water column. In no case shall length be greater than 700 feet or distance between manholes when greater than 700 feet.
 8. Dispose of test water in a manner that will not damage or interfere with adjacent property and in a manner acceptable with CH2M and regulatory agencies.
- C. Pneumatic Testing for 18-inch and Smaller Diameter Pipe:
1. Equipment:
 - a. Calibrate gauges with standardized test gauge provided by Engineer at start of each testing day. Engineer will witness calibration.
 - b. Install compressor, air piping manifolds, gauges, and valves at ground surface.
 - c. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
 - d. Restrain plugs used to close sewer lines to prevent blowoff.
 2. Procedure:
 - a. No person shall enter manhole or structure, or occupy area above opening of manhole or structure where pipe is under pressure.
 - b. Determine height of groundwater table at time of test.
 - c. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average backpressure of groundwater submerging pipe.
 - d. Allow 2 minutes minimum for air temperature to stabilize.
 - e. Allowable leakage for sewers constructed of air-permeable materials, such a concrete or clay:
 - 1) When pressure is decreased to 3.5 psig, air pressure test shall begin.

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- 2) Test shall consist of measuring time in seconds for pressure in pipe to drop from 3.5 psig to 2.5 psig.
- 3) Pipe leakage shall be considered acceptable if time in seconds for pressure drop is equal to or greater than required time as calculated below:

$$K = 0.0111d^2L$$

$$C = 0.000392dL$$

If C_t is less than or equal to 1.0, then time = K_t

If C_t is between 1.0 and 1.75, then time = K_t/C_t

If C_t is greater than or equal to 1.75, then time = $K_t/1.75$

Where: d = pipe diameter in inches
L = pipe length in feet
K = value for each length of pipe of a specific diameter
C = value for each length of pipe of a specific diameter
 K_t = Sum of all K values
 C_t = Sum of all C values

- f. This method is based on allowable air loss rate of 0.003 cubic foot per minute (cfm) per square foot of internal pipe surface, with total air loss rate not less than 2.0 cfm nor greater than 3.5 cfm.
- g. Allowable leakage for sewers constructed of nonair-permeable materials such as ductile iron, and polyvinyl chloride (PVC).
 - 1) When nonair-permeable pipe is subjected to low pressure air test, time in seconds for pressure drop shall be equal to or greater than three times required time calculated using procedure above.
 - 2) Defective Piping Sections: Replace or test and seal individual joints and retest as specified.

D. Hydrostatic Joint Testing:

1. If pipe fails to pass hydrostatic test and location of leak cannot be readily identified, individual joint tests shall be performed. After leaking joints have been located and repaired, retest pipeline.
2. Testing shall be performed prior to installing PVC liner patch at joints.
3. Provide device specifically designed for testing of pipe joints and consisting of a metal cylinder, seal ring on each side of joint, and method of applying pressure to joint.
 - a. Manufacturer:
 - 1) Mechanical Research and Design, Inc., Manitowoc, WI.
 - 2) Cherne Industries, Inc., Minneapolis, MN.

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4. Measurement Accuracy: Plus or minus 0.05 gallon of water leakage under specified conditions.
 5. Determine height of groundwater table at time of test.
 6. Minimum Pressure, Each Joint: 2.5 psi above backpressure of groundwater.
 7. Minimum Test Duration, Each Joint:
 - a. 20 minutes for 60-inch diameter pipe and smaller.
 - b. 10 minutes for pipe larger than 60-inch diameter.
 8. Maximum Leakage: Leakage per joint shall not exceed maximum water loss limit of 0.0008 gallon per hour per inch-diameter times length of distance between pipe joints.
- E. Test Report Documentation:
1. Test date.
 2. Pipe section or pipe joint tested.
 3. Test Method.
 4. Test Pressure.
 5. Length of test.
 6. Pressure or water loss.
 7. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/ replacement performed to remedy excessive leakage.
 8. Signed by Subcontractor and CH2M to represent that test has been satisfactorily completed.
- F. Subsequent Failure: Visible infiltration of groundwater following successful test shall be considered evidence that original test was in error or that subsequent failure of pipeline has occurred.
- G. PVC Pipe Deflection Test:
1. General:
 - a. Test installed pipeline for deflection by pulling a mandrel through sewer without aid of mechanical pulling device.
 - b. Perform test at least 10 days after trench backfill and compaction have been completed.
 2. Mandrel:
 - a. Full circle, solid or rigid odd number of legs (minimum 9 legs) steel cylinder with pulling rings at each end.
 - b. Diameter: Sized to allow only as much initial deflection for ultimate deflection of 5 percent.

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- c. Obtain CH2M approval, through Subcontractor calculations, for use of mandrel smaller than $96\frac{2}{3}$ percent of inside diameter of pipe.
- 3. Correcting Deficiencies or Obstructions:
 - a. Excavate to springline of pipeline and replace and recompact pipe zone material.
 - b. Internal pipe rerounding or vibration will not be allowed.
 - c. If pipe does not pass mandrel test after replacement of pipe zone material and trench backfill, re-excavate and replace pipeline.

END OF SECTION

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SECTION 33 05 01.13
POLYVINYL CHLORIDE PIPE LINER

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. ASTM International (ASTM):
 - a. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
 - b. D2240, Standard Test Method for Rubber Property - Durometer Hardness.

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings: Manufacturer's material specifications.
 2. Samples:
 - a. Liner: 12 inches by 12 inches.
 - b. Weld Strip: 12 inches long.
 - c. Joint Strip: 12 inches long.
- B. Informational Submittals:
1. Manufacturer's installation instructions.
 2. Manufacturer's affidavit attesting to use of material for a minimum period of 10 years as a pipe lining in sewage conditions recognized as corrosive or otherwise detrimental to concrete.
 3. Test Reports.
 4. Manufacturer's Certificate of Compliance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of: Ameron Protective Linings; T-Lock Amer-Plate.

2.02 SERVICE CONDITIONS

- A. Lining system shall be suitable for exposure to raw sewage with pH of 6 to 8, hydrogen sulfide, and diluted sulfuric acid at ambient temperatures.

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2.03 MATERIALS

- A. Plastic liner older than 180 days from date of manufacture shall not be used.
- B. Material used in liner and welding strips shall be combination of polyvinyl chloride resin, pigments, and plasticizers, specially compounded to remain flexible. Polyvinyl chloride resin shall constitute not less than 99 percent, by weight, of resin used in formulation. Copolymer resins will not be permitted.
- C. Size sheets to provide minimum liner coverage specified in Section 33 05 01.12, Gravity Sewer Pipe and Fittings.
- D. Liner sheets shall be minimum of 0.065-inch thick.
- E. Locking extensions (T-shaped) of same material as liner shall be integrally extruded with sheet. Locking extensions shall be approximately 2.5 inches apart and shall be minimum of 0.375 inch high with minimum web thickness of 0.085 inch. Locking extensions shall be such that when they are embedded in concrete, liner will be held permanently in place. Locking extension shall be parallel and continuous except where interrupted for joint flaps and/or strap channels.
- F. Certified test results shall be submitted for each material formulation used in manufacture of liner. Liner materials shall be tested for physical and chemical properties.
- G. Tensile specimens shall be prepared and tested in accordance with ASTM D412 using Die B. Weight change specimens shall be 1 inch by 3 inches and thickness of installed liner.
- H. Materials specimens shall be tested for physical properties before and after 112-day exposure to chemical solutions listed below. After conditioning to constant weight at 110 degrees F, tensile and weight change specimens shall be exposed to the following solutions for a period of 112 days at 77 degrees F, plus or minus 5 degrees. At 28-day intervals, tensile specimens, and weight change specimens shall be removed from each chemical solution and tested. Material specimens that fail to meet 112-day exposure will be rejected.

Chemical Solution Concentration	
Sulfuric Acid	20 percent*
Sodium Hydroxide	5 percent
Ammonium Hydroxide	5 percent*

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Chemical Solution Concentration	
Sulfuric Acid	20 percent*
Nitric Acid	1 percent*
Ferric Chloride	1 percent
Sodium Hyperchlorite	1 percent
Soap	0.1 percent
Detergent (linear alkyl benzyl sulfonate or LAS)	0.1 percent
Bacteriological	BOD not less than 700 ppm
*Volumetric percentages of concentrated C.P. grade reagents	

- I. Plastic liner sheets, joint, corner, and welding strips shall have the following physical properties when tested at 77 degrees F, plus or minus 5 degrees:

Plastic Liner Sheet Properties		
Property	Before 112-day Chemical Exposure Test *	After 112-day Chemical Exposure Test *
Tensile Strength ASTM D412	2,200 psi min	2,100 psi
Elongation at Break	200% min	200%
Hardness, Shore Durometer, Type D	Within 1 sec. 50 to 60	± 5% of initial test result
ASTM D2240 **	10 sec 35-50	± 5% of initial test result
Weight Change	Not Applicable	± 1.5%
* All values are minimum required except for hardness and weight, which is the maximum permissible gain or loss in weight.		
** Except that a single thickness of material shall be used.		

- J. Provide transverse flaps at ends of sheets. Remove locking extensions from flaps so that maximum of 0.032 inch of base of locking extension remains on sheet.
- K. Weld strips shall be minimum width of 7/8 inch and minimum thickness of 1/8 inch. Edges of weld strips shall be beveled in manufacturing process.

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- L. Joint strips for pipe shall be minimum width of 3.75 inches and minimum thickness shall be 3/32 inch.

2.04 FABRICATION

A. Welds:

1. Supply pipe linings as pipe-size sheets, fabricated by shop-welding sheets together.
2. Make shop-welds by lapping sheets minimum of 1/2 inch and applying heat and pressure to lap to produce continuous welded joint.
3. Shop-welded joints used to fuse individual sections of liner together shall meet minimum requirements of liner for thickness, corrosion resistance, and impermeability.
4. Welds shall show no cracks or separations.
5. Tensile Strength: Across shop-welded joints shall be measured in accordance with ASTM D412, using Die B.
6. Minimum Tensile Strength: Across shop-welds shall be 2,000 psi at test temperature of 77 degrees F, plus or minus 5 degrees.

B. Shop Assembly:

1. Installation of lining in reinforced concrete pipe, including preheating of sheets in cold weather and welding of joints, shall be done in strict conformity with applicable specifications, instructions, and recommendations of lining manufacturer.
2. Install lining with locking extensions running parallel with longitudinal axis of pipe.
3. Terminate locking extensions maximum of 1-1/2 inches from end of inside surface of pipe section. Extend joint flaps, when used, approximately 4 inches beyond end of inside surface.
4. Set lining flush with inner edge of bell or spigot end of pipe section. Extend lining to opposite end or approximately 4 inches beyond opposite end depending upon type of lining joint to be made with adjoining concrete pipe.
5. Liner shall be held snugly in place against inner forms. For pipes and similar circular sections, light steel banding straps, prefabricated tubes, or other approved means shall be used. If used, banding straps shall be placed in strap channels. Methods of banding other than in strap channels shall require prior approval by Engineer.
6. Vibrate concrete poured against lining to produce dense, homogenous concrete. Securely anchor locking extensions into concrete.
7. Protect lining from damage when removing forms. Do not use sharp instruments to pry forms from lined surfaces.

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8. Patch cut, torn, and abraded areas in lining. Make patches with welding strip fused to liner over entire patch area. Larger patches may consist of smooth liner sheet applied with adhesive over damaged area. Welding strips shall be fused to patch edges and to lining adjoining damaged area.

2.05 SOURCE QUALITY CONTROL

- A. Liner must be continuous and free of pinholes across joints and in liner itself. Joint welding and sealing must be equally as effective as liner. Shop test for pinholes using electrical spark tester set at 20,000 volts. Repair and retest holes.
- B. Liner plate locking extensions embedded in concrete shall withstand pull test of minimum 100 pounds per linear inch, applied perpendicularly to concrete surface for period of 1 minute, without rupture of locking extensions or withdrawal from embedment. Test shall be made at a temperature of 70 to 80 degrees F, inclusive. Pull test shall be performed on minimum of one pipe in every 100 pipe sections.
- C. Plastic liner sheets, including locking extensions and welding strips, shall be free of cracks, cleavages, and other defects adversely affecting protective characteristics of material. Defects in installed liner shall be repaired in accordance with requirements of protective lining manufacturer prior to spark testing installed liner.
- D. A test report, including independent testing laboratory certified test results of 112-day chemical resistance test, spark test of liner sheets and results of tensile strength test for shop-welds shall be submitted at least seven days prior to start of manufacture of pipe. Spark test and pull test results of in-place liner shall be submitted before or with delivery of pipe. Pipe sections failing spark or pull tests will be rejected and shall not be delivered to Site.

PART 3 EXECUTION

3.01 INSTALLATION OF FIELD JOINTS IN LINING

- A. Protect PVC-lined concrete pipe or structures where they join structures that are not so lined.
- B. The following shall apply when lining coverage is 360 degrees:
 1. When groundwater is encountered, discontinue pumping of groundwater for at least three days prior to making liner joint.
 2. Do not make lining joint if visible leakage is evident at pipe joint.

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3. To provide for relief of potential future groundwater buildup, do not weld 6 to 8 inches downstream side of joint strip or flap at pipe invert.
- C. Remove mortar and foreign material from lining surfaces adjacent to pipe joint, leaving them clean and dry. Joints shall not be filled with cement mortar or other joint filler without specific authorization from Engineer.
- D. Do not line joint closure until after trench has been backfilled and compacted and joint has been successfully tested. Pipe joints must be dry before lining closure joints are made.
- E. Make field closures in lining at pipe joints in accordance with either of following methods:
 1. Joints may be made with separate 4-inch joint strip and two welding strips. Center 4-inch joint strip over joint, tack-welded to lining, then weld to adjacent liner sheets with a weld strip along each edge. Width of space between adjacent sheets shall not exceed 2 inches. Lap 4-inch joint strip over each sheet minimum of 1 inch.
 2. Joints may be made with flap with locking extensions removed and extending approximately 4 inches beyond end of pipe. Overlap flap and lining of adjacent pipe section minimum of 1 inch and tack weld in place. Complete field joint by welding flap to lining of adjacent pipe using minimum 1-inch wide weld strip. Protect flap from damage during pipe installation. Avoid excessive tension or distortion by bending back flap to expose pipe joint. At temperatures below 50 degrees F, heating of flap shall be required to avoid damage.
- F. Trim joint flap or strip on beveled pipe a width (measured from end of spigot) of approximately 4 inches for circumferential length of lining.
- G. Welding of joints is to be in strict conformance with specifications and lining manufacturer's instructions.
- H. Welding shall fuse both sheets and weld strip together to provide continuous joint equal in corrosion resistance and impermeability to liner plate.
- I. Hot-air welding guns shall provide air to sheets to be joined at a temperature between 500 and 600 degrees F. Hold welding guns approximately 0.5 inch from junction of two pieces to be joined. Move gun slowly enough to cause small bead of molten material to be visible along both edges and in front of weld strip.

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3.02 FIELD QUALITY CONTROL

- A. Visually inspect completed lining and weld areas.
- B. Physically test welds by nondestructive probing method. Manually probe with a blunt instrument, such as putty knife.
- C. After pipe is installed in trench, test surfaces covered with lining, including weld strips, with electrical holiday detector with instrument set at 20,000 volts. Spark test results of liner and weld strips on installed pipe shall be submitted prior to final acceptance.
- D. Patch over holes and repair liner as recommended by lining manufacturer and as approved by Engineer and CH2M.

3.03 PROTECTION OF INSTALLED WORK

- A. Prevent damage to installed lining from equipment and materials used in Work. Repair damaged lining by methods recommended by lining manufacturer and as approved by Engineer and CH2M.

END OF SECTION

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SECTION 33 05 13
MANHOLES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 2. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A48/A48M, Standard Specification for Gray Iron Castings.
 - c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A536, Standard Specification for Ductile Iron Castings.
 - e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
 - g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
 - h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - j. C150/C150M, Standard Specification for Portland Cement.
 - k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
 - n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 - p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.

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- q. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
- r. C1311, Standard Specification for Solvent Release Sealants.
- s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
- u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.
- 2. Product Data:
 - a. Concrete mix design.
 - b. Manhole frame to structure seals.
 - c. Manhole frame to structure anchor bolt.
 - d. Rubber gaskets and sealants.
 - e. External joint wrap.

B. Informational Submittals:

- 1. Experience Record:
 - a. Precast concrete production capabilities.
 - b. Evidence of current Precast/Prestressed Concrete Institute (PCI) plant certification.
- 2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
- 3. Test Reports: Precast manufacturer's concrete test cylinders.
- 4. Manufacturer's recommended installation instructions.
- 5. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

- 1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.

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2. Precast Plant: Precast/Prestressed Concrete Institute (PCI) certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
2. Gaskets: Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
 - a. Sanitary sewage.
 - b. Corrosion or rotting under wet or dry conditions.
 - c. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
 - d. Biological environment in soils and sanitary sewers.
 - e. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
 - f. Temperature ranges, variations, and gradients in construction area.
 - g. Variations in moisture conditions and humidity.
 - h. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
 - i. Vibrations because of traffic loading.
 - j. Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.
3. Materials shall be compatible with each other and manhole materials.
4. Designed to provide a 20-year service life.

B. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:
 - a. Cement: Meet requirements of ASTM C150/C150M.
 - b. Compressive Strength:
 - 1) Minimum 4,000 psi.
 - 2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.
2. Reinforcement: Grade 60, unless otherwise specified.

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3. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.
4. Floor: Below pipe to provide clearance for grouting channels.
5. Joint:
 - a. Form joint contact services with machined castings.
 - b. Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.
6. Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.
2. Diameter: Minimum 48 inches.
3. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.
4. Top and bottom surfaces shall be parallel.
5. Joints: Tongue-and-groove and confined O-ring with rubber gaskets meeting ASTM C443.

B. Cone Sections:

1. Eccentric.
2. Same wall thickness and reinforcement as riser section.
3. Top and bottom surfaces shall be parallel.

C. Base Sections and Base Slab:

1. Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

D. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.

E. Joint Seal Manufacturers and Products:

1. Butyl Gaskets:
 - a. Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
 - b. Henry Company, Houston, TX; Ram-Nek.
 - c. Trelleborg Engineered Solutions, Park Hills, MO; NPC Bidco C-56.

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2. Confined Plastic or Rubber O-Ring:
 - a. As recommended by precasting manufacturer.
 - b. Meet requirements of ASTM C443.
3. External Wrap:
 - a. Sealing Systems, Inc., Loretto, MN; Gator Wrap.
 - b. Henry Company, Houston, TX; RU116 Rubr-Nek External Joint Wrap.
 - c. Trelleborg Engineered Solutions, Park Hills, MO; NPC External Joint Wrap.
 - d. Cretex Specialty Products, Waukesha, WI; Cretex Wrap.

2.03 CAST-IN-PLACE MANHOLES

- A. Concrete and Reinforcing Steel: As specified in Section 03 30 10, Reinforced Concrete.

2.04 MANHOLE FRAMES AND COVER

- A. Castings:
 1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
 2. Cast Iron: ASTM A48/A48M Class 30B.
 3. Ductile Iron: ASTM A536, Grade 60-40-12.
 4. Plane or grind bearing surfaces to ensure flat, true surfaces.
- B. Cover: True and seat within ring at all points. With the word SEWER in 2-inch raised letters.
- C. Watertight Covers: High temper phosphor bronze with 60,000 psi minimum tensile strength meeting ASTM B139/B139M.
- D. Watertight Cover Gasket: Molded from high-quality rubber such as nitrile or EPDM.

2.05 MANHOLE FRAME CONNECTION TO STRUCTURE

- A. Butyl Sealant:
 1. Conform to ASTM C1311, or AASHTO M198 and ASTM C990.
 2. Trowelable or cartridge applied.
 3. Manufacturers and Products:
 - a. Tremco Commercial Sealants and Waterproofing, Beachwood, OH; Tremco Butyl Sealant.
 - b. Bostik, Middleton, MA; Chem-Calk 300.

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- c. Press-Seal Gasket Company, Fort Wayne, IN; EZ-Stik #3.

B. External Wrap:

1. Meet requirements of ASTM C923.
2. Construct of high quality rubber that will provide flexible watertight seal around joint.
3. Thickness: Minimum 60 mils.
4. Consist of a top and bottom section and be sealed to structure, frame top, and bottom with mastic as applicable.
5. Length: Extend from manhole frame and extension ring to cone section.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Manufacturers and Products:
 - a. Sealing Systems, Inc., Loretto, MN; Infi-Shield.
 - b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
 - c. Cretex Specialty Products, Waukesha, WI; X-85 Seal.

C. Internal Wrap or Sealing Membrane:

1. Meet requirements of ASTM C923.
2. Minimum internal thickness of 3/16 inch or as recommended by manufacturer for installation climate.
3. Designed for application and have a demonstrated history of accommodating differential expansion between frame and concrete.
4. Width: Minimum 8 inches.
5. Expansive type wraps shall be fabricated of high quality rubber or urethane.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Wrap shall not restrict access to manhole.
8. Manufacturers and Products:
 - a. Sealing Systems, Inc., Loretto, MN; Flex-Seal Utility Sealant.
 - b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
 - c. Cretex Specialty Products, Waukesha, WI; Internal Manhole Chimney Seal.

D. Frame to Structure Anchor Bolts:

1. 3/4-inch-diameter HAS stainless steel bolts; minimum 6-5/8-inch embedment.

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DESIGN AND CONSTRUCTION STANDARDS

2. Manufacturer and Product: Hilti; HVA Capsules Adhesive Anchoring System.

2.06 MONOLITHIC LINER

- A. As specified in Section 33 05 01.13, Polyvinyl Chloride Pipe Liner.

2.07 MORTAR

- A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.
- B. Admixtures: May be included; do not exceed the following percentages of weight of cement:
 1. Hydrated Lime: 10 percent.
 2. Diatomaceous Earth or Other Inert Material: 5 percent.
- C. Mix Consistency:
 1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
 2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.08 BACKFILL AROUND AND UNDER MANHOLE

- A. Structural fill as specified in Section 31 23 23, Fill and Backfill.

2.09 MANHOLE MARKER POSTS

- A. Size and Type: 4 inches by 4 inches by 8 feet, pressure-treated construction Grade or better rated for direct burial.
- B. Prime top (exposed) 3 feet 8 inches, followed by two coats of safety orange enamel.
 1. Primer: Tnemec; Series 36 Undercoater.
 2. Enamel: Tnemec; Series 2H Tnemec Gloss.
- C. Lettering:
 1. Stencil letters SANITARY MANHOLE on all sides of each post.

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2. Letters: Black enamel, 2 inches high.

2.10 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE

A. Manufacturers and Products:

1. NPC, Inc., Milford, New Hampshire; Kor-N-Seal flexible rubber boot with stainless steel accessories.
2. A-LOK Products, Inc., Tullytown, PA; Z-LOK XP or A-LOK flexible connectors.

B. Doghouse Manhole/Manhole Over Existing Pipe (where use of a boot is not possible):

1. Green Streak; hydrophilic waterstop CJ-0725-3k.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Engineer and CH2M.
3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill:

1. As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Precast:
 - a. Place on compacted structural fill.

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- b. Properly locate, ensure firm bearing throughout, and plumb first section.
 2. Cast-in-Place:
 - a. Invert: Minimum 8 inches below lowest connecting pipe.
 - b. First section of manhole shall be cast in concrete base.
- B. Sections:
 1. Inspect precast manhole sections to be joined.
 2. Clean ends of sections to be joined.
 3. Do not use sections with chips or cracks in tongue.
- C. Preformed Plastic Gaskets or Rubber O-Ring:
 1. Use only pipe primer furnished by gasket manufacturer.
 2. Install gasket material in accordance with manufacturer's instructions.
 3. Completed Manhole: Rigid and watertight.
- D. Mortar Joints:
 1. Thoroughly wet joint with water prior to placing mortar.
 2. Place mortar on groove of lower section prior to section installation.
 3. Fill joint completely with mortar of proper consistency.
 4. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joint.
 5. Prevent mortar from drying out and cure by applying approved curing compound or comparable approved method.
 6. Do not use mortar mixed for longer than 30 minutes.
 7. Chip out and replace cracked or defective mortar.
 8. Completed Manhole: Rigid and watertight.
- E. External Joint Wraps: Install in accordance with manufacturer's instructions.
- F. Extensions:
 1. Provide on manholes in streets or other locations where change in existing grade may be likely.
 2. Install to height not exceeding 12 inches.
 3. Lay grade rings in mortar with sides plumb and tops level.
 4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE INVERT

- A. Construct with smooth transitions to ensure unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.

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DESIGN AND CONSTRUCTION STANDARDS

- B. Where full section of pipe is laid through manhole, break out top section and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.

3.05 MANHOLE FRAMES AND COVERS

- A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.
- B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.
- C. Anchor frame to manhole with specified bolts.
- D. Install exterior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.06 WATERTIGHT MANHOLES

- A. Unless otherwise noted, manholes covers shall be bolted down with sealing gasket.

3.07 CAST-IN-PLACE MANHOLE

- A. Concrete and Reinforcing Steel: As specified in Section 03 30 10, Reinforced Concrete.

3.08 MANHOLE PIPING

- A. Drop Assembly: See Drawings for detail of installation requirements.
- B. Flexible Joints:
 - 1. Provide in pipe not more than 1-1/2 feet from manhole walls.
 - 2. Where last joint of pipe is between 1-1/2 feet and 6 feet from manhole wall, provide flexible joint in manhole wall.
- C. Stubouts for Future Connections:
 - 1. Provide same type and class of pipe as specified for use in service connection, lateral, main, or trunk sewer construction. Where there are two different classes of pipe at manhole use higher strength pipe.
 - 2. Grout pipe in precast walls or manhole base to provide watertight seal or use flexible joints as specified herein.
 - 3. Maximum Length: 1-1/2 feet outside manhole wall.

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4. Construct invert channels as shown. Unless otherwise approved by Engineer, match inside top elevation of service connection pipe to inside top elevation of outlet pipe.
 5. Test Plugs:
 - a. Install rubber-gasketed plugs in end of stubouts with gasket joints similar to sewer pipe being used.
 - b. Plugs shall withstand internal or external pressures without leakage.
 - c. Adequately brace plugs against hydrostatic or air test pressures.
- D. Permanent Plugs: Clean interior contact surfaces of pipes to be cut off or abandoned as shown, and construct plug as follows:
1. Pipe 18 Inches or Less in Diameter: Concrete plug in end, minimum 2 feet long.
 2. Pipe 20 Inches and Larger: Concrete plug in end, minimum 4 feet long.
 3. Plugs shall be watertight and capable of withstanding internal and external pressures without leakage.

3.09 MANHOLES OVER EXISTING PIPING

- A. Maintain flow through existing pipelines at all times.
- B. Concrete Pipe: Apply bonding agent on surfaces in contact with concrete.
- C. Construct base under existing piping.
- D. Construct manhole as detailed in Drawings.
- E. Apply minimum of two complete wraps of hydrophilic waterstop centered on pipe in wall.
- F. Place a minimum of 24 inches of concrete around each pipe penetration outside manhole against undisturbed soil or compacted aggregate unless otherwise detailed.
- G. Grout channel through manhole.
- H. Saw cut out or demolish existing pipe within new manhole using method approved by CH2M.
- I. Protect new concrete or grout for 7 days after placing concrete.

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3.10 CONNECTIONS TO EXISTING MANHOLES

- A. Core manhole bases and grouting as necessary.
- B. Seal pipe in manhole using flexible connector.
- C. Regrout to provide smooth flow into and through manholes.
- D. Provide diversion facilities and perform work necessary to maintain flow during connection.

3.11 FIELD QUALITY CONTROL

- A. Conduct negative air pressure (vacuum) test on 20 percent of manholes in accordance with ASTM C1244. Conduct tests in presence of CH2M.
- B. Hydrostatic Testing:
 - 1. When, in CH2M's opinion, groundwater table is too low to permit visual detection of infiltration leaks, hydrostatically test up to 20 percent but in no case less than 10 percent of the total manholes.
 - 2. Procedure: Plug inlets and outlets and fill manhole with water to height determined by CH2M.
 - 3. Manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls to take place.
 - 4. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above invert.
 - 5. Repair manholes that do not meet leakage test, or do not meet specified requirements from visual inspection.
 - 6. If more than 25 percent of manholes tested fail the hydrostatic test, test all or as many manholes as CH2M deems necessary.

END OF SECTION

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DESIGN AND CONSTRUCTION STANDARDS

SECTION 33 12 13 (FCP)
WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Water Works Association (AWWA): C800, Underground Service Line Valves and Fittings.
3. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - b. B32, Standard Specification for Solder Metal.
 - c. B88, Standard Specification for Seamless Copper Water Tube.
 - d. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
4. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product Data:
 - 1) Pipe material data.
 - 2) Materials of construction for corporation stops, curb stops, and meter stops.
 - 3) Fitting types.
 - b. Details with dimensions and fabricating tolerances for component ends.
 - c. Drawing showing how components of water service connection will fit together.
 - d. Operating pressure and allowable test pressure for components making up the service connection.
 - e. Allowable test pressure for connected components.

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- f. Proposed thrust restraint data for restraining joints including drawing details, materials, assembly ratings, and pipe attachment methods.
 - g. Factory test results of components.
- B. Informational Submittals:
- 1. Manufacturer's Certificate of Compliance, in accordance with AWWA C800.
 - 2. Manufacturer's Certificate of Compliance, in accordance with NSF/ANSI 61.
 - 3. Statement of Qualifications:
 - a. Piping manufacturer.
 - b. Fitting and specials manufacturer.
 - 4. Procedure for field testing water mains and service connections, including disinfection.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
- 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SERVICE CONNECTION

- A. Furnish components same size as nominal designation of service pipe. For example, 3/4-inch connection consists of:
- 1. 3/4-inch corporation stop.
 - 2. 3/4-inch curb stop.
 - 3. 3/4-inch angle valve.
 - 4. 3/4-inch meter coupling.

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DESIGN AND CONSTRUCTION STANDARDS

- B. Refer to Part E. Standard Details for Water, Wastewater and Recycled Water Construction and coordinate product names and requirements with these Specifications.

2.03 SERVICE SADDLES

- A. Provide in accordance with the following:

Mainline Material	Saddle Characteristics	Tap Size	Manufacturer*
Concrete Cylinder Pipe 6" to 36" 18" to 40"	Ductile iron double or triple wide strap saddle with iron pipe tap; neoprene O-ring seal; wide stainless steel straps	3/4" - 2"	Smith-Blair Type 362 Type 366
PVC C900-16 or C905-10 Pipe	Double strap saddle with coated saddle and wide stainless steel straps	5/8" - 4"	Smith-Blair Type 317
	One-piece, full-circle, stainless steel double bolt service saddle	3/4" - 2"	Smith-Blair Type 372
		1/2" - 2"	
HDPE	Double strap saddle with coated saddle and wide stainless steel straps	5/8" - 2"	Smith-Blair Type 317
	One-piece, full-circle, stainless steel double bolt service saddle	3/4" - 2"	Smith-Blair Type 372
		1/2" - 2"	
Cast Iron/Ductile Iron	Double strap saddle with coated saddle and carbon steel electro galvanized straps	3/4" - 4"	Smith-Blair Type 313

*Model number for each manufacturer will depend on pipe material saddle is attached to and whether the native soils are aggressive or relatively neutral.

1. Choose model number for each manufacturer based on pipe being saddled and corrosivity of surrounding soils.
2. Style:
 - a. Double strap with wide straps for metal pipe.
 - b. One-piece, full-circle, single stainless body with double bolt for use on plastic pipe.
3. Saddle: Coated to prevent corrosion.
4. Manufacturers:
 - a. Smith-Blair.
 - b. JCM Industries.
 - c. Romac Industries.

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2.04 REPAIR SERVICE CLAMPS

- A. Size: Application range and pressure encompassing that of existing pipe to be repaired.
- B. Characteristics:
 - 1. IP threads.
 - 2. Use full circle repair clamp only.
 - 3. Compatible with pipe being repaired.
 - 4. Resistant to surrounding soil corrosivity.
 - 5. Clamps:
 - a. Single- or double-sided bolts designed to accommodate anticipated operating pressures.
 - b. Stainless steel body.
 - c. Neoprene gaskets cemented in place.
 - d. Length based on damage to main.
 - 6. Service Size: 1/2-inch through 2-inch.
- C. Manufacturers and Products:
 - 1. Smith-Blair.
 - 2. Mueller Co.

2.05 CORPORATION STOPS

- A. Characteristics:
 - 1. Accommodate piping being connected.
 - 2. Meet criteria promulgated by CH2M.
 - 3. Resistant to soil corrosivity.
 - 4. Service Size: 3/4-inch through 2-inch.
 - 5. Connecting Piping: Copper.
- B. Manufacturers and Products:
 - 1. Mueller; Model H-15000, H-15008, H-15025.
 - 2. Hays Manufacturing Co.; Model 5200, 5204.

2.06 COUPLINGS

- A. Characteristics:
 - 1. Accommodate piping being connected.
 - 2. For use in water service connections.

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3. Same nominal size as service.
4. Meet criteria promulgated by the CH2M.
5. Resistant to soil corrosivity.
6. Service Size: 3/4-inch through 2-inch.

B. Manufacturers Products:

1. Mueller; Model H-12210, H-15450.
2. Hays Manufacturing Co.

2.07 UNIONS

A. Characteristics:

1. Copper-to-copper union.
2. Accommodate pipe being connected.
3. Meet criteria promulgated by the CH2M.
4. For use on water service connections.
5. Same nominal size as service.
6. Service Size: 1/2-inch through 2-inch.
7. Soil Corrosivity: Yes.

B. Manufacturers and Products:

1. Mueller; Model H-15400.
2. Hays Manufacturing Co.; Model 5615.

2.08 MISCELLANEOUS FITTINGS

A. Characteristics: Miscellaneous fittings, reducers, and adapters.

B. Manufacturers and Products:

1. Mueller Co.
2. Hays Manufacturing Co.

2.09 CURB STOPS

A. Characteristics:

1. Size to match associated service.
2. Connections to match adjacent piping.
3. Materials to resist soil corrosivity (if any).
4. Meet criteria promulgated by CH2M.
5. Service Size: 1-inch and 1-1/2-inches.

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DESIGN AND CONSTRUCTION STANDARDS

B. Manufacturers and Products:

1. Mueller; Model H-10102, H-15331.
2. Or equal.

2.10 CURB BOXES

A. Characteristics:

1. Furnish with lids and/or plugs as required by CH2M.
2. Length to match application, extension type.
3. Arch pattern base.
4. Size to match curb stop.
5. Rated for H₂O loading.
6. Soil Corrosivity: Yes.

B. Manufacturers and Products:

1. Mueller; Model H-10310.
2. Or equal.

2.11 PRESSURE REDUCING VALVES

A. Characteristics:

1. Size to match associated service.
2. Connections to match adjacent piping.
3. Materials to resist soil corrosivity (if any).
4. Meet criteria promulgated by CH2M.
5. Rated for working pressure of adjacent piping.
6. Service Size: 3/4-inch.
7. Soil Corrosivity: Yes.

B. Manufacturers and Products:

1. Mueller; Model H-9300, No. 2, with strainer.
2. Or equal.

2.12 METER STOP

A. Characteristics:

1. Inlet compatible with inlet service piping.
2. Outlet compatible with meter inlet configuration.
3. Service Size: 3/4 inch and 1 inch.

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DESIGN AND CONSTRUCTION STANDARDS

4. Connecting Piping: Copper.
5. Soil Corrosivity: Yes.

B. Manufacturers and Products:

1. Mueller; Model H-14255.
2. Hays Manufacturing Co.; Model 25012.

2.13 METER BOXES, VAULTS, AND COVERS

A. Characteristics:

1. Able to withstand AASHTO H20 loading characteristics.
2. Rectangular body.
3. Cast iron lid, removable for meter reading.

B. Manufacturers and Products:

Service Size	Characteristics	Manufacturer & Model
3/4" through 2"	Rectangular concrete body and cast-iron lids; extensions as required	Brooks Products, Inc.; model number dependent on service size
3/4" through 2"	Rectangular plastic body, cast-iron reading lid	Rhino Water Meter Boxes; model number dependent on service size
3 inches, or 4 inches, or 6 inches	Precast sectional vault; 3/8-inch steel plate cover; two meter reading lids	Brooks Products, Inc.; model number dependent on service size

2.14 METER YOKES

A. Characteristics:

1. Size to match associated service.
2. Connections to match adjacent piping.
3. Materials to resist soil corrosivity (if any).
4. Meet criteria promulgated by CH2M.
5. Rated for working pressure of adjacent piping.
6. Service Size: 5/8 inch through 1 inch.
7. Connecting Piping: Copper.

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8. Soil Corrosivity: Yes.

B. Manufacturers and Products:

1. Ford Meter Box Company; Model 70 Series, No. 101-8.
2. Hays Manufacturing Co.

2.15 METERS

A. Characteristics:

1. Size to match associated piping service and flow requirements.
2. Magnetic drive, positive displacement.
3. Connections to match adjacent piping.
4. Materials to resist soil corrosivity: Yes.
5. Frost protection bottom.
6. 6-wheel resolution and high power transmitter.
7. Rated for working pressure of adjacent piping.
8. Service Size:
 - a. 5/8 inch through 2 inch, positive displacement, magnetic drive.
 - b. 3 inch, positive displacement, magnetic drive with translator encoder register to allow for AMR.
9. Connecting Piping: Copper.

B. Manufacturers and Products:

1. SENSUS iPerl for 3/4 inch to 1 inch.
2. SENSUS iPerl for 1-1/2 inch and larger.

2.16 GALVANIZED PIPE AND FITTINGS

A. Characteristics:

1. Standard weight with screwed ends and couplings.
2. Rated for working pressure of service.
3. Conforming to ASTM A53/A53M.
4. Fittings:
 - a. 150-pound malleable iron screwed fittings.
 - b. Use with ferrous pipe having American Standard pipe threads.
5. Meet lead free requirement of NSF/ANSI 61 Certification.

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2.17 COPPER TUBING

A. Characteristics:

1. Size: Matching that of service connection and meter.
2. Type K, soft, seamless.
3. Conform to ASTM B88.
4. Commercially pure wrought copper solder joint fittings.
5. Joints:
 - a. 95-5 coreless wire solder.
 - b. Conform to ASTM B32, Grade 95 1A.

Add Cross-Linked
Polyethylene (PEX) AWWA
C904, ASTM F876

2.18 POLYETHYLENE PLASTIC PIPE

A. Characteristics:

1. Manufactured from ultra-high molecular weight, high-density polyethylene.
2. Conforming to ASTM D3350, PE 355434C.
3. Working Pressure 150 psi.
4. Standard dimension ratio (SDR) of 11 or smaller.

B. Manufacturer and Product: Phillips Products Co.; Driscopipe 5100.

PART 3 EXECUTION

3.01 GENERAL

- A. Install service connections, excluding meters, during or after construction of the main.
- B. Install water meters after entire water system is ready for operation.
- C. Depth of cover over the pipe shall be minimum 36 inches.
- D. Install service connection in accordance with Part E: Standard Details for Water, Wastewater and Recycled Water Construction.
- E. Compression fittings must be used.

3.02 TRENCH EXCAVATION AND BACKFILL

- A. In accordance with Sections 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

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3.03 CONNECTION TO MAIN

- A. Clean exterior of main of dirt and other foreign matter that may impair the quality of the completed connection.
- B. Place service clamp (saddle) at desired location.
- C. Clamp by tightening alternate nuts progressively.
- D. Do not place service clamp within 1 foot of pipe joint, or another clamp.
- E. Make taps with adapters for the size main being tapped.

3.04 UNDERCROSSING OF HARD SURFACE ROADS

- A. Bore or jack undercrossings, unless noted otherwise on Drawings.

3.05 GALVANIZED PIPE

- A. Cut threads with sharp tools.
- B. Ream pipes after cutting.
- C. Join pipe and coupling with an application of a nontoxic pipe compound.

3.06 COPPER TUBING

- A. Cut square ends, ream clean, and flare and make up tightly.
- B. Prevent the tube from kinking or buckling on short radius bends. If tube should kink or buckle, cut out kinked or buckled sections and splice with brass fitting.

3.07 POLYETHYLENE PLASTIC PIPE

- A. Install in conformance with manufacturer's recommendations.

3.08 METER BOXES AND METERS

- A. Installation:
 - 1. Construct enclosures plumb, and flush with existing ground surface unless shown otherwise.
 - 2. Use standard extension sections to adjust to grade.
 - 3. Place lightly compacted earth backfill inside meter box to depth shown.

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4. Backfill around meter vaults as specified in Section 31 23 23.15, Trench Backfill.
5. Install meter in horizontal position with dial at required depth below cover.
6. Corporation Stops: OPEN position.
7. Angle Stops: CLOSED position.

3.09 TESTING

- A. Inspect service connections for leakage under normal system pressure. Joints shall be watertight before acceptance.
- B. Test Duration: At least 15 minutes.
- C. Inspect for leaks and repair before backfilling.

3.10 DISINFECTION OF SERVICE CONNECTIONS

- A. Flush new copper tubing before connecting to existing copper tubing or meter stop, by opening corporation stop, allowing water to run for 2 minutes.

END OF SECTION

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FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

SECTION 33 12 13 (FIR)
WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product Data:
 - 1) Pipe material data.
 - 2) Materials of construction for corporation stops, curb stops, and meter stops.
 - 3) Fitting types.
 - b. Details with dimensions and fabricating tolerances for component ends.
 - c. Drawing showing how components of water service connection will fit together.
 - d. Operating pressure and allowable test pressure for components making up the service connection.
 - e. Allowable test pressure for connected components.
 - f. Proposed thrust restraint data for restraining joints including drawing details, materials, assembly ratings, and pipe attachment methods.
 - g. Factory test results of components.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with AWWA C800.
2. Manufacturer's Certificate of Compliance, in accordance with NSF/ANSI 61.
3. Procedure for field testing water mains and service connections, including disinfection.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by

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manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SERVICE CONNECTION

A. Furnish components same size as nominal designation of service pipe. For example, 3/4-inch connection consists of:

1. 3/4-inch corporation stop.
2. 3/4-inch curb stop.
3. 3/4-inch angle valve.
4. 3/4-inch meter coupling.

2.03 SERVICE SADDLES

A. Provide in accordance with the following:

Mainline Material	Saddle Characteristics	Tap Size	Manufacturer*
PVC C900-16 or C905-10 Pipe	Double strap saddle with coated saddle and wide stainless steel straps	5/8" - 4"	Smith-Blair Type 317
	One-piece, full-circle, stainless steel double bolt service saddle	3/4" - 2"	Smith-Blair Type 372
		1/2" - 2"	
Cast Iron/Ductile Iron	Double strap saddle with coated saddle and carbon steel electro galvanized straps	3/4" - 4"	Smith-Blair Type 313

*Model number for each manufacturer will depend on pipe material saddle is attached to and whether the native soils are aggressive or relatively neutral.

1. Choose model number for each manufacturer based on pipe being saddled and corrosivity of surrounding soils.
2. Style:
 - a. Double strap with wide straps for metal pipe.
 - b. One-piece, full-circle, single stainless body with double bolt for use on plastic pipe.
3. Saddle: Coated to prevent corrosion.

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4. Manufacturers:
 - a. Smith-Blair.
 - b. JCM Industries.
 - c. Romac Industries.

2.04 CORPORATION STOPS

A. Characteristics:

1. Accommodate piping being connected.
2. Resistant to soil corrosivity.
3. Service Size: 3/4-inch through 2-inch.
4. Connecting Piping: Copper or PVC.

B. Manufacturer and Products: Mueller; Model H-15000, H-15205, H-15008.

2.05 COUPLINGS

A. Characteristics:

1. Accommodate piping being connected.
2. For use in water service connections.
3. Same nominal size as service.
4. Resistant to soil corrosivity.
5. Service Size: 3/4-inch through 2-inch.

B. Manufacturer and Products: Mueller; Model H-12210, H-15450.

2.06 UNIONS

A. Characteristics:

1. Copper-to-copper union.
2. Accommodate pipe being connected.
3. For use on water service connections.
4. Same nominal size as service.
5. Service Size: 1/2-inch through 2-inch.
6. Resistant to soil corrosivity.

B. Manufacturer and Product: Mueller; Model H-15400.

2.07 MISCELLANEOUS FITTINGS

A. Characteristics: Miscellaneous fittings, reducers, and adapters.

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B. Manufacturer: Mueller.

2.08 CURB STOPS

A. Characteristics:

1. Size to match associated service.
2. Connections to match adjacent piping.
3. Materials to resist soil corrosivity: Yes.
4. Service Size: 1-inch and 1-1/2-inch.

B. Manufacturer and Products: Mueller; Model H-10102, H-15331.

2.09 METER STOP

A. Characteristics:

1. Inlet compatible with inlet service piping.
2. Outlet compatible with meter inlet configuration.
3. Service Size: 3/4-inch and 1-inch.

B. Manufacturer and Product: Mueller Model H-14255.

2.10 METER BOXES, VAULTS, AND COVERS

A. Characteristics:

1. Able to withstand AASHTO H20 loading characteristics.
2. Rectangular body.
3. Cast iron lid, removable for meter reading.

B. Manufacturers and Products:

Service Size	Characteristics	Manufacturer & Model
1" through 2"	Rectangular concrete body and cast-iron lids; extensions as required	Ford Meter Box Company, Inc.; Long Yoke Box, Model YL111-444-LL-TP-NL for 1" size

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Service Size	Characteristics	Manufacturer & Model
3 inches, or 4 inches, or 6 inches	4-foot diameter circular precast manhole conforming to ASTM C478 with O-ring joints, flexible rubber boot pipe seals; Manhole frame and cover; provide 1-7/8-inch diameter hole for electronic transmitter	Ford Meter Box Company, Inc.; model number dependent on service size

2.11 METER YOKES

A. Characteristics:

1. Size to match associated service.
2. Connections to match adjacent piping.
3. Materials to resist soil corrosivity: Yes.
4. Rated for working pressure of adjacent piping.
5. Service Size: 5/8-inch by 3/4-inch, 3/4-inch, or 1-inch. Type A or Type B.
6. Type A: Valve type coppersetters; second compressive type valve at outlet; height 12 inches.
7. Type B: One end tapped 3/4-inch IP; one end 3/4-inch IP male thread.
8. Connecting Piping: Copper.
9. Resistant to soil corrosivity.

B. Manufacturer and Product: Ford Meter Box Company; Model 70 Series, No. 101-8.

2.12 METERS

A. Meters as specified in Section 40 92 00 (FIR), Flow Measurement System.

2.13 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Characteristics:

1. Materials shall conform to NSF 61.
2. Size: Matching that of service connection.

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3. Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection.
4. Fittings:
 - a. Schedule to match pipe.
 - b. ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type.
 - c. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
5. Joint: Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
6. Solvent Cement: Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service and as recommended by pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
7. Threaded Lubricant: Teflon tape.

2.14 COPPER TUBING

A. Characteristics:

1. Size: Matching that of service connection and meter.
2. Type K, soft, seamless.
3. Conform to ASTM B88.
4. Joints: Compression.

PART 3 EXECUTION

3.01 GENERAL

- A. Install service connections, excluding meters, during or after construction of the main.
- B. For installation of new meter on existing service line, Subcontractor to pothole and determine existing water service line location and size prior to starting Work. Subcontractor to coordinate with CH2M for location of new water meter.
- C. Depth of cover over the pipe shall be minimum shown in Part E. Standard Details for Water, Wastewater and Recycled Water Construction.

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- D. Install service connection in accordance with Part E. Standard Details for Water, Wastewater and Recycled Water Construction.
- E. Prior to Work, perform notifications of local residents/businesses in accordance with CH2M requirements.

3.02 TRENCH EXCAVATION AND BACKFILL

- A. In accordance with Sections 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

3.03 CONNECTION TO MAIN

- A. Clean exterior of main of dirt and other foreign matter that may impair the quality of the completed connection.
- B. Place service clamp (saddle) at desired location.
- C. Clamp by tightening alternate nuts progressively.
- D. Do not place service clamp within 1 foot of pipe joint, or another clamp.
- E. Make taps with adapters for the size main being tapped.

3.04 PVC PIPE

- A. Install in conformance with manufacturer's recommendations.

3.05 COPPER TUBING

- A. Cut square ends, ream clean, and flare and make up tightly.
- B. Prevent the tube from kinking or buckling on short radius bends. If tube should kink or buckle, cut out kinked or buckled sections and splice with brass fitting.

3.06 METER BOXES AND METERS

- A. Installation:
 - 1. Construct enclosures plumb, and flush with existing ground surface unless shown otherwise.
 - 2. Use standard extension sections to adjust to grade.
 - 3. Place lightly compacted earth backfill inside meter box to depth shown.

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4. Backfill around meter vaults as specified in Section 31 23 23.15, Trench Backfill.
5. Install meter in horizontal position with dial at required depth below cover.
6. Corporation Stops: OPEN position.
7. Angle Stops: CLOSED position.

3.07 TESTING

- A. Inspect service connections for leakage under normal system pressure and trapped air removed from the system. Joints shall be watertight before acceptance.
- B. Test Duration: At least 60 minutes.
- C. Allowable Leakage: None.
- D. Inspect for leaks and repair before backfilling.

3.08 DISINFECTION OF SERVICE CONNECTIONS

- A. Disinfect as specified in Section 33 13 00, Disinfecting of Water Utility Distribution.

END OF SECTION

SECTION 33 12 19
WATER UTILITY DISTRIBUTION FIRE HYDRANTS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
 - a. C502, Dry-Barrel Fire Hydrants.
 - b. C600, Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
 2. ASTM International (ASTM): C94, Standard Specification for Ready-Mixed Concrete.
 3. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

- A. Action Submittals: Catalog cuts of system components.
- B. Informational Submittal: Certificate of Compliance: Upon completion of the system installation, verify all fire department hose connections, and check all fire safety devices to ensure their readiness for emergency connection and operation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
1. Use or reuse of components and materials without a traceable certification is prohibited.

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2.02 HIGH PRESSURE HYDRANTS

A. Hydrant:

1. Break flange or safety top type.
2. Nominal 5-1/4-inch main valve opening with 6-inch bottom connections.
3. Conform to AWWA C502, except working pressure of 250 psi.
4. Two 2-1/2-inch hose nozzles.
5. One 4-1/2-inch pumper nozzle.
6. Operating Nut: 1-1/2-inch National Standard pentagon nut.
7. Mechanical joint inlet connection.
8. Yellow aboveground line.
9. Manufacturer and Product: Mueller Co.; Super Centurion.

B. Main Valve:

1. Depth of bury 3-1/2 feet.
2. Equip with O-ring seals.
3. Valve opens on counterclockwise rotation.

2.03 PRECAST CONCRETE PIER BLOCK

A. Nominal dimensions of 8-inch thickness by 16-inch square base.

B. Compressive Strength: 3,000 psi at 28 days.

2.04 GRAVEL FOR DRAINAGE

A. Washed 3/4-inch crushed rock or graded river gravel. Washed 3/4-inch drainage gravel. Free of organic matter, sand, loam, clay, and other small particles that will restrict water flow through gravel.

2.05 FOUNDATION STABILIZATION MATERIAL

A. Furnish when existing trench material or imported pipe base material will not support soft or flooded spots in excavated trench.

B. Maximum 3-inch hard rock free from excessive clay material, but enough fines to bind larger fragments.

2.06 CONCRETE FOR THRUST BLOCKING

A. As specified in Section 03 30 10, Reinforced Concrete.

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2.07 THRUST TIES

- A. 3/4-inch diameter steel rods.
- B. Duc-Lugs Manufacturer: The Stellar Corp., Columbus, OH.

PART 3 EXECUTION

3.01 GENERAL

- A. Install hydrants in accordance with Sections 3.7 and 3.8 of AWWA C600, unless specified otherwise.

3.02 EXCAVATION

- A. Excavate to subgrade. Fill over excavated areas with foundation stabilization material. Tamp to provide firm foundation.

3.03 BASE BLOCK

- A. Place on firm, level subgrade to ensure uniform support.

3.04 INSTALLATION OF HYDRANTS

- A. Locate hydrants to provide accessibility and to minimize potential damage from vehicles.
 - 1. Relocate improperly set hydrants.
 - 2. Hydrant Located behind Curbs: Set barrel so pumper nozzle or hose nozzle caps are a minimum of 18 inches from gutter face of curb.
 - 3. Hydrant Located in Space between Curb and Sidewalk: Not less than 8 inches, clear from sidewalks.
 - 4. Hydrant Located between Sidewalk and Property Line: Minimum clearance 8 inches from sidewalk.
 - 5. Set hydrants so safety flange is a minimum of 2 inches above finished ground or sidewalk level.
- B. Place hydrant on base block carefully to prevent the base block from breaking.
- C. Joints shall conform to Section 3.4 of AWWA C600 when cast or ductile iron pipe is used.
- D. Maintain hydrant in a plumb position during subsequent Work.

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DESIGN AND CONSTRUCTION STANDARDS

3.05 GRAVEL FOR DRAINAGE

- A. Place gravel around base block and hydrant bottom in accordance with Section 3.7 of AWWA C600.

3.06 CONCRETE THRUST BLOCKING

- A. Place blocking after hydrant is set in final position and join to pipe.
- B. Concrete thrust block shall have a minimum of 4 square feet of bearing area against undisturbed earth.

3.07 THRUST TIES

- A. Install thrust ties in lieu of concrete thrust blocking when ground surface behind hydrant is less than 2 feet above top of hydrant base.
 - 1. Install two tie rods between main valve and hydrant, water main tee and main valve.
 - 2. Install mechanical joint glands with lugs in joints between hydrant, main valve and main line tee.

END OF SECTION

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
 - a. B300, Hypochlorites.
 - b. B301, Liquid Chlorine.
 - c. B302, Ammonium Sulfate.
 - d. B303, Sodium Chlorite.
 - e. C651, Disinfecting Water Mains.
 - f. C652, Disinfection of Water Storage Facilities.
 - g. C653, Disinfection of Water Treatment Plants.
2. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
3. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this Specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Method of disposal for highly chlorinated disinfecting water.
7. Certified Bacteriological Test Results:
 - a. Facility tested is free from coliform bacteria contamination.
 - b. Forward results directly to CH2M.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

1.03 QUALITY ASSURANCE

- A. Independent Testing Agency: Certified in the State where facility being tested is located, with 10 years' experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

1.04 SEQUENCING

- A. Commence disinfection after completion of following:
 - 1. Completion and acceptance of internal painting of system(s).
 - 2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, tanks, and equipment.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.
- B. Subcontractor to coordinate with CH2M to make arrangement for water supply and convey water in disinfected pipelines and containers.

PART 3 EXECUTION

3.01 GENERAL

- A. Conform to AWWA C651 for pipes and pipelines, and C652 for tanks and reservoirs, except as modified in these Specifications.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER DESIGN AND CONSTRUCTION STANDARDS

- B. Subcontractor's Equipment:
 - 1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
 - 2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.
- C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
 - 1. Tanks.
 - 2. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
 - 3. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.
- D. Prior to application of disinfectants, clean tank and pipelines of loose and suspended material.
- E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 PIPING AND PIPELINES

- A. Cleaning:
 - 1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
 - 2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
 - 3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
 - 4. Flush pipe through flushing branches and remove branches after flushing is completed.

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- B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.03 TANKS

A. Cleaning:

1. Clean interior surfaces using water under pressure before sterilizing.
2. Isolate tank from system to prevent contaminating materials from entering distribution system.
3. Cleaning shall:
 - a. Remove deposits of foreign nature.
 - b. Remove biological growths.
 - c. Clean slopes, walls, top, and bottom.
 - d. Avoid damage to structure.
 - e. Avoid pollution or oil deposits by workers and equipment.
4. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank.

- B. Disinfecting Procedure: In accordance with AWWA C652, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

3.04 DISPOSAL OF CHLORINATED WATER

- A. Do not allow flow into a waterway without neutralizing disinfectant residual.
- B. See appendix of AWWA C651 and C652 for acceptable neutralization methods.

3.05 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this Specification.
2. Provide valves at sampling points.
3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from laboratory selected by CH2M.

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- C. Chlorine Concentration Sampling and Analysis:
 - 1. Collect and analyze Samples in accordance with AWWA Standards.
 - 2. Sampling Locations: Coordinate with CH2M.
 - 3. Analysis to be performed by laboratory selected by CH2M. Samples will be analyzed using method for free chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

- D. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

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FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
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SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
 - b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 2. American Water Works Association (AWWA):
 - a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
 - c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - f. Manual M11, Steel Pipe—A Guide for Design and Installation.
 3. ASTM International (ASTM):
 - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
 5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

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- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.
- C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

- A. Teflon Bellows Connector:
 - 1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
 - 2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
 - 3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
 - 4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
 - 5. Manufacturers and Products:
 - a. Garlock; Style 214.
 - b. Resistoflex; No. R6904.
 - c. Unisource Manufacturing, Inc.; Style 112.
 - d. Proco Products, Inc.; Series 442.
- B. Elastomer Bellows Connector:
 - 1. Type: Fabricated spool, with single filled arch.
 - 2. Materials: Nitrile tube and wrap-applied neoprene cover.
 - 3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
 - 4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
 - 5. Thrust Restraint: Control rods to limit travel of elongation and compression.
 - 6. Manufacturers and Products:
 - a. Goodall Rubber Co.; Specification E-1462.
 - b. Garlock; Style 204.

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- c. Unisource Manufacturing, Inc.; Style 1501.
- d. Proco Products, Inc.; Series 220.

C. Metal Bellows Connector:

- 1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
- 2. Material: Type 316 stainless steel.
- 3. End Connections: ANSI 150-pound carbon steel flanges.
- 4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
- 5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
- 6. Manufacturers and Products:
 - a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
 - b. Metraflex; Model MN.
 - c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Flexible Metal Hose Connector:

- 1. Type: Close pitch, annular corrugated with single braided jacket.
- 2. Material: Bronze.
- 3. End Connections: Female copper solder joint.
- 4. Minimum Burst Pressure: 500 psig at 70 degrees F.
- 5. Length: Minimum manufacturer recommendation for vibration isolation.
- 6. Manufacturers:
 - a. U.S. Hose Corp.; Series 300.
 - b. Anamet Industrial, Inc.
 - c. Unisource Manufacturing, Inc.
 - d. Proco Products, Inc.

E. Closure Collar Concrete: As specified in Section 03 30 10, Reinforced Concrete.

F. Quick Connect Couplings for Chemical Services:

- 1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
- 2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
- 3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
- 4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

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5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
 - a. OPW; Kamlock.
 - b. Ryan Herco; 1300 Series.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser Piping Specialties; Style 38.
 - 2) Smith-Blair, Inc.; Style 411.
 - b. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 253.
 - 2) Smith-Blair, Inc.; Style 441.

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
 - a. Dresser Piping Specialties; Style 162.
 - b. Smith-Blair, Inc.; Style 413.

D. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser Piping Specialties; Style 128.

FORT CAMPBELL/FORT IRWIN WATER, WASTEWATER AND RECYCLED WATER
DESIGN AND CONSTRUCTION STANDARDS

- 2) Smith-Blair, Inc.; Style 913.
 - b. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 128.
 - 2) Smith-Blair, Inc.; Style 912.
- E. Restrained Flange Adapter:
 - 1. Pressure Rating:
 - a. Minimum Working Pressure Rating: Not less than 150 psi.
 - b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
 - 2. Thrust Restraint:
 - a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
 - b. Products employing set screws that bear directly on pipe will not be acceptable.
 - 3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.
- F. Restrained Dismantling Joints:
 - 1. Pressure Rating:
 - a. Minimum working pressure rating shall not be less than rating of the connecting flange.
 - b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
 - 2. Manufacturers and Products:
 - a. Dresser Piping Specialties; Style 131.
 - b. Smith Blair, Inc.; Model 975.
- G. Exposed Metallic Piping Plain End Couplings:
 - 1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
 - 2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
 - 3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or equal.

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2.04 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.
2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.
3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250 degrees F.
7. Rated Deflection and Pressure:
 - a. Lateral Deflection: 3/4 inch, minimum.
 - b. Burst Pressure: Four times the working pressure.
 - c. Compression deflection and minimum working pressure as follows:

Size (inch)	Deflection (inch)	Pressure (psig)
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
 - a. General Rubber Corp.; Style 1015 Maxijoint.
 - b. Mercer; Flexmore Style 450.
 - c. Goodall Rubber Co.; Specification E-711.
 - d. Unisource Manufacturing, Inc.; Series 1500.
 - e. Proco Products, Inc.; Series 251.

B. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
 - a. Garlock; Style 215.
 - b. Resistoflex; No. R6905.

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- c. Unisource Manufacturing, Inc.; Style 113.
- d. Proco Products, Inc.; Series 443.

C. Metal Bellows:

- 1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
- 2. Material: Type 316 stainless steel.
- 3. End Connections: ASME 150-pound carbon steel flanges.
- 4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
- 5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
- 6. Manufacturers and Products:
 - a. U.S. Bellows, Inc.; Universal Tied expansion joint.
 - b. Metraflex, Model MN.
 - c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Copper Pipe Expansion Compensator:

- 1. Material: Stainless steel bellows with female copper solder joint ends.
- 2. Working Pressure Rating: 175 psig, minimum.
- 3. Accessories: Anti-torque device to protect bellows.
- 4. Manufacturers and Products:
 - a. Senior Flexonics; Model HB.
 - b. Hispan; Model 8510.
 - c. Unisource Manufacturing, Inc.; Style EC-FFS.

E. Galvanized and Black Steel Pipe Expansion Compensator:

- 1. Material: Carbon steel with stainless steel bellows.
- 2. Working Pressure Rating: 175 psig, minimum.
- 3. Accessories: Anti-torque device to protect bellows.
- 4. Manufacturers and Products:
 - a. Senior Flexonics; Model H.
 - b. Hispan; Model 8503.
 - c. Unisource Manufacturing, Inc.; Style EC-MMT.

F. Flexible Metal Hose:

- 1. Type: Close pitch, annular corrugated with single braided jacket.
- 2. Material: Stainless steel, ASTM A276, Type 321.
- 3. End Connections:
 - a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.

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- b. 2-1/2 Inches and Smaller: Screwed ends with one union end.
- 4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12 inches and smaller.
- 5. Length: Provide hose live-length equal to lengths shown on Drawings.
- 6. Manufacturer:
 - a. U.S. Hose Corp.; Series 401M.
 - b. Anamet Industrial, Inc.; BWC21-1.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:

- 1. Ball and socket type for earth settlement compensation.
- 2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
- 3. Assembly shall accommodate up to 4 inches of expansion in length.
- 4. Ductile iron conforming to AWWA C153/A21.53.
- 5. Rated for 350 psi.
- 6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
- 7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
- 8. Joint connecting to mechanical joint shall be thrust restrained.
- 9. Bonding:
 - a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
 - b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
 - c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.

2.06 SEAL WATER HOSE

- A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

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DESIGN AND CONSTRUCTION STANDARDS

2.07 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
 - a. Body: Malleable or ductile iron.
 - b. Straps: Galvanized steel.
 - c. Hex Nuts and Washers: Steel.
 - d. Seal: Rubber.
5. Manufacturers and Products:
 - a. Smith-Blair; Series 313 or 366.
 - b. Dresser; Style 91.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
 - a. Body: Nylon-coated iron.
 - b. Seal: Buna-N.
 - c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or 317.

2.08 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: Mechanical joint outlet.

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

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2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
 - a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
 - b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
 - c. Continuously fillet weld on each side all around.
3. Factory Finish:
 - a. Galvanizing:
 - 1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
 - 2) Electroplated zinc or cadmium plating is unacceptable.
 - b. Shop Lining and Coating: Factory prepare, prime, and finish coat.

B. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Products: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
 - a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
 - b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

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2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
 - a. Rated for thrust load developed at 250 psi.
 - b. Safety Factor: 2, minimum.
 - c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
 - a. American Cast Iron Pipe Co.
 - b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
 - a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
 - b. Continuously fillet welded on each side all around.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as shown on Drawings and as specified in Section 33 05 01, Conveyance Piping-General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

- B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

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C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from face of structures; joint may be flush with face.
2. Install a second flexible joint, whether or not shown.
 - a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.
 - b. Pipe Diameter Larger than 18 Inches: Within two to three pipe diameter of first joint.

D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 33 05 01, Conveyance Piping—General.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
 - a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
 - b. Clean pipe surface before placing closure collars.
 - c. Wet nonmetallic pipe thoroughly prior to pouring collars.
 - d. Prevent concrete from entering pipe.

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- e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
- f. Make entire collar in one placement.
- g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 PIPING EXPANSION

- A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.
- B. Expansion Joints:
 1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
 2. Nonmetallic Pipe: Teflon bellows expansion joint.
 3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
 4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
 5. Pipe Run Offset: Flexible metal hose.
- C. Anchors: Install to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

- A. Ferrous Metal Piping (except stainless steel): Double-strap iron.
- B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE

- A. Install in accordance with manufacturer's written instructions.

3.07 COUPLINGS

- A. General:
 1. Install in accordance with manufacturer's written instructions.
 2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
 3. Remove pipe coating if necessary to present smooth surface.
 4. Application:
 - a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.

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DESIGN AND CONSTRUCTION STANDARDS

- b. Concrete Encased Couplings: Flexible coupling.

3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

- A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.
- B. Product Applications Unless Shown Otherwise:
 - 1. Nonmetallic Piping: Teflon bellows connector.
 - 2. Copper Piping: Flexible metal hose connector.
 - 3. Compressor and Blower Discharge: Metal bellows connector.
 - 4. All Other Piping: Elastomer bellows connector.
- C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

- A. Application:
 - 1. As indicated on Drawings and as specified in Section 33 05 01, Conveyance Piping-General.
 - 2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
 - 3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
- B. Installation:
 - 1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
 - 2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

- A. Applications:
 - 1. Watertight and Below Ground Penetrations:
 - a. Wall pipes with thrust collars.
 - b. Provide taps for stud bolts in flanges to be set flush with wall face.
 - 2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
 - 3. Existing Walls: Rotary drilled holes.

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4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.
- B. Wall Pipe Installation:
1. Isolate embedded metallic piping from concrete reinforcement.
 2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

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SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
 2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
 3. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
 4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
 5. American Water Works Association (AWWA):
 - a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - b. C500, Metal-Seated Gate Valves for Water Supply Service.
 - c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
 - d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
 - e. C509, Resilient-Seated Gate Valves for Water Supply Service.
 - f. C510, Double Check Valve Backflow Prevention Assembly.
 - g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
 - h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
 - j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - k. C542, Electric Motor Actuators for Valves and Slide Gates.
 - l. C550, Protective Interior Coatings for Valves and Hydrants.
 - m. C606, Grooved and Shouldered Joints.
 - n. C800, Underground Service Line Valves and Fittings.

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6. ASTM International (ASTM):
 - a. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - e. B61, Standard Specification for Steam or Valve Bronze Castings.
 - f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
 - h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
 - i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
 - j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
 - k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
 - l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
 - n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
 - a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
 - b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
 - c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
 - d. SP-88, Diaphragm Valves.
 - e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

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13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
 - d. Power and control wiring diagrams, including terminals and numbers.
 - e. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance for:
 - a. Electric actuators; full compliance with AWWA C542.
 - b. Butterfly valves; full compliance with AWWA C504.
2. Component and attachment testing seismic certificate of compliance.
3. Tests and inspection data.
4. Operation and Maintenance Data.
5. Manufacturer's Certificate of Proper Installation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

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- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve same size as adjoining pipe, unless otherwise called out on Drawings.
- D. Valve ends to suit adjacent piping.
- E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
- F. Size operators and actuators to operate valve for full range of pressures and velocities.
- G. Valve to open by turning counterclockwise, unless otherwise specified.
- H. Factory mount operator, actuator, and accessories.
- I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MATERIALS

- A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
 - 1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
 - 2. Stainless steel Alloy 18-8 may be substituted for bronze.

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- B. Valve materials in contact with or intended for drinking water service to meet the following requirements:
 - 1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
 - 2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.

2.03 FACTORY FINISHING

- A. General:
 - 1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
 - 2. Exterior coating for valves and hydrants shall be same as adjacent piping unless specified otherwise.
 - 3. Material in contact with potable water shall conform to NSF/ANSI 61.
 - 4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”
- B. Where epoxy lining and coating are specified, factory finishing shall be as follows:
 - 1. In accordance with AWWA C550.
 - 2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
 - 3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.04 VALVES

- A. Gate Valves:
 - 1. General:
 - a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
 - 1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
 - 2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
 - 3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.

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- 4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
 - 5) Repaired AWWA gate valves shall not be submitted or supplied.
 - 6) Supply AWWA gate valves with stainless steel bolting.
2. Type V130 Resilient Seated Gate Valve 3 Inches to 12 Inches:
 - a. Iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem, in accordance with AWWA C509, minimum design working water pressure 200 psig, full port, fusion-epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
 - b. Manufacturers and Products:
 - 1) M&H Valve; AWWA C509.
 - 2) U.S. Pipe; A-USPO.
 3. Type V132 Resilient Seated Gate Valve 3 Inches to 12 Inches, for Buried Service:
 - a. Iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
 - b. Manufacturers and Products:
 - 1) M&H Valve; AWWA C509.
 - 2) U.S. Pipe; A-USPO.
 - 3) Mueller Co.; Resilient Wedge.
 4. Type V137 Resilient Seated Gate Valve 4 Inches to 12 Inches:
 - a. UL Listed and FM Approved for fire protection, iron body, resilient seat, bronze mounted, mechanical joint ends, nonrising stem, 2-inch operating nut, in accordance with AWWA C509, design working water pressure 200 psig, full port, fusion-epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified, indicator post flange and indicator post assembly with lockable handle.
 - b. Manufacturers and Products:
 - 1) Kennedy Valve; Ken-Seal II.
 - 2) M&H Valve; Style 4067.
 - 3) Mueller; P-2360.

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B. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
 - a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
 - b. Manufacturers and Products:
 - 1) Threaded:
 - a) Conbraco Apollo; 70-100.
 - b) Nibco; T-580-70.
 - 2) Soldered:
 - a) Conbraco Apollo; 70-200.
 - b) Nibco; S-580-70.

C. Plug Valves:

1. Type V400 Eccentric Plug Valve 2 Inches and Smaller:
 - a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, threaded ends, lever operator, cast-iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber.
 - b. Manufacturers and Products:
 - 1) Pratt; Ballcentric.
 - 2) DeZurik; Style PEC.
 - 3) Milliken; Millcentric Series 603.
2. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
 - a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
 - b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
 - c. For buried service, provide external epoxy coating.
 - d. Operators:
 - 1) 3-Inch to 4-Inch Valves: Wrench lever manual.

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- 2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
- e. Manufacturers and Products:
 - 1) Pratt; Ballcentric.
 - 2) DeZurik; Style PEC.
 - 3) Milliken; Millcentric Series 600.

D. Butterfly Valves:

1. General:

- a. In full compliance with AWWA C504 and following requirements:
 - 1) Suitable for throttling operations and infrequent operation after periods of inactivity.
 - 2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
 - 3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
 - 4) No travel stops for disc on interior of body.
 - 5) Self-adjusting V-type or O-ring shaft seals.
 - 6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
 - 7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
 - 8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
 - 9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
 - 10) Valves to be in full compliance with NSF/ANSI 61.
- b. Non-AWWA butterfly valves to meet the following actuator requirements:
 - 1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

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2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
 - a. AWWA C504, Class 150B.
 - b. Short body type, flanged ends.
 - c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat bonded or molded in body only, and stainless steel seating surface.
 - d. Manufacturers and Products:
 - 1) Pratt; Model 2FII or Triton XR-70.
 - 2) DeZurik; AWWA Valve.
3. Type V504 Butterfly Valve General Service 4 Inches to 48 Inches:
 - a. AWWA C504, Class 150B.
 - b. Mechanical joint end type.
 - c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat bonded or molded in body only, and stainless steel seating surface.
 - d. Manufacturers and Products:
 - 1) Pratt; Groundhog.
 - 2) DeZurik; Buried AWWA Valve.

E. Check and Flap Valves:

1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
 - a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with bronze seat, stainless steel hinge shaft.
 - b. Valves, 2 inches through 12 inches rated 175-pound WWP and 14 inches through 24 inches rated 150-pound WWP. Valves to be fitted with adjustable outside lever and weight or fitted with adjustable outside lever and spring. Increasing-pattern body valve may be used where increased outlet piping size is shown.
 - c. Manufacturers and Products:
 - 1) M&H Valve; Style 59, 159, or 259.
 - 2) Mueller Co.; No. A-2600 Series.
2. Type V610 Swing Check Valve 2-1/2 Inches to 12 Inches for Fire Protection Service:
 - a. UL Listed, FM Approved, iron body, bronze-mounted, rated 175 pounds WOG, self-adjusting bronze disc, ends ASME B16.1 flanged, with a 1-inch NPT tapped and plugged boss.
 - b. Manufacturers and Products:
 - 1) Kennedy; Figure 126.
 - 2) Mueller; A-2120-6.

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3. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
 - a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru Union.
 - 2) ASAHI/America.
 - 3) Spears; True Union.
4. Type V631 CPVC Ball Check Valve 4 Inches and Smaller:
 - a. ASTM D1784 Cell Class 23477B CPVC body, single or dual union socket weld ends, rated 150 psi at 73 degrees F, 110 psi at 140 degrees F, Viton seat and seal.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru Union.
 - 2) ASAHI/America.
 - 3) Spears; True Union.
5. Type V632 Ball Check Valve 3 Inches and Larger:
 - a. Flanged end, iron body valve with cleanout and floating or sinking type hollow steel ball, vulcanized nitrile rubber exterior, flanges ASME B16.1, Class 125, rated 150-pound working pressure, suitable for vertical up or horizontal flow.
 - b. Manufacturers and Products:
 - 1) FLYGT Corp.
 - 2) Flomatic Corp.
 - 3) Golden Anderson.
6. Type V634 Rubber Flapper Check Valve 2 Inches to 24 Inches:
 - a. Iron body, ASME B16.1, Class 125 flanges, steel-reinforced Buna-N flapper raised seating ring, rated 150-pound CWP.
 - b. Manufacturers and Products:
 - 1) APCO; Series 100.
 - 2) Val-Matic; "Swingflex."
7. Type V640 Double Check Valve Backflow Prevention Assembly 3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
 - b. Manufacturer and Product: Watts; Series 007/709.
8. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly 3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves with an independent relief valve between the valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi

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- maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
- b. Manufacturer and Product: Watts; Series 009/909.
9. Type V690 Flap Gate 6 Inches to 96 Inches:
 - a. Cast-iron body and cover, bronze-mounted, flanged frame type, dual pivot-point hinge arms, hinge arms bronze, hinge pins Type 304 stainless steel, seat bronze and impacted into grooves in body and cover flap, lubrication fittings for each pivot, upper and lower pivot adjustment.
 - b. Manufacturers and Products:
 - 1) Rodney Hunt Co.; Series FV-AC or FV-AR.
 - 2) Hydro Gate; Model 50C or 50.
 10. Type V692 Flap Valve 4 Inches to 30 Inches:
 - a. Flange style frame, cast-iron body, bronze seats on body and cover, bronze hinge pins.
 - b. Manufacturers and Products:
 - 1) M&H Valve; Style 47-02.
 - 2) Clow Valve; No. F-3012.
 11. Type V694 Check Valve 1 Inch to 48 Inches:
 - a. Elastomer type flanged or slip-on as shown on Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, rated for 50 psi minimum operating pressure; flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced Buna-N.
 - b. Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series TF-1 or 35-1.

F. Self-Regulated Automatic Valves:

1. Type V752 Sewage Air Release Valve 2 Inches to 4 Inches:
 - a. Suitable for sewage service; automatically exhausts entrained air that accumulates in a system.
 - b. Rated working pressure of 150 psi, operating pressure of 150 psi, built and tested to AWWA C512.
 - c. Materials: Cast-iron or ductile iron body and cover with NPT threaded inlet and 1/2-inch NPT threaded outlet, concave or skirted stainless steel float and trim; Buna-N resilient seat.
 - d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose

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- with quick disconnect couplings to permit backflushing after installation without dismantling valve.
- e. Manufacturers and Products:
 - 1) APCO Valve and Primer Corp.; Series 400 SARV or 450 SARV.
 - 2) Val-Matic Valve; Series 48 or 49.
2. Type V754 Sewage Combination Air Valve 2 Inches to 6 Inches:
- a. Suitable for sewage service; combines operating functions of air and vacuum valve and an air release valve. Air and vacuum portion shall automatically exhaust air during filling of a system and allow air to re-enter during draining or when a vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system. Single body unit with air and vacuum valve and an air release valve in a single housing.
 - b. Rated working pressure of 150 psi; built and tested to AWWA C512.
 - c. Materials: Cast-iron or ductile iron body and covers, NTP threaded inlet and outlet, with concave or skirted stainless steel float and trim.
 - d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
 - e. Manufacturers and Products:
 - 1) APCO Valve and Primer Corp.; Series 440 SCAV.
 - 2) Val-Matic Valve; Series 800.

2.05 OPERATORS AND ACTUATORS

A. Manual Operators:

- 1. General:
 - a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
 - b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
 - c. Operator self-locking type or equipped with self-locking device.
 - d. Position indicator on quarter-turn valves.
 - e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground

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- and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
 - a. Galvanized and painted handwheel.
 - b. Cranks on gear type operator.
 - c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
 - d. Valve handles to take a padlock, and wheels a chain and padlock.
 3. Buried Operator:
 - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
 - b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
 - c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.06 ACCESSORIES

- A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing valve tag number shown on Drawings.
- B. T-Handled Operating Wrench:
 1. One each galvanized operating wrenches, 4 feet long.
 2. Manufacturers and Products:
 - a. Mueller; No. A-24610.
 - b. Clow No.; F-2520.
 3. One each galvanized operating keys for cross handled valves.
- C. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.
 1. Manufacturers and Products:
 - a. Pratt.
 - b. DeZurik.
- D. Floor Stand:
 1. Nonrising, heavy pattern, indicating type.

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2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
 3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
 4. Anchor Bolts: Type 304 stainless steel.
 5. Manufacturers and Products:
 - a. Clow; Figure F-5515.
 - b. Mueller, Figure A-26426.
- E. Floor Box:
1. Plain type, for support of nonrising type stem.
 2. Complete with solid extension stem, operating nut, and stem guide brackets. Stem length as required to extend valve operating nut to within 3 inches of finish floor.
 3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
 4. Anchor Bolts: Type 304 stainless steel.
 5. Manufacturers and Products:
 - a. Neenah Foundry; R 7506.
 - b. Clow; No. F5690.
- F. Chain Wheel and Guide:
1. Handwheel direct-mount type.
 2. Complete with chain.
 3. Galvanized or cadmium-plated.
 4. Manufacturers and Products:
 - a. Clow Corp.; Figure F-5680.
 - b. Walworth Co.; Figure 804.
 - c. DeZurik Corp.; Series W or LWG.
- G. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.
1. Box: Cast iron with minimum depth of 9 inches.
 2. Lid: Cast iron, minimum depth 3 inches, marked WATER.
 3. Extensions: Cast iron.
 4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
 5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
 6. Manufacturers and Products:
 - a. East Jordan Iron Works; Cast-Iron Valve Boxes.

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- b. Bingham & Taylor; Cast-Iron Valve Boxes.
- H. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum of 10-inch ID shaft.
- 1. Box: High-density, reinforced concrete, minimum depth 12 inches, cast-iron ring seat.
 - 2. Lid: Cast iron, minimum depth 3 inches, marked WATER.
 - 3. Extensions: Concrete.
 - 4. Manufacturers and Products:
 - a. Christy Concrete Products; G Series.
 - b. BES Concrete Products; G Series.
- I. Indicator Post Assembly:
- 1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
 - 2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
 - 3. Padlockable eye bolt for wrench.
 - 4. Adjustable bury depth. Bury depth as required for valve installation.
 - 5. UL Listed and FM Approved.
 - 6. Manufacturers and Products:
 - a. Clow; Style 2945.
 - b. Mueller; A-20806.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Flange Ends:
- 1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
 - 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- B. Screwed Ends:
- 1. Clean threads by wire brushing or swabbing.
 - 2. Apply joint compound.
- C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

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D. Valve Installation and Orientation:

1. General:
 - a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
 - b. Install valves in location for easy access for routine operation and maintenance.
 - c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
 - a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
 - b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Eccentric Plug Valves:
 - a. Unless otherwise restricted or shown on Drawings, install valve as follows:
 - 1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
 - 2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
 - 3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).
4. Butterfly Valves:
 - a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
 - b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
 - c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
 - d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
 - e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
5. Check Valves:
 - a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
 - b. Install valve in vertical flow (up) piping only for gas services.
 - c. Install swing check valve with shaft in horizontal position.

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- E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.
- G. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.
- H. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.
- I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.
- J. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate "L" type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 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 under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

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- G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

END OF SECTION

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
 - a. Submit prior to testing and include at least the information that follows.
 - 1) Testing dates.
 - 2) Piping systems and section(s) to be tested.
 - 3) Test type.
 - 4) Method of isolation.
 - 5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify CH2M in writing 5 days in advance of testing. Perform testing in presence of CH2M.
- B. Pressure Piping:
 1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
 2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
 3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
 4. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.
 5. New Piping Connected to Existing Piping:

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- a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
 6. Items that do not require testing include: Piping between wetwells and wetwell isolation valves, equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.
 7. Test Pressure: As indicated on Piping Schedule.
- C. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- D. Gravity Piping:
1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
 3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
1. Perform testing on installed piping prior to application of insulation.
 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
 5. Examine joints and connections for leakage.
 6. Correct visible leakage and retest as specified.
 7. Empty pipe of water prior to final cleaning or disinfection.
- C. Buried Piping:
1. Test after backfilling has been completed.
 2. Expel air from piping system during filling.
 3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

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4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

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

where:

- L = Allowable leakage, in gallons per hour.
- S = Length of pipe tested, in feet.
- D = Nominal diameter of pipe, in inches.
- P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

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- D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
- E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.
- B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.
- D. Exfiltration Test:
 - 1. Hydrostatic Head:
 - a. At least 6 feet above maximum estimated groundwater level in section being tested.
 - b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 - 2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.
- E. Infiltration Test:
 - 1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
- F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- G. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

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3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by Engineer at start of each testing day. CH2M will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

Table 1*					
A	B	C	D	E	F
Pipe Diameter (Inches)	Time per Foot up to Length in Col C (Seconds)	Test Length (Feet)	Test Time for any Length Between Col C & E (Min:Sec)	Length at Which Time in Col F Applies (Feet)	Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

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Table 1*					
A	B	C	D	E	F
Pipe Diameter (Inches)	Time per Foot up to Length in Col C (Seconds)	Test Length (Feet)	Test Time for any Length Between Col C & E (Min:Sec)	Length at Which Time in Col F Applies (Feet)	Time per Foot for Total Length (Seconds)
Example: 15-inch diameter pipe: For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15 For 250 feet, T = 7:05 (Col D) For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50 *Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.					

- D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- E. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.06 FIELD QUALITY CONTROL

- A. Test Report Documentation:
 - 1. Test date.
 - 2. Description and identification of piping tested.
 - 3. Test fluid.
 - 4. Test pressure.
 - 5. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/replacement performed to remedy excessive leakage.
 - 6. Signed by Subcontractor and CH2M to represent that test has been satisfactorily completed.

END OF SECTION

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DESIGN AND CONSTRUCTION STANDARDS

SECTION 40 92 00 (FIR)
FLOW MEASUREMENT SYSTEM

PART 1 GENERAL

1.01 DEFINITIONS

- A. AMR: Automatic Meter Reader.
- B. MXU: Meter Transceiver Unit.

1.02 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Detailed dimensional drawings, including mounting requirements and piping connection sizes and locations.
- B. Informational Submittals:
 - 1. Special shipping, storage and protection, and handling instructions.
 - 2. Manufacturer's printed installation instructions.
 - 3. Operation and Maintenance Data.
 - 4. Manufacturer's Certificate of Proper Installation.

1.03 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with CH2M named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of CH2M, removal and replacement of meters, registers, and all components of the AMR system during a period of 1 year after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective equipment shall be as specified in the General Conditions. For warranty-related issues, manufacturer shall provide loaner equipment at no additional cost while the failed equipment is repaired or replaced. Manufacturer shall assist by telephone with any troubleshooting at no cost, and shall promptly respond to emergency calls. The manufacturer's responsibility for this extended warranty shall be:

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1. Full register cost for the first 10 years following date of Substantial Completion.
2. Battery warranty for MXUs shall be a full warranty for a minimum of 10 years following date of Substantial Completion and be a prorated warranty for the subsequent 10 years.
3. Warranty for MXUs shall be at least 5 years following date of Substantial Completion.

PART 2 PRODUCTS

2.01 FLOW ELEMENT AND TRANSMITTER

A. Flowmeter:

1. General:
 - a. Function: Measure flow rate of a conducting liquid by means of Faraday's Law.
 - b. Service: Cold Water (33 degrees F to 149 degrees F).
 - c. Location Environment: Outside.
 - d. Type: Electromagnetic, bi-directional flow.
 - e. Parts: Sensor, cable, transmitter, transceiver.
2. Performance:
 - a. Velocity Range: Up to 20 fps.
3. Process Pipe Size: As indicated on Drawings.
4. Transceiver Unit:
 - a. Manufacturer and Product: Sensus RadioRead Meter Transceiver Unit (MXU) Model 520M.
 - b. Number of Ports: Single.
5. Register: In weatherproof enclosure.
6. Power Supply:
 - a. Dual battery pack.
 - b. 20 foot TR/PL cable.
7. Meter Manufacturer and Product:
 - a. 1-inch Meter Size: Sensus; iPERL TR/PL.
 - b. Meter Size Greater than 1-inch: Sensus; accuMAG.
Model Number: M#B2 X G1AAD 1, where # shall be replaced with meter diameter size.
 - c. Size as shown on the Drawings.
 - d. No "or equal" or substitute products will be considered.

2.02 FACTORY FINISHING

- A. Manufacturer's standard baked enamel finish.

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DESIGN AND CONSTRUCTION STANDARDS

2.03 SOURCE QUALITY CONTROL

A. General:

1. Perform manufacturer's standard factory inspections and tests prior to packaging and shipment.
2. Testing procedures shall ensure proper operation of functions and demonstrate specified performance.
3. Perform testing according to manufacturer's standard procedure and forms.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

- A. Conduct tests on each meter, all MXUs, using CH2M's existing AMR system by same manufacturer.
- B. Functional Test: Test shall be considered successful when reads are obtained from all MXUs on two successive occasions, at least 1 week apart.

3.03 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:
1. 1/2 person-day for installation assistance and inspection.
 2. 1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

END OF SECTION

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Part E

Standard Details for Water, Wastewater and Recycled Water Construction

U.S. Army Directorate of Contracting (DOC)
Fort Campbell/Fort Irwin

Parts Include:

Part A: Water Distribution System Design Standards

Part B: Wastewater Collection System Design Standards

Part C: Recycled Water Distribution System Design Standards

Part D: Standard Specifications for Water, Wastewater and Recycled Water Construction

Part E: Standard Details for Water, Wastewater and Recycled Water Construction

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Fort Campbell, KY

Fort Irwin, CA

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