

- B. Comply with requirements for hangers, supports, and anchor devices specified in [Section 210529 "Hangers and Supports for Fire-Suppression Piping and Equipment"] and [Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."]
- C. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than **20 ft. (6 m)** long.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping **20 ft. (6 m)** or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft. (6 m)** or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 6. On [PVC] and [fiberglass] piping, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for copper tubing with maximum spacing and minimum rod diameters to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Install hangers for PVC piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Install hangers for fiberglass piping with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support horizontal piping within [**12 inches (300 mm)**] <Insert dimension> of each fitting and coupling.
- H. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- I. Support vertical runs of [PVC] [fiberglass] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- 3.7 JOINT CONSTRUCTION
- A. Comply with Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts in accordance with coupling manufacturer's written instructions.
 5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners in accordance with fitting manufacturer's written instructions.
 6. PVC Piping Gasketed Joints: Use joining materials in accordance with AWWA C900. Construct joints with elastomeric seals and lubricant in accordance with ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.

7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
8. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - a. Dielectric Fittings:
 - 1) Dielectric [nipples][unions] for [NPS 2 (DN 50)]<Insert pipe size> and smaller.
 - 2) Dielectric [flanges][flange kits][nipples] for [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)]<Insert pipe size range>.
 - 3) Dielectric flange kits for [NPS 5 (DN 125)]<Insert pipe size> and Larger.

3.8 INSTALLATION OF ANCHORAGE

- A. Anchorage: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Concrete thrust blocks.
 2. Locking mechanical joints.
 3. Set-screw mechanical retainer glands.
 4. Bolted flanged joints.
 5. Heat-fused joints.
 6. Pipe clamps and tie rods.
 7. <Insert devices>.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: In accordance with AWWA C600.
 2. Gasketed-Joint, PVC Water-Service Piping: In accordance with AWWA M23.
 3. Bonded-Joint Fiberglass, Water-Service Piping: In accordance with AWWA M45.
 4. Fire-Service-Main Piping: In accordance with NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.9 INSTALLATION OF VALVES

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

- G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. [**Install full-size valved bypass.**]
- H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.
- I. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

3.10 INSTALLATION OF DETECTOR-CHECK VALVES

- A. Install in vault or aboveground.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers. Comply with requirements of concrete piers in Section 033000 "Cast-in-Place Concrete."

3.11 INSTALLATION OF WATER METERS

- A. Install water meters, piping, and specialties in accordance with utility company's written instructions.
- B. Water Meters:
 - 1. Install [**displacement**][**turbine**]-type water meters, **NPS 2 (DN 50)** and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
 - 2. Install [**compound**][**turbine**]-type water meters, **NPS 3 (DN 80)** and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
 - 3. Install detector-type water meters in meter vault in accordance with AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- C. Support water meters and piping **NPS 3 (DN 80)** and larger on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.12 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation in accordance with utility company's written instructions.

3.13 INSTALLATION OF VACUUM BREAKER ASSEMBLIES

- A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

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3.14 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support **NPS 2-1/2 (DN 65)** and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.15 INSTALLATION OF WATER METER BOXES

- A. Install water meter boxes in paved areas flush with surface.
- B. Install water meter boxes in grass or earth areas with top [**2 inches (50 mm)**]**<Insert dimension>** above surface.

3.16 INSTALLATION OF CONCRETE VAULTS

- A. Install precast concrete vaults in accordance with ASTM C891.

3.17 INSTALLATION OF PROTECTIVE ENCLOSURES

- A. Install concrete base level and with top approximately [**2 inches (50 mm)**]**<Insert measurement>** above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

3.18 INSTALLATION OF FIRE HYDRANTS

- A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
- C. AWWA Fire Hydrants: Comply with AWWA M17.
- D. UL/FM Global Fire Hydrants: Comply with NFPA 24.

3.19 INSTALLATION OF FLUSHING HYDRANTS

- A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.
- B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant

box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.

- C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.20 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

- A. Install ball drip valves at each check valve for fire department connection to mains.
- B. Install protective pipe bollards **[on two sides of][on three sides of]<Insert arrangement>** each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.21 INSTALLATION OF ALARM DEVICES

- A. Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- F. Connect alarm devices to building fire-alarm system. Wiring and fire-alarm devices are specified in **[Section 284600 "Fire Detection and Alarm."][Section 284614 "Single- and Multiple-Station Alarms."][Section 284600 "Fire Detection and Alarm" and Section 284614 "Single- and Multiple-Station Alarms."]**

3.22 CONNECTIONS

- A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.
- B. Connect water-distribution piping to **[utility water main][existing water main]<Insert piping system>**. Use **[tapping sleeve and tapping valve][service clamp and corporation valve]<Insert method>**.
- C. Connect water-distribution piping to interior **[domestic water][and][fire-suppression]** piping.
- D. Connect waste piping from concrete vault drains to **[sanitary sewerage system. See Section 333115 "Site Sanitary Sewerage Piping" for connection to sanitary-sewer][storm-drainage system. See Section 334400 "Storm Utility Drainage Piping" for connection to storm-sewer]** piping.

- E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.23 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in **50 psig (350 kPa)** increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to **0 psig (0 kPa)**. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is **2 quarts (1.89 L)** per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.24 IDENTIFICATION

- A. Install continuous underground[**detectable**] warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.25 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
 - 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure

if biological examination shows evidence of contamination.

- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 14 00 00



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Task	Specification	Specification Description
33 14 11 00	33 14 00 00	Site Water Distribution Piping
33 14 13 00	33 14 00 00	Site Water Distribution Piping
33 14 13 13	31 62 23 00	Composite Piles
33 14 13 13	33 14 00 00	Site Water Distribution Piping
33 14 13 13	33 42 00 00	Stormwater Conveyance



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SECTION 33 14 13 23 - GROUND-LOOP HEAT-PUMP PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes and fittings.
2. Borehole backfill.
3. Antifreeze solution.
4. Accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Pipes and fittings.
2. Joining method and equipment.
3. Propylene-glycol solution.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. Piping tests.
2. Hydrostatic tests.
3. Antifreeze solution testing report.

B. Borehole backfilling and drilling operations reports.

C. Dimensioned site layout.

D. Startup performance results.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

1. **[Centennial Plastics, Inc.]**
2. **[Chevron-Phillips Chemical Company; Performance Pipe Division]**
3. **[Versaprofiles]**
4. **[WL Plastics]**
5. **<Insert manufacturer's name>**

- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Centennial Plastics, Inc.]**
 2. **[Chevron-Phillips Chemical Company; Performance Pipe Division]**
 3. **[Versaprofiles]**
 4. **[WL Plastics]**
 5. **<Insert manufacturer's name>**
- C. HDPE Pipe: ASTM F2619/F2619M.
- D. Molded HDPE Fittings: ASTM D2683 or ASTM D3261, ASTM F1055 PE resin, socket, butt-fusion or electro-fusion type, made to match HDPE pipe dimensions and class.
- E. U-Bend Assembly: Factory fabricated with embossed depth stamp every **[24 inches (600 mm)]****[36 inches (900 mm)]****<Insert dimension>** from U-bend.
- F. Ground-Loop, Heat-Pump Piping Minimum Working Pressure: **[160 psig (1100 kPa)]****[200 psig (1380 kPa)]****<Insert value>**.
- G. Ground-Loop, Heat-Pump Piping Operating Temperature: Between **23 and 104 deg F (minus 5 and plus 40 deg C)**.

2.2 BOREHOLE BACKFILL

- A. Seal Material: Bentonite clay with thermal conductivity greater than **1.07 Btu/h x sq. ft. x deg F (0.7 W/sq. m x K)** in accordance with ASTM D5334.
- B. Permeability: Not more than 1 nm/s in accordance with ASTM D5084.

2.3 ANTIFREEZE SOLUTION

- A. Inhibited Propylene Glycol:
1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon steel, brass, copper, stainless steel, and cast-iron piping and fittings.
 2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
 3. pH value maintained between **<Insert range>**, with reserve alkalinity greater than **<Insert number>** mL.
 4. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
 5. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by manufacturer to provide freeze protection to **[minus 20 deg F (minus 29 deg C)]****<Insert temperature>**. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
 6. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

2.4 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches (750 mm)** deep; colored as follows:
1. **[Blue]<Insert color>** for water systems.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, warning tape, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF HORIZONTAL PIPING

- A. Separate trenches by **10 ft. (3 m)** minimum unless otherwise indicated. Remove rocks in trenches that could contact pipe.
- B. Extend pipe from trench onto bottom of body of water at an elevation that is at least **12 inches (300 mm)** below frost line. Seal membrane or impervious liner under body of water after installing piping.
- C. Install HDPE piping in trenches in accordance with ASTM D2774 or ASTM F645.
1. Clean HDPE pipe and fittings and make heat-fusion joints in accordance with ASTM D2657. Minimize number of joints.
- D. Install the header piping [**12 inches (300 mm)**]**<Insert dimension>** deep and install the horizontal piping from the header to the heat field piping.
- E. Extend the horizontal piping and connect to ground-loop heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.
1. Terminate water-service piping at building wall until building ground-loop heat-pump piping systems are installed. Terminate piping with caps. Make connections to building ground-loop heat-pump piping systems when those systems are installed.
- F. Purge, flush, and pressure test all piping before backfilling trenches.
1. Pressure test piping in accordance with ASTM F2164.
- G. Backfill all horizontal piping and header trenches.
1. Install sand in trench and all around pipe to protect pipe from damage by sharply edged rocks and similar material.
 2. Install continuous detectable underground warning tape prior to backfilling of trenches for underground piping. Locate tape a minimum of [**24 inches (600 mm)**]**<Insert dimension>** below finished grade, directly over piping.

- H. Seal penetrations through building walls.
- I. Wall sleeves are specified in Section 230500 "Common Work Results for HVAC."
- J. Mechanical sleeve seals are specified in Section 230500 "Common Work Results for HVAC."

3.3 INSTALLATION OF VERTICAL PIPING

- A. Excavating, trenching, warning tape, and backfilling are specified in Section 312000 "Earth Moving."
- B. Install HDPE piping in boreholes in accordance with ASTM D2774 or ASTM F645.
 - 1. Clean HDPE pipe and fittings and make heat-fusion joints in accordance with ASTM D2657. Minimize number of joints.
 - 2. Provide factory fabricated U-bend assembly at base of vertical piping.
- C. Purge, flush, and pressure test all piping before backfilling boreholes.
 - 1. Pressure test in accordance with ASTM F2164.
- D. Completely fill the borehole from bottom to top with backfill material.
- E. Install the header piping [**12 inches (300 mm)**]**<Insert dimension>** deep and install the horizontal piping from the header to the boreholes.
- F. Extend the horizontal piping and connect to ground-loop heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service piping at building wall until building ground-loop heat-pump piping systems are installed. Terminate piping with caps. Make connections to building ground-loop heat-pump piping systems when those systems are installed.
- G. Purge, flush, and pressure test all piping before backfilling trenches.
 - 1. Pressure test in accordance with ASTM F2164.
- H. Backfill all horizontal piping and header trenches.
 - 1. Install sand in trench and all around pipe to protect pipe from damage by sharply edged rocks and similar material.
 - 2. Install continuous detectable warning tape for underground piping. Locate tape a minimum of [**24 inches (600 mm)**]**<Insert dimension>** below finished grade, directly over piping.**Underground warning tapes are specified in Section 312000 "Earth Moving."**
- I. Mark borehole locations, header pipes, and horizontal runs with metallic locator tape as specified in Section 230553 "Identification for HVAC Piping and Equipment."
- J. Seal penetrations through building walls.
- K. Wall sleeves are specified in Section 230500 "Common Work Results for HVAC."
- L. Mechanical sleeve seals are specified in Section 230500 "Common Work Results for HVAC."

3.4 ANTIFREEZE SOLUTION FILL

- A. Fill system with required quantity of propylene glycol and water to provide [minus 10 deg F (minus 23 deg C)]<Insert temperature> freezing temperature.
- B. Test dilute solution using gas chromatography to verify concentration of propylene glycol.
- C. Maintain records of system testing on-site. Submit report to Architect.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

3.6 FIELD QUALITY CONTROL

- A. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.
- B. Hydrostatic Tests: Test at not less than one and one-half times the pipe working pressure and temperature rating specified above.
 - 1. Test for piping system leaks in accordance with ASTM F2164.
 - 2. Increase pressure in **50 psig (345 kPa)** increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to **30 psig (207 kPa)**. Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.
 - 3. Maintain a minimum pipe velocity of **24 in./s (610 mm/s)** for a minimum of 15 minutes to remove all air.
- C. Prepare test and inspection reports.

END OF SECTION 33 14 13 23



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Task	Specification	Specification Description
33 14 13 23	32 91 19 13	Facility Septic Tanks
33 14 13 23	33 14 00 00	Site Water Distribution Piping
33 14 13 23	33 42 00 00	Stormwater Conveyance
33 14 13 23	33 46 00 00	Subdrainage
33 14 13 26	33 14 00 00	Site Water Distribution Piping
33 14 13 36	33 14 00 00	Site Water Distribution Piping
33 14 13 39	33 14 00 00	Site Water Distribution Piping
33 14 13 43	33 14 00 00	Site Water Distribution Piping
33 14 13 53	21 05 00 00	Common Work Results for Fire Suppression
33 14 13 53	22 05 00 00	Common Work Results for Plumbing
33 14 13 53	22 11 16 00	Domestic Water Piping
33 14 13 53	22 13 16 00	Sanitary Waste And Vent Piping
33 14 13 53	22 11 16 00a	Storm Drainage Piping
33 14 13 53	22 15 13 00	General-Service Compressed-Air Piping
33 14 13 53	23 05 00 00	Common Work Results for HVAC
33 14 13 53	23 21 13 00	Hydronic Piping
33 14 13 53	22 11 16 00d	Steam And Condensate Piping
33 14 13 53	23 23 00 00	Refrigerant Piping
33 14 13 53	33 14 00 00	Site Water Distribution Piping
33 14 19 00	22 05 23 00	General-Duty Valves for Plumbing Piping
33 14 19 00	23 05 23 00	General-Duty Valves for HVAC Piping
33 14 19 00	33 14 00 00	Site Water Distribution Piping
33 14 23 00	33 14 00 00	Site Water Distribution Piping



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SECTION 33 31 00 00 - SITE SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-iron soil pipe and fittings - hub and spigot.
2. Cast-iron soil pipe and fittings - hubless.
3. Ductile-iron, pressure pipe and fittings.
4. ABS pipe and fittings.
5. PVC pipe and fittings.
6. Fiberglass sewer pipe and fittings.
7. Concrete pipe and fittings.
8. Nonpressure-type transition couplings.
9. Pressure-type pipe couplings.
10. Expansion joints and deflection fittings.
11. Encasement for piping.
12. Manholes.
13. Concrete.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans and elevations, or Building Information Model (BIM), drawn to scale, showing items described in this Section and coordinated with all building trades. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than **1 inch equals 50 ft. (1:50)** and to vertical scale of not less than **1 inch equals 5 ft. (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

- B. Product Certificates: For each type of pipe and fitting.

- C. Field quality-control reports.

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes in accordance with manufacturer's written rigging instructions.

1.6 QUALITY ASSURANCE

- A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:
 - 1. Notify **[Architect][Construction Manager][Owner]** no fewer than **[two]<Insert number>** days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without **[Architect's][Construction Manager's][Owner's]** written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Sanitary Sewage Piping: **[10-ft. head of water (30 kPa)]<Insert pressure>**.
 - 2. Sanitary Sewage Piping, Force-Main: **[50 psig (345 kPa)][100 psig (690 kPa)][150 psig (1035 kPa)]<Insert pressure>**.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1. **[AB & I Foundry; a part of the McWane family of companies]**
 - 2. **[Charlotte Pipe and Foundry Company]**
 - 3. **[Tyler Pipe; a part of the McWane family of companies]**
 - 4. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - 1. **[AB & I Foundry; a part of the McWane family of companies]**

2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain cast-iron, hub-and-spigot pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Class:[Service (SV)][and][Extra-Heavy (XH)]; ASTM A74.

E. Gaskets: ASTM C564, rubber.

F. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. [AB & I Foundry; a part of the McWane family of companies]
2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [AB & I Foundry; a part of the McWane family of companies]
2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain cast-iron, hubless pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 or CISPI 301.

E. Shielded Couplings, CISPI-Trademark:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [ANACO-Husky; a part of the McWane family of companies]
 - b. [Charlotte Pipe and Foundry Company]
 - c. [Dallas Specialty & Mfg. Co.]
 - d. [Fernco Inc]
 - e. [Mission Rubber Company, LLC]
 - f. [Tyler Pipe; a part of the McWane family of companies]
 - g. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Mission Rubber Company, LLC]**
 - f. **[Tyler Pipe; a part of the McWane family of companies]**
 - g. **<Insert manufacturer's name>**
3. Source Limitations: Obtain CISPI-trademark, shielded couplings from single manufacturer.
4. Marked with CISPI collective trademark and NSF certification mark.
5. Standards: ASTM C1277 and CISPI 310.
6. Description: Stainless steel corrugated shield; stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Shielded Couplings, Heavy-Duty:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Mission Rubber Company, LLC]**
 - f. **[Tyler Pipe; a part of the McWane family of companies]**
 - g. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Mission Rubber Company, LLC]**
 - f. **[Tyler Pipe; a part of the McWane family of companies]**
 - g. **<Insert manufacturer's name>**
3. Source Limitations: Obtain heavy-duty, shielded couplings from single manufacturer.
4. Standard: ASTM C1540.
5. Description: Stainless steel shield; stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

G. Shielded Couplings, Cast-Iron:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the**

following]:

- a. **[MG Coupling]**
 - b. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
- a. **[MG Coupling]**
 - b. **<Insert manufacturer's name>**
3. Source Limitations: Obtain cast-iron, shielded couplings from single manufacturer.
4. Standard: ASTM A1056.
5. Description: Two-piece, ASTM A48/A48M, cast-iron housing; stainless steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

H. Unshielded Couplings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **<Insert manufacturer's name>**
3. Source Limitations: Obtain unshielded couplings from single manufacturer.
4. Standard: ASTM C1461.
5. Description: Rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS - SANITARY SEWERAGE

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. **[American Cast Iron Pipe Company]**
 2. **[McWane Ductile; a part of the McWane family of companies]**
 3. **[U.S. Pipe]**
 4. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[American Cast Iron Pipe Company]**

2. [McWane Ductile; a part of the McWane family of companies]
3. [U.S. Pipe]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Push-on-Joint Piping:

1. Pipe: AWWA C151/A21.51.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron.
3. Compact Fittings: AWWA C153/A21.53.
4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.

F. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

G. Pipe Outer Coating:

1. Type: Asphaltic.
2. Minimum Uniform Thickness: [1 mil (0.025 mm)]<Insert thickness>.
3. Comply with AWWA C151/A21.51.

H. Cement Mortar Lining: AWWA C104/A21.4.

I. Seal Coating-Applied Lining:

1. Nominal Pipe Sizes 6 through 12 Inches (150 through 300 mm): 1/8 inch (3 mm).
2. Nominal Pipe Sizes 14 through 24 Inches (250 through 600 mm): <Insert inches (mm)>.

J. Asphaltic Sealcoat Lining:

1. Minimum Uniform Lining: [1 mil (0.025 mm)]<Insert thickness>.
2. Comply with AWWA C104/A21.4.

K. PE Encasement: Comply with AWWA C105/A21.5.

L. Coating:

1. Coat pipe and fittings exposed inside of structures with two coats of <Insert paint type and paint code> bituminous paint to achieve minimum dry film of thickness of <Insert mils (mm)> per coat.

2.5 ABS PIPE AND FITTINGS

A. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.

- B. Piping materials to bear label, stamp, or other markings of specified testing agency.
- C. ABS Solid-Wall Pipe: ASTM D2661, Schedule 40.
 - 1. Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
 - 2. Joints: ASTM D2235, solvent weld.
- D. ABS Cellular-Core Pipe: ASTM F628, Schedule 40.
 - 1. Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
 - 2. Joints: ASTM D2235, solvent weld.
- E. ABS Pipe and Fittings: SDR [23.5][35][42] with bell-and-spigot-style, solvent-sealed ends.
 - 1. Joints: ASTM D2235, solvent weld.
- F. Solvent Cement: ASTM D2235.

2.6 PVC PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1. **[Atkore]**
 - 2. **[Charlotte Pipe and Foundry Company]**
 - 3. **[JM Eagle]**
 - 4. **[National Pipe and Plastic, Inc. (Oldcastle)]**
 - 5. **[Silver-line Plastics]**
 - 6. **[Westlake Pipe & Fittings]**
 - 7. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - 1. **[Atkore]**
 - 2. **[Charlotte Pipe and Foundry Company]**
 - 3. **[JM Eagle]**
 - 4. **[National Pipe and Plastic, Inc. (Oldcastle)]**
 - 5. **[Silver-line Plastics]**
 - 6. **[Westlake Pipe & Fittings]**
 - 7. **<Insert manufacturer's name>**
- C. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.
- D. Piping materials to bear label, stamp, or other markings of specified testing agency.
- E. PVC Type PSM Gravity Sewer Piping:
 - 1. Pipe: ASTM D3034, **[SDR 35]<Insert SDR>**, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D3034, PVC with bell ends.
 - 3. Gaskets: ASTM F477, elastomeric seals.

- F. PVC Pressure Piping:
1. Pipe: AWWA C900, **[Class 100][Class 150][and][Class 200]** PVC pipe with bell-and-spigot ends for gasketed joints.
 2. Fittings: AWWA C900, **[Class 100][Class 150][and][Class 200]** PVC pipe with bell ends.
 3. Gaskets: ASTM F477, elastomeric seals.
- G. PVC Type DWV Piping:
1. Pipe: ASTM D1785 or ASTM D2665, **[Schedule 40][and][Schedule 80]** PVC, with plain ends for solvent-cemented joints.
 2. Fittings: **[ASTM D2466, Schedule 40][and][ASTM D2467, Schedule 80]** PVC, socket type.
 3. Adhesive Primer: ASTM F656.
 4. Solvent Cement: ASTM D2564.

2.7 FIBERGLASS SEWER PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. **[Augusta Fiberglass]**
 2. **[Industrial Fiberglass Specialties, Inc.]**
 3. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Augusta Fiberglass]**
 2. **[Industrial Fiberglass Specialties, Inc.]**
 3. **<Insert manufacturer's name>**
- C. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.
- D. Piping materials to bear label, stamp, or other markings of specified testing agency.
- E. Fiberglass Sewer Pipe: ASTM D3262, RTRP, for gasketed joints fabricated with **[Type 2, polyester][or][Type 4, epoxy]** resin.
1. Liner: **[Reinforced thermoset][Nonreinforced thermoset][Thermoplastic][No liner]**.
 2. Grade: **[Reinforced, surface layer matching pipe resin][Nonreinforced, surface layer matching pipe resin][No surface layer]<Insert grade>**.
 3. Stiffness: **[9 psig (62 kPa)][18 psig (124 kPa)][36 psig (248 kPa)][72 psig (496 kPa)]**
- F. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF, for gasketed joints.
1. Laminating Resin: **[Type 1, polyester][or][Type 2, epoxy]** resin.
 2. Reinforcement: Grade with finish compatible with resin.
- G. Gaskets: ASTM F477, elastomeric seals.

2.8 CONCRETE PIPE AND FITTINGS - SANITARY SEWERAGE

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. **[Northern Concrete Pipe, Inc.]**
 2. **[Rinker Materials Corporation, Concrete Pipe Division]**
 3. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Northern Concrete Pipe, Inc.]**
 2. **[Rinker Materials Corporation, Concrete Pipe Division]**
 3. **<Insert manufacturer's name>**
- C. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.
- D. Piping materials to bear label, stamp, or other markings of specified testing agency.
- E. Nonreinforced-Concrete Sewer Pipe and Fittings: **ASTM C14 (ASTM C14M), [Class 1][Class 2][Class 3]**, with **[bell-and-spigot][or][tongue-and-groove]** ends for gasketed joints with **ASTM C443 (ASTM C443M)**, rubber gaskets.
- F. Reinforced-Concrete Sewer Pipe and Fittings: **ASTM C76 (ASTM C76M)**.
1. **[Bell-and-spigot][or][tongue-and-groove]** ends for gasketed joints, with **ASTM C443 (ASTM C443M)**, rubber gaskets.
 2. Class II, **[Wall A][Wall B][Wall C]**.
 3. Class III, **[Wall A][Wall B][Wall C]**.
 4. Class IV, **[Wall A][Wall B][Wall C]**.
 5. Class V, **[Wall A][Wall B]**.

2.9 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
 2. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
 3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

- a. [Dallas Specialty & Mfg. Co.]
- b. [Fernco Inc]
- c. [Mission Rubber Company, LLC]
- d. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

- a. [Dallas Specialty & Mfg. Co.]
- b. [Fernco Inc]
- c. [Mission Rubber Company, LLC]
- d. <Insert manufacturer's name>

3. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.

4. Description: Elastomeric sleeve with [**stainless steel shear ring and**] corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

- a. [Dallas Specialty & Mfg. Co.]
- b. [Mission Rubber Company, LLC]
- c. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

- a. [Dallas Specialty & Mfg. Co.]
- b. [Mission Rubber Company, LLC]
- c. <Insert manufacturer's name>

3. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.

4. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

- a. [Fernco Inc]
- b. [Mission Rubber Company, LLC]
- c. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

- a. **[Fernco Inc]**
 - b. **[Mission Rubber Company, LLC]**
 - c. **<Insert manufacturer's name>**
3. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
 4. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
- F. Nonpressure-Type, Rigid Couplings:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **<Insert manufacturer's name>**
 3. Source Limitations: Obtain nonpressure-type, rigid couplings from single manufacturer.
 4. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.10 PRESSURE-TYPE PIPE COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. **[Cascade Waterworks Mfg. Co.]**
 2. **[Dresser Utility Solutions]**
 3. **[Ford Meter Box Company, Inc. (The)]**
 4. **[JCM Industries, Inc]**
 5. **[Romac Industries, Inc.]**
 6. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Cascade Waterworks Mfg. Co.]**
 2. **[Dresser Utility Solutions]**
 3. **[Ford Meter Box Company, Inc. (The)]**
 4. **[JCM Industries, Inc]**
 5. **[Romac Industries, Inc.]**
 6. **<Insert manufacturer's name>**
- C. Source Limitations: Obtain pressure-type pipe couplings from single manufacturer.

- D. Standard: AWWA C219.
- E. Description: Tubular-sleeve coupling with center sleeve, gaskets, end rings, and bolt fasteners.
- F. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include [150 psig (1035 kPa)][200 psig (1380 kPa)]<Insert value> minimum pressure rating and ends of same sizes as piping to be joined.
- G. Center-Sleeve Material: [Manufacturer's standard][Carbon steel][Stainless steel][Ductile iron][Malleable iron].
- H. Gasket Material: Natural or synthetic rubber.
- I. Metal Component Finish: Corrosion-resistant coating or material.

2.11 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [EBAA Iron Sales, Inc.]
 - b. [Romac Industries, Inc.]
 - c. [Star Pipe Products]
 - d. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [EBAA Iron Sales, Inc.]
 - b. [Romac Industries, Inc.]
 - c. [Star Pipe Products]
 - d. <Insert manufacturer's name>
3. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
4. Standards:
 - a. AWWA C110/A21.10.
 - b. AWWA C153/A21.53.
5. Description: Compound fitting with combination of flanged and mechanical-joint ends. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250 psig (1725 kPa) minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the

following]:

- a. **[EBAA Iron Sales, Inc.]**
 - b. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
- a. **[EBAA Iron Sales, Inc.]**
 - b. **<Insert manufacturer's name>**
3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Standards:
- a. AWWA C110/A21.10.
 - b. AWWA C153/A21.53.
5. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends. Include rating for **250 psig (1725 kPa)** minimum working pressure and for up to 15 degrees of deflection.

2.12 ENCASEMENT FOR PIPING

- A. Standards: ASTM A674 or AWWA C105/A21.5.
- B. Material: **[Linear low-density polyethylene film of 0.008-inch (0.20-mm)][or][high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)]** minimum thickness.
- C. Form: **[Sheet][or][tube]**.
- D. Color: **[Black][or][natural]<Insert color>**.

2.13 MANHOLES

- A. Standard Precast Concrete Manholes:
 1. Standard: ASTM C478/C478M.
 2. Description: Precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 3. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
 4. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 5. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (100-mm)** minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
 6. Riser Sections: **4-inch (100-mm)** minimum thickness, of length to provide depth indicated.
 7. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
 8. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
 9. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
 10. Steps: **[Individual FRP steps or FRP ladder][Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP][ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in**

ASTM D4101, PP]<Insert material>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than **[60 inches (1500 mm)]<Insert dimension>**.

11. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
12. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Standards: ASTM C913 and ASTM C890.
2. Description: Designed in accordance with ASTM C890 for A-16 designation, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
3. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
4. Joint Sealant: **ASTM C990 (ASTM 990M)**, bitumen or butyl rubber.
5. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
6. Steps: **[Individual FRP steps or FRP ladder][Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP][ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP]<Insert material>**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than **[60 inches (1500 mm)]<Insert dimension>**.
7. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
8. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Associated Fiberglass Enterprises]**
 - b. **[Containment Solutions, Inc]**
 - c. **[L. F. Manufacturing, Inc]**
 - d. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Associated Fiberglass Enterprises]**
 - b. **[Containment Solutions, Inc]**

- c. [L. F. Manufacturing, Inc]
 - d. <Insert manufacturer's name>
3. Source Limitations: Obtain FRP manholes from single manufacturer.
 4. Standard: ASTM D3753.
 5. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
 6. Ballast: Increase thickness of concrete base as required to prevent flotation.
 7. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
 8. Resilient Pipe Connectors: ASTM C923/C923M, cast or fitted into manhole walls, for each pipe connection.
 9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<Insert dimension>.
 10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended in writing by ring manufacturer.
 11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
- D. Manhole Frames and Covers:
1. Description: Ferrous; **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser, with **4-inch- (100-mm-)** minimum-width flange and **26-inch- (660-mm-)** diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
 2. Material: [**ASTM A536, Grade 60-40-18 ductile**][**ASTM A48/A48M, Class 35 gray**] iron unless otherwise indicated.
- E. Manhole-Cover Inserts:
1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. [L. F. Manufacturing, Inc]
 - b. [Vortex Companies]
 - c. <Insert manufacturer's name>
 2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert **manufacturer's name; product name or designation**> or comparable product by one of the following:
 - a. [L. F. Manufacturing, Inc]
 - b. [Vortex Companies]
 - c. <Insert manufacturer's name>
 3. Source Limitations: Obtain manhole-cover inserts from single manufacturer.
 4. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
 5. Type: [**Solid**][**Drainage with vent holes**][**Valve**].

2.14 CONCRETE

- A. Description: Cast-in-place concrete complying with ACI 318, **ACI 350 (ACI 350M)**, and the following:
1. Cement: ASTM C150/C150M, Type II.
 2. Fine Aggregate: ASTM C33/C33M, sand.
 3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (420-MPa)** deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, **4000 psi (27.6 MPa)** minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: **[1][2]** percent through manhole.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: **[4][8]** percent.
- D. Ballast and Pipe Supports: Portland cement design mix, **3000 psi (20.7 MPa)** minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (420 MPa)** deformed steel.

PART 3 - EXECUTION**3.1 EARTHWORK**

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for using lubricants, cements, and other installation

requirements.

- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping in accordance with the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of [1][2]<Insert number> percent unless otherwise indicated.
 - 2. Install piping [NPS 6 (DN 150)]<Insert pipe size> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 3. Install piping with [36-inch (915-mm)][48-inch (1220-mm)][60-inch (1520-mm)][72-inch (1830-mm)]<Insert dimension> minimum cover.
 - 4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 6. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
 - 7. Install PVC Type PSM sewer piping in accordance with ASTM D2321 and ASTM F1668.
 - 8. Install PVC Type DWV gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
 - 9. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
 - 10. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479/C1479M and ACPA's "Concrete Pipe & Box Culvert Installation Manual."
 - 11. Install reinforced-concrete sewer piping in accordance with ASTM C1479/C1479M and ACPA's "Concrete Pipe & Box Culvert Installation Manual."
- G. Install force-main, pressure piping in accordance with the following:
 - 1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 2. Install piping with [36-inch (915-mm)][48-inch (1220-mm)][60-inch (1520-mm)][72-inch (1830-mm)]<Insert dimension> minimum cover.
 - 3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
 - 4. Install ductile-iron special fittings in accordance with AWWA C600.
 - 5. Install PVC pressure piping in accordance with AWWA M23 or to ASTM D2774 and ASTM F1668.
- H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:
 - 1. Hub-and-spigot, cast-iron soil pipe.
 - 2. Hubless cast-iron soil pipe and fittings.
 - 3. Ductile-iron pipe and fittings.
 - 4. Expansion joints and deflection fittings.
- I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping in accordance with the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
 3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 4. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
 5. Join PVC Type PSM sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
 6. Join fiberglass sewer piping in accordance with ASTM D4161 for elastomeric-seal joints.
 7. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe & Box Culvert Installation Manual" for rubber-gasket joints.
 8. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe & Box Culvert Installation Manual" for rubber-gasket joints.
 9. Join dissimilar pipe materials with nonpressure-type, flexible[**or rigid**] couplings.
- B. Join force-main, pressure piping in accordance with the following:
1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
 2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.
 3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
 4. Join dissimilar pipe materials with pressure-type couplings.
- C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. **[Unshielded][Shielded]** flexible[**or rigid**] couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible[**or rigid**] couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 2. Use pressure pipe couplings for force-main joints.

3.4 INSTALLATION OF MANHOLES

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.
- C. Install FRP manholes in accordance with manufacturer's written instructions.
- D. Form continuous concrete channels and benches between inlets and outlet.

- E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [3 inches (76 mm)]<Insert dimension> above finished surface elsewhere unless otherwise indicated.
- F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete in accordance with ACI 318.

3.6 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus **6-inch (150-mm)** overlap with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
 - 2. Make branch connections from side into existing piping, **NPS 4 to NPS 20 (DN 100 to DN 500)**. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
 - 3. Make branch connections from side into existing piping, **NPS 21 (DN 525)** or larger, or to underground manholes by cutting opening into existing unit large enough to allow **3 inches (76 mm)** of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in **6 inches (150 mm)** of concrete for minimum length of **12 inches (300 mm)** to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of **3000 psi (20.7 MPa)** unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to **[grease][oil][and][sand]** interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least [8-inch- (203-mm-)]<Insert dimension> thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least [36 inches (915 mm)]<Insert dimension> below final grade. Fill to within [12 inches (300 mm)]<Insert dimension> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use[**warning tape or**] detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (600 mm)** of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage in accordance with requirements of authorities having jurisdiction and the following:

- a. Fill sewer piping with water. Test with pressure of at least **10-ft. (3-m)** head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
6. Air Tests: Test sanitary sewerage in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:
- a. Test plastic gravity sewer piping in accordance with ASTM F1417.
 - b. Test concrete gravity sewer piping in accordance with ASTM C1628.
7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than one and one-half times the maximum system operating pressure, but not less than **[150 psig (1035 kPa)]<Insert value>**.
- a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.
8. Manholes: Perform hydraulic test in accordance with **ASTM C969 (ASTM C969M)**.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 3.10 CLEANING
- A. Clean dirt and superfluous material from interior of piping. [**Flush with potable water.**]

END OF SECTION 33 31 00 00



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Task	Specification	Specification Description
33 31 11 00	32 91 19 13	Facility Septic Tanks
33 31 11 00	33 31 00 00	Site Sanitary Sewerage Piping
33 31 11 00	33 42 00 00	Stormwater Conveyance
33 31 11 00	33 46 00 00	Subdrainage



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SECTION 33 32 00 00 - SITE PACKAGED SEWAGE PUMPING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged sewage pumping stations - dry well.
2. Packaged sewage pumping stations - wet well.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" for seismic-load, wind-load, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration and seismic controls.

1.2 PERFORMANCE REQUIREMENTS

- A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than **125 psig (860 kPa)**.
- B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Show fabrication and installation details for each packaged sewage pumping station.

1. Indicate layout at minimum scale of **1/2 inch per foot (1:25)**.
2. Detail pumping station assemblies and indicate dimensions.
3. Indicate size, materials, and components.
4. Indicate shipping, installed, and operating weights; loads; required clearances; method of field assembly; components.
5. Indicate basin size, inlet and discharge locations, cover dimensions, vent location, check valve and isolation valve locations.
6. Indicate electrical characteristics and junction box locations.
7. Indicate power, signal, and control wiring diagrams.
8. Signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of sewage pump, signed by product manufacturer.
- B. Source quality-control test reports.

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- C. Field quality-control reports.
- D. Qualification Statements: For **[Installer][testing agency]**.
- E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For equipment.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- D. Comply with HI 14.1-14.2, HI 14.3, and HI 14.4.
- E. Comply with UL 778.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service in accordance with requirements indicated:
 - 1. Notify **[Architect][Construction Manager][Owner]** no fewer than **[two]<Insert number>** days in advance of proposed interruption of sanitary sewer service.
 - 2. Do not proceed with interruption of sanitary sewer service without **[Architect's][Construction Manager's][Owner's]** written permission.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of packaged sewage pumping stations that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Structural failures, including shell.
 - b. Faulty operation of sewage pumps, controls, or accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Shells: **<Insert number>** years from date of Substantial Completion.
 3. Warranty Period for Sewage Pumps and Controls: **<Insert number>** years from date of Substantial Completion.
 4. Warranty Period for Accessories: **<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED SEWAGE PUMPING STATIONS - DRY WELL

A. Packaged Sewage Pumping Stations - Dry Well with Dry-Well Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Dakota Pump Incorporated]**
 - b. **[PumpTech, LLC]**
 - c. **[Smith & Loveless]**
 - d. **[USEMCO]**
 - e. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Dakota Pump Incorporated]**
 - b. **[PumpTech, LLC]**
 - c. **[Smith & Loveless]**
 - d. **[USEMCO]**
 - e. **<Insert manufacturer's name>**
3. Source Limitations: Obtain dry well with dry-well sewage pump, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for **[comminutor and]**collection of sanitary sewage and with dry equipment chamber for sewage pumps, controls, and accessories.
 - a. Orientation: Shell underground with dry equipment chamber **[underground with top flush with grade][partially recessed underground][above grade][underground with entrance tube to grade]<Insert orientation>**.
 - b. Shell:
 - 1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
 - a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
 - b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
 - c) Entrance Tube: From dry compartment to entrance at grade, and of size

- required to replace largest piece of equipment, but not smaller than [36 inches (914 mm)]<Insert dimension> in diameter. Entrance tube walls are to be 1/4-inch (6.4-mm) minimum thickness.
- d) Weld steel access ladder and air vent to shell[**and entrance tube**].
 - e) Apply three coats of epoxy resin to interior and exterior surfaces.
 - f) Include [at least two][four]<Insert number> exterior magnesium anode(s) for cathodic protection.
- 2) Fabricate shell from fiberglass with structural-steel reinforcement.
 - a) Attach structural-steel reinforcement to top and bottom heads.
 - b) Fabricate shell with continuous joints to make watertight and gastight construction.
 - c) Attach air vent to pump chamber[**and entrance tube**].
 - d) Ladder: [Steel][Fiberglass].
 - 3) Install sump, 18 inches (450 mm) in diameter by 10 inches (254 mm) deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
 - 4) Entrance tube may be furnished separately for field installation.
 - 5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
 - 6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
 - 7) Factory fabricate piping between unit components.
 - a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
 - b) Use fittings for changes in direction and branch connections.
 - c) Flanged and union joints may be used instead of joints specified.
 - d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.
 - 8) Piping Connections: Unless otherwise indicated, make the following piping connections:
 - a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
 - b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - 9) Valves: Ferrous alloy.
 - a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
 - b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
 - c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
 - d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.
 - 10) Wiring: Tin-coated copper.

- c. Comminutor: Full size of sewage inlet pipe.
 - 1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
 - 2) Body: Stainless steel or ductile iron with flanged ends and access plate.
 - 3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
 - 4) Motor: Explosion proof, directly connected to body.
 - 5) Control Panel: **[NEMA 250, Type 12]**<Insert designation> enclosure for installation in dry equipment chamber.
 - 6) **<Insert special control features>**.
- d. Sewage Pumps: **[Two][Three]**<Insert number> dry-well-type, nonclog sewage pumps with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; mechanical or stuffing-box seals; and pedestal-mounted motor.
- e. Controls:
 - 1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
 - 2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
 - 3) System: **[Electrode][Float switch][Pressure switch][Ultrasonic]**. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
 - 4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
 - 5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
 - 6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
 - a) Mounting: **[Inside, on dry-chamber wall][Outside, on pedestal, at grade]**<Insert building description and room number>.
 - b) Enclosure: NEMA 250, **[Type 1][Type 4][Type 4X]**<Insert type>.
 - 7) Install labels on panel face to identify switches and controls.
 - 8) Wiring: Tin-copper wiring.
 - 9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."
- f. Submersible Sump Pump:
 - 1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.

- 2) Pump End Bell and Motor Shell: Cast iron.
 - 3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
 - 4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
 - 5) Shaft: Stainless steel.
 - 6) Bearings: Grease-lubricated, factory-sealed ball bearings.
 - 7) Seals: Mechanical.
 - 8) Accessories: Inlet strainer.
 - 9) Controls: Float switch.
- g. Accessories:
- 1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
 - 2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.
 - a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.
 - 3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.
 - a) Ventilating system capacity to change air in dry equipment chamber every two minutes.
 - 4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
 - 5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
 - 6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.
5. Capacities and Characteristics:
- a. Diameter or Dimensions of Shell: **<Insert inches (mm) or other dimensions>**.
 - b. Height of Shell Base Section: **<Insert inches (mm)>**.
 - c. Pumping Station, Inlet Pipe Size: **<Insert NPS (DN)>**.
 - d. Pumping Station, Discharge Pipe Size: **<Insert NPS (DN)>**.
 - e. Comminutor:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Pipe Size: **<Insert NPS (DN)>**.
 - 3) Motor Size: **<Insert value>**.
 - 4) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value> V**.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - f. Sewage Pumps: **[Two][Three]<Insert number> required**.

- g. Each Sewage Pump:
- 1) Capacity: <Insert gpm (L/s)>.
 - 2) Total Dynamic Head: <Insert feet (kPa)>.
 - 3) Speed: <Insert rpm>.
 - 4) Impeller:
 - a) Type: <Insert type>.
 - b) Diameter: <Insert inches (mm)>.
 - c) Solids Size Design: <Insert inches (mm)>.
 - 5) Inlet Size: <Insert NPS (DN)>.
 - 6) Discharge Size: <Insert NPS (DN)>.
 - 7) Motor Size: <Insert value> hp.
 - 8) Electrical Characteristics:
 - a) Volts: [240][277][480]<Insert value> V.
 - b) Phases: [Single][Three].
 - c) Hertz: 60.
 - 9) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."
- h. Sump Pump:
- 1) Capacity: <Insert gpm (L/s)>.
 - 2) Total Dynamic Head: <Insert feet (kPa)>.
 - 3) Speed: <Insert rpm>.
 - 4) Discharge Size: <Insert NPS (DN)>.
 - 5) Motor Size: <Insert value> hp.
 - 6) Electrical Characteristics:
 - a) Volts: [120][240][277][480]<Insert value> V.
 - b) Phases: [Single][Three].
 - c) Hertz: 60.
 - 7) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."
- i. Pumping Station Electrical Characteristics:
- 1) Full-Load Amperes: <Insert value>.
 - 2) Minimum Circuit Ampacity: <Insert value>.
 - 3) Maximum Overcurrent Protection: <Insert amperage>.

B. Packaged Sewage Pumping Stations - Dry Well with Vacuum-Primed Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

- a. **[Dakota Pump Incorporated]**
 - b. **[PumpTech, LLC]**
 - c. **[USEMCO]**
 - d. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
- a. **[Dakota Pump Incorporated]**
 - b. **[PumpTech, LLC]**
 - c. **[USEMCO]**
 - d. **<Insert manufacturer's name>**
3. Source Limitations: Obtain dry well with vacuum-primed sewage pump, packaged sewage pumping stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for **[comminutor and]**collection of sanitary sewage and with dry equipment chamber for sewage pumps, vacuum pumps, controls, and accessories.
- a. Orientation: Shell underground with dry equipment chamber **[underground with top flush with grade][partially recessed underground][above grade][underground with entrance tube to grade]<Insert orientation>**.
 - b. Shell:
 - 1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
 - a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
 - b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
 - c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than **[36 inches (914 mm)]<Insert dimension>** in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
 - d) Weld steel access ladder and air vent to shell **[and entrance tube]**.
 - e) Apply three coats of epoxy resin to interior and exterior surfaces.
 - f) Include **[at least two][four]<Insert number>** exterior magnesium anode(s) for cathodic protection.
 - 2) Fabricate shell from fiberglass with structural-steel reinforcement.
 - a) Attach structural-steel reinforcement to top and bottom heads.
 - b) Fabricate shell with continuous joints to make watertight and gastight construction.
 - c) Attach air vent to pump chamber **[and entrance tube]**.
 - d) Ladder: **[Steel][Fiberglass]**.
 - 3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
 - 4) Entrance tube may be furnished separately for field installation.
 - 5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
 - 6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade,

- outlet turned down, and with insect screen in outlet.
- 7) Factory fabricate piping between unit components.
 - a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
 - b) Use fittings for changes in direction and branch connections.
 - c) Flanged and union joints may be used instead of joints specified.
 - d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.
 - 8) Piping Connections: Unless otherwise indicated, make the following piping connections:
 - a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
 - b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - 9) Valves: Ferrous alloy.
 - a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
 - b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
 - c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
 - d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.
 - 10) Wiring: Tin-coated copper.
- c. Comminutor: Full size of sewage inlet pipe.
- 1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
 - 2) Body: Stainless steel or ductile iron with flanged ends and access plate.
 - 3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
 - 4) Motor: Explosion proof, directly connected to body.
 - 5) Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.
 - 6) **<Insert special control features>**.
- d. Sewage Pumps: [**Two**][**Three**]**<Insert number>** dry-chamber-mounting, vacuum-primed, nonclog sewage pumps located in dry compartment above wet pit, with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; mechanical or stuffing-box seals; pedestal-mounted motor; and suction piping extending to bottom of wet pit.
- e. Vacuum Pumps: Duplex arrangement with controls, vacuum piping, and vent piping of size and capacity required for system. Include automatic alternator, with manual disconnect switch, to change sequence of lead-lag vacuum pumps at completion of each cycle.
- f. Controls:
- 1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel

- if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
- 2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
 - 3) System: **[Electrode][Float switch][Pressure switch][Ultrasonic]**. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
 - 4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
 - 5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
 - 6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
 - a) Mounting: **[Inside, on dry-chamber wall][Outside, on pedestal, at grade]<Insert building description and room number>**.
 - b) Enclosure: NEMA 250, **[Type 1][Type 4][Type 4X]<Insert type>**.
 - 7) Install labels on panel face to identify switches and controls.
 - 8) Wiring: Tin-copper wiring.
 - 9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."
- g. Submersible Sump Pump:
- 1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
 - 2) Pump End Bell and Motor Shell: Cast iron.
 - 3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
 - 4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
 - 5) Shaft: Stainless steel.
 - 6) Bearings: Grease-lubricated, factory-sealed ball bearings.
 - 7) Seals: Mechanical.
 - 8) Accessories: Inlet strainer.
 - 9) Controls: Float switch.
- h. Accessories:
- 1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
 - 2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

- a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.
- 3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.
 - a) Ventilating system capacity to change air in dry equipment chamber every two minutes.
 - 4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
 - 5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
 - 6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.
5. Capacities and Characteristics:
 - a. Diameter or Dimensions of Shell: **<Insert inches (mm) or other dimensions>**.
 - b. Height of Shell Base Section: **<Insert inches (mm)>**.
 - c. Pumping Station, Inlet Pipe Size: **<Insert NPS (DN)>**.
 - d. Pumping Station, Discharge Pipe Size: **<Insert NPS (DN)>**.
 - e. Comminutor:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Pipe Size: **<Insert NPS (DN)>**.
 - 3) Motor Size: **<Insert value>** hp.
 - 4) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - f. Sewage Pumps: **[Two][Three]<Insert number>** required.
 - g. Each Sewage Pump:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Total Dynamic Head: **<Insert feet (kPa)>**.
 - 3) Speed: **<Insert rpm>**.
 - 4) Impeller:
 - a) Type: **<Insert type>**.
 - b) Diameter: **<Insert inches (mm)>**.
 - c) Solids Size Design: **<Insert inches (mm)>**.
 - 5) Inlet Size: **<Insert NPS (DN)>**.
 - 6) Discharge Size: **<Insert NPS (DN)>**.
 - 7) Motor Size: **<Insert value>** hp.
 - 8) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.



- 9) Motors:
- a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

- 1) Capacity: <Insert gpm (L/s)>.
- 2) Total Dynamic Head: <Insert feet (kPa)>.
- 3) Speed: <Insert rpm>.
- 4) Discharge Size: <Insert NPS (DN)>.
- 5) Motor Size: <Insert value> hp.
- 6) Electrical Characteristics:
 - a) Volts: [120][240][277][480]<Insert value> V.
 - b) Phases: [Single][Three].
 - c) Hertz: 60.

7) Motors:

- a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

- 1) Full-Load Amperes: <Insert value>.
- 2) Minimum Circuit Ampacity: <Insert value>.
- 3) Maximum Overcurrent Protection: <Insert amperage>.

2.2 PACKAGED SEWAGE PUMPING STATIONS - WET WELL

A. Packaged Sewage Pumping Stations - Wet Well with Submersible Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Metropolitan Industries, Inc]**
 - b. **[PumpTech, LLC]**
 - c. **[USEMCO]**
 - d. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Metropolitan Industries, Inc]**
 - b. **[PumpTech, LLC]**
 - c. **[USEMCO]**
 - d. **<Insert manufacturer's name>**
3. Source Limitations: Obtain wet well with submersible sewage pumps, packaged sewage pumping

- stations from single manufacturer.
4. Description: Factory fabricated, assembled, and tested with wet well for **[comminutor]**, submersible sewage pumps and collection of sanitary sewage and dry equipment chamber for controls and accessories.
- a. Orientation: Shell underground with dry equipment chamber **[underground with top flush with grade][partially recessed underground][above grade][underground with entrance tube to grade]<Insert orientation>**.
 - b. Shell:
 - 1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
 - a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
 - b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
 - c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than **[36 inches (914 mm)]<Insert dimension>** in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
 - d) Weld steel access ladder and air vent to shell **[and entrance tube]**.
 - e) Apply three coats of epoxy resin to interior and exterior surfaces.
 - f) Include **[at least two][four]<Insert number>** exterior magnesium anode(s) for cathodic protection.
 - 2) Fabricate shell from fiberglass with structural-steel reinforcement.
 - a) Attach structural-steel reinforcement to top and bottom heads.
 - b) Fabricate shell with continuous joints to make watertight and gastight construction.
 - c) Attach air vent to pump chamber **[and entrance tube]**.
 - d) Ladder: **[Steel][Fiberglass]**.
 - 3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
 - 4) Entrance tube may be furnished separately for field installation.
 - 5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
 - 6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
 - 7) Factory fabricate piping between unit components.
 - a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
 - b) Use fittings for changes in direction and branch connections.
 - c) Flanged and union joints may be used instead of joints specified.
 - d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.
 - 8) Piping Connections: Unless otherwise indicated, make the following piping connections:
 - a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.

- b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
- 9) Valves: Ferrous alloy.
- a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
- b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
- c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
- d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.
- 10) Wiring: Tin-coated copper.
- c. Comminutor: Full size of sewage inlet pipe.
- 1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
- 2) Body: Stainless steel or ductile iron with flanged ends and access plate.
- 3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
- 4) Motor: Explosion proof, directly connected to body.
- 5) Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.
- 6) **<Insert special control features>**.
- d. Sewage Pumps: [**Two**][~~Three~~]**<Insert number>** submersible-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
- e. Controls:
- 1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
- 2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
- 3) System: [**Electrode**][**Float switch**][**Pressure switch**][**Ultrasonic**]. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
- 4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
- 5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
- 6) Control Panel: Enclosure complying with UL 508A with separate compartments and

covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.

- a) Mounting: **[Inside, on dry-chamber wall][Outside, on pedestal, at grade]<Insert building description and room number>**.
 - b) Enclosure: NEMA 250, **[Type 1][Type 4][Type 4X]<Insert type>**.
 - 7) Install labels on panel face to identify switches and controls.
 - 8) Wiring: Tin-copper wiring.
 - 9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."
- f. Submersible Sump Pump:
- 1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
 - 2) Pump End Bell and Motor Shell: Cast iron.
 - 3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
 - 4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
 - 5) Shaft: Stainless steel.
 - 6) Bearings: Grease-lubricated, factory-sealed ball bearings.
 - 7) Seals: Mechanical.
 - 8) Accessories: Inlet strainer.
 - 9) Controls: Float switch.
- g. Accessories:
- 1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
 - 2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.
 - a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.
 - 3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.
 - a) Ventilating system capacity to change air in dry equipment chamber every two minutes.
 - 4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
 - 5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
 - 6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

5. Capacities and Characteristics:

- a. Diameter or Dimensions of Shell: **<Insert inches (mm) or other dimensions>**.
- b. Height of Shell Base Section: **<Insert inches (mm)>**.
- c. Pumping Station, Inlet Pipe Size: **<Insert NPS (DN)>**.
- d. Pumping Station, Discharge Pipe Size: **<Insert NPS (DN)>**.
- e. Comminutor:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Pipe Size: **<Insert NPS (DN)>**.
 - 3) Motor Size: **<Insert value>** hp.
 - 4) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
- f. Sewage Pumps: **[Two][Three]<Insert number>** required.
- g. Each Sewage Pump:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Total Dynamic Head: **<Insert feet (kPa)>**.
 - 3) Speed: **<Insert rpm>**.
 - 4) Impeller:
 - a) Type: **<Insert type>**.
 - b) Diameter: **<Insert inches (mm)>**.
 - c) Solids Size Design: **<Insert inches (mm)>**.
 - 5) Inlet Size: **<Insert NPS (DN)>**.
 - 6) Discharge Size: **<Insert NPS (DN)>**.
 - 7) Motor Size: **<Insert value>** hp.
 - 8) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - 9) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."
- h. Sump Pump:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Total Dynamic Head: **<Insert feet (kPa)>**.
 - 3) Speed: **<Insert rpm>**.
 - 4) Discharge Size: **<Insert NPS (DN)>**.
 - 5) Motor Size: **<Insert value>** hp.
 - 6) Electrical Characteristics:
 - a) Volts: **[120][240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - 7) Motors:

- a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."
- i. Pumping Station Electrical Characteristics:
- 1) Full-Load Amperes: **<Insert value>**.
 - 2) Minimum Circuit Ampacity: **<Insert value>**.
 - 3) Maximum Overcurrent Protection: **<Insert amperage>**.
- B. Packaged Sewage Pumping Stations - Wet Well with Submersible Grinder Sewage Pumps:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Environment One Corporation]**
 - b. **[Metropolitan Industries, Inc]**
 - c. **[PumpTech, LLC]**
 - d. **[USEMCO]**
 - e. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Environment One Corporation]**
 - b. **[Metropolitan Industries, Inc]**
 - c. **[PumpTech, LLC]**
 - d. **[USEMCO]**
 - e. **<Insert manufacturer's name>**
 3. Source Limitations: Obtain wet well with submersible grinder sewage pumps, packaged sewage pumping stations from single manufacturer.
 4. Description: Factory fabricated, assembled, and tested with wet well for submersible grinder sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.
 - a. Orientation: Shell underground with dry equipment chamber **[underground with top flush with grade][partially recessed underground][above grade][underground with entrance tube to grade]<Insert orientation>**.
 - b. Shell:
 - 1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
 - a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
 - b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
 - c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than **[36 inches (914 mm)]<Insert dimension>** in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.
 - d) Weld steel access ladder and air vent to shell **[and entrance tube]**.
 - e) Apply three coats of epoxy resin to interior and exterior surfaces.
 - f) Include **[at least two][four]<Insert number>** exterior magnesium anode(s)

for cathodic protection.

- 2) Fabricate shell from fiberglass with structural-steel reinforcement.
 - a) Attach structural-steel reinforcement to top and bottom heads.
 - b) Fabricate shell with continuous joints to make watertight and gastight construction.
 - c) Attach air vent to pump chamber[**and entrance tube**].
 - d) Ladder: [**Steel**][**Fiberglass**].
- 3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
- 4) Entrance tube may be furnished separately for field installation.
- 5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
- 6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
- 7) Factory fabricate piping between unit components.
 - a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
 - b) Use fittings for changes in direction and branch connections.
 - c) Flanged and union joints may be used instead of joints specified.
 - d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.
- 8) Piping Connections: Unless otherwise indicated, make the following piping connections:
 - a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
 - b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
- 9) Valves: Ferrous alloy.
 - a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
 - b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
 - c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
 - d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.
- 10) Wiring: Tin-coated copper.
 - c. Sewage Pumps: [**Two**][**Three**]**<Insert number>** submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
 - d. Controls:

- 1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
 - 2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
 - 3) System: **[Electrode][Float switch][Pressure switch][Ultrasonic]**. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
 - 4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
 - 5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
 - 6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
 - a) Mounting: **[Inside, on dry-chamber wall][Outside, on pedestal, at grade]<Insert building description and room number>**.
 - b) Enclosure: NEMA 250, **[Type 1][Type 4][Type 4X]<Insert type>**.
 - 7) Install labels on panel face to identify switches and controls.
 - 8) Wiring: Tin-copper wiring.
 - 9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."
- e. Submersible Sump Pump:
- 1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
 - 2) Pump End Bell and Motor Shell: Cast iron.
 - 3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload protection.
 - 4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
 - 5) Shaft: Stainless steel.
 - 6) Bearings: Grease-lubricated, factory-sealed ball bearings.
 - 7) Seals: Mechanical.
 - 8) Accessories: Inlet strainer.
 - 9) Controls: Float switch.
- f. Accessories:
- 1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
 - 2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.

- a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.
- 3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.
 - a) Ventilating system capacity to change air in dry equipment chamber every two minutes.
 - 4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
 - 5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
 - 6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.
5. Capacities and Characteristics:
 - a. Diameter or Dimensions of Shell: **<Insert inches (mm) or other dimensions>**.
 - b. Height of Shell Base Section: **<Insert inches (mm)>**.
 - c. Pumping Station, Inlet Pipe Size: **<Insert NPS (DN)>**.
 - d. Pumping Station, Discharge Pipe Size: **<Insert NPS (DN)>**.
 - e. Sewage Pumps: **[Two][Three]<Insert number>** required.
 - f. Each Sewage Pump:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Total Dynamic Head: **<Insert feet (kPa)>**.
 - 3) Speed: **<Insert rpm>**.
 - 4) Impeller: **[Cutter][Cutter or grinder][Grinder]** type.
 - 5) Inlet Size: **<Insert NPS (DN)>**.
 - 6) Discharge Size: **<Insert NPS (DN)>**.
 - 7) Motor Size: **<Insert value>** hp.
 - 8) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - 9) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."
 - g. Sump Pump:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Total Dynamic Head: **<Insert feet (kPa)>**.
 - 3) Speed: **<Insert rpm>**.
 - 4) Discharge Size: **<Insert NPS (DN)>**.
 - 5) Motor Size: **<Insert value>** hp.
 - 6) Electrical Characteristics:
 - a) Volts: **[120][240][277][480]<Insert value>** V.

- b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - 7) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."
 - h. Pumping Station Electrical Characteristics:
 - 1) Full-Load Amperes: **<Insert value>**.
 - 2) Minimum Circuit Ampacity: **<Insert value>**.
 - 3) Maximum Overcurrent Protection: **<Insert amperage>**.
- C. Packaged Sewage Pumping Stations - Wet Well with Suspended Sewage Pumps:
 - 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Dakota Pump Incorporated]**
 - b. **[PumpTech, LLC]**
 - c. **[Smith & Loveless]**
 - d. **<Insert manufacturer's name>**
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Dakota Pump Incorporated]**
 - b. **[PumpTech, LLC]**
 - c. **[Smith & Loveless]**
 - d. **<Insert manufacturer's name>**
 - 3. Source Limitations: Obtain wet well with suspended sewage pumps, packaged sewage pumping stations from single manufacturer.
 - 4. Description: Factory fabricated, assembled, and tested with wet well for **[comminutor]**,suspended sewage pumps and collection of sanitary sewage and with dry equipment chamber for pump motors, controls, and accessories.
 - a. Orientation: Shell underground with dry equipment chamber **[underground with top flush with grade][partially recessed underground][above grade][underground with entrance tube to grade]<Insert orientation>**.
 - b. Shell:
 - 1) Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
 - a) Walls: **1/4-inch (6.4-mm)** minimum thickness.
 - b) Top and Bottom Heads: **3/8-inch (9.5-mm)** minimum thickness. Weld reinforcing steel to top and bottom heads.
 - c) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than **[36 inches (914 mm)]<Insert dimension>** in diameter. Entrance tube walls are to be **1/4-inch (6.4-mm)** minimum thickness.

- d) Weld steel access ladder and air vent to shell[**and entrance tube**].
 - e) Apply three coats of epoxy resin to interior and exterior surfaces.
 - f) Include [at least two][four]<Insert number> exterior magnesium anode(s) for cathodic protection.
- 2) Fabricate shell from fiberglass with structural-steel reinforcement.
- a) Attach structural-steel reinforcement to top and bottom heads.
 - b) Fabricate shell with continuous joints to make watertight and gastight construction.
 - c) Attach air vent to pump chamber[**and entrance tube**].
 - d) Ladder: [**Steel**][**Fiberglass**].
- 3) Install sump, **18 inches (450 mm)** in diameter by **10 inches (254 mm)** deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
- 4) Entrance tube may be furnished separately for field installation.
- 5) Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
- 6) Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
- 7) Factory fabricate piping between unit components.
- a) Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
 - b) Use fittings for changes in direction and branch connections.
 - c) Flanged and union joints may be used instead of joints specified.
 - d) Use dielectric fittings for connections between ferrous- and copper-alloy piping.
- 8) Piping Connections: Unless otherwise indicated, make the following piping connections:
- a) Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment having **NPS 2 (DN 50)** or smaller threaded pipe connection.
 - b) Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
- 9) Valves: Ferrous alloy.
- a) Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
 - b) Sump Pump Piping: Include ball or gate and check valves on discharge pipe.
 - c) Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
 - d) Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.
- 10) Wiring: Tin-coated copper.
- c. Comminutor: Full size of sewage inlet pipe.
- 1) Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with

- controls; for pipeline installation.
 - 2) Body: Stainless steel or ductile iron with flanged ends and access plate.
 - 3) Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
 - 4) Motor: Explosion proof, directly connected to body.
 - 5) Control Panel: **[NEMA 250, Type12]<Insert designation>** enclosure for installation in dry equipment chamber.
 - 6) **<Insert special control features>**.
- d. Sewage Pumps: **[Two][Three]<Insert number>** wet-well-mounting-type, nonclog sewage pumps suspended from dry-compartment floor, with controls and piping. Include ASTM A48/A48M, Class 25, nonclog, cast-iron impeller capable of passing solids of **3-inch (76-mm)** minimum diameter; grease-lubricated bearings and stuffing-box seal; shaft coupling; and pedestal-mounted motor.
- e. Controls:
- 1) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
 - 2) Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gauge; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
 - 3) System: **[Electrode][Float switch][Pressure switch][Ultrasonic]**. Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on **6-inch (150-mm)** minimum differential of liquid level.
 - 4) Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
 - 5) 120 V accessory controls with 15 A, single-phase circuit breakers or fuses for each item.
 - 6) Control Panel: Enclosure complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20 A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
 - a) Mounting: **[Inside, on dry-chamber wall][Outside, on pedestal, at grade]<Insert building description and room number>**.
 - b) Enclosure: NEMA 250, **[Type 1][Type 4][Type 4X]<Insert type>**.
 - 7) Install labels on panel face to identify switches and controls.
 - 8) Wiring: Tin-copper wiring.
 - 9) Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."
- f. Submersible Sump Pump:
- 1) Discharge Size: **NPS 1-1/4 (DN 32)** minimum.
 - 2) Pump End Bell and Motor Shell: Cast iron.
 - 3) Motor: 1/3 hp, 1750 rpm, hermetically sealed, capacitor-start, with built-in overload

- protection.
- 4) Impeller: ASTM B584, cast bronze or ASTM B36/B36M, brass.
 - 5) Shaft: Stainless steel.
 - 6) Bearings: Grease-lubricated, factory-sealed ball bearings.
 - 7) Seals: Mechanical.
 - 8) Accessories: Inlet strainer.
 - 9) Controls: Float switch.
- g. Accessories:
- 1) Lighting: Minimum of two, UL 1598, heavy-duty, cast-metal, wet-location-type fixtures with 100 W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
 - 2) Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.
 - a) Dehumidification system capacity adequate to remove at least **15 pints (7 L)** of water per day from service area air that is **80 deg F (27 deg C)** with a relative humidity of 60 percent.
 - 3) Ventilation: Electrically powered ventilation system. Include centrifugal blower with **4-inch- (100-mm-)** round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.
 - a) Ventilating system capacity to change air in dry equipment chamber every two minutes.
 - 4) Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
 - 5) High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
 - 6) Remote Alarm Circuit: Include contacts for connection to remote alarm panel.
5. Capacities and Characteristics:
- a. Diameter or Dimensions of Shell: **<Insert inches (mm) or other dimensions>**.
 - b. Height of Shell Base Section: **<Insert inches (mm)>**.
 - c. Pumping Station, Inlet Pipe Size: **<Insert NPS (DN)>**.
 - d. Pumping Station, Discharge Pipe Size: **<Insert NPS (DN)>**.
 - e. Comminutor:
 - 1) Capacity: **<Insert gpm (L/s)>**.
 - 2) Pipe Size: **<Insert NPS (DN)>**.
 - 3) Motor Size: **<Insert value>** hp.
 - 4) Electrical Characteristics:
 - a) Volts: **[240][277][480]<Insert value>** V.
 - b) Phases: **[Single][Three]**.
 - c) Hertz: 60.
 - f. Sewage Pumps: **[Two][Three]<Insert number>** required.
 - g. Each Sewage Pump:

- 1) Capacity: <Insert gpm (L/s)>.
- 2) Total Dynamic Head: <Insert feet (kPa)>.
- 3) Speed: <Insert rpm>.
- 4) Impeller:
 - a) Type: <Insert type>.
 - b) Diameter: <Insert inches (mm)>.
 - c) Solids Size Design: <Insert inches (mm)>.
- 5) Inlet Size: <Insert NPS (DN)>.
- 6) Discharge Size: <Insert NPS (DN)>.
- 7) Motor Size: <Insert value> hp.
- 8) Electrical Characteristics:
 - a) Volts: [240][277][480]<Insert value> V.
 - b) Phases: [Single][Three].
 - c) Hertz: 60.
- 9) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

h. Sump Pump:

- 1) Capacity: <Insert gpm (L/s)>.
- 2) Total Dynamic Head: <Insert feet (kPa)>.
- 3) Speed: <Insert rpm>.
- 4) Discharge Size: <Insert NPS (DN)>.
- 5) Motor Size: <Insert value> hp.
- 6) Electrical Characteristics:
 - a) Volts: [120][240][277][480]<Insert value> V.
 - b) Phases: [Single][Three].
 - c) Hertz: 60.
- 7) Motors:
 - a) General requirements for motors are specified in Section 330500 "Common Work Results for Utilities."

i. Pumping Station Electrical Characteristics:

- 1) Full-Load Amperes: <Insert value>.
- 2) Minimum Circuit Ampacity: <Insert value>.
- 3) Maximum Overcurrent Protection: <Insert amperage>.

2.3 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A6/A6M, W or HP shapes, or ASTM A36/A36M, plates or beams.
- B. Grout: ASTM C1107/C1107M, Grade B, nonshrink cement grout.
 1. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

- C. Concrete: Specified in Section 033000 "Cast-in-Place Concrete."

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect sewage[**and sump**] pumps in accordance with HI 14.6. Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.
- B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before packaged sewage pumping station installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF PACKAGED SEWAGE PUMPING STATIONS

- A. Install packaged sewage pumping station components where indicated, in accordance with specific equipment and piping arrangement indicated.
- B. Shell Base Supports: Form from structural-steel beams, of number and lengths required to support bottom of shell and to anchor beams to concrete foundation.
 - 1. Use elevator blocks attached to bottom of shell to slope station floor **1 inch in 10 ft. (25.4 mm in 3 m)** down toward sump.
- C. Grout under and around shell. Ensure that there are no voids between foundation slab and underslab of pumping station.
- D. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.
- E. Connect anode conductors to grounding lugs on steel housing.
- F. Join separate sections of housing by field welding.
- G. Field weld entrance tube to housing.

3.4 PIPING CONNECTIONS

- A. Sanitary sewer piping installation requirements are specified in Section 333115 "Site Sanitary Sewerage Piping." Drawings indicate general arrangement of piping.
- B. Install piping adjacent to machine to allow service and maintenance.

3.5 ELECTRICAL CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 IDENTIFICATION

- A. Install identifying labels permanently attached to equipment.
- B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.
- C. Arrange for installing green[**warning tape or**] detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Section 312000 "Earth Moving."

3.7 PAINTING

- A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with an epoxy-polyamide paint in accordance with SSPC-Paint 16.
- B. Paint field-welded areas to match factory coating.

3.8 STARTUP SERVICE

- A. **[Engage a factory-authorized service representative to perform][Perform]** startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Adjust pump, accessory, and control settings, and safety and alarm devices.
 - 3. **<Insert, in separate subparagraphs, startup steps if any>**.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage][Engage]** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service, Including Testing: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Packaged sewage pumping stations will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train][Train]** Owner's maintenance personnel to adjust, operate, and maintain packaged sewage pumping stations. See Section 017900 "Demonstration and Training."

END OF SECTION 33 32 00 00

Task	Specification	Specification Description
33 32 16 00	33 32 00 00	Site Packaged Sewage Pumping Stations
33 34 13 13	32 91 19 13	Facility Septic Tanks
33 34 13 23	32 91 19 13	Facility Septic Tanks
33 34 13 33	32 91 19 13	Facility Septic Tanks
33 34 51 00	32 91 19 13	Facility Septic Tanks
33 34 53 13	32 91 19 13	Facility Septic Tanks
33 34 56 00	32 91 19 13	Facility Septic Tanks
33 40 00 00	22 11 16 00a	Storm Drainage Piping
33 40 00 00	22 05 76 00	Storm Drainage Piping Specialties
33 41 00 00	22 11 16 00a	Storm Drainage Piping
33 41 00 00	22 05 76 00	Storm Drainage Piping Specialties
33 41 16 13	32 91 19 13	Facility Septic Tanks
33 41 16 13	22 11 16 00a	Storm Drainage Piping
33 41 16 13	22 05 76 00	Storm Drainage Piping Specialties
33 41 16 13	33 42 00 00	Stormwater Conveyance
33 41 16 13	33 46 00 00	Subdrainage
33 41 19 00	22 11 16 00a	Storm Drainage Piping
33 41 19 00	22 05 76 00	Storm Drainage Piping Specialties
33 41 19 13	22 11 16 00a	Storm Drainage Piping
33 41 19 13	22 05 76 00	Storm Drainage Piping Specialties
33 41 19 13	33 46 00 00	Subdrainage



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SECTION 33 42 00 00 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron, culvert pipe and fittings.
4. Ductile-iron, pressure pipe and fittings.
5. Corrugated-steel pipe and fittings.
6. Corrugated-aluminum pipe and fittings.
7. ABS pipe and fittings.
8. Corrugated-PE pipe and fittings.
9. PVC pipe and fittings.
10. Fiberglass sewer pipe and fittings.
11. Concrete pipe and fittings.
12. Nonpressure transition couplings.
13. Pressure pipe couplings.
14. Expansion joints and deflection fittings.
15. Backwater valves.
16. Cleanouts.
17. Drains.
18. Concrete trench drain forming system.
19. Encasement for piping.
20. Manholes.
21. Polymer-concrete, channel drainage systems.
22. Plastic, channel drainage systems.
23. Catch basins.
24. Stormwater inlets.
25. Stormwater detention structures.
26. Pipe outlets.
27. Dry wells.
28. Stormwater disposal systems.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. **[Catch basins][stormwater inlets][and][dry wells]**. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers,

design calculations, and concrete design-mix reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than **1 inch equals 50 feet (1:500)** and vertical scale of not less than **1 inch equals 5 feet (1:50)**. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials are to bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes in accordance with manufacturer's written rigging instructions.
- D. Handle **[catch basins][and][stormwater inlets]** in accordance with manufacturer's written rigging instructions.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:
 - 1. Notify **[Architect][Construction Manager][Owner]** no fewer than **[two]<Insert number>** days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without **[Architect's][Construction Manager's][Owner's]** written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide**

products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. [AB & I Foundry; a part of the McWane family of companies]
2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [AB & I Foundry; a part of the McWane family of companies]
2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain hub-and-spigot, cast-iron soil pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Class: ASTM A74, [Service][and][Extra Heavy] class(es).

E. Gaskets: ASTM C564, rubber.

F. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. [AB & I Foundry; a part of the McWane family of companies]
2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [AB & I Foundry; a part of the McWane family of companies]
2. [Charlotte Pipe and Foundry Company]
3. [Tyler Pipe; a part of the McWane family of companies]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain hubless cast-iron soil pipe and fittings from single manufacturer.

D. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A888 or CISPI 301.

E. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Ideal Tridon Group]**
 - f. **[Matco-Norca]**
 - g. **[MIFAB, Inc]**
 - h. **[Mission Rubber Company, LLC]**
 - i. **[Tyler Pipe; a subsidiary of McWane Inc.]**
 - j. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Ideal Tridon Group]**
 - f. **[Matco-Norca]**
 - g. **[MIFAB, Inc]**
 - h. **[Mission Rubber Company, LLC]**
 - i. **[Tyler Pipe; a subsidiary of McWane Inc.]**
 - j. **<Insert manufacturer's name>**

3. Source Limitations: Obtain CISPI, hubless-piping couplings from single manufacturer.
4. Description: Stainless steel corrugated shield; stainless steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
5. Standards:
 - a. ASTM C1277 and CIPSI 310 for couplings.
 - b. ASTM C564 for gaskets.

F. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Ideal Tridon Group]**
 - f. **[Matco-Norca]**
 - g. **[MIFAB, Inc]**
 - h. **[Mission Rubber Company, LLC]**
 - i. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ANACO-Husky; a part of the McWane family of companies]**
 - b. **[Charlotte Pipe and Foundry Company]**
 - c. **[Dallas Specialty & Mfg. Co.]**
 - d. **[Fernco Inc]**
 - e. **[Ideal Tridon Group]**
 - f. **[Matco-Norca]**
 - g. **[MIFAB, Inc]**
 - h. **[Mission Rubber Company, LLC]**
 - i. **<Insert manufacturer's name>**
3. Source Limitations: Obtain heavy-duty, hubless-piping couplings from single manufacturer.
4. Description: Stainless steel shield; stainless steel bands and tightening devices; and rubber sleeve with integral, center pipe stop.
5. Standards:
 - a. ASTM C1277 and ASTM C1540 for couplings.
 - b. ASTM C564 for rubber gaskets.

G. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[MG Coupling]**
 - b. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[MG Coupling]**
 - b. **<Insert manufacturer's name>**
3. Source Limitations: Obtain cast-iron, hubless-piping couplings from single manufacturer.
4. Description: Two-piece, cast-iron housing; stainless steel bolts and nuts; and rubber sleeve with integral, center pipe stop.
5. Standards:
 - a. ASTM C1277 for couplings.
 - b. ASTM A48/A48M for cast-iron castings.
 - c. ASTM C564 for gaskets.

2.3 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

- A. Pipe: ASTM A716, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, for push-on joints.

- D. Gaskets: AWWA C111/A21.11, rubber.

2.4 PPE Channel Drainage Systems

- A. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - 1. **<Insert manufacturer's name>**

2.5 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

- 1. **[American Cast Iron Pipe Company]**
- 2. **[McWane Ductile; a part of the McWane family of companies]**
- 3. **[U.S. Pipe]**
- 4. **<Insert manufacturer's name>**

- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

- 1. **[American Cast Iron Pipe Company]**
- 2. **[McWane Ductile; a part of the McWane family of companies]**
- 3. **[U.S. Pipe]**
- 4. **<Insert manufacturer's name>**

- C. Source Limitations: Obtain ductile-iron, pressure pipe and fittings from single manufacturer.

- D. Ductile-Iron, Push-on-Joint Piping:

- 1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- 2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
- 3. Gaskets: AWWA C111/A21.11, rubber.

- E. Ductile-Iron, Mechanical-Joint Piping:

- 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
- 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.6 CORRUGATED-STEEL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be**

incorporated into the Work include, but are not limited to, the following]:

1. [American Piping Products]
2. [Specialty Pipe & Tube]
3. [Steel Mart, Inc.]
4. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [American Piping Products]
2. [Specialty Pipe & Tube]
3. [Steel Mart, Inc.]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain corrugated-steel pipe and fittings from single manufacturer.

D. Description: ASTM A760/A760M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated steel with O-ring seals.
2. Standard-Joint Bands: Corrugated steel.
3. Coating: [Aluminum][Zinc].

2.7 CORRUGATED-ALUMINUM PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. [Brunner Enterprises, Inc.]
2. [Continental Steel & Tube]
3. [Sapa North America]
4. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [Brunner Enterprises, Inc.]
2. [Continental Steel & Tube]
3. [Sapa North America]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain corrugated-aluminum pipe and fittings from single manufacturer.

D. Description: ASTM B745/B745M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated aluminum with O-ring seals.
2. Standard-Joint Bands: Corrugated aluminum.

2.8 ABS PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be

incorporated into the Work include, but are not limited to, the following]:

1. [Charlotte Pipe and Foundry Company]
2. [JM Eagle]
3. [Royal Building Products, a Westlake Company]
4. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [Charlotte Pipe and Foundry Company]
2. [JM Eagle]
3. [Royal Building Products, a Westlake Company]
4. <Insert manufacturer's name>

C. Source Limitations: Obtain ABS pipe and fittings from single manufacturer.

D. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

E. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

F. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

G. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.

H. Gaskets: ASTM F477, elastomeric seals.

I. Solvent Cement: ASTM D2235.

2.9 CORRUGATED-PE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. [Emco Industrial Plastics]
2. [Industrial Specialties Mfg, Inc.]
3. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [Emco Industrial Plastics]
2. [Industrial Specialties Mfg, Inc.]
3. <Insert manufacturer's name>

C. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.

D. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252, Type S, with smooth waterway for coupling joints.

- E. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294, Type S, with smooth waterway for coupling joints.
- F. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
- G. Corrugated-PE Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings.

2.10 PVC PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1. **[Charlotte Pipe and Foundry Company]**
 - 2. **[GF Piping Systems]**
 - 3. **[JM Eagle]**
 - 4. **[National Pipe and Plastic, Inc. (Oldcastle)]**
 - 5. **[North America Pipe Corporation]**
 - 6. **[Rocky Mountain Colby Pipe Company]**
 - 7. **[Silver-line Plastics]**
 - 8. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - 1. **[Charlotte Pipe and Foundry Company]**
 - 2. **[GF Piping Systems]**
 - 3. **[JM Eagle]**
 - 4. **[National Pipe and Plastic, Inc. (Oldcastle)]**
 - 5. **[North America Pipe Corporation]**
 - 6. **[Rocky Mountain Colby Pipe Company]**
 - 7. **[Silver-line Plastics]**
 - 8. **<Insert manufacturer's name>**
- C. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.
- D. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- E. PVC Cellular-Core Piping:
 - 1. PVC Cellular-Core Pipe and Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
 - 2. Fittings: ASTM D3034, **[SDR 35]<Insert SDR>**, PVC socket-type fittings.
- F. PVC Corrugated Sewer Piping:
 - 1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
 - 3. Gaskets: ASTM F477, elastomeric seals.
- G. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

H. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, **[SDR 35]<Insert SDR>**, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

I. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, **[T-1][T-2]** wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

J. PVC Pressure Piping:

1. Pipe: AWWA C900, **[Class 100][Class 150][and][Class 200]** PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, **[Class 100][Class 150][and][Class 200]** PVC pipe with bell ends
3. Gaskets: ASTM F477, elastomeric seals.

K. PVC Water-Service Piping:

1. Pipe: ASTM D1785, **[Schedule 40][and][Schedule 80]** PVC, with plain ends for solvent-cemented joints.
2. Fittings: **[ASTM D2466, Schedule 40][and][ASTM D2467, Schedule 80]** PVC, socket type.

L. Adhesive Primer: ASTM F656.

2.11 FIBERGLASS SEWER PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

1. **[Augusta Fiberglass]**
2. **[Industrial Fiberglass Specialties, Inc.]**
3. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. **[Augusta Fiberglass]**
2. **[Industrial Fiberglass Specialties, Inc.]**
3. **<Insert manufacturer's name>**

C. Source Limitations: Obtain fiberglass sewer pipe and fittings from single manufacturer.

D. Fiberglass Sewer Pipe: ASTM D3262, RTRP for gasketed joints fabricated with **[Type 2, polyester][Type 4, epoxy][Type 2, polyester or Type 4, epoxy]** resin.

1. Liner: **[Reinforced thermoset][Nonreinforced thermoset][Thermoplastic][No liner]**.
2. Grade: **[Reinforced, surface layer matching pipe resin][Nonreinforced, surface layer matching pipe resin][No surface layer]<Insert grade>**.
3. Stiffness: **[9 psig (62 kPa)][18 psig (124 kPa)][36 psig (248 kPa)][72 psig (496 kPa)]**.

E. Fiberglass Nonpressure Fittings: ASTM D3840, RTRF for gasketed joints.

1. Laminating Resin: **[Type 1, polyester][Type 2, epoxy][Type 1, polyester or Type 2, epoxy]** resin.
2. Reinforcement: Grade with finish compatible with resin.

F. Gaskets: ASTM F477, elastomeric seals.

2.12 CONCRETE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

1. **[FOLTZ Concrete Pipe Co.]**
2. **[Northern Concrete Pipe, Inc.]**
3. **[Rinker Materials Corporation, Concrete Pipe Division]**
4. **<Insert manufacturer's name>**

B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. **[FOLTZ Concrete Pipe Co.]**
2. **[Northern Concrete Pipe, Inc.]**
3. **[Rinker Materials Corporation, Concrete Pipe Division]**
4. **<Insert manufacturer's name>**

C. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

D. Nonreinforced-Concrete Sewer Pipe and Fittings: **ASTM C14 (ASTM C14M)**, **[Class 1][Class 2][Class 3]**, with **[bell-and-spigot][or][tongue-and-groove]** ends and **[gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets][sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant]**.

E. Reinforced-Concrete Sewer Pipe and Fittings: **ASTM C76 (ASTM C76M)**.

1. **[Bell-and-spigot][or][tongue-and-groove]** ends and **[gasketed joints with ASTM C443 (ASTM C443M), rubber gaskets][sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant]**
2. Class I, Wall **[A][B]**.
3. Class II, Wall **[A][B][C]**.
4. Class III, Wall **[A][B][C]**.
5. Class IV, Wall **[A][B][C]**.
6. Class V, Wall **[B][C]**.

2.13 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-

resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: **ASTM C443 (ASTM C443M)**, rubber.
2. For Cast-Iron Soil Pipes: ASTM C564, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Dallas Specialty & Mfg. Co.]**
 - b. **[Fernco Inc]**
 - c. **[Logan Clay Pipe]**
 - d. **[Mission Rubber Company, LLC]**
 - e. **[NDS Inc]**
 - f. **[Plastic Oddities]**
 - g. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Dallas Specialty & Mfg. Co.]**
 - b. **[Fernco Inc]**
 - c. **[Logan Clay Pipe]**
 - d. **[Mission Rubber Company, LLC]**
 - e. **[NDS Inc]**
 - f. **[Plastic Oddities]**
 - g. **<Insert manufacturer's name>**
3. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.
4. Description: Elastomeric sleeve with **[stainless steel shear ring and]** corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Cascade Waterworks Mfg. Co.]**
 - b. **[Dallas Specialty & Mfg. Co.]**
 - c. **[Mission Rubber Company, LLC]**
 - d. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert**

manufacturer's name; product name or designation> or comparable product by one of the following:

- a. [Cascade Waterworks Mfg. Co.]
 - b. [Dallas Specialty & Mfg. Co.]
 - c. [Mission Rubber Company, LLC]
 - d. <Insert manufacturer's name>
3. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
 4. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- E. Ring-Type, Flexible Couplings:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. [Fernco Inc]
 - b. [Logan Clay Pipe]
 - c. [Mission Rubber Company, LLC]
 - d. <Insert manufacturer's name>
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. [Fernco Inc]
 - b. [Logan Clay Pipe]
 - c. [Mission Rubber Company, LLC]
 - d. <Insert manufacturer's name>
 3. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
 4. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.14 PRESSURE PIPE COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. [Cascade Waterworks Mfg. Co.]
 2. [Dresser Utility Solutions]
 3. [Ford Meter Box Company, Inc. (The)]
 4. [Jay R. Smith Mfg Co; a division of Morris Group International]
 5. [JCM Industries, Inc]
 6. [Romac Industries, Inc.]
 7. [Victaulic Company]
 8. [Viking Johnson]
 9. <Insert manufacturer's name>
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

1. [Cascade Waterworks Mfg. Co.]
2. [Dresser Utility Solutions]
3. [Ford Meter Box Company, Inc. (The)]
4. [Jay R. Smith Mfg Co; a division of Morris Group International]
5. [JCM Industries, Inc]
6. [Romac Industries, Inc.]
7. [Victaulic Company]
8. [Viking Johnson]
9. <Insert manufacturer's name>

- C. Source Limitations: Obtain pressure pipe couplings from single manufacturer.
- D. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.
- E. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include [150-psig (1035-kPa)][200-psig (1380-kPa)]<Insert psig (kPa)> minimum pressure rating and ends sized to fit adjoining pipes.
- F. Center-Sleeve Material: [Manufacturer's standard][Carbon steel][Stainless steel][Ductile iron][Malleable iron].
- G. Gasket Material: Natural or synthetic rubber.
- H. Metal Component Finish: Corrosion-resistant coating or material.

2.15 EXPANSION JOINTS AND DEFLECTION FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [EBAA Iron Sales, Inc.]
 - b. [Romac Industries, Inc.]
 - c. [Star Pipe Products]
 - d. <Insert manufacturer's name>
 2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [EBAA Iron Sales, Inc.]
 - b. [Romac Industries, Inc.]
 - c. [Star Pipe Products]
 - d. <Insert manufacturer's name>
 3. Source Limitations: Obtain ductile-iron, flexible expansion joints from single manufacturer.
 4. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Dresser Utility Solutions]**
 - b. **[EBAA Iron Sales, Inc.]**
 - c. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
 - d. **[JCM Industries, Inc]**
 - e. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Dresser Utility Solutions]**
 - b. **[EBAA Iron Sales, Inc.]**
 - c. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
 - d. **[JCM Industries, Inc]**
 - e. **<Insert manufacturer's name>**
3. Source Limitations: Obtain ductile-iron expansion joints from single manufacturer.
4. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile iron **[or][steel with protective coating]**; bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53.
5. Pressure Rating: **250-psig (1725-kPa)** minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[EBAA Iron Sales, Inc.]**
 - b. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[EBAA Iron Sales, Inc.]**
 - b. **<Insert manufacturer's name>**
3. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
4. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include AWWA C111/A21.11, ductile-iron glands, rubber gaskets, and steel bolts. Include AWWA C111/A21.11 ductile-iron glands, rubber gaskets, and steel bolts.
5. Pressure Rating: **250 psig (1725 kPa)** minimum.

2.16 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
 - b. **[Josam Company]**
 - c. **[Tyler Pipe; a subsidiary of McWane Inc.]**
 - d. **[WATTS; A Watts Water Technologies Company]**
 - e. **[Zurn Industries, LLC]**
 - f. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
 - b. **[Josam Company]**
 - c. **[Tyler Pipe; a subsidiary of McWane Inc.]**
 - d. **[WATTS; A Watts Water Technologies Company]**
 - e. **[Zurn Industries, LLC]**
 - f. **<Insert manufacturer's name>**
3. Source Limitations: Obtain cast-iron backwater valves from single manufacturer.
4. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
5. Horizontal type; with swing check valve and hub-and-spigot ends.
6. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
7. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Endura; a brand of IPEX]**
 - b. **[IPS Corporation]**
 - c. **[NDS Inc]**
 - d. **[Plastic Oddities]**
 - e. **[Sioux Chief Manufacturing Company, Inc.]**
 - f. **[Zurn Industries, LLC]**
 - g. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Endura; a brand of IPEX]**
 - b. **[IPS Corporation]**

- c. [NDS Inc]
 - d. [Plastic Oddities]
 - e. [Sioux Chief Manufacturing Company, Inc.]
 - f. [Zurn Industries, LLC]
 - g. <Insert manufacturer's name>
3. Source Limitations: Obtain PVC backwater valves from single manufacturer.
 4. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.17 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. [Jay R. Smith Mfg Co; a division of Morris Group International]
 - b. [Josam Company]
 - c. [MIFAB, Inc]
 - d. [Tyler Pipe; a subsidiary of McWane Inc.]
 - e. [WATTS; A Watts Water Technologies Company]
 - f. [Zurn Industries, LLC]
 - g. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [Jay R. Smith Mfg Co; a division of Morris Group International]
 - b. [Josam Company]
 - c. [MIFAB, Inc]
 - d. [Tyler Pipe; a subsidiary of McWane Inc.]
 - e. [WATTS; A Watts Water Technologies Company]
 - f. [Zurn Industries, LLC]
 - g. <Insert manufacturer's name>
3. Source Limitations: Obtain cast-iron cleanouts from single manufacturer.
4. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
5. Top-Loading Classification(s): **[Light Duty][Medium Duty][Heavy Duty][and][Extra-Heavy Duty]**.
6. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. [Endura; a brand of IPEX]

- b. [IPS Corporation]
 - c. [NDS Inc]
 - d. [Plastic Oddities]
 - e. [Sioux Chief Manufacturing Company, Inc.]
 - f. [Zurn Industries, LLC]
 - g. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
- a. [Endura; a brand of IPEX]
 - b. [IPS Corporation]
 - c. [NDS Inc]
 - d. [Plastic Oddities]
 - e. [Sioux Chief Manufacturing Company, Inc.]
 - f. [Zurn Industries, LLC]
 - g. <Insert manufacturer's name>
3. Source Limitations: Obtain PVC cleanouts from single manufacturer.
4. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.18 DRAINS

A. Cast-Iron Area Drains:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
- a. [Jay R. Smith Mfg Co; a division of Morris Group International]
 - b. [Josam Company]
 - c. [MIFAB, Inc]
 - d. [Neenah Foundry Company]
 - e. [Tyler Pipe; a subsidiary of McWane Inc.]
 - f. [WATTS; A Watts Water Technologies Company]
 - g. [Zurn Industries, LLC]
 - h. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
- a. [Jay R. Smith Mfg Co; a division of Morris Group International]
 - b. [Josam Company]
 - c. [MIFAB, Inc]
 - d. [Neenah Foundry Company]
 - e. [Tyler Pipe; a subsidiary of McWane Inc.]
 - f. [WATTS; A Watts Water Technologies Company]
 - g. [Zurn Industries, LLC]
 - h. <Insert manufacturer's name>

3. Source Limitations: Obtain cast-iron area drains from single manufacturer.
4. Description: ASME A112.6.3 gray-iron round body with anchor flange and round[**secured**] grate. Include bottom outlet with inside caulk or spigot connection, of sizes indicated.
5. Top-Loading Classification(s): [**Medium Duty**][and][**Heavy Duty**].

B. Cast-Iron Trench Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
 - b. [**Josam Company**]
 - c. [**MIFAB, Inc**]
 - d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
 - e. [**WATTS; A Watts Water Technologies Company**]
 - f. [**Zurn Industries, LLC**]
 - g. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert **manufacturer's name; product name or designation**> or comparable product by one of the following:
 - a. [**Jay R. Smith Mfg Co; a division of Morris Group International**]
 - b. [**Josam Company**]
 - c. [**MIFAB, Inc**]
 - d. [**Tyler Pipe; a subsidiary of McWane Inc.**]
 - e. [**WATTS; A Watts Water Technologies Company**]
 - f. [**Zurn Industries, LLC**]
 - g. <Insert manufacturer's name>
3. Source Limitations: Obtain cast-iron trench drains from single manufacturer.
4. Description: ASME A112.6.3, **6-inch- (150-mm-)** wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular[**secured**] grate. Include units of total length indicated and quantity of bottom outlets with inside caulk or spigot connections, of sizes indicated.
5. Top-Loading Classification(s): [**Medium Duty**][**Heavy Duty**][and][**Extra-Heavy Duty**].

C. Steel Trench Drains:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [**Rockford Sanitary Systems, Inc**]
 - b. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert **manufacturer's name; product name or designation**> or comparable product by one of the following:
 - a. [**Rockford Sanitary Systems, Inc**]
 - b. <Insert manufacturer's name>
3. Source Limitations: Obtain steel trench drains from single manufacturer.

4. Description: Factory fabricated from ASTM A242/A242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
 5. Plate Thicknesses: [1/8 inch (3.2 mm)][and][1/4 inch (6.4 mm)].
 6. Overall Widths: [7-1/2 inches (190 mm)][and][12-1/3 inches (313 mm)].
- D. Grate Openings: [1/4 inch (6.4 mm) circular][3/8 inch (9.5 mm) circular][3/8 inch (9.5 mm) circular or 3/8-by-3-inch (9.5-by-76-mm) slots][3/8-by-3-inch (9.5-by-76-mm) slots].

2.19 CONCRETE TRENCH DRAIN FORMING SYSTEM

A. Concrete Trench Drain Forming System :

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [ABT, Inc.]
 - b. [Eric'sons Dura Trench]
 - c. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [ABT, Inc.]
 - b. [Eric'sons Dura Trench]
 - c. <Insert manufacturer's name>
3. Source Limitations: Obtain concrete trench drain forming system from single manufacturer.
4. Description: Radius trench drain forming system including a removable form that is customizable for width, depth, length, shape, slope, frame material, and grate material.
5. Form Bottom: [Smooth radius][Vee][Flat]<Insert option>.
6. Form Use: [Single use][or][reusable].
7. Form Covers: Plywood or metal to keep concrete out of trench form during installation.
8. Width: [8 inches (203 mm)][10 inches (254 mm)][12 inches (305 mm)][18 inches (457 mm)][24 inches (610 mm)]<Insert width> inside dimension.
9. Depth: [See drawings]<Insert dimension>.
10. Length: [See drawings]<Insert dimension>.
11. Bottom Shape: [Smooth radius][Vee]<Insert shape>.
12. Slope: [Level - no slope][0.5 percent][1.0 percent]<Insert slope>.
13. Frame/Grate Seat:
 - a. Load Bearing, <Insert loading requirement>.
 - b. Material: [Powder-coated steel][Galvanized steel][Iron][Aluminum][Plastic][FRP][Stainless steel]<Insert material>.
14. Concrete Anchors: [18 inches (457 mm) on center]<Insert spacing>
15. Grate:
 - a. Manufacturer's Load Bearing Designation: "[Heavy][Medium] Duty."

- b. Material: [Ductile iron][FRP][Galvanized steel][Cast iron][Stainless steel]<Insert material>.
- c. Grate Type: [ADA][Heel-proof][slotted][perforated][bar]<Insert grate type>.

2.20 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Material: [Linear low-density polyethylene film of 0.008-inch (0.20-mm)][or][cross-laminated HDPE film of 0.004-inch (0.10-mm)] minimum thickness.
- C. Form: [Sheet][or][tube].
- D. Color: [Black][or][natural]<Insert color>.

2.21 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: **4-inch (102-mm)** minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
9. Steps: [Individual FRP steps or FRP ladder][Individual FRP steps; FRP ladder; or **ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]<Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]<Insert inches (mm)>.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. Description: ASTM C913; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.

3. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
4. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
5. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]**<Insert material>**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]**<Insert inches (mm)>**.
6. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Fiberglass Manholes:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. [**Associated Fiberglass Enterprises**]
 - b. [**Containment Solutions, Inc**]
 - c. [**L. F. Manufacturing, Inc**]
 - d. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. [**Associated Fiberglass Enterprises**]
 - b. [**Containment Solutions, Inc**]
 - c. [**L. F. Manufacturing, Inc**]
 - d. **<Insert manufacturer's name>**
3. Source Limitations: Obtain fiberglass manholes from single manufacturer.
4. Description: ASTM D3753.
5. Diameter: **48 inches (1200 mm)** minimum unless otherwise indicated.
6. Ballast: Increase thickness of concrete base as required to prevent flotation.
7. Base Section: Concrete, **6-inch (150-mm)** minimum thickness.
8. Resilient Pipe Connectors: **ASTM C923 (ASTM C923M)**, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of manhole to finished grade is less than [**60 inches (1500 mm)**]**<Insert inches (mm)>**.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, **6- to 9-inch (150- to 225-mm)** total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

D. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: [ASTM A536, Grade 60-40-18 ductile][ASTM A48/A48M, Class 35 gray] iron unless otherwise indicated.

2.22 CONCRETE

A. General: Cast-in-place concrete in accordance with ACI 318 (ACI 318M), ACI 350 (ACI 350M), and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: [1][2] percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: [4][8] percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.23 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

- a. [ABT, Inc.]
- b. [ACO, Inc.]
- c. [Forté Composites, Inc.]
- d. [Hubbell Utility Solutions; Hubbell Incorporated]
- e. [Jay R. Smith Mfg Co; a division of Morris Group International]
- f. [Josam Company]
- g. [MultiDrain Systems, Inc.]
- h. <Insert manufacturer's name>

2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

- a. [ABT, Inc.]
- b. [ACO, Inc.]
- c. [Forté Composites, Inc.]
- d. [Hubbell Utility Solutions; Hubbell Incorporated]
- e. [Jay R. Smith Mfg Co; a division of Morris Group International]
- f. [Josam Company]
- g. [MultiDrain Systems, Inc.]
- h. <Insert manufacturer's name>

3. Source Limitations: Obtain narrow, sloped-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

- a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
- b. Include extension sections necessary for required depth.
- c. Dimensions: **4-inch (102-mm)** inside width. Include number of units required to form total lengths indicated.
- d. Frame: **[Gray-iron or galvanized steel for grates][Not required]**.
- e. Joining Section: As recommended in writing by system manufacturer.

6. Grates: Manufacturer's designation "**[heavy][medium]** duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

- a. Material: **[Ductile iron][Fiberglass][Galvanized steel][Gray iron][Stainless steel]<Insert material>**.
- b. Locking Mechanism: **[Manufacturer's standard device for securing grates to channel sections][Not required]**.

7. Covers: Solid **[ductile or gray iron]<Insert material>**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

B. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

- a. [ABT, Inc.]
 - b. [ACO, Inc.]
 - c. [Eric'sons Dura Trench]
 - d. [Forté Composites, Inc.]
 - e. [Josam Company]
 - f. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
- a. [ABT, Inc.]
 - b. [ACO, Inc.]
 - c. [Eric'sons Dura Trench]
 - d. [Forté Composites, Inc.]
 - e. [Josam Company]
 - f. <Insert manufacturer's name>
3. Source Limitations: Obtain narrow, level-invert channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.
- a. Include rounded bottom, with level invert and with **NPS 4 (DN 100)** outlets in number and locations indicated.
 - b. Dimensions: [**5-inch (127-mm)**]<Insert inches (mm)> inside width and [**9-3/4 inches (248 mm)**]<Insert inches (mm)> deep. Include number of units required to form total lengths indicated.
 - c. Frame: [**Gray-iron or galvanized steel for grates**][**Not required**].
6. Grates: Manufacturer's designation "[**heavy**][**medium**] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
- a. Material: [**Ductile iron**][**Fiberglass**][**Galvanized steel**][**Gray iron**][**Stainless steel**]<Insert material>.
 - b. Locking Mechanism: [**Manufacturer's standard device for securing grates to channel sections**][**Not required**].
7. Covers: Solid [**ductile or gray iron**]<Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems :
1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. [ABT, Inc.]
 - b. [ACO, Inc.]
 - c. [Eric'sons Dura Trench]
 - d. [Hubbell Utility Solutions; Hubbell Incorporated]

- e. **[Josam Company]**
 - f. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[ABT, Inc.]**
 - b. **[ACO, Inc.]**
 - c. **[Eric'sons Dura Trench]**
 - d. **[Hubbell Utility Solutions; Hubbell Incorporated]**
 - e. **[Josam Company]**
 - f. **<Insert manufacturer's name>**
 3. Source Limitations: Obtain wide, level-invert channel drainage systems from single manufacturer.
 4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 5. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.
 - a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - b. Dimensions: **[8-inch (203-mm)]<Insert inch (mm)>** inside width and **[13-3/4 inches (350 mm)]<Insert inches (mm)>** deep. Include number of units required to form total lengths indicated.
 - c. Frame: **[Gray iron or galvanized steel for grates][Not required]**.
 - d. Channel-Section Joining and Fastening Materials: As recommended in writing by system manufacturer.
 6. Grates: Manufacturer's designation "**[heavy][medium]** duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - a. Material: **[Ductile iron][Fiberglass][Galvanized steel][Gray iron][Stainless steel]<Insert material>**.
 - b. Locking Mechanism: **[Manufacturer's standard device for securing grates to channel sections][Not required]**.
 7. Covers: Solid **[ductile or gray iron]<Insert material>**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
- D. Drainage Specialties: Precast, polymer-concrete units.
1. Large Catch Basins:
 - a. **24-by-12-inch (610-by-305-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
 - b. Gray-iron slotted grate.
 - c. Frame: Include gray-iron or steel frame for grate.
 2. Small Catch Basins:
 - a. **19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm)** polymer-concrete body, with outlets in quantities and sizes indicated.
 - b. Gray-iron slotted grate.

- c. Frame: Include gray-iron or steel frame for grate.
3. Oil Interceptors:
 - a. Polymer-concrete body with interior baffle and four steel support channels and two 1/4-inch- (6.4-mm-) thick, steel-plate covers.
 - b. Capacity: [140 gal. (530 L)][200 gal. (757 L)][260 gal. (984 L)].
 - c. Inlet and Outlet: [NPS 4 (DN 100)][NPS 6 (DN 150)].
4. Sediment Interceptors:
 - a. 27-inch- (686-mm-) square, polymer-concrete body, with outlets in quantities and sizes indicated.
 - b. 24-inch- (610-mm-) square, gray-iron frame and slotted grate.

2.24 PLASTIC, CHANNEL DRAINAGE SYSTEMS

A. General Requirements for Plastic, Channel Drainage Systems:

1. Modular system of plastic channel sections, grates, and appurtenances.
2. Designed so grates fit into frames without rocking or rattling.
3. Number of units required to form total lengths indicated.

B. FRP Channel Drainage Systems :

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. [ACO, Inc.]
 - b. [Aquaduct, Inc.]
 - c. [Jay R. Smith Mfg Co; a division of Morris Group International]
 - d. [Zurn Industries, LLC]
 - e. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [ACO, Inc.]
 - b. [Aquaduct, Inc.]
 - c. [Jay R. Smith Mfg Co; a division of Morris Group International]
 - d. [Zurn Industries, LLC]
 - e. <Insert manufacturer's name>
3. Source Limitations: Obtain FRP channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.
 - a. Dimensions: [4 inches (102 mm)][4 or 6 inches (102 or 152 mm)][6 inches (152 mm)][6 or 8 inches (152 or 203 mm)][8 inches (203 mm)] wide. Include number of units required to form total lengths indicated.

- b. Frame: **[Galvanized steel][Stainless steel][Manufacturer's standard metal]<Insert material>** for grates.
6. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
- a. Material: **[Fiberglass][Galvanized steel][Gray iron][Stainless steel]<Insert material>**.
- b. Locking Mechanism: **[Manufacturer's standard device for securing grates to channel sections][Not required]**.
7. Covers: Solid **[ductile or gray iron]<Insert material>**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
8. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
9. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. HDPE or PE Channel Drainage Systems :
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
- a. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
- b. **[Sioux Chief Manufacturing Company, Inc.]**
- c. **[Tuf-Tite Corporation]**
- d. **[Zurn Industries, LLC]**
- e. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
- a. **[Jay R. Smith Mfg Co; a division of Morris Group International]**
- b. **[Sioux Chief Manufacturing Company, Inc.]**
- c. **[Tuf-Tite Corporation]**
- d. **[Zurn Industries, LLC]**
- e. **<Insert manufacturer's name>**
3. Source Limitations: Obtain HDPE or PE channel drainage systems from single manufacturer.
4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
5. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.
- a. Dimensions: **4 inches (102 mm)** wide. Include number of units required to form total lengths indicated.
6. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
- a. Material: **[Fiberglass][Galvanized steel][Gray iron][Stainless steel]<Insert material>**.
- b. Color: **<Insert color or delete subparagraph>**.
7. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.25 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: **ASTM C478 (ASTM C478M)**, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: **6-inch (150-mm)** minimum thickness for floor slab and **4-inch (102-mm)** minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: **4-inch (102-mm)** minimum thickness, **48-inch (1200-mm)** diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
8. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]**<Insert material>**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 inches (1500 mm)**]**<Insert inches (mm)>**.
9. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: **ASTM C913**, precast, reinforced concrete; designed in accordance with **ASTM C890** for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: **ASTM C990 (ASTM C990M)**, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 225-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and grate.
4. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]**<Insert material>**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [**60 inches (1500 mm)**]**<Insert inches (mm)>**.
5. Pipe Connectors: **ASTM C923 (ASTM C923M)**, resilient, of size required, for each pipe connecting to base section.

C. Rectangular Frames and Grates: **ASTM A536**, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: **24 by 24 inches (610 by 610 mm)** minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

D. Round Frames and Grates: **ASTM A536**, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with

4-inch- (102-mm-) minimum width flange, and **26-inch- (660-mm-)** diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.26 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening[, **of materials and dimensions in accordance with utility standards**].
- B. Gutter Inlets: Made with horizontal gutter opening[, **of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.
- C. Combination Inlets: Made with vertical curb and horizontal gutter openings[, **of materials and dimensions in accordance with utility standards**]. Include heavy-duty frames and grates.
- D. Frames and Grates: Heavy duty[, **in accordance with utility standards**].

2.27 STORMWATER DETENTION STRUCTURES

- A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed in accordance with ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
 1. Ballast: Increase thickness of concrete as required to prevent flotation.
 2. Grade Rings: Include two or three reinforced-concrete rings, of **6- to 9-inch (150- to 229-mm)** total thickness, that match **24-inch- (610-mm-)** diameter frame and cover.
 3. Steps: [**Individual FRP steps or FRP ladder**][**Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**][**ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP**]**<Insert material>**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at **12- to 16-inch (300- to 400-mm)** intervals. Omit steps if total depth from floor of structure to finished grade is less than [**60 inches (1500 mm)**]**<Insert inches (mm)>**.
- B. Manhole Frames and Covers: ASTM A536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include **24-inch (610-mm)** ID by **7- to 9-inch (175- to 225-mm)** riser with **4-inch- (102-mm-)** minimum width flange, and **26-inch- (660-mm-)** diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2.28 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregularly sized and shaped, graded stone in accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control."
 1. Average Size:
 - a. NSSGA No. R-3, screen opening **2 inches (51 mm)**.
 - b. NSSGA No. R-4, screen opening **3 inches (76 mm)**.

- c. NSSGA No. R-5, screen opening **5 inches (127 mm)**.
 - C. Filter Stone: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
 - D. Energy Dissipaters: In accordance with NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, **3-ton (2721-kg)** average weight armor stone, unless otherwise indicated.
- 2.29 DRY WELLS
- A. ASTM C913, precast, reinforced, perforated concrete rings. Include the following:
 - 1. Floor: Cast-in-place concrete.
 - 2. Cover: Liftoff-type concrete cover with cast-in lift rings.
 - 3. Wall Thickness: **4 inches (102 mm)** minimum with **1-inch (25-mm)** diameter or **1-by-3-inch- (25-by-76-mm-)** maximum slotted perforations arranged in rows parallel to axis of ring.
 - a. Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
 - b. Ring Construction: Designed to be self-aligning.
 - 4. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
 - B. Manufactured PE Dry Wells:
 - 1. Description: Manufactured PE side panels and top cover that assemble into **50-gal. (190-L)** storage capacity units.
 - 2. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[NDS Inc]**
 - b. **<Insert manufacturer's name>**
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[NDS Inc]**
 - b. **<Insert manufacturer's name>**
 - 4. Source Limitations: Obtain manufactured PE dry wells from single manufacturer.
 - 5. Side Panels: With knockout ports for piping and seepage holes.
 - 6. Top Cover: With knockout port for drain.
 - 7. Filter Fabric: As recommended by unit manufacturer.
 - 8. Filtering Material: ASTM D448, Size No. 24, **3/4- to 2-1/2-inch (19- to 63-mm)** washed, crushed stone or gravel.
 - C. Constructed-in-place aggregate type. Include the following:
 - 1. Lining:
 - a. Clay or concrete bricks.

- b. Concrete blocks or precast concrete rings with notches or weep holes.
2. Filtering Material: ASTM D448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
3. Cover: Precast, reinforced-concrete slab, designed for structural loading in accordance with ASTM C890 and made in accordance with ASTM C913. Include slab dimensions that will extend **12 inches (300 mm)** minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
4. Manhole: **24-inch- (610-mm-)** diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

2.30 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Advanced Drainage Systems, Inc]**
 - b. **[CULTEC, Inc]**
 - c. **[Hancor Inc.]**
 - d. **[Infiltrator Systems Inc]**
 - e. **[Interface H2O]**
 - f. **[StormTech LLC]**
 - g. **[Suntree Technologies, Inc.]**
 - h. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Advanced Drainage Systems, Inc]**
 - b. **[CULTEC, Inc]**
 - c. **[Hancor Inc.]**
 - d. **[Infiltrator Systems Inc]**
 - e. **[Interface H2O]**
 - f. **[StormTech LLC]**
 - g. **[Suntree Technologies, Inc.]**
 - h. **<Insert manufacturer's name>**
3. Source Limitations: Obtain chamber systems from single manufacturer.
4. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
5. Filtering Material: ASTM D448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
6. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of **4 oz./sq. yd. (135 g/sq. m)**.

- B. Piping Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252 for **NPS 10 (DN 250)** and smaller, AASHTO M 294 for **NPS 12 to NPS 60 (DN 300 to DN 1500)**. Include proprietary fittings, couplings, seals, and filter fabric.

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Advanced Drainage Systems, Inc]**
 - b. **[Hancor Inc.]**
 - c. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Advanced Drainage Systems, Inc]**
 - b. **[Hancor Inc.]**
 - c. **<Insert manufacturer's name>**

3. Source Limitations: Obtain pipe systems from single manufacturer.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

- F. Install gravity-flow, nonpressure drainage piping in accordance with the following:
 1. Install piping pitched down in direction of flow.
 2. Install piping **[NPS 6 (DN 150)]<Insert value>** and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.

3. Install piping with [36-inch- (915-mm-)][48-inch- (1220-mm-)][60-inch- (1520-mm-)][72-inch- (1830-mm-)]<Insert inch- (mm-)> minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
7. Install corrugated-steel piping in accordance with ASTM A798/A798M.
8. Install corrugated-aluminum piping in accordance with ASTM B788/B788M.
9. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
10. Install PE corrugated sewer piping in accordance with ASTM D2321.
11. Install PVC cellular-core piping in accordance with ASTM D2321 and ASTM F1668.
12. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
13. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
14. Install PVC water-service piping in accordance with ASTM D2321 and ASTM F1668.
15. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
16. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
17. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install force-main pressure piping in accordance with the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
2. Install piping with [36-inch- (915-mm-)][48-inch- (1220-mm-)][60-inch- (1520-mm-)][72-inch- (1830-mm-)]<Insert inch- (mm-)> minimum cover.
3. Install ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings in accordance with AWWA C600.
5. Install PVC pressure piping in accordance with AWWA M23, or ASTM D2774 and ASTM F1668.
6. Install PVC water-service piping in accordance with ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping in accordance with AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
6. Join corrugated-steel sewer piping in accordance with ASTM A798/A798M.

7. Join corrugated-aluminum sewer piping in accordance with ASTM B788/B788M.
8. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
9. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
10. Join PVC cellular-core piping in accordance with ASTM D2321 and ASTM F891 for solvent-cemented joints.
11. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
12. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
13. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
14. Join fiberglass sewer piping in accordance with ASTM D3839 for elastomeric-seal joints.
15. Join nonreinforced-concrete sewer piping in accordance with **ASTM C14 (ASTM C14M)** and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
16. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
17. Join dissimilar pipe materials with nonpressure-type flexible couplings.

B. Join force-main pressure piping in accordance with the following:

1. Join ductile-iron pressure piping in accordance with AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings in accordance with AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
4. Join PVC water-service piping in accordance with ASTM D2855 for solvent-cemented joints.
5. Join dissimilar pipe materials with pressure-type couplings.

3.4 INSTALLATION OF BACKWATER VALVES

- A. Install horizontal-type backwater valves in piping where indicated.
- B. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.
- C. Install terminal-type backwater valves on end of piping and in manholes where indicated.

3.5 INSTALLATION OF CLEANOUTS

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Use Light-Duty, top-loading classification cleanouts in **[earth or unpaved foot-traffic]<Insert area type>** areas.
 2. Use Medium-Duty, top-loading classification cleanouts in **[paved foot-traffic]<Insert area type>** areas.
 3. Use Heavy-Duty, top-loading classification cleanouts in **[vehicle-traffic service]<Insert area type>** areas.
 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in **[roads]<Insert area>**.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, **[18 by 18 by 12 inches (450 by 450 by 300 mm)]<Insert inches (mm)>** deep. Set with tops **[1 inch (25 mm)]<Insert inch(es (mm))>** above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 INSTALLATION OF DRAINS

- A. Install type of drains in locations indicated.
 - 1. Use Light-Duty, top-loading classification drains in [**earth or unpaved foot-traffic**]<Insert area type> areas.
 - 2. Use Medium-Duty, top-loading classification drains in [**paved foot-traffic**]<Insert area type> areas.
 - 3. Use Heavy-Duty, top-loading classification drains in [**vehicle-traffic service**]<Insert area type> areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification drains in [**roads**]<Insert area>.
- B. Embed drains in **4-inch- (102-mm-)** minimum concrete around bottom and sides.
- C. Fasten grates to drains if indicated.
- D. Set drain frames and covers with tops flush with pavement surface.
- E. Assemble trench sections with flanged joints.
- F. Embed trench sections in [**4-inch- (102-mm-)**]<Insert inch- (mm)-> minimum concrete around bottom and sides.

3.7 INSTALLATION OF MANHOLES

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [**3 inches (76 mm)**]<Insert inches (mm)> above finished surface elsewhere unless otherwise indicated.

3.8 INSTALLATION OF CATCH BASINS

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.9 INSTALLATION OF STORMWATER INLETS/OUTLETS

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

- E. Construct energy dissipaters at outlets, as indicated.

3.10 INSTALLATION OF DRY WELLS

- A. Excavate hole to diameter of at least **6 inches (150 mm)** greater than outside of dry well. Do not extend excavation into ground-water table.
- B. Install precast, concrete-ring dry wells in accordance with the following:
 - 1. Assemble rings to depth indicated.
 - 2. Extend rings to height where top of cover will be approximately **8 inches (203 mm)** below finished grade.
 - 3. Backfill bottom of inside of rings with filtering material to level at least **12 inches (300 mm)** above bottom.
 - 4. Extend effluent inlet pipe **12 inches (300 mm)** into rings and terminate into side of tee fitting.
 - 5. Backfill around outside of rings with filtering material to top level of rings.
 - 6. Install cover over top of rings.
- C. Install manufactured, PE dry wells in accordance with manufacturer's written instructions and the following:
 - 1. Assemble and install panels and cover.
 - 2. Backfill bottom of inside of unit with filtering material to level at least [**12 inches (300 mm)**]**<Insert inches (mm)>** above bottom.
 - 3. Extend effluent inlet pipe [**12 inches (300 mm)**]**<Insert inches (mm)>** into unit and terminate into side of tee fitting.
 - 4. Install filter fabric around outside of unit.
 - 5. Install filtering material around outside of unit.
- D. Install constructed-in-place dry wells in accordance with the following:
 - 1. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
 - 2. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
 - 3. Extend lining material to height where top of manhole will be approximately [**8 inches (203 mm)**]**<Insert inches (mm)>** below finished grade.
 - 4. Backfill bottom of inside of lining with filtering material to level at least [**12 inches (300 mm)**]**<Insert inches (mm)>** above bottom.
 - 5. Extend effluent inlet pipe [**12 inches (300 mm)**]**<Insert inches (mm)>** into lining and terminate into side of tee fitting.
 - 6. Backfill around outside of lining with filtering material to top level of lining.
 - 7. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.

3.11 CONCRETE PLACEMENT

- A. Place cast-in-place concrete in accordance with **ACI 318 (ACI 318M)**.

3.12 INSTALLATION OF CHANNEL DRAINAGE SYSTEMS

- A. Install with top surfaces of components, except piping, flush with finished surface.

- B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
- C. Embed channel sections and drainage specialties in [4-inch- (102-mm-)]<Insert inch- (mm-)> minimum concrete around bottom and sides.
- D. Fasten grates to channel sections if indicated.
- E. Assemble channel sections with flanged or interlocking joints.
- F. Embed channel sections in [4-inch- (102-mm-)]<Insert inch- (mm-)> minimum concrete around bottom and sides.

3.13 INSTALLATION OF STORMWATER DISPOSAL SYSTEMS

- A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill in accordance with chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.
- B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, in accordance with piping manufacturer's written instructions.

3.14 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221414 "Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Section 221414 "Storm Drainage Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus **6-inch (150-mm)** overlap, with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
 2. Make branch connections from side into existing piping, **NPS 4 to NPS 20 (DN 100 to DN 500)**. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than **6 inches (150 mm)** of concrete with 28-day compressive strength of **3000 psi (20.7 MPa)**.
 3. Make branch connections from side into existing piping, **NPS 21 (DN 525)** or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow **3 inches (76 mm)** of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in **6 inches (150 mm)** of concrete for minimum length of **12 inches (300 mm)** to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of **3000 psi (20.7 MPa)** unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."
- E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. **[Unshielded][Shielded]** flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 2. Use pressure-type pipe couplings for force-main joints.

3.15 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 1. Close open ends of piping with at least **[8-inch- (203-mm-)]<Insert inch- (mm)->** thick, brick masonry bulkheads.
 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
 1. Remove manhole or structure and close open ends of remaining piping.
 2. Remove top of manhole or structure down to at least **[36 inches (915 mm)]<Insert inches (mm)>** below final grade. Fill to within **[12 inches (300 mm)]<Insert inches (mm)>** of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.16 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 1. Use **[warning tape or]** detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.17 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately **24 inches (610 mm)** of backfill is in place, and again at completion of Project.



1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping in accordance with ASTM F1417.
6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than [150 psig (1035 kPa)]<Insert psig (kPa)>.
 - a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.18 CLEANING

A. Clean interior of piping of dirt and superfluous materials. [Flush with potable water.]

END OF SECTION 33 42 00 00

Task	Specification	Specification Description
33 42 00 00	22 11 16 00a	Storm Drainage Piping
33 42 00 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 11 00	22 11 16 00a	Storm Drainage Piping
33 42 11 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 11 00	33 14 13 23	Ground-Loop Heat-Pump Piping
33 42 11 00	33 42 00 00	Stormwater Conveyance
33 42 11 00	33 46 00 00	Subdrainage
33 42 13 00	22 11 16 00a	Storm Drainage Piping
33 42 13 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 13 00	33 42 00 00	Stormwater Conveyance
33 42 13 13	22 11 16 00a	Storm Drainage Piping
33 42 13 13	22 05 76 00	Storm Drainage Piping Specialties
33 42 13 13	33 42 00 00	Stormwater Conveyance
33 42 23 00	22 11 16 00a	Storm Drainage Piping
33 42 23 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 23 00	23 43 00 00	Electronic Air Cleaners
33 42 23 00	33 42 00 00	Stormwater Conveyance
33 42 26 00	33 42 00 00	Stormwater Conveyance
33 42 26 16	22 11 16 00a	Storm Drainage Piping
33 42 26 16	22 05 76 00	Storm Drainage Piping Specialties
33 42 26 16	33 42 00 00	Stormwater Conveyance
33 42 26 19	22 11 16 00a	Storm Drainage Piping
33 42 26 19	22 05 76 00	Storm Drainage Piping Specialties
33 42 26 19	33 42 00 00	Stormwater Conveyance
33 42 26 23	22 11 16 00a	Storm Drainage Piping
33 42 26 23	22 05 76 00	Storm Drainage Piping Specialties
33 42 26 23	33 42 00 00	Stormwater Conveyance
33 42 31 00	22 11 16 00a	Storm Drainage Piping
33 42 31 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 31 00	23 43 00 00	Electronic Air Cleaners
33 42 31 00	33 42 00 00	Stormwater Conveyance
33 42 33 00	22 11 16 00a	Storm Drainage Piping
33 42 33 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 33 00	23 43 00 00	Electronic Air Cleaners
33 42 33 00	33 42 00 00	Stormwater Conveyance
33 42 36 00	22 11 16 00a	Storm Drainage Piping
33 42 36 00	22 05 76 00	Storm Drainage Piping Specialties
33 42 36 00	33 42 00 00	Stormwater Conveyance
33 44 00 00	22 11 16 00a	Storm Drainage Piping
33 44 00 00	22 05 76 00	Storm Drainage Piping Specialties



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SECTION 33 44 36 00 - OIL WATER SEPARATOR

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for oil/water separator. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Scope

1. The separator shall be designed for gravity separation of sand, grit, settleable solids, or semisolids, and free oils (hydrocarbons and other petroleum products) from wastewater. Separator shall be installed belowground with top access at or above grade level. The source of the influent to the separator shall be gravity flow from storm water runoff, hydrocarbon spills, and/or cleaning/maintenance operations.

C. Performance

1. Influent Characteristics

- a. Provide separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures. Minimum separator retention time shall be 10 minutes. Operating temperatures of the influent oil in water mixture shall range from 40 degrees F. to 80 degrees F. The specific gravity of the oils at operating temperatures shall range from 0.71 to 0.92. The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.

2. Effluent Characteristics

- a. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

D. Design Criteria

1. The separator shall be listed to Underwriters' Laboratories UL-SU2215. Construction and performance of the oil/water separators shall be in accordance with UL-SU2215. Provide certification documentation detailing criteria under which the system was tested. UL-SU2215 label shall be prominently displayed on manway covers.
2. Separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Publication 421, "Monographs on Refinery Environmental Control - Management of Water Discharges; Design and Operation of Oil/Water Separators." Effective surface area calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document specified effluent quality based on complete removal of the specified oil globule at design flow. A separator with lower effective surface area than required is not permissible.
3. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters' Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, September 30, 1997, Double Wall construction with 360 degree Steel Secondary Containment. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank shall have a double steel shell with a space between the layers. The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from a small sump at the bottom. Tank construction using thin walled primary tank with external fiberglass jacket shall not be permissible.
4. Separator Corrosion Control System shall be in strict accordance with Underwriters' Laboratories Inc. Subject UL-1746 Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks and the HighGuard® External Corrosion Protection Specifications.

5. Oil/water separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
6. Separator vessel volume shall allow for a hydraulic retention time of ten (10) minutes to ensure laminar flow conditions which result in hydraulic uniformity and high effluent quality. Volume reduction will adversely affect separator performance by increasing horizontal velocity and turbulence, therefore a separator of smaller volume is not permissible.
7. Separator shall be the standard patented product of a steel tank manufacturer regularly engaged in the production of such equipment. Manufacturer shall have at least 20 years experience in manufacturing similar units for identical applications. No subcontracting of tank fabrication shall be permitted.
8. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.
9. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58, September 30, 1997. Calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document structural strength under specified overbearing or external pressure. A separator with a reduced shell thickness is not permissible.
10. Separator shall have an oil storage capacity equal to about 43% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.
11. To prevent extensive shutdown and maintenance, the separator design must allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids. The use of plastic perforated tubes, spherical balls, or irregular shaped media will increase the facility's maintenance costs and shall not be permitted.
12. Separator shall consist of inlet and outlet connections, integral sand interceptor compartment, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with removable parallel flat/corrugated plate coalescer, with removable plates, and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access ways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs.

E. Submittals:

1. Shop Drawings: shop drawings for oil water separators shall show principal dimensions and location of all fittings.
2. Instructions: provide three complete sets of installation, operation, and maintenance instructions with separator.
3. Quality Control: Quality control, inspection procedures, and reports shall be considered part of the submittal package.

F. Warranty

1. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s).
2. The manufacturer's warranty shall be standard limited warranty in effect at time of purchase.

1.2 PRODUCTS**A. Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Highland Tank, One Highland Road, Box 338, Stoystown, PA 15563, Phone 814-893-5701, FAX 893-6126, E-mail ows.info@highlandtank.com, Website <http://www.highlandtank.com>

B. Product

1. Provide and install Highland Tank Model HTC Series "G" UL-SU2215 approved Belowground Double Wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator with Integral Sand Interceptor Compartment. Separator shall be furnished with oil level alarm and leak detection systems. Oil/Water Separator shall be of capacity to comply with Spill Prevention Control and Countermeasures (SPCC) plan requirements at the facility. The sizing of this oil/water separator is consistent with industry protocols for complying with the minimum federal spill and discharge regulations therefore a separator of smaller volume is not permissible.
2. Separator shall be furnished with a Corella™ inclined parallel flat/corrugated plate coalescer to simultaneously separate free oil droplets and settleable or suspended solids particles from water without clogging of the coalescer.

C. Description

1. Separator shall be standard prefabricated inclined parallel flat/corrugated plate, gravity displacement type unit.
2. Separator shall be cylindrical with capacities, dimensions, construction, and thickness in strict accordance with Underwriters' Laboratories Subject 58, Double Wall construction using flat-flanged heads. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
3. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:
 - a. An influent connection, flanged. An internal influent nozzle at the inlet end of the separator. Nozzle discharge to be located at the furthest diagonal point from the effluent discharge opening.
 - b. An integral sand interceptor compartment containing one (1) manhole, UL approved, complete with extension, cover, gasket, and bolts. A heavy-duty bulkhead shall retain sand, grit, settleable solids or semisolids and prevent them from entering the separation chamber. Bulkhead shall have a transfer pipe.
 - c. A velocity head diffusion baffle at the inlet to:
 - 1) reduce horizontal velocity and flow turbulence.
 - 2) distribute the flow equally over the separator's cross-sectional area.
 - 3) direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
 - 4) completely isolate all inlet turbulence from the separation chamber.
 - d. A sediment chamber to disperse flow and collect oily solids and sediments.
 - e. A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.
 - f. An Oil/Water Separation Chamber containing a removable Corella™ inclined parallel flat/corrugated plate coalescer. The coalescer shall have individual removable plates, sloped towards the sediment chamber. Each coalescing plate shall be flat on the top and corrugated on the bottom. The flat top plate shall resist clogging and clotting with solids. The corrugations of each of the plate bottoms shall be shaped and positioned to enhance collisions between the rising oil droplets and coalesce between them thereby improving separator efficiency. The coalescer shall:
 - 1) effect separation of oil and solids from all strata of the wastewater stream.
 - 2) shorten the vertical distance that an oil globule or solid particle has to rise or sink, respectively, for effective removal. Minimum plate gap to be 3/4".
 - 3) enhance coalescence and agglomeration by causing the smaller globules and particles (those possessing smaller rising/settling rates) to coalesce and collect on the plates thereby forming larger globules and particles that separate rapidly in water.
 - 4) direct the flow paths of the separated oil to the surface of the separator and separated solids to the bottom of the separator.
 - 5) allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids.
 - g. The Oil/Water Separation Chamber shall also contain a sectionalized removable "Petro-Screen"™ polypropylene impingement coalescer designed to intercept oil globules of less



than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.

- h. An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.
- i. An effluent connection, flanged.
- j. Fittings for vent, interface/level sensor, leak detection, waste oil pump-out, sampling, and gauge.
- k. Two (2) manholes, UL approved, complete with extension, cover, gasket, and bolts. One manway shall be placed between the inlet and the parallel flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.
- l. Lifting lugs at balancing points for handling and installation.
- m. Identification plates: Plates shall be affixed in prominent location and be durable and legible throughout equipment life.
- n. HighGuard® Corrosion Protection System consisting of:
 - 1) Isolation Spool Pieces
 - 2) Dielectric Isolation Gaskets and Bushings
 - 3) External surfaces commercial grit blast, coated 75 mils DFT Self-Reinforcing Polyurethane.
- o. Internal surfaces commercial grit blast and coated with 10 mils DFT heavy duty Polyurethane.

D. Accessories

- 1. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi hi oil level (audible and visual) of oil storage in the oil/water separator and an audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) shall be intrinsically safe. Level sensor floats shall be made of stainless steel. The control panel shall contain both level sensor and detection control. The control panel shall be NEMA 4. Power to the control panel shall be as directed by the Owner.
- 2. Separator shall be supplied with Polyester Hold-down straps.
- 3. Separator shall be supplied with prefabricated Concrete Deadman Anchors.
- 4. Separator shall be supplied with cylindrical and/or rectangular steel Grade Level Manways designed to AASHTO H20 requirements.

1.3 EXECUTION

A. Installation

- 1. Installation shall be in strict compliance with manufacturer's instructions and shall comply with all applicable local, state, and federal requirements.

END OF SECTION 33 44 36 00



Task	Specification	Specification Description
33 44 36 00	22 13 19 00	Sanitary Waste Piping Specialties
33 44 36 00	22 11 16 00a	Storm Drainage Piping
33 44 36 00	22 05 76 00	Storm Drainage Piping Specialties



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SECTION 33 46 00 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Perforated-wall pipes and fittings.
 2. Drainage conduits.
 3. Drainage panels.
 4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
 2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
 3. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

- A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cusped, molded-plastic drainage core wrapped in geotextile filter fabric.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Airfield Systems, LLC]**
 - b. **[American Wick Drain Corporation (AWD)]**
 - c. **[JDR Enterprises, Inc]**
 - d. **[MAPEI Corporation]**
 - e. **[TenCate Geosynthetics]**
 - f. **<Insert manufacturer's name>**

2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Airfield Systems, LLC]**
 - b. **[American Wick Drain Corporation (AWD)]**
 - c. **[JDR Enterprises, Inc]**
 - d. **[MAPEI Corporation]**
 - e. **[TenCate Geosynthetics]**
 - f. **<Insert manufacturer's name>**

3. Nominal Size:
 - a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **[30 gpm (114 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 - b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **[45 gpm (170 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.

4. Filter Fabric: PP geotextile.
5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

- B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.
 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Varicore Technologies, Inc.]**
 - b. **<Insert manufacturer's name>**

 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Varicore Technologies, Inc.]**
 - b. **<Insert manufacturer's name>**

 3. Nominal Size:
 - a. 6 Inches (152 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of **[15 gpm (57 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 - b. 12 Inches (305 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of **[30 gpm (114 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 - c. 18 Inches (457 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of **[45 gpm (170 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.

 4. Filter Fabric: Nonwoven, needle-punched geotextile.
 5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.

6. Couplings: HDPE.
- C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Advanced Drainage Systems, Inc]**
 - b. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Advanced Drainage Systems, Inc]**
 - b. **<Insert manufacturer's name>**
 3. Nominal Size:
 - a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **[30 gpm (114 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 - b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **[45 gpm (170 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 4. Filter Fabric: PP geotextile.
 5. Fittings: HDPE with combination **NPS 4 and NPS 6 (DN 100 and DN 150)** outlet connection.
 6. Couplings: Corrugated HDPE band.
- D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. **[Advanced Building Products Inc.]**
 - b. **[Low & Bonar PLC]**
 - c. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Advanced Building Products Inc.]**
 - b. **[Low & Bonar PLC]**
 - c. **<Insert manufacturer's name>**
 3. Nominal Size: **6 inches (150 mm)** high by approximately **0.9 inch (23 mm)** thick.
 - a. Minimum In-Plane Flow: **[2.4 gpm (9.1 L/min.)]<Insert value>** at hydraulic gradient of

[1.0]<Insert value> when tested in accordance with ASTM D4716.

4. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.
- E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Invisible Structures, Inc.]**
 - b. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Invisible Structures, Inc.]**
 - b. **<Insert manufacturer's name>**
 3. Nominal Size:
 - a. 18 Inches (0.5 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of **[82 gpm (310 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 - b. 36 Inches (1 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of **[164 gpm (621 L/min.)]<Insert value>** at hydraulic gradient of **[1.0]<Insert value>** when tested in accordance with ASTM D4716.
 4. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, **[36 to 60 inches (915 to 1525 mm)]<Insert dimensions>** wide with drainage core faced with geotextile filter fabric.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[American Wick Drain Corporation (AWD)]**
 - b. **[Dorken Systems Inc.]**
 - c. **[Eljen Corporation]**
 - d. **[JDR Enterprises, Inc]**
 - e. **[MAPEI Corporation]**
 - f. **[Mar-flex Waterproofing & Building Products]**
 - g. **[Midwest Diversified Technologies Incorporated]**
 - h. **[Sika Greenstreak]**

- i. [TenCate Geosynthetics]
 - j. [Thrace-LINQ, Inc.; Thrace Group]
 - k. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
- a. [American Wick Drain Corporation (AWD)]
 - b. [Dorken Systems Inc.]
 - c. [Eljen Corporation]
 - d. [JDR Enterprises, Inc]
 - e. [MAPEI Corporation]
 - f. [Mar-flex Waterproofing & Building Products]
 - g. [Midwest Diversified Technologies Incorporated]
 - h. [Sika Greenstreak]
 - i. [TenCate Geosynthetics]
 - j. [Thrace-LINQ, Inc.; Thrace Group]
 - k. <Insert manufacturer's name>
3. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
- a. Minimum Compressive Strength: [10,000 lbf/sq. ft. (479 kPa)][15,000 lbf/sq. ft. (718 kPa)][18,000 lbf/sq. ft. (862 kPa)][21,000 lbf/sq. ft. (1005 kPa)]<Insert value> when tested in accordance with ASTM D1621.
 - b. Minimum In-Plane Flow Rate: [2.8 gpm/ft. (35 L/min. per m)][7 gpm/ft. (87 L/min. per m)][15 gpm/ft. (186 L/min. per m)]<Insert value> of unit width at hydraulic gradient of [1.0]<Insert value> and compressive stress of [25 psig (172 kPa)]<Insert value> when tested in accordance with ASTM D4716.
4. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:
- a. Survivability: [Class 1][Class 2][Class 3].
 - b. Apparent Opening Size: [No. 40 (0.425-mm)][No. 60 (0.25-mm)][No. 70 (0.212-mm)] sieve, maximum.
 - c. Permittivity: [0.5][0.2][0.1] per second, minimum.
5. Filter Fabric, Woven: Geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:
- a. Survivability: [Class 1][Class 2][Class 3].
 - b. Apparent Opening Size: [No. 40 (0.425-mm)][No. 60 (0.25-mm)][No. 70 (0.212-mm)][No. 30 (0.6-mm)] sieve, maximum.
 - c. Permittivity: [0.5][0.2][0.1][0.02] per second, minimum.
6. Film Backing: Polymeric film bonded to drainage core surface.
- B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
- 1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the

following]:

- a. **[Advanced Building Products Inc.]**
 - b. **[Low & Bonar PLC]**
 - c. **<Insert manufacturer's name>**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
- a. **[Advanced Building Products Inc.]**
 - b. **[Low & Bonar PLC]**
 - c. **<Insert manufacturer's name>**
3. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately **0.4 inches (10.2 mm)** thick.
- a. Minimum In-Plane Flow Rate: **[2.4 gpm/ft. (30 L/min. per m)]<Insert value>** of unit width at hydraulic gradient of **[1.0]<Insert value>** and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.
4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from **120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m)** when tested in accordance with ASTM D4491.
- C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[JDR Enterprises, Inc]**
 - b. **[Solmax International Inc.]**
 - c. **[Strata Systems, Inc]**
 - d. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[JDR Enterprises, Inc]**
 - b. **[Solmax International Inc.]**
 - c. **[Strata Systems, Inc]**
 - d. **<Insert manufacturer's name>**
 3. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately **0.25 inches (6 mm)** thick.
 - a. Minimum In-Plane Flow Rate: **[2.4 gpm/ft. (30 L/min. per m)][5 gpm/ft. (62 L/min. per m)]<Insert value>** of unit width at hydraulic gradient of **[1.0]<Insert value>** and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.
 4. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates

range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

- D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. **[Invisible Structures, Inc.]**
 - b. **<Insert manufacturer's name>**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 - a. **[Invisible Structures, Inc.]**
 - b. **<Insert manufacturer's name>**
 3. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately **1 inch (25 mm)** thick.
 - a. Minimum In-Plane Flow Rate: **[40 gpm/ft. (500 L/min. per m)]<Insert value>** of unit width at hydraulic gradient of **[1.0]<Insert value>** and normal pressure of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.

2.4 SOIL MATERIALS

- A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

- A. Material: Comply with **[ASTM D226, Type I, asphalt][or][ASTM D227, coal-tar]**-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from **110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m)** when tested in accordance with ASTM D4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
1. Survivability: AASHTO **[M 288 Class 2]<Insert class>**.
 2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

33 - Utilities

- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION OF FOUNDATION DRAINAGE

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than **6 inches (150 mm)** deep and **12 inches (300 mm)** wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with **[adhesive][or][tape]**.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of **[flat-style geotextile filter fabric][waterproofing felt]** over top of drainage course, overlapping edges at least **4 inches (100 mm)**.
- J. Install drainage panels on foundation walls as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
 - 3. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
 - 4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
- K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Final backfill to finish elevations and

slope away from building.

3.4 INSTALLATION OF UNDERSLAB DRAINAGE

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least **6 inches (150 mm)** between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with **[adhesive][or][tape]**.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.
- F. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at inside edge of footing.
 - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
 - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 INSTALLATION OF RETAINING-WALL DRAINAGE

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than **4 inches (100 mm)**.
- C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with **[adhesive][or][tape]**.
- D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- E. Add drainage course to width of at least **6 inches (150 mm)** on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping to width of at least **6 inches (150 mm)** on side away from footing and above top of pipe to within **12 inches (300 mm)** of finish grade.
- G. Place drainage course in layers not exceeding **3 inches (75 mm)** in loose depth; compact each layer

placed and wrap top of drainage course with flat-style geotextile filter fabric.

- H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course, overlapping edges at least **4 inches (100 mm)**.
- I. Install drainage panels on wall as follows:
 1. Coordinate placement with other drainage materials.
 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 3. If weep holes are used instead of drainage pipe, cut **1/2-inch- (13-mm-)** diameter holes on core side at weep-hole locations. Do not cut fabric.
 4. Mark horizontal chalk line on wall at a point **6 inches (150 mm)** less than panel width above footing bottom. Before marking wall, subtract footing width.
 5. Separate **4 inches (100 mm)** of fabric at beginning of roll and cut away **4 inches (100 mm)** of core. Wrap fabric around end of remaining core.
 6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from **2 to 6 inches (50 to 150 mm)** below top of panel, approximately **48 inches (1200 mm)** apart. [**Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.**] Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 7. If another panel is required on same row, cut away **4 inches (100 mm)** of installed panel core and wrap fabric over new panel.
 8. If additional rows of panel are required, overlap lower panel with **4 inches (100 mm)** of fabric.
 9. Cut panel as necessary to keep top **12 inches (300 mm)** below finish grade.
 10. For inside corners, bend panel. For outside corners, cut core to provide **3 inches (75 mm)** for overlap.
- J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.6 INSTALLATION OF LANDSCAPING DRAINAGE

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than **4 inches (100 mm)**.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least **6 inches (150 mm)** between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with [**adhesive**][**or**][**tape**].
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within **12 inches (300 mm)** of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of [**flat-style geotextile filter fabric**][**waterproofing felt**] over top of drainage course,

overlapping edges at least **4 inches (100 mm)**.

- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding **6 inches (150 mm)**. Thoroughly compact each layer. Fill to finish grade.

3.7 INSTALLATION OF PIPING

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions and other requirements indicated.
 1. Foundation Subdrainage: Install piping level and with a minimum cover of [**36 inches (915 mm)**]**<Insert dimension>** unless otherwise indicated.
 2. Underslab Subdrainage: Install piping level.
 3. Plaza Deck Subdrainage: Install piping level.
 4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of [**36 inches (915 mm)**]**<Insert dimension>** unless otherwise indicated.
 5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of [**0.5<Insert value>**] percent and with a minimum cover of [**36 inches (915 mm)**]**<Insert dimension>** unless otherwise indicated.
 6. Lay perforated pipe with perforations down.
 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping in accordance with ASTM D2321.

3.8 CONSTRUCTION OF PIPE JOINTS

- A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.
- B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.
- C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 INSTALLATION OF BACKWATER VALVES

- A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."
- B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
- C. Install horizontal backwater valves in piping[**in manholes or pits**] where indicated.

3.10 INSTALLATION OF CLEANOUTS

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for **[Foundation][Retaining-Wall][and][Landscaping]** Subdrainage:
 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 2. In vehicular-traffic areas, use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, **[18 by 18 by 12 inches (450 by 450 by 300 mm)]<Insert dimensions>** deep. Set top of cleanout flush with grade.
 3. In nonvehicular-traffic areas, use **NPS 4 (DN 100) [cast-iron][PVC]** pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, **[12 by 12 by 4 inches (300 by 300 by 100 mm)]<Insert dimensions>** deep. Set top of cleanout **[1 inch (25 mm)][2 inches (50 mm)]<Insert dimension>** above grade.
 4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."
- C. Cleanouts for Underslab Subdrainage:
 1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 2. Use **NPS 4 (DN 100)** cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

- A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to **[building's]** solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of **[foundation][underslab]** subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
 1. Install PE warning tape or detectable warning tape over ferrous piping.
 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
 2. Remove obstructions, replace damaged components, and repeat test until results are

satisfactory.

- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.14 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 46 00 00



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Task	Specification	Specification Description
33 46 23 00	33 46 00 00	Subdrainage
33 46 53 00	33 11 13 00a	Potable Water Supply Wells
33 46 53 00	33 46 00 00	Subdrainage
33 52 16 13	21 05 00 00	Common Work Results for Fire Suppression
33 52 16 13	22 05 00 00	Common Work Results for Plumbing
33 52 16 13	23 05 00 00	Common Work Results for HVAC
33 52 16 13	23 11 23 00	Facility Natural-Gas Piping
33 52 16 13	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
33 52 16 23	23 11 23 00	Facility Natural-Gas Piping
33 52 16 23	23 11 26 00	Facility Liquefied-Petroleum Gas Piping
33 52 16 26	23 11 23 00	Facility Natural-Gas Piping
33 52 16 26	23 11 26 00	Facility Liquefied-Petroleum Gas Piping



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SECTION 33 71 00 00 - OVERHEAD MEDIUM-VOLTAGE WIRING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conductors, connectors, and splices.
2. Wood poles.
3. Concrete poles.
4. Crossarms.
5. Guys and anchors.
6. Hardware and accessories.
7. Surge arresters.
8. Cutouts, switches, and fuses.
9. Pole-mounted distribution transformers.
10. Primary metering products.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.
1. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
 2. Initial Unloaded Sag: The sag of a conductor before the application of an external load.
- B. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.
- C. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

1.3 COORDINATION

- A. Coordinate with utility supplying electricity to lines specified in this Section, and make **[final connections][arrangements for final connections by utility]**.
- B. Coordinate with those responsible for **[voice][data][video]<Insert services involved>** systems that will have cables supported by poles installed in accordance with this Section.

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1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Conductors, connectors, and splices.
 - 2. Wood poles.
 - 3. Concrete poles.
 - 4. Crossarms.
 - 5. Guys and anchors.
 - 6. Hardware and accessories.
 - 7. Surge arresters.
 - 8. Cutouts, switches, and fuses.
 - 9. Pole-mounted distribution transformers.
 - 10. Primary metering products.
- B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturers' published instructions.
- B. Field Reports:
 - 1. Factory Test Reports:
 - a. Wood poles.
 - b. Concrete poles.
 - c. Crossarms.
 - d. Cutouts, switches, and fuses.
 - e. Pole-mounted distribution transformers.
 - f. Primary metering products.
 - 2. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

- A. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish to Owner extra materials[, **from same production run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. [**Include the following:**]
 - 1. Fuses: [**One**]<Insert number> additional spare fuse(s) or fuse element(s) for each furnished fuse or fuse element.
 - 2. Padlocks: [**One**]<Insert number> for every [**three**]<Insert number> installed, but no fewer than [**three**]<Insert number>.
 - 3. Insulators: [**One**]<Insert number> for every 10 of each type, but no fewer than [**three**]<Insert number> of each type.

- B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to overhead medium-voltage wiring, that are packaged with protective covering for storage on-site and identified with labels describing contents. **Include the following:**
1. **[Two]<Insert number>** sets of special-purpose tools required for maintenance of cutouts, switches, and reclosers, complete with toolbox.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.
- C. Comply with **[IEEE C2][CPUC General Order 95]**, except where stricter requirements are indicated or where local requirements that are stricter apply.
- D. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for **[heavy][medium][light]** line loading unless otherwise indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than **1 inch (25 mm)**.

PART 2 - PRODUCTS

2.1 CONDUCTORS, CONNECTORS, AND SPLICES

- A. Conductor Type AAC: **[Bare][and covered]**, all-aluminum, Alloy 1350-H19, complying with ASTM B230/B230M and ASTM B231/B231M.
- B. Conductor Type AAAC: **[Bare][and covered]**, all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B398/B398M and ASTM B399/B399M.
- C. Conductor Type ACSR: **[Bare][and covered]**, aluminum conductor, steel reinforced, complying with ASTM B232/B232M.
- D. Conductor Type CU: **[Bare][and covered]**, hard-drawn copper, complying with ASTM B1 and ASTM B8.
- E. Conductor Covering: UV resistant, complying with ICEA-S-70-547. **[HDPE][or][XLP]**, **[150 mil (3.81 mm)]<Insert value>** thick.
- F. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.
1. Conductors: **[Aluminum, Alloy 1350, complying with ASTM B230/B230M and ASTM**

- B231/B231M**][Hard-drawn copper, complying with ASTM B1 and ASTM B8]; stranded for 2 AWG and larger.
2. Conductor Insulation: **[XLP, complying with NEMA WC 70/ICEA S-95-658][EPR, complying with NEMA WC 70/ICEA S-95-658]**<Insert insulation>.
 3. Insulation Level: **[100][133]**<Insert number> percent of rated circuit line-to-line voltage.
 4. Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; **18 mil (460 µm)** minimum thickness.
 5. Insulation Shield: Include the following two components:
 - a. Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.
 - b. Metallic Tape Shield: Bare copper, **5 mil (127 µm)** minimum thickness, helically applied with a 15 percent minimum overlap.
 6. Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.
 7. Messenger: **[Copper][Composite copper and copper]**-clad steel.
 8. Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.
- G. Aluminum Secondary-Voltage Line Conductors: **[Aluminum conductor, steel reinforced, complying with ASTM B232/B232M][Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering]**, **[60 mil (1.52 mm)]**<Insert value> thick.
- H. Copper Secondary-Voltage Line Conductors: **[Bare hard-drawn copper, complying with ASTM B1 and ASTM B8][Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering]**, **[60 mil (1.52 mm)]**<Insert value> thick. **[Neutral-supported, secondary service-drop cable.]**
- I. Racked Secondary Conductors, 600 V and Less: **[Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658]**<Insert conductor and insulation combination>.
- J. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:
 1. Conductors and Neutral: **[Copper with copper-clad-steel neutral][Aluminum with bare Alloy 1350 aluminum neutral][Aluminum with ACSR neutral]**.
 2. Insulation: **[XLP, complying with NEMA WC 70/ICEA S-95-658][High-modular-weight, low-density polyethylene][Weather-resistant polyolefin, complying with ICEA S-70-547]**.
- K. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:
 1. Copper to Copper: Copper alloy, complying with UL 486A-486B.
 2. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.
 3. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.
 4. Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.
 5. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.
 6. Splices under Tension: Compression type with strength exceeding the conductors spliced.
 7. Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of

- each splice.
8. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Section 260513 "Medium-Voltage Cables."

2.2 WOOD POLES

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 1. **[Ace Pole Company]**
 2. **[Baxter, J. H. & Co]**
 3. **[Bell Lumber and Pole Company]**
 4. **[Brown Wood Preserving Co., Inc.]**
 5. **[Dayton Superior Corporation]**
 6. **[Koppers Performance Chemicals]**
 7. **[McFarland Cascade]**
 8. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
 1. **[Ace Pole Company]**
 2. **[Baxter, J. H. & Co]**
 3. **[Bell Lumber and Pole Company]**
 4. **[Brown Wood Preserving Co., Inc.]**
 5. **[Dayton Superior Corporation]**
 6. **[Koppers Performance Chemicals]**
 7. **[McFarland Cascade]**
 8. **<Insert manufacturer's name>**
- C. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with **[creosote][pentachlorophenol,][ammoniacal copper arsenate,][ammoniacal copper zinc arsenate][chromated copper arsenate]**.
- D. Wood Species: **[Douglas fir][Lodgepole pine][Western larch][Southern yellow pine]<Insert wood species selected from ATIS O5.1>**.
- E. Pole Marking:
 1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
 2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high, with aluminum nails.
- F. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

2.3 CONCRETE POLES

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:

1. **[Accord Industries]**
 2. **[Bayshore Concrete Products Corporation]**
 3. **[CPI Concrete Products]**
 4. **[StressCrete Group]**
 5. **[Valmont Industries, Inc.]**
 6. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Accord Industries]**
 2. **[Bayshore Concrete Products Corporation]**
 3. **[CPI Concrete Products]**
 4. **[StressCrete Group]**
 5. **[Valmont Industries, Inc.]**
 6. **<Insert manufacturer's name>**
- C. Description: Spun-cast prestressed concrete, complying with requirements of ASTM C1089.
1. Comply with requirements of RUS Bulletin 1724E-216.
- D. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design must be suitable for installation at a location where annual temperature range is between **[minus 4 deg F and plus 100 deg F (minus 20 deg C and plus 38 deg C)]<Insert design temperature range at site location>**. Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.
- E. Shaft: Hollow, for poles at overhead-to-underground connections. Provide metric designator 91 (trade size 3-1/2) minimum cable raceway capacity, with **[conduit elbow][cable entry port]** at base.
- F. Water Absorption: Not more than 3 percent.
- G. Surface: Smooth, hard, nonporous, and resistant to **[soil acids][road salts][frost and freezing damage]**.
- H. Pole Marking:
1. Manufacturer's Mark: Comply with ATIS O5.1; locate **10 ft (3 m)** from the pole butt for poles **50 ft (15 m)** long or less.
 2. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than **2-1/2 inch (65 mm)** high.
- 2.4 CROSSARMS
- A. Description: **[Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade][Galvanized, steel angles]**, and complying with IEEE C2 for required climbing space and wire clearances.
- B. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch (6 mm)** thick by **1-1/4 inch (30 mm)** wide, minimum, with length to suit crossarm dimensions.

2.5 GUYS AND ANCHORS

- A. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.
1. Cable: Seven strands. **[Zinc-coated steel, complying with ASTM A475][Aluminum-clad steel, complying with ASTM B416][Copper-clad steel, complying with ASTM B228]**. Breaking strength must be not less than **[10,000 lb (45 kN)]<Insert value>**.
 2. Cable Termination:
 - a. Thimble eye.
 - b. Hooks and guy strain plates, complying with IEEE C135.1.
 - c. Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.
- B. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.
1. Power-installed screw-type anchors.
 - a. **15 inch (380 mm)** screw; with rod **8 ft (2.4 m)** long by **1-1/2 inch (38 mm)** in diameter. Rated at **10,000 lb (45 kN)** when installed.
 - b. Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.
 2. **<Insert anchor size or type>**.
- C. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Article.
- D. Guy Markers: Round, of vinyl or PVC material, **[white][yellow]** color, **8 ft (2.4 m)** long. Shatter resistant at temperatures below **0 deg F (minus 18 deg C)**.

2.6 HARDWARE AND ACCESSORIES

- A. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.
1. Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings **[with the exception that base material must be malleable iron or ductile iron, and finish must be hot-dip galvanized]**.
- B. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with **[one][two]**-bolt attachment to pole.
- C. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12 gage struts designed to support **[two][three][four]** spool insulators for attachment of secondary drop conductors. Spool spacing of **[4 inch (100 mm)][8 inch (200 mm)][12 inch (300 mm)]**.
- D. Pole Riser Shields: Galvanized steel with **[boot][backplate][vent]**.
- E. Padlocks: ASTM F883.
1. Class: **[PO1][PO2]**.
 2. Grade: **[1][2][3][3][5][6]**.

3. Option: [A][B][C][D][E][F][G].

F. Insulators: Units rated 6 kV and above must be free from radio interference.

1. Porcelain insulators must be wet-process type, complying with the following:

- a. Pin: ANSI C29.5.
- b. Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
- c. Suspension: ANSI C29.2.
- d. Guy Strain: ANSI C29.4.
- e. Secondary Spool: ANSI C29.3, Class 53-2.

2. Polymer-composite, fiberglass-reinforced insulators must comply with the following:

- a. Line Post: CEA LWIWG-02.
- b. Dead End/Suspension: CEA LWIWG-01.
- c. Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.

G. Grounding Materials: Comply with Section 260526 "Grounding and Bonding for Electrical Systems," using materials listed by RUS for the intended purpose without restriction.

1. Conductors: 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B8 unless otherwise indicated.
2. Ground Conductor Protectors: PVC or half-round wood molding, [**fir, pressure treated in accordance with AWP A C25**][cypress][cedar].

2.7 SURGE ARRESTERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. [ABB, Electrification Business]
2. [Eaton]
3. [Hitachi Energy USA Inc.; business of Hitachi, Ltd.]
4. [Hubbell Utility Solutions; Hubbell Incorporated]
5. [MacLean Power Systems]
6. <Insert manufacturer's name>

B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. [ABB, Electrification Business]
2. [Eaton]
3. [Hitachi Energy USA Inc.; business of Hitachi, Ltd.]
4. [Hubbell Utility Solutions; Hubbell Incorporated]
5. [MacLean Power Systems]
6. <Insert manufacturer's name>

C. Distribution-Class Surge Arresters: [**Porcelain**][Polymer]-enclosed, gapless, metal-oxide type[**with automatic-indicating type, ground-lead disconnection feature**], complying with IEEE C62.11 and NEMA LA 1.

- D. Intermediate-Class Surge Arresters: **[Porcelain][Polymer]**-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.
1. Voltage Rating: **[3][6][9][10][12][15][27][30][36]** kV[, **at the altitude of Project,**] unless otherwise indicated.

2.8 CUTOUTS, SWITCHES, AND FUSES

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. **[Eaton]**
 2. **[Hitachi Energy USA Inc.; business of Hitachi, Ltd.]**
 3. **[Hubbell Utility Solutions; Hubbell Incorporated]**
 4. **[Joslyn Hi-Voltage]**
 5. **[MacLean Power Systems]**
 6. **[S&C Electric Company]**
 7. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Eaton]**
 2. **[Hitachi Energy USA Inc.; business of Hitachi, Ltd.]**
 3. **[Hubbell Utility Solutions; Hubbell Incorporated]**
 4. **[Joslyn Hi-Voltage]**
 5. **[MacLean Power Systems]**
 6. **[S&C Electric Company]**
 7. **<Insert manufacturer's name>**
- C. Description: Medium-voltage disconnect, protective[, **and bypass**] units must be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are **[45][60][75][95][150][200]** kV.
1. Momentary Current Rating of Switching Devices: **[20][40]<Insert value>** kA, asymmetrical at nominal system operating voltage.
 2. Fuse Characteristics: Time-current characteristics for each set of fuses selected in accordance with published recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves in accordance with IEEE 242 that illustrate optimum coordination of devices in this Project.
 3. Interrupting Rating of Fuses: **<Insert value>** symmetrical A at nominal system operating voltage.
- D. Fuse Cutouts: **[Open][enclosed]** type, rated **[100][200]** A, continuous, complying with ANSI C37.42.
1. Fuses: Enclosed link, **[Type K][Type T]**, complying with ANSI C37.42.
 2. Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.
 3. Switching Application: Include switch link instead of fuse.
 4. Switch Current Interrupting Rating: **[Transformer magnetizing current]<Insert value>**.
- E. Fused Switches: Single-pole, manual units.
1. Switch Rating: **[400][600]** A(rms) continuous and load-current interrupting.
 2. Fuses: Dropout-type power fuses.

- F. Nonfused Switches: Single-pole, manual units, rated [100][200][400][600] A(rms) continuous.
- G. Group-Operated, Load-Interrupter Switches: **[Fused][Nonfused]**, three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.
1. High-pressure contact type, complying with ANSI C37.32.
 2. Factory assembled to suit specific configuration and mounting conditions for this Project.
 3. Operating Handle: Padlock equipped.
 4. Current Interrupting Rating: Equal to continuous current rating of switch.
 5. Fuses: Nondropout power type.
- H. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.
1. Comply with ANSI C37.32.
 2. Factory assembled to suit specific configuration and mounting conditions for this Project.
 3. Operating Handle: Padlock equipped.
 4. Suitable for field conversion to load-interrupter switch by adding interrupter modules.

2.9 POLE-MOUNTED DISTRIBUTION TRANSFORMERS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. **[Eaton]**
 2. **[GE Power; General Electric Company]**
 3. **[Hitachi Energy USA Inc.; business of Hitachi, Ltd.]**
 4. **[Howard Industries, Inc]**
 5. **[Kuhlman Electric Corporation]**
 6. **[Pauwels Transformers]**
 7. **[Pioneer Transformers Ltd]**
 8. **[Prolec GE; A Xignux and General Electric Company Joint Venture]**
 9. **<Insert manufacturer's name>**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>** or comparable product by one of the following:
1. **[Eaton]**
 2. **[GE Power; General Electric Company]**
 3. **[Hitachi Energy USA Inc.; business of Hitachi, Ltd.]**
 4. **[Howard Industries, Inc]**
 5. **[Kuhlman Electric Corporation]**
 6. **[Pauwels Transformers]**
 7. **[Pioneer Transformers Ltd]**
 8. **[Prolec GE; A Xignux and General Electric Company Joint Venture]**
 9. **<Insert manufacturer's name>**
- C. Description: Single-phase, two-winding, **[single][two]**-bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested in accordance with IEEE C 57.12.90[.][**and with the following additional requirements:**]
1. Cooling Class: OA.

2. Temperature Rise: 65 deg C.
3. Insulating Liquid:
 - a. Mineral oil, ASTM D3487, Type II.
 - b. High molecular weight, mineral oil based, and UL listed as less-flammable type.
 - c. Biodegradable insulating and cooling liquid, UL listed as less flammable type.
 - d. Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.

D. BIL: [95][75][60] kV.

E. Primary Voltage: <Insert voltage>.

F. Taps: [Two, 2.5 percent above and below][Four, 2.5 percent below], high-voltage and full-load rated. [Tap changer must have an external operating handle.]

G. Mounting Brackets: [Single][Double], integral; suitable for pole mounting, individually or in cluster, or on crossarm.

H. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.

I. Bushings: Creepage distance must exceed nominal value standard for unit rating by at least 75 percent.

J. Hardware: Stainless steel.

K. Tank and Cover: Stainless steel, complying with ASTM A167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.

L. Show transformer kiloampere capacity using 2-1/2 inch (65 mm) numerals placed near the low-voltage bushings.

2.10 PRIMARY METERING PRODUCTS

A. Primary Metering Equipment:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [Eaton]
 - b. [GE Power; General Electric Company]
 - c. [Hitachi Energy USA Inc.; business of Hitachi, Ltd.]
 - d. [Landis+Gyr Inc.]
 - e. [Schweitzer Engineering Laboratories, Inc.]
 - f. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [Eaton]

- b. [GE Power; General Electric Company]
- c. [Hitachi Energy USA Inc.; business of Hitachi, Ltd.]
- d. [Landis+Gyr Inc.]
- e. [Schweitzer Engineering Laboratories, Inc.]
- f. <Insert manufacturer's name>

B. Metering Transformers:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. [GE Power; General Electric Company]
 - b. [Hitachi Energy USA Inc.; business of Hitachi, Ltd.]
 - c. [Kuhlman Electric Corporation]
 - d. [Prolec GE; A Xignux and General Electric Company Joint Venture]
 - e. <Insert manufacturer's name>
2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. [GE Power; General Electric Company]
 - b. [Hitachi Energy USA Inc.; business of Hitachi, Ltd.]
 - c. [Kuhlman Electric Corporation]
 - d. [Prolec GE; A Xignux and General Electric Company Joint Venture]
 - e. <Insert manufacturer's name>

C. Description: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:

1. BIL: [45][60][75][95][150][200] kV.
2. Secondary connection box arranged for conduit connection.
3. Potential-Transformer Voltage Rating: [2.4][4.16][7.2][12.0][12.47]<Insert value> kV to 120 V(ac), 60 Hz.
4. Potential-Transformer Accuracy Class: Minimum 0.3 at [75]<Insert value> VA burden.
5. Voltage Rating: [2.4][4.16][7.2][12.0][12.47]<Insert value> kV.
6. Current Rating: <Insert value> to 5 A.
7. Accuracy Class: Minimum 0.2 at [50]<Insert value> VA burden.

D. Watt-Hour Meter: Outdoor solid-state unit, [with demand register,][arranged for pulse initiation,] complying with ANSI C12.10, and including the following ratings and features:

1. Form: [8S][9S].
2. Element: [2][2-1/2][3].
3. Voltage: 120 V.
4. Current: 2-1/2 A.
5. Frequency: 60 Hz.
6. Kilowatt-Hour Register: Five-digit type.
7. Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.
8. Demand-Register Interval: [15][30] minutes.
9. Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.
10. Meter Test Block: Matched to meter, and furnished and equipped with open knife switches

- designed to isolate each metering component for test.
11. Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:
 - a. Hinged Door: Arranged for padlocking in closed position.
 - b. Size: Adequate to house meter and other equipment indicated, but not less than **20-by-30-by-11 inch (510-by-760-by-280 mm)** deep.

2.11 SOURCE QUALITY CONTROL

- A. Product Data: Prepare and submit catalog cuts, brochures, **[diagrams,][schedules,]** and performance data illustrating size, physical appearance, and other characteristics of product.
 1. For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 2. Material Certificates: For the following items, from manufacturers:
 - a. Wood poles.
 - b. Concrete poles.
 - c. Wood crossarms.
 3. Listing Documentation: Indicate that products comply with requirements specified in "Quality Assurance" Article.
 4. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.
- B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. Factory Tests:
 1. Testing Administrant: **[Owner will engage][Engage]** qualified pole and crossarm inspection agency to evaluate poles and crossarms.
 2. Factory Tests and Inspections:
 - a. Inspect poles and crossarms, by, or under supervision of, qualified pole and crossarm inspection agency recognized by authorities having jurisdiction, in accordance with referenced standards before delivering to site. Affix label with name and date of **[manufacturer's][qualified pole and crossarm inspection agency's]** certification of system compliance.
 - 1) RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.
 - b. Conduct routine tests of **[transformers][medium-voltage switches][and][metering equipment]** by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with referenced standards. Affix label with name and date of **[manufacturer's][qualified electrical testing laboratory's]** certification of system compliance.
 3. Nonconforming Work: Units that do not pass tests and inspections will be considered defective.
 4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION**3.1 RIGHT-OF-WAY CLEARANCE AND TREE TRIMMING**

- A. Clear right of way in accordance with Section 015639 "Temporary Tree and Plant Protection" and Section 311000 "Site Clearing."
- B. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of **15 ft (4.5 m)** on both sides horizontally and below medium-voltage conductors and **60 inch (1500 mm)** on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install underground power and metering circuits and those circuits indicated to be in raceways in accordance with Section 260543 "Underground Ducts and Raceways for Electrical Systems" and Section 260513 "Medium-Voltage Cables," and make splices and terminations for those circuits in accordance with the applicable Sections.
- B. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Apply warning signs and equipment labels in accordance with Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF MEDIUM-VOLTAGE LINE CONDUCTORS

- A. Selection: Install bare conductors unless otherwise indicated.
- B. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.
 - 1. String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
 - 2. Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
- C. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.
 - 1. Splice Location: Do not install within **10 ft (3 m)** of a support.
 - 2. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
 - 3. Splices and Terminations of Covered Conductors: Comply with manufacturer's published

- instructions.
4. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's published instructions.
- D. Armor Rod: Install to protect conductors if line conductors are supported by insulators.
- E. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.
- F. Support line conductors and taps as follows:
1. Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.
 2. Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.
 3. Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.

3.4 INSTALLATION OF POLES AND CROSSARMS

- A. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
- B. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:
1. On level ground, set poles so tops of consecutive poles vary not more than **60 inch (1500 mm)** in elevation.
 2. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.
- C. Set poles in accordance with the following:
1. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
 2. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:
 - a. Poles up to 35 ft (10.6 m) Long: **24 inch (600 mm)**.
 - b. Poles 36 to 60 ft (11 to 18.3 m) Long: **30 inch (760 mm)**.
 - c. Poles 61 to 75 ft (18.6 to 22.9 m) Long: **36 inch (900 mm)**.
 3. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
 4. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch (25 mm)** minimum, **2 inch (51 mm)** maximum, (after conductors are installed at required tension) for each **10 ft (3 m)** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
 5. Backfill holes in **6 inch (150 mm)** maximum lifts, and thoroughly tamp each layer before starting the next.
 6. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
 7. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead

ends; place gains on last two poles on side facing terminal or dead end.

8. Poles Set in Concrete Paved Areas: Install poles with minimum of **6 inch (150 mm)** wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with **[pea gravel]<Insert appropriate material>** to a level **1 inch (25 mm)** below top of concrete slab.

D. Field treat factory-treated poles and crossarms as follows:

1. Poles Treated More Than One Year before Installation: Treat portion from **24 inch (600 mm)** above ground line to butt.
2. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
3. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
4. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.

E. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

1. Buck Arms: Install at corners and junction poles unless otherwise indicated.
2. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
3. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
4. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

F. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.5 INSTALLATION OF GUYS AND ANCHORS

A. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch (900 mm)** or more. Comply with IEEE C2.

1. Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
2. At the anchor end, attach guy strand assembly with preformed grips.

B. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.

C. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.

D. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch (150 to 230 mm)** from ground.

E. Install strain insulators to provide a minimum of **12 inch (300 mm)** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

F. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

3.6 INSTALLATION OF HARDWARE AND ACCESSORIES

- A. Install washers against wood and under nuts, including eyenuts and locknuts.
- B. Install nuts and locknuts wrench-tight on threaded connections.
- C. Medium-Voltage Line Insulators: Install **[pin][or][post]** type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.
 - 1. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
 - 2. Install horizontal line-post insulators for armless construction.
- D. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.
- E. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.
- F. Guy Strain Type Insulators: Install **[porcelain][fiberglass-reinforced]** units.

3.7 INSTALLATION OF SURGE ARRESTERS

- A. Install surge arresters to protect **[distribution][metering equipment][reclosers]**, **[group-operated, load-interrupter switches]**, **[aerial-to-underground transitions]**, and other items indicated.
 - 1. Units Installed 6000 ft (1800 m) or More above Sea Level: Use arresters specifically rated for this service.

3.8 INSTALLATION OF CUTOUTS, SWITCHES, AND FUSES

- A. Hook-Stick-Operated Switches: Install to maximize safe operating access.
- B. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle **42 inch (1067 mm)** above finished grade.
 - 1. Locking Provisions: Install padlock at hasp.

3.9 INSTALLATION OF PRIMARY METERING PRODUCTS

- A. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of **[galvanized rigid steel][intermediate metal][PVC]** conduit. Install to prevent collection of moisture in raceway and cabinet system.
- B. Meter Cabinet: Mount on pole, **72 inch (1825 mm)** above finished grade to center of cabinet.
 - 1. Make conduit connections with raintight hubs.
 - 2. Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.
 - 3. Install meter and meter test block within cabinet.
 - 4. Install identical phase sequence, and color-code for both potential and current leads.
 - 5. Identify leads using designations consistent with marking on transformer terminals.

3.10 GROUNDING

- A. Comply with IEEE C2 grounding requirements.
- B. Ground Rods: **[Copper-clad][Zinc-coated][Stainless] steel[, sectional type]; [3/4 inch-by-10 ft (19 mm-by-3 m)][5/8 inch-by-8 ft (16 mm-by-2.4 m)]** in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install **[two]<Insert number>** parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω .
 2. Drive ground rods until tops are **12 inch (300 mm)** below finished grade in undisturbed earth.
- C. Grounding Conductors:
1. 4 AWG minimum, soft-drawn copper.
 2. Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communications service and transformer spaces.
 3. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
 4. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
 5. Transformer Enclosures and Secondary Neutrals: Interconnect and connect to grounding conductor.

3.11 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
1. **<Insert requirements>**.
- B. Field tests and inspections must be witnessed by **[Architect][Tenant][authorities having jurisdiction]<Insert names or titles of witnesses>**.
- C. Tests and Inspections:
1. Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.
 2. Guy Anchors: Test one of each type and capacity installed[, **plus additional units specifically indicated for testing**]. Apply rated pull-out force in the same pull direction applied by the guy at the test location.
 - a. Acceptable Test Results: Denoted by movement of less than **3/8 inch (10 mm)** by the holding component of the anchor in the earth or other medium in which it is installed.
 - b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.
 3. Ground Resistance: Comply with Section 260526 "Grounding and Bonding for Electrical Systems." Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.
 - a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
 - b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground,

tested individually, exceeds 25 Ω , add a ground electrode not less than 10 ft (3 m) away and interconnect with 2 AWG, minimum, bare conductor buried at least 12 inch (300 mm) below furnished grade.

4. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and published recommendations.
5. Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply DC voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
6. Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 M Ω .
7. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 M Ω and more.
8. New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.
 - a. Verify proper grounding of metallic equipment parts.
 - b. Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.
 - c. Switches:
 - 1) Manually operate each cutout and switch at least three times, to verify proper operation.
 - 2) Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.
 - d. Group-Operated, Load-Interrupter Switches and Air-Break Switches:
 - 1) Perform mechanical operator tests in accordance with manufacturer's published instructions.
 - 2) Test resistance to ground of parts to be energized. Acceptable value is 200 000 M Ω .
 - 3) Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.
 - e. Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.
9. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
 - a. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.
 - b. Perform preenergizing inspections and tests recommended by manufacturer.
 - c. Verify proper equipment grounding.
 - d. Verify that clearances of terminals and connecting wires comply with IEEE C2.
10. Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.



- a. Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.
- b. Verify that required grounding and shorting connections provide good contact.
- c. Verify that clearances of terminals and connecting wires comply with IEEE C2.
- d. Perform electrical tests in accordance with manufacturer's published instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.

11. Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

- a. Verify tightness of electrical connections.
- b. Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers in accordance with manufacturer's published instructions.

D. Nonconforming Work:

- 1. Units will be considered defective if they do not pass tests and inspections.
- 2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [support][supervise] field tests and inspections.

- 1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.12 ADJUSTING

A. Pole-Mounted Distribution Transformers: Set voltage taps as directed by Architect.

3.13 CLEANING

A. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.

- 1. Clean enclosures internally, on completion of installation, in accordance with manufacturer's published instructions.

END OF SECTION 33 71 00 00



Task	Specification	Specification Description
33 71 19 00	33 71 00 00	Overhead Medium-Voltage Wiring
33 71 19 13	33 71 00 00	Overhead Medium-Voltage Wiring
33 71 19 23	26 05 19 00	Low-Voltage Electrical Power Conductors and Cables
33 71 19 23	26 05 43 00	Underground Ducts and Utility Structures
33 71 19 23	27 11 00 00	Communications Equipment Room Fittings
33 71 19 23	27 13 13 00	Communications Copper Backbone Cabling
33 71 19 23	27 15 33 00	Communications Coaxial Horizontal Cabling
33 71 19 23	33 71 00 00	Overhead Medium-Voltage Wiring



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SECTION 34 01 23 33 - WELDED TRACK RAILS

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of continuous welded rail, and continuous welded rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control: Construction Equipment: Subject to inspection and acceptance by the Owner. Track equipment shall satisfy clearance requirements of Exhibit G of this Section, and shall have tapered wheels and a wheel gauge of 56-11/16 inches.

1. Rail tester: Automation Industries, Inc., Sperry Div.'s SRS Car 802, or accepted equivalent.
2. Rail grinder: Rail-mounted, self-propelled, high-speed type capable of removing at least 0.001 inch of metal per pass after track has been installed; Fairmont Railway Motors, A Division of Harsco Corp.'s RGC-24-A-1, or accepted equivalent. Diameter of grinding wheel shall be not smaller than 10 inches. Downward pressure of grinder shall be controllable to the extent that more metal may be removed per pass at high spots and that low spots shorter than five inches may be bridged.
3. Track geometry car: Capable of measuring deviation from track construction tolerances indicated in Exhibit H of this Section, and of recording those deviations; System Sciences Inc.'s EM-25 Hy-Rail Geometry Car, or accepted equivalent.

1.2 PRODUCTS

- A. Tags: Brass or anodized aluminum; 1-1/4 inches wide by two inches long by 0.050 inch thick; and stamped with numerals 3/4 inch high, except that numerals for fractions shall be 3/8 inch high.
- B. Adhesive For Bonding Tags To Concrete: Either Tru Loc United of Dublin's TRU LOC Epoxy No. 135, or DevCon Corp.'s 2-Ton Clear Epoxy Stock No. 14310, or accepted equivalent.
- C. Paint: Yellow alkyd primer; FS TT-P-645.
- D. Welding Material: Full penetration, complete fusion thermit type.

1.3 EXECUTION

A. Examination

1. Inspect CWR before loading CWR onto rail train; accept only undamaged CWR. Replace in-kind CWR which becomes damaged and stolen after Contractor has accepted CWR.
2. Examine ties before laying CWR; ensure that ties are free from ballast and that inserts contain no debris.

B. Laying CWR

1. Lower CWR onto tract, and with gauge side of CWR facing centerline of track. If CWR will be cut, paint a six- inch stripe on gauge side of each sawn rail. After CWR has been placed, arrange ends of opposite CWR to be more than ten feet from the ends of the placed CWR when measured along centerline of track, and arrange field weld to be more than 10 feet from weld in opposite CWR, more than 14 feet from shop welds in same CWR, and more than 14 feet from center of bonded joints. Align gauge side of CWR in tangent track to be equidistant from track centerline, and align gauge side of low CWR in curved track to be 28-1/4 inches from track

centerline. Do not strike rail with metal objects. If rail ends will be welded, align rail ends with a rail alignment beam. Record weight, mill-brand, rolling year, and heat number of end rails in CWR; date and time of placing CWR; length of CWR; air and rail temperature; stationing of both ends of CWR; and weather conditions. Place thermometer on shaded side of CWR base next to web and allow thermometer to remain there until no change in temperature is detected, but for not less than five minutes, then read and record temperature and remove thermometer.

a. If CWR will be bolted to abutting CWR, saw-cut end of CWR in which pulling hole has been drilled; sawcut one inch from hole away from end of CWR and perpendicular to CWR, then discard portion containing hole. Cut off bent rail ends of CWR square and clean with either rail saw or abrasive cutting disc. Bevel end of CWR in accordance with AREA Standard Plan Number 1005-40, and drill bolt holes perpendicular to web of CWR using template as drilling guide. If rail is not heat-treated carbon type, harden and chamfer end of CWR by methods and with results specified in AREA MRE, Chapter 4, Part 2, Supplementary Requirement S1.

b. If CWR will be welded to abutting CWR, remove burrs and lipped metal from end of CWR, then remove loose oxide, scale, and foreign material from within six inches of end of CWR.

2. Gapping CWR

a. At Joints to be welded: Align CWR with abutting CWR, and adjust end of CWR to be thickness-of-field-weld away from abutting CWR.

b. At Joints to be bonded: Calculate gap width by the formula:

$$G = 0.000078L(t-T) + Q$$

where G = gap, in inches.

L = length of CWR, in feet.

t = 60 degrees F if rail will be anchored in subway;

75 degrees F if rail will be anchored in Station undercover;

80 degrees F if rail will be anchored elsewhere.

T = temperature of rail when being anchored.

Q = 0.125 inch if joint will be noninsulated; end post thickness otherwise.

c. Align CWR with abutting CWR, adjust end of CWR to be width-of-gap away from abutting CWR, and, if gap will be wider than 1- 1/2 inches, insert a dutchman 1/2 inch shorter than width of gap. Remove dutchman before anchoring rail and if it is anticipated that rail will become warmer before being bonded.

C. Temporarily Anchoring CWR: If CWR is either on tangent or on curves the radius of which is larger than 1,900 feet, anchor CWR, by either rail clips or track spikes, at track gauge on every fifth rail fastener or tie plate. CWR on curves with radius of less than 1,900 feet, anchor CWR, by either rail clips or track spikes, at track gauge on every third rail fastener or tie plate. Anchor CWR to tie plates with track spikes and insulators at grade crossing and with rail clips and insulators on concrete ties. Anchor CWR to rail fasteners with bolted rail clips at hi-rail access.

1. Drive track spikes adjacent to and along both sides of each CWR base with insulator placed between rail and track spike.

2. Anchor CWR to concrete ties with rail insulators placed on rail base and driving rail clips in tie embedded rail shoulders.

3. Anchor CWR to rail fasteners at hi-rail access with rail clips inserted in rail fastener, and torque clip bolt to 250 pounds.

D. Joining CWR: Remove rail clips within 300 feet of joint to be welded and of joints to be bonded. Weld ends of CWR indicated to be welded. Bond ends of CWR indicated to be bonded; if a dutchman has been inserted at joints to be bonded, remove dutchman.

1. Welding

a. Weld in accordance with Specifications for Fabrication of Continuous Welded Rail in Chapter 4, Part 2 of AREA MBE except that running surface shall have a crown ensuring that top of weld is smooth and flat after weld has cooled and excess weld has been ground off. Welding will be acceptable if it satisfies the requirements of Du-Wel Steel Products Co.'s Recommended Procedures for Boutet Process Quick Preheat Thermit Rail Welding.

- b. Finish weld by methods and with tools not causing weld to become hotter than 1077 degrees F. Remove surplus metal from hot rail head weld with a mechanical or hydraulic rail- shearing device. Trim and finish welds with a profile grinder. When measured with a three-foot metal straightedge, portions of rail shall be within the following tolerances:
 - 1) Top and sides of rail head: Within plus 0.03 inch and minus 0.00 inch of parent rail section.
 - 2) Rail base: Within plus 0.01 inch and minus 0.00 inch of the parent rail section, only for welds which are within three inches of edge of rail fasteners and tie plates.
 - 3) Rail web and remainder of rail weld: Within plus 0.125 inch and minus 0.00 inch of the parent rail section.
 - c. Reinstall rail clip on fastener from which removed.
 - d. Remove oxide, scale, and foreign material from web of rail on both sides of CWR and for three inches on one side of field weld. Paint a two-inch wide stripe one inch from weld the full height of the web on gauge side of CWR and along the base of CWR.
2. Bonding: TRACK APPURTENANCES.
- E. Measuring Rail Alignment At Shop Welds: Using a steel straightedge and a tapered gauge specified, measure the horizontal and vertical alignment of each string of CWR on both sides of rail head at each shop weld and at points 5/8 inch below top of rail and on top of rail along its centerline. Record measurements at center of welds and at points six inches and 18 inches each way of the weld to the nearest 0.001 inch.
- F. Grinding And Removing Shop Welds: If the Owner judges that a shop weld in CWR is misaligned, the Owner will order weld be ground or removed. If the Owner orders weld be ground, grind weld and adjacent rail to the extent determined by the Owner, but not more than 1/16 inch thickness. If the Owner orders weld be removed, saw-cut rails 1/2 inch from each side of weld, field-weld ends of CWR, and finish welds in accordance with directions by the Owner.
- G. Permanently Anchoring CWR: Anchor CWR on aerial structures, in tie- and-ballasted track, in subways, and through station platforms only if temperature of CWR is as specified.
 1. Mechanically vibrate CWR and loosen rail clips that have been temporarily fastened at every third or fifth tie or rail fastener and in increments of 500 feet. Set CWR to horizontal and vertical alignments within construction tolerances as directed by the Owner.
 2. Continue vibrating CWR as remainder of rail clips are being permanently installed.
 3. Record rail-anchoring data include type of adjustment by which zero stress in CWR was achieved and end movement of CWR at 30- minute intervals or at 200-foot lengths of track when rail is being anchored.
 4. After CWR has been finally surfaced, rail fasteners shall be laterally adjustable not less than 1/4 inch in both directions.
- H. Testing
 1. CWR and shop welds: Ultrasonically test CWR and shop welds with a track inspection car. Identify each test with the Project number and title, date, testing agent, and location by station.
 2. Field welds: Test field welds ultrasonically by the multiprobe pulse-echo technique, and with the Kroutkrame USK-7 tester or accepted equivalent.
- I. Adjusting: If shop weld is determined to be defective by ultrasonic testing, remove weld by saw cutting CWR not less than one inch on both sides of the weld, making another cut in CWR not less than 20 feet from weld, and installing new section of rail with two field welds; or cutting out a section of CWR equal distance each way from shop weld.
 1. If weld and section of CWR is on tangent track, furnish and install a rail not shorter than 14 feet and field-weld that rail to installed CWR.
 2. If weld and section of CWR is on curved track, furnish and install a rail not shorter than 39 feet and field-weld that rail to installed CWR.

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- J. Installing Tags: Install one foot inside superelevated CWR, and orient tag to be read in ascending order from tangent to spiral to spiral to curve.
 - 1. If concrete surfaces of tag locations are rough, grind surfaces smooth. Remove laitance, dust, and clean concrete surface.
 - 2. Apply epoxy to back of tags, and tags on track concrete surfaces and on concrete ties at beginning and ending points of curved track and at elevation increments of 1/4 inch within spirals and curves.
- K. Grinding CWR: Grind top of rail head not fewer than three times and in a continuous operation, all within three days after starting to grind. Remove not less than 95 percent of rust and mill scale.
- L. Adjusting Track: Eliminate track deviations, as disclosed by the Owner's analysis of as-built survey data and final track inspection, exceeding specified tolerances.
- M. Clean-Up: Remove debris, excess rail, spilled concrete, and clusters of grinding particles. Cut exposed tie wires and stirrups flush with concrete surfaces, remove cuttings.

END OF SECTION 34 01 23 33

SECTION 34 01 23 33a - THERMITE WELDED TRACK RAIL

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of welding crane and railroad rail -thermite method. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit the following.

1. Samples
 - a. Operator qualification welds
 - b. Procedure qualification welds
2. Test Reports
 - a. Ultrasonic tests
 - b. Hardness tests
3. Certificates
 - a. Rails
 - b. Welder's qualification
 - c. Welding procedure
 - d. Cold weather welding procedures
 - e. Wet weather welding procedures
 - f. Rail correction method
 - g. Rail preparation
4. Manufacturer's Instructions: Thermite kit
5. Closeout Submittals: Submit welded joint records as required by paragraph entitled "Joint Records."

C. Quality Assurance: Use only qualified procedures and personnel. Procedures and personnel previously qualified in accordance with this specification shall not require requalification, provided qualifications have not lapsed and qualification records are available.

1. Operator Qualification: The Contractor shall notify the Owner in writing one week prior to making qualification welds. Operators shall qualify by welding one acceptable rail joint in accordance with a qualified procedure. This qualification may be accomplished either prior to production welding or on the first joints to be welded at the work site. If welding operator qualification is conducted at the work site, perform no further welding until the qualification weldments have been accepted by visual inspection and ultrasonic tests. Written approval of the acceptability of the welded joint shall be obtained from the Owner prior to continuing with welding. Welding operator's qualification shall be effective from the test date and will remain in effect for a period of one year.
2. Acceptable Welds: Shall be those welds that meet the visual inspection and ultrasonic test requirements of MIL-STD-1699. Welds selected for testing for Brinell Hardness shall meet the requirements of ASTM E 10 and paragraph entitled "Hardness Test."
3. Procedure Qualification
 - a. Written Procedure: Prepare for the welding process to be used. The procedure shall include the information specified in paragraph entitled "Submittals," as well as any particulars of the process deemed pertinent to the successful completion of the welds.
 - b. Manufacturer's Procedure: No separate qualification is necessary for various rail weights, although in order to be qualified for a specific rail weight or cross section, the procedure shall include fit-up requirements and other features unique to the rail weight or cross section of the rails to be welded.
 - c. Welding Procedure Qualification

- 1) Provide welding procedure qualification records acceptable to the Owner as proof of previous qualification under this specification. The records shall include the information specified in paragraph entitled "Submittals," as well as any particulars of the process deemed pertinent to the successful completion of the welds.
 - 2) Welding procedure not previously qualified under this specification may be qualified by providing four consecutive acceptable welded rail joints. An acceptable weld is defined as a weld which has been visually inspected and ultrasonically tested and has been found acceptable in accordance with MIL-STD-1699 and ASTM E 10. This qualification may be accomplished either by shop fabrication of the joints or on the first four joints welded at the work site. If procedure qualification is accomplished at the work site, perform no further welding until the qualification weldments have been accepted by visual inspection and ultrasonic tests. Obtain written approval of the acceptability of the four welded joints from the Owner prior to continuing with welding.
 - 3) Ambient temperature: Welding procedure shall be considered qualified for use at an ambient temperature of 50 degrees F and above regardless of ambient temperature during welding of qualification assemblies. No welding shall be conducted below 50 degrees F without a specifically qualified procedure. Procedures qualified for use at ambient temperatures less than 50 degrees F shall be qualified by welding test assemblies in accordance with the procedure qualification requirements of this specification at the desired minimum ambient temperature plus or minus 5 degrees F. Procedures thus qualified shall be considered acceptable for use at the minimum qualified ambient temperature and above.
 - 4) Wet weather welding: Perform welding only during dry weather. No welding will normally be permitted on wet, showery and inclement days. However, if means are provided to protect the work and work area, welding may be performed during other than dry weather, if approved by the Owner. Welding in confined spaces shall comply with AWS D1.1 to assure adequate ventilation for personnel safety.
4. Required Data: Submit thermite kit manufacturer's instructions and recommendations covering rail end preheat treatment, thermite ignition, mold removal, and finishing.
 5. Welding Procedure
 - 1) Thermite kit manufacturer's name and kit size or designation
 - 2) Thermite kit batch numbers and manufacturing date
 - 3) Welding procedure designation (name, number)
 - 4) Size of rail section being joined and type of rail
 - 5) Test assembly identification number
 - 6) Results of nondestructive testing of qualifications assemblies
 - 7) Date of qualification (test date)
 6. Required Qualification Welds: Submit operator qualification welds in accordance with paragraph entitled "Operator Qualification." Submit procedure qualification welds in accordance with paragraph entitled "Welding Procedure Qualifications." Include results of ultrasonic test and hardness tests. Welder's certification or procedure qualification may be substituted, pursuant to paragraph entitled "Quality Assurance."
- D. Delivery And Storage: Deliver materials in the manufacturer's original unbroken packages or containers plainly labeled with the manufacturer's name and brand.
1. Receipt Inspection of All Thermite Weld Kits: Shall consist of a visual inspection of the weld kit package for freedom from damage and the recording of the thermite weld mix batch number and manufacturing date. Do not use kits which have been manufactured more than 2 years before the date of use or show signs of having been wet.
 2. Material Control: Store materials in the original package and keep dry at all times until used.

1.2 PRODUCTS

- A. Materials: Provide in kit form including preformed mold, thermite powder, wicking cord, luting material, and all necessary materials and accessories needed to provide one welded rail joint per kit. Molds shall be factory-made, moisture free, and of nonhygroscopic material.

1.3 EXECUTION

- A. Sequence Of Operation: Perform work in strict accordance with the qualified procedure.
1. Rail Preparation: Cut rails which are battered, cracked or notched, or which contain bolt holes so that these irregularities are removed. Rail surface shall be free of grease, dirt, loose oxide, and moisture on the face of and for approximately 5 inches from the joint to be welded. Clean rail ends by grinding or wire brushing. Use a torch to remove grease, oil, or moisture in accordance with procedures in thermite manufacturers instructions. Rail cutting, when necessary, shall be by the saw-cut method. Remove all burrs, rolled-over edges, and loose oxide before applying the mold. No flame cutting of rails is permitted. If the space between the mold and the rail is unusually large on used or relayer rails, fill this gap with a piece of wicking cord before luting or packing.
 2. Rail Alignment: Separate rail ends as recommended by the welding process manufacturer. Align rails as to both surface and gage, and raise the rails at the joint to compensate for the greater thermal contraction that occurs in the rail head during cooling relative to the web and base regions. Measure the amount of joint elevation with a 36 inch long straightedge centered at the joint. The correct elevation is obtained when 1/16 inch separates the top of the rail head and bottom surface of the straightedge at both ends.
 3. Placing of Molds: Attach the molds to the rails, centered over the joint, and seal the molds to the rail with luting material according the welding kit manufacturer's instructions. Handle the luting material, a mixture of clay and sand, so that none is introduced into the weld chamber. Align so that the centerline of the mold coincides with the centerline of the gap. Install the tapping plug or discs in the crucible and pour in the prescribed amount of thermite mixture.
 4. Preheating Rail Ends: In accordance with the manufacturer's instructions and recommendations.
 5. Ignition of Thermite: Follow manufacturer's instructions and recommendations.
 6. Mold Removal: Follow manufacturer's instructions.
 7. Finishing: Follow manufacturer's instructions and recommendations. No finishing is required on the web and base of rail. Perform final grinding when the weld and rail have cooled to ambient temperature. Under no circumstances shall a cutting torch be used to remove excess weld metal.
 8. Joint Records: Provide a record of the date and location of each weld made. The record shall also include the rail type, size, thermite kit manufacturer's name, and thermite weld portion batch number. Also, provide a record of the nondestructive test date and acceptance date.
- B. Inspection And Testing
1. Visual Inspection: Each welded joint shall be inspected by the Contractor after removal of the mold and grinding or removal of excess metal. The inspector shall pay particular attention to surface cracking, lack of fusion and other surface irregularities. The Contractor shall correct or replace all defective welds at no additional cost to the Owner. The method of correction shall be approved by the Owner.
 2. Nondestructive Inspection: Inspect each welded joint by ultrasonic tests using the method of inspection and acceptance as prescribed in MIL-STD-1699. The Contractor shall correct or replace all defective welds at no additional cost to the Owner. The method of correction shall be approved by the Owner. All repairs to defective welds shall be ultrasonically inspected by the Contractor using the method of inspection and acceptance as prescribed in MIL-STD-1699.
 3. Hardness Tests: Perform Brinell hardness test in accordance with ASTM E 10 and ASTM E 110. The Brinell Hardness Number (BHN) of the weld and for the rail for a distance of 6 inches on each side of the joint shall be greater than 250. In the heat-affected zone (a distance not greater than one inch to each side of the joint) the BHN may be up to 20 points lower except for the top of the rail, which shall be not less than 250. Check hardness on at least 10 percent of all welds. Tests shall be performed on randomly selected welds or as directed by the Owner.



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END OF SECTION 34 01 23 33a

SECTION 34 01 23 33b - DIRECT FIXATION TRACK

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of direct-fixation track. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control

1. Construct a complete section of direct-fixation track not shorter than 250 track feet; construct within trackway and where required by the Owner. Section constructed as indicated will become a part of the permanent track; otherwise, remove section and construct another section until section is constructed as indicated.
2. If inserts will be installed in a hole cored into the track concrete, furnish services of grout manufacturer's representative for one working day at start of coring operations. Representative shall inspect cored hole; if hole is acceptable to representative, representative shall enforce grout manufacturer's mixing and installation procedures and methods and witness the placing of grout and inserts.

1.2 PRODUCTS

- #### A. Grout: Premeasured, prepackaged, cement-based, nonmetallic, nonshrink type; CRD C621. Retemper only in accordance with manufacturer's printed instructions. Water shall be potable.

1. Shrinkage

- a. Grout for repairing voids in track concrete: Zero percent shrinkage in plastic state and not more than 0.1 percent expansion in hardened state when tested in accordance with CRD-C621, Sections 10.1 and 10.2.
- b. Grout for setting anchorage inserts: Zero percent shrinkage and expansion in plastic and hardened states when tested in accordance with CRD C621, Sections 10.1 and 10.2.

2. Compressive strength, when tested in accordance with CRD C621:

- a. Grout for repairing voids in track concrete: 5,000 psi at end of 28 days.
- b. Grout for setting anchorage inserts: 2,000 psi at end of seven days.

3. Initial setting time, when tested in accordance with ASTM C191:

- a. Grout for repairing voids in track concrete: Not sooner than 60 minutes.
- b. Grout for setting anchorage inserts: Not sooner than 10 minutes.

- #### B. Shims: ASTM A 167, UNS S30400; and 1/16-, 1/8- and 1/4-inch thick. Shim for rail fastener not having full bottom plate shall be 1/4 inch larger on all sides than rail fastener under which it will be placed. Holes shall be one inch diameter, and either punched or drilled to anchor bolt pattern.

- #### C. Thread Sealant: Low melting point wax; Sanchem, Inc.'s NO-OX-ID 'A' Special, or accepted equivalent.

1.3 EXECUTION

- #### A. Preparation: Test the Owner -selected anchorage inserts.

1. Pull-out test

a. Test equipment

- 1) Reaction plate: Steel plate with a hole drilled in center that is one inch larger than the insert top collar.
- 2) Loading system: As shown on accepted working drawings.

- b. Test Procedures
 - 1) Restrained test: Place reaction plate over anchorage insert to be tested. Set-up accepted loading system and connect that system to bolt engaged in anchorage insert. Exert initial uplift of 1,000 pounds against reaction plate. Increase load against reaction plate at rate of 1,000 pounds per second until load becomes 20,000 pounds.
 - 2) Unrestrained test: Remove reaction plate and apply load of 10,000 pounds uplift on anchorage insert against reaction surface outside six-inch diameter area in which anchorage insert is centered.
 - c. Acceptance criteria: No evidence of anchorage moving upward.
 - d. Remedies: Anchorage insert failing to satisfy acceptance criteria will be rejected.
 - 1) Test every insert along that rail in both directions until 10 successive inserts in each direction satisfy the acceptance criteria.
 - 2) Remove defective anchorage insert and furnish and install new insert. Test new insert, and prepare a pullout test inspection report after that insert has been tested.
2. Torque test
- a. Procedure: Screw anchor bolt into anchorage insert tight against lock nut set two inches from end of bolt. Apply 500 foot-pounds to anchor bolt head.
 - b. Acceptance criteria: Anchorage insert shall show no evidence of rotational movement.
 - c. Remedies: Anchorage insert failing to satisfy acceptance criteria or not installed within the tolerances specified or both, will be rejected. Should an insert fail the torque test, test inserts in accordance with Article 1.4A.1.a.1).
- B. Examination: Verify that the following conditions exist, and record data on Exhibits A, B, and C of this Section and of other Sections:
1. Bearing surface of track concrete is within allowable tolerances for cant, elevation, and dimensions.
 2. Rail fastener anchorage inserts are undamaged, and have been installed perpendicular to and flush with top of concrete.
 3. Anchorage inserts have been subjected to restrained and unrestrained pull-out tests and torque tests, and defective inserts have been removed and replaced.
- C. Installation
1. Remove plugs from anchorage inserts and place rail fasteners with anchor bolts engaged in inserts. Coat threads of anchor bolts with thread sealant.
 2. Install shims between rail fastener and track concrete. Install not more than two shims at each rail fastener.
 3. Fully anchor rail fasteners to track concrete with anchor bolts torqued to 300 foot-pounds. Tighten anchor bolts on both sides of rail simultaneously. Check torquing equipment daily; torque of equipment shall be within two foot-pounds of that of calibrated and certified torque wrench specified in CONTINUOUS WELDED RAIL.

END OF SECTION 34 01 23 33b

SECTION 34 01 23 33c - BALLASTED TRACK RAIL

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of timber ties, tie plates, rail fasteners, and timber screws for other than special trackwork; loading, transporting, unloading. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions: Surfacing track: Raising and aligning track.

C. Quality Control

1. Source quality control: If ballast appearance changes, visually inspect production site immediately before shipping first batch of ballast having that changed appearance.
2. Construction equipment: Subject to inspection and acceptance by the Owner.
 - a. Ballast roller: Self-propelled, pneumatic-tired, and not lighter than nine tons.
 - b. Ballast compactor: Vibratory, be not lighter than 2-1/2 tons, and be capable of applying a dynamic load of nine tons. Ensure that control of compactor's tamping cycle will induce maximum uniform compaction.
 - c. Ballast tamper: Production type having not fewer than 16 squeeze-type vibrating tamping heads, and have construction buggy and automatic liner.
 - d. Ballast equalizer: Have rubber broom brushes; Tamper (Div. Camron Corp.) Model BEB-17, or accepted equivalent.
 - e. Vibrator/compactor for shoulder and crib: Acceptable to the Owner.

1.2 PRODUCTS

A. Ballast: Crushed granite or granite gneiss satisfying AREA specification for size No. 4, except percentage of wear of processed ballast, tested in the Los Angeles machine, shall be not more than 45 percent.

B. Timber Ties: New; preserved; either oak, Lophira Alota, or Lophira Procera; and conform to AREA MRE Chapter 3, Part 1. Ties shall be seven inches thick by nine inches wide, plus one inch, minus 1/4 inch, both between points 12 inches from each end of tie. Ties shall be Boulton-treated or air-dried to an oven dry moisture content of not more than 50 percent before being preserved, unless ties are released for treatment by the Owner before ties have attained specified moisture content.

1. Anti-splitting device: 18 gauge, six-inch by eight-inch; either Portec Inc.'s, Railway Products Division Gang-Nail Protection End Plate or fluted spiral-threaded steel dowel 1/2 inch diameter by 7-3/4 inches long, or accepted equivalent.
2. Preservative: 60/40 creosote-coal tar solution (Grade C) conforming to AREA MRE Chapter 3, Part 7.
3. Fabrication
 - a. Saw top, bottom, sides, and ends of ties.
 - b. Incising: AREA MRE Chapter 3, Part 9.
 - c. Anti-splitting device: Applied before tie is seasoned.
 - 1) If device will be a plate, install plate at each end of each tie.
 - 2) If device will be a dowel, install two dowels between four and six inches from each end of each tie, one dowel two inches from top surface, and one dowel two inches from bottom surface.
4. Preserving: Preserve fabricated ties by the empty-cell process in accordance with AREA MRE Chapter 3, Part 9.

- a. Preserve fabricated tie only after tie has been inspected and released for treatment by the Owner, only after preservatives have been tested by an accepted independent testing laboratory, and in the presence of the Owner if the Owner so elects.
- b. Preserve fabricated ties either to refusal or until ties retain not less than eight pounds of solution per cubic foot.
- c. Record treatment as specified in AREA Records of Treatment and Reports of Inspection.
- d. Ties will be inspected by the Owner before ties are loaded for shipment. Tie will either be released for shipment or rejected at that time.

C. Rail Fastener And Anchorage Assembly

1. Rail fastener: L. B. Foster Co.'s Transit Div.'s Type H-10, or accepted equivalent.
2. Anchorage assembly: Timber screws; steel, 7-1/2 inches long with 0.875 inch diameter shoulder and square head; Camcar Div. of Textron Industries, Inc.'s 3/4-4 Interior Torx Truss Square Head, or accepted equivalent.

D. Tie Plate And Anchorage Assembly

1. Tie plate: Seven-inch wide by 14-inch, rubber-impregnated fiber, double-shoulder type; The Johnson Rubber Co., or accepted equivalent.
2. Track spike: Arthur Railroad Spikelock Corp.'s Spikelock, or accepted equivalent.
3. Track spike insulator: Nylon conforming to ASTM D789, Type 1, Grade 2, and resistant to ultraviolet rays.

1.3 EXECUTION**A. Examination**

1. Examine exposed conduit, conduit stub-ups, and drainage fittings for conformance to vertical and horizontal positioning and interface with surface mounted electrical appurtenances.
2. Examine alignment and elevation of existing work for interface with work of this Section. Use bench marks and horizontal control points established by the Owner. Report adjustments at interfaces with existing work, to produce alignment and elevations indicated for work of this Section, to the Owner for resolution before work of this Section is started.

B. Preparation: Stake out centerlines of track and curvature points. Set top of rail elevation markers at 31-foot intervals along centerline of track.**C. Installation**

1. Uniformly distribute a 1-1/2-inch layer of ballast on approach slabs and on ballasted deck aerial structures. Roll ballast to the extent that ballast will be seated in asphaltic concrete approximately 1/2 inch.
2. Initial ballast
 - a. Uniformly distribute ballast to the extent that thickness of each layer of compacted ballast will be four inches. Arrange top of initial layer of ballast to be not less than four inches below surface of final ballast.
 - b. Uniformly spread each lift of ballast with not less than four passes of either a roller or compactor.
3. Concrete ties: Place ties on 30-inch centers in primary track and at crosswalks, on 33-inch centers in secondary and yard tracks, and on 20-inch centers at insulated joints.
 - a. Place ties in a manner which will ensure that bottom of each tie will bear fully on initial layer of ballast and be normal to track centerline.
 - b. Arrange ends of concrete ties containing contact rail bracket anchor inserts to be on contact rail side and ends of ties on line side of track to be equidistant from rail.
 - c. Place tie pads on concrete tie between rail shoulders.
4. Timber ties: Place ties on 18-inch centers at hi-rail access and on 19-3/16-inch centers at grade crossing.

- a. Place ties normal to centerline of track, with wider heartwood facing downward, and with ends on line side of track equidistant from centerline of track.
 - b. Place tie plate square with CWR and centered on timber ties to final rail line and gauge within limits of grade crossing. Place rail fasteners square with CWR and centered on timber ties to final rail line and gauge within limits of hi-rail access.
 - c. Drill 1/4 inch diameter holes through installed timber ties for track spikes and timber screws, and coat surfaces of drilled holes with pentachlorophenol. Anchor rail fasteners and tie plates with timber screws to ties. Tighten timber screws to torque specified by screw manufacturer.
- D. Surfacing: Place ballast in cribs and at shoulders of track, and in quantities which will fill tie cribs, be sufficient for initial track raise, and hold track after initial track raise.
1. Surface track by methods which will neither bend rail, strain joints, nor damage rail fastenings. Tamp ballast on both sides of tie simultaneously, from points 15 inches inside both rail centers to ends of tie. Limit each track lift to not more than four inches. Initially raise track to an elevation which will ensure that a final raise of neither less than one inch nor more than three inches will bring track to final surface.
 2. Remove ties and fastenings made unserviceable, in the opinion of the Owner, during surfacing operation and install new ties and clips.
 3. Dress ballast to the extent that ballast between ties will be level and one inch below base of rail, and that ballast at shoulder will be compacted and sloped as indicated.
 4. Place plugs in holes in which contact rail assembly inserts have not been placed.

END OF SECTION 34 01 23 33c



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SECTION 34 01 23 33d - CONCRETE TRACK CROSS TIES

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of ballast, precast concrete ties, rail fastenings, and continuous welded rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Submit certified test results of ballast tests not less than 15 days before starting shipment.

C. Quality Control

1. Source quality control: If ballast source or appearance change, test ballast gradation and visually inspect production site immediately before initially shipping first batch of ballast from that source and of that appearance.
2. Construction equipment: Subject to inspection and acceptance by the Owner.
 - a. Ballast roller: Self-propelled, pneumatic-tired, and not lighter than nine tons.
 - b. Ballast compactor: Vibratory, not lighter than 2-1/2 ton, and be capable of applying a dynamic load of nine tons. Ensure that control of compactor's tamping cycle will induce maximum uniform compaction.
 - c. Ballast tamper: Production Type with a minimum of 16 squeeze-vibratory tamping shoes.

1.2 PRODUCTS

A. Materials

1. Sub-ballast (where required): Aggregate-soil materials conforming to an ASTM D 1241, Type I, Gradation A mixture. Use sub-ballast in frost areas where the ballast thickness requirement exceeds 10 inches and elsewhere as required.
2. Ballast: Crushed stone, Size No. 4 for mainline ballast materials and Size No. 5 for yard and house tracks, conforming to Chapter 1, Part 2, of American Railway Engineering Association (AREA) "Manual for Railway Engineering (Fixed Properties)."
3. Concrete Ties: Comply with the material requirements specified in Chapter 10 of AREA "Manual for Railway Engineering (Fixed Properties)." Concrete ties shall be a minimum of 8 ft. 6 in. in length.
4. Welded Rail: New rail shall be 115 lb. Section, **unless directed otherwise**, and shall conform to Chapter 4, Part 2 of AREA "Manual for Railway Engineering (Fixed Properties)." Relay rail shall conform to criteria specified in Chapter 4, Part 2 of AREA "Manual for Railway Engineering (Fixed Properties)." Mingling of new and relay rail will not be permitted.

1.3 EXECUTION

A. Installation

1. Initial ballast
 - a. Uniformly distribute ballast over the sub-ballast and firmly compact before distributing ties.
 - b. Uniformly spread each lift of ballast within initial layer with not less than four passes of either a roller or compactor. Limit the depth of each compacted lift within the initial layer to four inches. Make top of initial layer not less than four inches below final ballast surface.
2. Ties: Place primary track ties on 30-inch centers. Place secondary track ties on 33-inch centers.

- a. Place ties to ensure that bottom of each tie will bear fully on initial layer of ballast and be normal to track centerline.
- b. Arrange ends of ties containing contact rail bracket anchor inserts to be on contact rail side.
3. Continuous Welded Rail (CWR)
 - a. Remove ballast and debris from inserts and concrete ties before placing rail pads, CWR, and rail clips.
 - b. Place CWR on the pads in accordance with accepted working drawings. Do not drag CWR over rail pads. Use no on-track equipment until CWR has been fastened to concrete ties.
 - c. Install, anchor and field-weld CWR producing zero thermal stress in rail at 85 degrees F, plus five degrees F, or minus 10 degrees F. Anchor opposite rails at temperatures within five degrees F of each other.
 - d. Anchor rails in ballasted track by installing rail clips and fastener insulators in accordance with concrete tie manufacturer's recommendations. Proceed with final rail anchoring in ballasted track only after track has been ballasted preventing tie movements caused by thermally induced force and until track has been initially raised, tamped, and aligned.
- B. Surfacing And Aligning: Place ballast in cribs and shoulders of track structures, and in quantities which will fill tie cribs and be sufficient for initial track raise and to hold track after initial track raise.
 1. Surface track without bending rail, straining joints, or damaging rail fastenings. Simultaneously tamp ballast on both sides of tie, from points 15 inches inside both rail centers to ends of tie. Limit each track lift to not more than four inches. Initially raise track to an elevation ensuring that a final raise of neither less than one inch nor more than three inches will be required to bring track to final elevation.
 2. After track has been initially raised and aligned, field-weld and anchor rails within specified zero thermal stress range. Remove damaged ties and fastenings, in the judgment of the Owner, during surfacing operation and install new ties and clips. Suspend surfacing when ambient temperature is hotter than 95 degrees F.
 3. Compact shoulders and cribs with a vibrator compactor acceptable to the Owner. At no additional expense to the Owner, remove at random a maximum of one percent of ties so that the Owner may inspect compaction of ballast beneath ties to determine tamping variables of each piece of tamping equipment, and to spot-check production work. Reinstall ties immediately after compacted ballast has been accepted.
 4. Complete final surfacing and aligning of track. Reslope fouled and disturbed subballast outside toe of ballast slope.

END OF SECTION 34 01 23 33d

SECTION 34 01 23 33e - TIMBER TRACK CROSS TIES

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of products for hi-rail accesses, timber panels, and grade crossings. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

- A. Ties: Timber type; 8-1/2 feet long except ties on which contact rail insulators will be mounted shall be ten feet long. Furnish ties which will be within limits of panels, and ties which will be not more than 10 feet beyond panels.
- B. Panel Timbers, Flangeway Timbers, And Support Blocks: American Railway Engineering Association (AREA) "Manual for Railway Engineering," Chapter 3, Part 6, Type A, fine-grained hardwood such as maple, gum, or birch and specially fabricated as indicated. Support blocks shall be fabricated from a single piece of timber.
- C. Hi-Rail Access: Panel timbers, flangeway timbers, and support blocks.
- D. Drive Dowels: Steel conforming to ASTM A 575, twisted, of diameter not smaller than 3/4 inch.
- E. Drive Spikes: Dome head steel type, 3/4-inch diameter by 12-inches long, and galvanized in accordance with ASTM A 153; Lewis Bolt and Nut Co., or accepted equivalent.
- F. Guard Posts: Galvanized steel pipe conforming to ASTM A 53, Grade B, 4-inch diameter by 8-feet long.
- G. Ballast Prime Coat: Grade MC-250.
- H. Asphalt Concrete: Asphaltic Concrete in accordance with the requirements of YYYYY57YYYY.
- I. Concrete: Class 3000 Portland Cement Concrete, in accordance with requirements of YYYYY73YYYY.
- J. Timber Screws For Anchoring Rail Fasteners
- K. Rail Fasteners: L. B. Foster Co.'s, Transit Products Division, "Type H-10", or approved equivalent.
- L. Tie Plates:
- M. Track Spikes:
- N. Guard Rails: Guard Rail, conforming to the requirements of YYYYY616YYYY.
- O. Ballast: Conforming to the requirements of YYYYY602YYYY.
- P. Aggregate Base: Aggregate.
- Q. Fabrication: Fabricate timbers and blocks before pressure-treating.
 1. Fabricate timbers to be eight feet long.

- a. Orient timber heartwood to be downward.
 - b. Cut ends of timbers square except bevel distal ends of timbers, which will comprise the end panels, at 45 degrees.
 - c. Cut timbers to dimension ensuring that top of installed panel is 3/4 inch below top of rail.
 - d. Notch flangeway timbers to clear rail fastener and tie plate hardware by not less than 1/2 inch.
 - e. Drill 5/8 inch diameter holes for drive spikes through timbers, and on 19 3/16-inch centers. Arrange adjacent holes to be on opposite sides of tie centerline.
 - f. In hi-rail access timber panels, drill four, 5/8 inch diameter holes for drive dowels; drill parallel to center of timbers' vertical dimension. Holes shall be no closer to end of timbers than one foot, and remainder equidistant from each other.
2. Fabricate blocks to fit between rail fasteners and tie plates, and such that blocks will support notched portion of flangeway timbers.
 3. Pressure-treat timbers and blocks in accordance with AREA Chapter 3, Part 6.
 4. Assemble treated timbers into panels eight feet long, with heartwood downward and ends aligned with each other. Drive dowels.

1.3 EXECUTION

- A. Examination: In accordance with requirements of YYYY602YYYY.
- B. Preparation: In accordance with requirements of YYYY602YYYY.
- C. Installation:
 1. Place initial layer of ballast.
 2. Distribute and place timber ties on 19-3/16-inch centers, with wider heartwood downward, normal to centerline of track, and aligned with ends of ties on line side of track equal distance from rail.
 3. Place aggregate base.
 4. Place and anchor rail fasteners and tie plates to timber ties with timber screws and track lock spikes
 5. Unload, lay, and join CWR; clip and spike CWR to rail fasteners and tie plates, and raise, align, and surface track to indicated lines, grades, and elevations.
 6. Dress ballast level one inch below top of ties and to slopes indicated.
 7. Drill 1/2 inch diameter holes into installed ties for drive spikes for a depth of five inches, immediately remove debris from holes, and fill holes with pentachlorophenol. Panels may be installed to facilitate the temporary access by hi-rail equipment, but shall be removed for grinding of the running rail.
 8. Place one-piece support blocks in space between ties and flangeway timbers, against base of rail, and between rail fasteners. Place panels on ties and support blocks, and arrange panels with ends coinciding with centers between the ties; butt ends of panels. Dap and saw flangeway timbers, panel timbers, and support blocks to satisfy field conditions within specified tolerances, and apply pentachlorophenol to dapped and sawed timbers and blocks. Insert no shims between panels and ties.
 9. Drive spikes vertically, and until spike head bears on timbers.
 10. Apply prime coat and asphalt concrete in accordance with the requirements of YYYY57YYYY.
 11. Apply asphaltic concrete between flangeway timbers and grade crossings in accordance with the requirements of YYYY57YYYY.
 12. Install crossing in accordance with crossing manufacturer's printed installation instructions.
 13. Install guard posts vertically and project posts three feet above top of rail; fill posts with concrete and crown top in accordance with the requirements of YYYY73YYYY.
 14. Install guard rail in accordance with the requirements of YYYY616YYYY.
 15. Tolerances from design dimensions.
 - a. Top of flangeway timber, vertical depression below top of rail: Plus 1/4 inch, minus zero.
 - b. Clearance between side of flangeway timbers and edge of rail: Plus 1/2 inch, minus zero.



- c. Difference in elevation between surface of flangeway timber and surface of abutting asphalt concrete: 1/4 inch.

END OF SECTION 34 01 23 33e



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SECTION 34 01 23 33f - RESILIENT TRACK CROSS TIES

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of resiliently supported track at-grade, and continuous welded rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control:

1. Testing of Resiliently Supported Two-Block Concrete Tie Assembly: In lieu of qualification testing of two-block concrete tie complete with resilient supports and rail fastening assemblies in accordance with Flexural Strength Testing of two-block ties in AREA MRE Chapter 10, Section 1.10 and tests for Noise and Vibration Performance as specified in this Section, Contractor may submit for the Owner approval certification by an independent testing laboratory that ties, supports, and rail fastenings have passed the tests specified or equivalent tests.
 - a. Submit for the Owner approval, prior to fabrication and testing, shop drawings detailing two-block concrete ties, resilient supports, and rail fastenings; detailed description of steps required for complete installation, replacement and adjustment of individual components; and detailed description of all tests.
 - b. Arrange testing to be performed by an independent testing agency approved by the Owner. Production testing may be performed at Contractor's facility providing that facilities and testing procedures meet the approval of the Owner.
 - c. All testing performed by Contractor shall be witnessed by the Owner.
 - d. Qualification tests for Noise and Vibration Performance.
 - 1) Test assembly
 - a) Except as otherwise specified herein, perform tests on a single concrete tie block complete with resilient supports, and rail fastening assembly certified to be identical to those to be furnished. Single concrete tie block shall be cut from a complete two-block tie assembly by cutting in half the tie bar joining the tie blocks.
 - b) Cast or grout two-block tie and single tie block complete with resilient supports in a Class 4000 concrete foundation block as specified.
 - c) Assemble a section of 115 RE rail not shorter than one foot, rail pad, and rail fastenings to two-block tie. Torque or drive rail fastenings in same manner and with the same force or torque as specified.
 - d) Immediately prior to starting tests, stabilize temperature of all components of the assembly at 68 degrees F, plus or minus four degrees F.
 - e) Perform testing only when ambient temperature is 68 degrees F, plus or minus four degrees F unless otherwise specified.
 - 2) Sequence of tests on assembled resiliently supported two-block concrete tie.
 - a) Static vertical stiffness test
 - i. Vertical test load: Zero to 15,000 pounds, applied at a steady rate of 2,000 pounds per minute with optional 30-second pauses at every 1,000-pound increment.
 - ii. Point of application: Downward at and normal to centerline of rail and centerline of tie block.
 - b) Test procedure
 - i. Preconditioning and seating loading: Apply vertical load varying at a rate of 2,000 pounds per minute from zero to 15,000 pounds and back to zero load. Set the deflection reading devices at zero one minute after load returns to zero pounds.

- ii. For each 1,000-pound load increment, measure and record vertical deflection of the rail head to the nearest 0.001 inch 30 seconds after rail head has stopped moving.
- iii. Upon completing measuring and recording vertical deflection of the rail lead at 15,000 pounds nominal load, commence reducing the load at the same rate that was used for loading and record vertical deflections of the rail at 1,000-pound load reduction increments. One minute after reaching zero load on rail, measure and record the residual deflection of the rail.
- iv. Average the two sets of vertical deflection readings for determining the normal deflections of the rail. Plot the normal deflections against the record values for vertical loads.
- v. Calculate the vertical static stiffness of the resiliently supported two-block assembly by dividing the measured difference in static force between nominal values of 7,000 and 8,000 pounds by the measured difference in the average static deflection at 7,000 and 8,000 pounds.
- c) Test acceptance criteria
 - i. Slope of the load-deflection curve: Not less than 50,000 pounds per inch nor more than 90,000 pounds per inch for all loads between 5,000 pounds and 15,000 pounds. Constancy of slope: Within 10 percent over the load range.
 - ii. Recovery of tie block to original rail-head position: Within 0.015 inch of its pre-test position within one minute after test load has been removed.
- 3) Dynamic vertical stiffness test
 - a) Vertical test load: Sinusoidal force with a zero-to-peak amplitude of 500 pounds and a frequency of six Hertz, superimposed on a static compressive force of 7,500 pounds.
 - b) Point of application: Downward at and normal to centerline of rail and centerline of tie block.
 - c) Points on rail for measuring deflections: Two along centerline of rail and equidistant from point of load application.
 - d) Measurement technique: Measure vertical force with a device capable of long term DC response to force, such as a strain gauge load cell. Measure vertical deflection with two identical linear variable differential transformer (LVDT) displacement gauges located symmetrically about the line of vertical force application. Locate displacement transducers above or below rail. Indicate DC force with a device capable of DC response without interference from the dynamic force component, such as an oscilloscope, oscillograph, or meter with long averaging time. Indicate the dynamic force and displacement with a device capable of detecting a six Hertz signal, but not responding to or compensating for DC signals, such as an oscilloscope, oscillograph or low frequency AC coupler meter.
 - e) Test procedure
 - i. Apply a constant vertical compressive force of 7,500 pounds to the top of the rail, centered over the rail and the centerline of the single tie block. After the constant force has been established, superimpose on it a sinusoidally varying six Hertz force with a zero-to-peak amplitude of 500 pounds.
 - ii. Observe and document the DC and AC components of the force and the AC component of the deflection to an accuracy of plus or minus three percent.
 - iii. Calculate the dynamic stiffness of the single tie block at a static compressive force of 7,500 pounds by dividing the measured peak-to-peak force by the measured peak-to-peak deflection.

- f) Test acceptance criteria: Dynamic vertical stiffness shall be not less than 300,000 pounds per inch nor more than 500,000 pounds per inch.
- 4) Static lateral stiffness test
 - a) Vertical preload: Apply a constant force of 7,500 pounds through the centerline of rail and centerline of tie block with a fixture not restraining or causing lateral motion of the tie block or imposing lateral forces in excess of two percent of the maximum lateral test force.
 - b) Lateral test load: Zero to 7,500 pounds, applied at a steady rate of 1,000 pounds per minute with optional 30-second pauses at each 500-pound increment. One complete test cycle shall be run using a compressive load on the tie bar, and one complete test cycle shall be run with a tensile load on the tie bar.
 - c) Point of application: Apply lateral test loads to the projecting end of the cut tie bar, with the line of action of the force along the centroid of the lower horizontal leg of the tie bar. Rollers or large radius linkages may be used to restrain motion of the tie bar caused by the eccentricity of the line of action of the force with the area of the boot resisting the lateral force. However, the means of restraint must not interfere with the deflection of the tie block under the vertical preload or the lateral deflection of the block.
 - d) Points on tie block for measuring deflections: Measure deflection of tie block at a point on the end of tie block opposite tie bar, one inch above top of boot in the unloaded position, and on centerline of tie block.
 - e) Test procedure
 - i. Apply 7,500-pound vertical preload downward through center of rail at the centerline of tie block. Adjust linkages or rollers to prevent excessive motion of the tie bar normal to the line of action of the lateral force.
 - ii. To precondition and seat tie and boot assembly, apply a lateral load varying from zero to 7,500 pounds and immediately return to zero at a rate of 1,000 pounds per minute. Zero lateral deflection reading devices one minute after the lateral load returns to zero pounds and immediately commence test.
 - iii. Apply lateral load to the tie bar at a constant rate of 1,000 pounds per minute. If non-recording instrumentation requires pauses in loading to read instruments, stop loading at each 500-pound increment, read instruments 30 seconds after stopping loading and immediately resume loading.
 - iv. Upon reading the load and deflection of the rail at 7,500 pounds lateral load, reduce lateral load to zero, then reduce vertical preload to zero.
 - v. If data was manually read, record data points on a graph of lateral deflection as a function of load.
 - vi. Calculate lateral static stiffness of the single tie block, boot and pad assembly by dividing the measured difference in static force between nominal values of 3,000 and 4,000 pounds by the measured difference in static deflection at 3,000 and 4,000 pounds.
 - vii. The nominal static lateral stiffness of a complete resiliently supported tie assembly is equal to the sum of stiffnesses measured under compression and tension of the tie bar.
 - f) Test acceptance criteria
 - i. Lateral stiffness with lateral load applied from gauge side: 120,000 to 170,000 pounds per inch.
 - ii. Lateral stiffness with lateral load applied from field side: 165,000 to 170,000 pounds per inch.
- 5) Water absorption of tie pad test:
 - a) Test procedure: ASTM D 1056

- i. Cut two 29 mm diameter samples of the pad used between the bottom of the tie and the elastomer boot from two different pads and weigh them to an accuracy of plus or minus one percent. This weight is designated as P0 for each pad in the following formula.
 - ii. Immerse the samples in distilled water at room temperature, and hold them 50 mm below the surface with a wire probe or cage.
 - iii. Decrease the pressure in the atmosphere above the water to 635 mm of mercury.
 - iv. After three minutes at the reduced pressure, return the pressure above the water to ambient atmospheric pressure.
 - v. After three minutes at ambient atmospheric pressure, remove samples from water, superficially dry surfaces by gentle blotting without squeezing samples and weigh them to an accuracy of plus or minus one percent. This weight is designated as P1 for each pad in the following formula.
 - vi. Calculate the percentage change in weight of each sample using the formula:

$$A = 100(P1 - P0)/P0 \text{ percent}$$
- b) Test acceptance criteria
- i. Weight change due to water absorption: not more than 0.10 grams
 - ii. Volume change due to water absorption: not more than 0.10 grams
- 6) High voltage withstand test: effect of high voltage on quality of tie pad material.
- a) Test Procedure: Place a metal ground plate between concrete test block and tie pad. Apply a DC potential of 15KV between rail-head and ground plate for one minute.
 - b) Test acceptance criteria: Neither cracks, pin-holes or electric flash over or arcing nor fracture to occur.
- 7) Electrical resistance and impedance test
- a) Dry resistance:
 - i. Remove moisture, if any, from concrete tie block assembly and with one lead of high potential tester connected to rail head and ground lead connected to rail fastening system, apply 500 volts DC for three minutes. Use the current value obtained to calculate resistance.
 - ii. Acceptable resistance to 500 volts DC: not less than 10 megohms.
 - b) Wet resistance:
 - i. Release ground plate, tie pad, and rail fastening system from concrete tie block and rail; immerse tie pad in distilled water for six hours at 100 degrees C for neoprene based elastomers and for 336 hours at 70 degrees C for natural rubber based elastomers.
 - ii. After tie pad has been removed from water without drying and with no portion of the concrete tie block assembly cooler than 35 degrees C., reassemble ground plate, tie pad, rail fastening system, and rail on the tie block and test for electrical resistance as follows:

With one lead of high potential tester connected to rail head and the other lead ground to rail fastening system, apply 500 volts DC for three minutes, and test for electrical resistance. Use current value obtained to calculate resistance.

Allowable resistance: Not less than one megohm.
 - c) Wet impedance:
 - i. With the rail tie pad and rail fastening system still wet and with no portion of the concrete tie block assembly cooler than 35 degrees C, apply a potential of 50 volts AC between rail head and grounded rail fastening system until reading has stabilized for 30 seconds of

- measurement for frequencies 1,000, 2,000, 4,000, 6,000, 8,000, and 10,000 Hertz.
 - ii. After reading has stabilized for 30 seconds, measure impedance of each frequency within an accuracy of plus or minus two percent and record each frequency.
 - iii. Impedance for frequencies between 20 Hz and 5 kHz with 50 volts AC shall be 10,000 ohms, at 6 kHz shall be 9,000 ohms, at 8 kHz shall be 7,000 ohms, and at 10 kHz shall be 6,000 ohms.
2. Construct a complete demonstration section of resiliently supported track not shorter than 50 track feet; construct within trackway and where required by the Owner. Section constructed to specified tolerances will become a part of the permanent track; otherwise, remove section and construct another section until constructed as indicated.

1.2 PRODUCTS

- A. Ties: Concrete and steel two-block type; either Nucor Corp.'s Nucor-VSB or Stedef Inc.'s Stedef-VSB, or accepted equivalent.
- B. Rail-Fastening System: Either Nucor Corp.'s S75 Fastenings, Stedef Inc.'s A. P. Fastening System, or accepted equivalent.
- C. Resilient Support
 - 1. Tie Boot And Pad: Conform to either Nucor Corp.'s S75, Stedef Inc.'s Technical Specification No. S120-4, or accepted equivalent.
 - a. Rubber boot with microcellular pad.
 - b. Tie pad: closed-cell cellular neoprene or elastomer.
 - c. Boot restraints: Either a rigid support that will engage lip of boot on both sides of the rail or a series of rubber bands or plastic strapping of size and strength which will restrain applied boot against sides and bottom of tie without noticeable sag and without compressing tie pad.
 - 2. Rail Pad: Rubber; nine millimeters thick; have longitudinal grooves; conform to either Nucor Corp.'s S75; International Union of Railways' Technical Specifications 864-5-0, Stedef Inc.'s Technical Specifications No. S120-OB; or accepted equivalent.
- D. Concrete Reinforcement: CONCRETE REINFORCEMENT.
- E. Concrete Formwork: CONCRETE FORMWORK.
- F. Concrete: Class 4000 Portland Cement Concrete.
- G. Superelevation Tags: Brass or anodized aluminum; 1-1/4 inches wide by two inches long by 0.050 inch thick; and stamped with numerals 3/4 inch high, except that numerals for fractions shall be 3/8 inch high.

1.3 EXECUTION

- A. Preparation: Establish track offset reference line, and chisel reference line mark on slab at intervals of not more than 20 feet. Along curved sections of track, chisel offset reference line mark at intervals to ensure that distance between chord drawn between two marks and indicated curve reference line will be not more than 0.005 foot.
- B. Installation
 - 1. Space two-block ties perpendicular to track centerline, and on 30-inch centers, plus or minus one inch except at insulated joints. Place two-block ties at insulated joints as indicated within plus or minus 1/2 inch.

2. Place rail pads between shoulders on concrete ties.
 3. Place rail on rail pads; do not disturb ties when connecting rails and fastening rail to ties. Torque or drive rail fastenings in accordance with manufacturer's printed instructions.
 4. Raise track, and support and block track to its final line and grade. Secure to hold track at final line and grade during concrete placement. Support assemblage only from base of rail. Conform track to required position.
 - a. Completely brace and support track section to be concreted at one time. Support track for not less than 100 feet beyond that track section being concreted, to ensure that track section will not be stressed.
 - b. Install reinforcement in accordance with CONCRETE REINFORCEMENT.
 - c. Install formwork in accordance with CONCRETE FORMWORK.
 - d. Immediately before installing boot and tie pad, ensure that no water is in boot. Apply boot restraints to each tie without scratching and tearing boot and pad; ensure that boot and tie pad fit flush against sides and bottom of tie.
 - e. Ensure that ties are normal to centerline of track. If tie needs to be adjusted to be perpendicular to track centerline, loosen rail-fastening system, align tie, and retighten or redrive rail-fastening system.
 - f. Before placing concrete, survey and verify final line and grade on raised and supported track comply with established controls.
 - g. Place concrete in accordance with CAST-IN-PLACE CONCRETE.
 - h. Ensure that there is no concrete spillage on ties, lip of boots, rail fastenings, and inside boot.
 5. After concrete has been placed for not less than four hours, loosen rail fastenings to prevent thermal stresses in rail.
 6. Remove track supports and formwork and cleanout drainage chases and blockouts.
- C. Jointing And Anchoring Rail: CONTINUOUS WELDED RAIL.
- D. Installing Superelevation Tags: Install tags on concrete ties one foot inside superelevated CWR, and orient tag to be read in ascending order from tangent to spiral, through spiral to curve.
 1. Wire brush attachment surfaces and remove all loose material from concrete surfaces.
 2. Wire brush back side of tags, apply epoxy to tags, and press tags onto concrete ties at beginning and ending points of curved track and at elevation increments of 1/4 inch within spirals.
- E. Final Alignment And Track Inspection: CONTINUOUS WELDED RAIL.

END OF SECTION 34 01 23 33f

SECTION 34 01 23 33g - DIRECT-FIXATION FASTENERS

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of direct fixation rail fasteners and anchorage. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control

1. Design criteria for special rail fasteners including anchorage
 - a. Function
 - 1) Secure and distribute loads of 115RE rail and special trackwork to concrete trackbed and timber ties.
 - 2) Provide vertical and lateral stability to the rail.
 - 3) Restrain rail from movement in longitudinal direction.
 - 4) Dampen vibrations generated by moving wheels on the rail.
 - 5) Electrically insulate rail from trackbed and timber ties.
 - b. Parts
 - 1) Have as few components as economically and technically feasible to facilitate assembling disassembling and maintaining in the field by means of standard hand tools.
 - 2) Rail fastener body shall consist of a 5/8 inch thick elastomer pad bonded to either a single steel plate or sandwiched and bonded between two steel plates, a rail fastening system for securing rail to fastener, and anchorage assemblies for anchoring rail and fastener assembly to fixed surfaces and for providing specific increments of lateral adjustments in rail alignments and track gauge. Top plate shall be no thinner than 1/2 inch and the bottom plate shall be no thinner than 3/16 inch.
 - 3) Components of rail fastener body which may replace or be added to the basic configuration in order to laterally adjust the rail shall be clearly identified with respect to the increment of particular adjustment.
 - 4) The rail fastening system or the means of preventing lateral movement of rail shall make point contact against rail. Contact area shall be at least one inch in length measured along the rail and not less than 0.15 square inch in area.
 - 5) Spacers or bushings adjacent to anchor bolt holes shall be no larger than 1 3/8 inches in diameter for those fasteners with spring rates greater than 180,000 psi.
 - c. Accommodation of rail removal: Design rail fastener to permit the release of rail fastening system so that rail may be removed by raising rail vertically until it is completely free of fastener without disturbing the horizontal or vertical alignment of the fastener.
 - d. Type of anchorage assemblies
 - 1) Embedded in concrete
 - a) Anchor bolt: Steel conforming to SAE J429, Grade 5, 7/8 inch diameter, 9 UNC Class 2A threads electroplated with zinc in accordance with ASTM B 633, Type III, SC2, and length sufficient to provide 1-1/4- inch thread engagement in insert;
 - b) Washers: Self-locking type, 7/8 inch, steel; Disc-Lock, or accepted equivalent.
 - c) Insert: Steel conforming to SAE J429, Grade 5, zinc electroplated in accordance with ASTM B 633, Type III, SC2, 7/8 inch diameter, 9 UNC Class 2B internal threads and 1-1/2 inches of thread engagement for anchor bolt; female type, not longer than 4-1/2 inches, and have nonwelded collar and rotation prevention coupling nut; with nylon or plastic pull away type plug. Bond threaded portion of insert coupling nut device to other portion of insert

- for depth of 7/8 inch with epoxy glue manufactured by the Lord Corp. or accepted equivalent.
- 2) Drilled in timber ties: Lag screw, steel, seven inches long with 7/8 inch diameter by 5/8 inch minimum length shoulder and washer-square head; Camcar Division of Textron Industries, Inc.'s 3/4-4 Torx, United Steel and Fasteners, Inc., or accepted equivalent.
- e. Rail fastening system
- 1) Rail fasteners employing nonthreaded rail hold-down assemblies shall provide on each side of the rail base a positive means of preventing more than 1/8 inch total lateral movement of the rail base relative to the fastener, in event of failure or loosening of one or both hold-down assemblies. Fasteners which employ threaded elements in the rail hold-down assembly shall not permit more than 1/8 inch total lateral movement of the rail base relative to the fastener, when the threaded elements are finger tight.
 - 2) Threaded elements
 - a) Strength: ASTM A 325 Type 1.
 - b) Nominal diameter: 3/4 inch
 - c) Thread: 9 UNC Class 2A fit
 - d) Nut: Self-locking hex head threaded 9 UNC Class 2B fit, torque nut conforming to Industrial Fasteners Institute's Standards (IFIS) IFI-100 and IFI-101.
 - e) Washer: Self-locking type, 3/4 inch, steel; Disc-Lock, or accepted equivalent.
 - f) Bolt threads: Electroplated cadmium coated per ASTM A 165 Type I.
- f. Lateral rail adjustment
- 1) Design rail fastener so that lateral adjustment of rail for specified increments is made by a method which does not require substitution or addition of component to fastener.
 - 2) Lateral movement of the anchor bolts in a slotted insert or lateral movement of the rail fastener relative to the anchor bolts shall not be used to achieve rail lateral maintenance adjustment requirements.
- g. Rail restraint: Design fastener so that the longitudinal and lateral rail restraint properties of the fastener assembly shall be identical in both directions respectfully in all positions of the rail on the fastener.
- h. Stability: Design fastener so that its stability in every direction is not dependent solely upon strength of bond of elastomer to metal.
- i. Compressive strength of elastomer: Design fastener so that the compressive strain on the elastomer does not exceed 25 percent of its compressive thickness for a load of 15,000 pounds applied vertically to the rail in fully assembled fastener.
- j. Bearing: Design rail fastener so that
- 1) Fastener has full bearing on elastomer for each specified position of lateral adjustment.
 - 2) Elastomer when installed in fastener assembly shall not be displaced under operating conditions.
- k. Bonding: Design rail fastener to have all exposed edge surfaces of metal parts adjacent to elastomer coated with the primer and material used to form the bond.
- l. Configuration: Design the rail fastener so that
- 1) The fastener assembly rail seat shall be steel, flat, continuous and shall impart no cant to rail. Underside of the fastener base is flat parallel to the plane of the rail seat and without projections into concrete or tie.
 - 2) Distance as installed, from base of anchor hold-down bolt head to the base of the fastener shall not exceed 2-1/2 inches. The overall vertical distance between base of rail and base of fastener shall be at least 1-5/16 inches and not more than 1-1/2 inches.

- 3) Overall dimensions of the fasteners, including the elastomer, shall be not less than six inches nor wider than 10 inches measured parallel to the rail and vary in length, not shorter than 32 inches or longer than 48 inches measured normal to the rail.
- 4) Rail fastener shall be designed to provide for a minimum of two anchorage assemblies; sized to accommodate 7/8 inch diameter anchor bolts or timber screws, and centered and located on top plate not closer than two inches from each end of fastener.
- 5) Each rail fastener shall provide a means of lateral adjustment having a minimum range of plus or minus 1/2 inch in increments of 1/8 inch. Lateral or longitudinal stability of rail shall not be reduced in any adjusted position. Friction alone shall not be used as a means of adjustment.
- 6) Each rail fastener shall provide an electrical leakage distance of not less than 1/2 inch under all load conditions, measured from ground portion of fastener in direct contact with the rail by the most direct path that does not pass through insulating material.
- 7) Leakage distance path shall be without recesses or other geometric configurations capable of collecting and holding moisture, dust or other materials creating a conductive path to ground.
- m. Elastomer: Determine all dimensions affecting the shape of the elastomer in the rail fastener to ensure complete conformance to the specified physical requirements.
2. Allowable deviations from indicated plate dimensions
 - a. Thickness: 1/32 inch.
 - b. Straightness: Using a 36-inch straightedge oriented in directions 1/32 inch.
 - c. Hole diameters: 1/32 inch.
 - d. Hole centerline locations: 1/16 inch.
 - e. Deviation from straightness of edges of riser plates parallel and adjacent to base of rail: 1/32 inch.
 - f. Deviation from over-all planar dimensions: 1/8 inch.
3. Testing of special direct fixation rail fasteners: In lieu of qualification testing of rail fastener assemblies, Contractor may submit for the Owner approval certification by a independent testing laboratory stating that fasteners have passed the tests specified in this Article or equivalent tests and that fasteners comply with design criteria as specified.
 - a. Submit for the Owner approval prior to fabrication and testing, shop drawings detailing fasteners and detailed description of steps required for their complete installation as well as their replacement or individual components and detailed description of all tests.
 - b. Arrange testing to be performed by a testing facility and in accordance with procedures approved by the Owner at no additional expense to the Owner. Production testing may be performed at Contractor's facility providing that facilities and testing procedures meet the approval of the Owner.
 - c. All testing performed by Contractor shall be witnessed by a representative provided by the Owner.
 - d. Method of selection: At random equal numbers of molded or post-bonded fasteners from the initial lot of 15 fasteners produced.
 - e. Quantity of fasteners selected: Four each of either the molded or post-bonded fasteners. If additional fasteners are necessary they shall be furnished at no additional cost to the Owner.
 - f. Visual inspection: Measure and examine each of the fasteners from the initial lot of fasteners produced for conformance with specifications and in compliance with the Owner approved shop drawings.
 - g. Complete assembly test
 - 1) Clean and dry components of test assembly.
 - 2) Assemble one complete rail fastener and mount to a section of 115RE rail not shorter than one foot.
 - 3) Mount test assembly on concrete block, having compressive strength of not less than 4,000 psi; secure test assembly to the block by the anchorage assembly as specified in DIRECT FIXATION TRACK, to simulate actual field installation.

- 4) Immediately prior to starting tests, stabilize temperature of fasteners at 68 degrees F, plus or minus four degrees F.
 - 5) Perform testing only when ambient temperature is 68 degrees F, plus or minus four degrees F unless otherwise specified.
 - 6) If a single rail fastener is unstable for test purposes, mount two complete fasteners on a section of 115RE rail not less than two feet long with not less than one inch longitudinal separation between the fasteners, and apply double the test load at a point midway between the two fasteners.
- h. Sequence of tests on assembled rail fasteners: Four rail fasteners designated as fasteners A, B, C, and D shall be assembled and mounted as specified in Paragraph 1.2B.3.g and shall be subjected to the following sequence of performance tests.
- 1) Rail fasteners A, B, C, and D: Subject each rail fastener to the static tests specified in Paragraphs 1.2B.3.j through 1.2B.3.p and the Dynamic to Static Stiffness Ratio Test as specified in Paragraph 1.2B.3.v. Rail fastener B shall then be subjected to the Corrosion Test as specified in Paragraph 1.2B.3.w.
 - 2) Rail fastener A: Subject rail fastener to the Vertical and Lateral Repeated Load Test as specified in Paragraph 1.2B.3.q and then retest rail fastener through each of the static tests specified in Paragraph 1.2B.3.h.1) above, without replacement of any component. Do not disassemble rail fastener from the rail after the Repeated Load Test With One Anchor as specified in Paragraph 1.2B.3.r and do not reposition any rail clip.
 - 3) Rail fastener B: Subject rail fastener to the Heat Aging Test as specified in Paragraph 1.2B.3.s and then retest rail fastener through each of the static tests specified in Paragraph 1.2B.3.h.1) above, without replacing any component.
 - 4) Rail fastener C: Subject rail fastener to the Heat Aging Test as specified in Paragraph 1.2B.3.s, and then retest rail fastener as specified in Paragraph 1.2B.3.t, Uplift Repeated Load Test. Retest rail fastener through each of the static tests specified in Paragraph 1.2B.3.h.1) above, without replacing any component.
 - 5) Rail fastener D: Subject rail fastener to the Push-Pull Test as specified in Paragraph 1.2B.3.u, and then retest rail fastener through each of the static test specified in Paragraph 1.2B.3.h.1) above, without replacing any component. For the Longitudinal Restraint Test, specified in Paragraph 1.2B.3.n, rail fastener shall not be disassembled from the rail after the Push-Pull Test, nor shall the rail hold-down assemblies be repositioned.
- i. Qualification failure: Should any fastener fail a test, the entire sequence of tests as specified in Paragraph 1.2B.3.h shall be performed on a new rail fastener of the same size. If the rail fastener must be modified to pass any tests, Working Drawings of the new rail fastener design shall be submitted for the Owner approval. A new lot of at least 15 rail fasteners, including at least four that are 32 inches or longer, of the new design shall be produced and all tests performed on the new rail fastener design. This cycle shall be continued until rail fasteners are approved, but no longer than four months after receipt of Notice to Proceed. The cost of all such additional testing of any component that does not comply with these Specifications, including expenses for witnessing tests by the Owner 's representative, shall be at Contractor's expense.
- j. Vertical load test
- 1) Total test load: 15,000 pounds developed in increments of 1,000 pounds.
 - 2) Point of application: Downward at centerline of the fastener normal to rail head.
 - 3) Test procedure
 - a) For each load increment, measure continually and record immediately the vertical deflection of the rail head to the nearest 0.001 inch.
 - b) Remove load and measure and record the final position of the rail head.
 - c) Plot record values for vertical loads against deflection on a graph.
 - 4) Test acceptance criteria

- a) Allowable envelope of load deflection curve: For loads in the range between 5,000 pounds and 12,000 pounds for a load corresponding to a 122,000 pound vehicle.
 - b) Slope of the load-deflection curve (spring rate of fastener): Not less than 120,000 pounds per inch nor more than 300,000 pounds per inch. Constancy of slope: Within 10 percent over the load range.
 - c) Recovery of fastener to original position: within .005 inch within one minute.
 - d) Stability: No movement of components caused by other than deflections, and no visual sign of failure by slippage, yielding, or fracture.
 - e) Ratio of deflection to thickness of elastomer:
 - (1) Maximum value for initial test: 4 to 1 or 25 percent
 - (2) Basis of determination: the deflection measured at 15,000 pounds divided by thickness of elastomer in inches; not to exceed as 25 percent of elastomer thickness.
 - (3) Value for repeated tests on same fastener: within 20 percent of initial test values.
- k. Vertical uplift test
- 1) Test loads: Increasing in increments of 200 pounds alternated upward and downward, apply up to 2,000 pounds total uplift load.
 - 2) Point of application: Center of the rail head along the centerline of the fastener.
 - 3) Test procedure
 - a) Continually measure and immediately record the loads and corresponding deflections to the nearest 0.001 inch on a load versus time graph, and a deflection versus time graph, respectively.
 - b) Remove load, and measure and record the final position of the rail head.
 - c) Apply reaction force to the concrete test block to which the fastener is anchored.
 - 4) Test acceptance criteria
 - a) Ratio of the deflection for the total uplift test load to the deflection for the total vertical downward test load: Shall not exceed 200 percent for special rail fasteners and between plus five percent and plus 125 percent for standard rail fasteners of the deflection for a 2,000 pound downward vertical load as determined from the vertical load test.
 - b) Stability: No indication of backlash and freeplay when the vertical load is continuously varied from vertical upwards to vertical downwards.
 - c) Recovery of fastener to original position: within 0.005 inch within one minute after application of the 2,000 pound upward test load and again after application of the 2,000 pound downward test load.
- l. Lateral load test
- 1) Test load: Increasing in increments of 1,000 pounds apply up to 7,500 pounds horizontally to rail head while under a constant vertical load downward at center line of rail head of 13,500 pounds.
 - 2) Point of horizontal load application: 0.625 inch below top of rail along the centerline of the fastener normal to the rail.
 - 3) Test procedure
 - a) Continuously measure and immediately record the lateral deflection of the rail head. Plot recorded values for lateral loads versus deflection on a graph.
 - b) Remove lateral load, and measure and record the final position of the rail head.
 - 4) Test acceptance criteria
 - a) Maximum lateral deflection for 4,000 pounds lateral test load: 0.125 inch.
 - b) Maximum lateral deflection for 7,500 pounds lateral test load: 0.30 inch.
 - c) Maximum difference between original and final position of the rail head: 0.062 inch.
 - d) Stability: No visual signs of failure by slippage, yielding or fracture during testing.

- m. Lateral restraint test
- 1) Set load: Lateral load increasing in increments of 500 pounds from zero to 2,500.
 - 2) Test loads: Two equal lateral loads increasing simultaneously in increments of 500 pounds from zero to 2,500.
 - 3) Point of application: Normal to and at base of rail, symmetrically on each side of the fastener centerline and within limits of fastener.
 - 4) Test procedure: Apply and release set load; set deflection indicators at zero; apply test loads; and measure and record, after each increment of loading, the deflection at the intersection of the centerline of the fastener and the gauge line of the rail to the nearest 0.001 inch.
 - 5) Test acceptance criteria
 - a) Maximum lateral deflection of rail when fully loaded: 0.125 inch.
 - b) Maximum difference between the original and final positions of the gauge line: 0.062 inch.
 - c) Stability: No visual signs of failure by slippage, yielding or fracture during testing.
- n. Longitudinal restraint test
- 1) Rail end support: Roller or other frictionless support properly elevated to prevent the longitudinal load from binding the rail to the fastener.
 - 2) Test load: Increments of 200 pounds increased to 10,000 pounds for special fasteners and 3,000 pounds for standard fasteners or until rail deflects 0.6 inch from its original position, whichever occurs first. The rate at which load is applied shall be between 100 and 1,000 pounds per minute.
 - 3) Point of test load application: longitudinally to the rail as its centroid.
 - 4) Duration per increment of test load: until longitudinal deflection of rail ceases.
 - 5) Procedure
 - a) Mark rail and rail clip at a point common to both.
 - b) Measure and record the longitudinal deflection for each load to the nearest 0.001 inch.
 - c) Remove the longitudinal load and measure and record the final position of rail.
 - d) Plot the recorded values for longitudinal loads against deflection.
- o. Test acceptance criteria
- 1) Envelope for longitudinal loads against deflection curve: For standard rail fasteners only.
 - 2) Difference between original and final rail position: not more than 0.125 inch, plus slippage between rail clip and rail.
 - 3) Stability: no visual yields, fractures, bond failures, and slippages during and after test, except slippage that may occur between rail clip and rail.
- p. High voltage withstand test
- 1) Effect of high voltage on quality of elastomer
 - a) Procedure: Place ground plate between rail fastener and concrete test block. Apply a DC potential of 15KV between rail head and ground plate for one minute.
 - b) Acceptance criteria: neither cracks, pinholes, electrical flashover, or arching nor fracture to occur.
- q. Electrical resistance and impedance test
- 1) Dry resistance:
 - a) Remove moisture, if any, from rail fastener assembly and with one lead of high potential tester connected to rail head and ground lead connected to anchor bolt, apply 500 volts DC for three minutes. Use the current value obtained to calculate resistance.
 - b) Acceptable resistance to 500 volts DC: not less than 10 megohms.
 - 2) Wet resistance:

- a) Release ground plate, rail fastener, and anchorage assembly from concrete test block and rail; immerse rail fastener in distilled water for 70 hours at 100 degrees C for neoprene based elastomers and for 336 hours at 70 degrees C for natural rubber based elastomers.
- b) After rail fastener has been removed from water without drying and with no portion of the rail fastener cooler than 35 degrees C, reassemble and anchor ground plate, rail fastener, and rail on the concrete test block.
- c) Connect one lead of high potential tester to rail head and ground lead to anchor bolt, apply 500 volts DC for three minutes and test for electrical resistance. Use current value obtained to calculate resistance.
- d) Allowable resistance: not less than one megohm.
- 3) Wet impedance:
 - a) With the rail fastener assembly still wet and with no portion of the assembly cooler 35 degrees C, apply a potential of 50 volts AC between rail head and grounded anchor bolt.
 - b) After reading has stabilized for 30 seconds, measure impedance frequencies of 1,000; 2,000; 4,000; 6,000; 8,000; and 10,000 hertz within an accuracy of plus or minus two percent and recorded for each frequency.
 - c) Impedance for frequencies between 20 Hz and 5 kHz with 50 volts AC shall be 10,000 ohms; at 6 kHz shall be 9,000 ohms, at 8 kHz shall be 7,000 ohms, and at 10 kHz shall be 6,000 ohms.
- r. Vertical and lateral repeated load test
 - 1) Procedure:
 - a) Apply test loads to the rail head, so as to produce a vertical downward load of 13,500 pounds and lateral loads 0.625 inch below top of rail and along the centerline of the rail fastener normal to the rail of 4,900 pounds to the gauge side and 3,200 pounds to the field side.
 - b) Alternate the lateral loads and combine with alternated application and release of the vertical load for a total of three million complete cycles. (One cycle consists of one application each of the lateral field side load and of the gauge side load and two applications of the vertical load).
 - c) Regulate the frequency to prevent the temperature of the components from exceeding 70 degrees C.
 - d) Do not retorque the threaded elements subsequent to the completion of 500,000 cycles of loading without written approval of the Owner.
 - 2) Acceptance criteria:
 - a) Minimum cycles of test load application with no visual evidence of failure: Three million.
 - b) Allowable visual failure by slippage, yielding abrasion, or fracture at any time during the test: None.
- s. Vertical and lateral repeated load test with one anchor test
 - 1) Procedure
 - a) After completion of Vertical and Lateral Load Test as specified in Paragraph 1.2B.3.q, reassemble rail fastener using only the original components subjected to testing.
 - b) Apply the Vertical and Lateral Repeated Load Test with gauge side anchor bolt removed for 15,000 cycles.
 - 2) Acceptance criteria: minimum cycles of application with no visual evidence of failure by slippage, yielding or cracking: 15,000 cycles.
- t. Heat aging procedure
 - 1) Test specimen: fully assembled rail fastener, except that the anchor bolts need not be installed.
 - 2) Procedure: age test specimen in an air oven for a period of 70 hours at a temperature of 100 degrees C in accordance with ASTM D 573.
 - 3) Acceptance criteria: none, the purpose being to age the rail fastener for additional testing.

- u. Uplift repeated load test
- 1) Test loads
 - a) Apply loads to the rail head so as to produce a vertical downward load of 12,000 pounds and a vertical upward load of 2,000 pounds at the centerline of the fastener in a direction normal to the rail.
 - b) Longitudinal load: starting at 100 pounds and increasing in increments of 100 pounds up to a maximum load of 600 pounds, at interval of not less than one increment per 100 cycles of vertical loading.
 - 2) Test procedure:
 - a) Alternate the upward and downward loads for 1.5 million cycles.
 - b) Regulate the frequency to prevent the temperature of components of the test specimen from reaching 70 degrees C.
 - c) Do not retorqued threaded elements subsequent to 500,000 loading cycles without written approval of the Owner.
 - d) During the final 500,000 loading cycles of vertical loading, apply the longitudinal load at centroid of rail as specified above and apply the vertical load at a rate of not less than 25 cycles per minute.
 - e) For each load increment, measure the longitudinal deflection of the rail to the nearest 0.001 inch and record.
 - f) Remove the longitudinal load and measure and record the final position of the rail. Plot the recorded values for the longitudinal load versus deflections on a graph.
 - 3) Test acceptance criteria:
 - a) The rail fastener shall withstand 1.5 million cycles of load application with no evidence of failure.
 - b) Upon visual inspection, no component of the rail fastener shall exhibit any evidence of failure by yielding, abrasion, or fracture.
 - c) The rail shall exhibit no visual evidence of wear or grooving that would contribute to a failure of the rail.
 - d) The plot of the loads versus deflections for the longitudinal load portion of the test shall show that movement of the rail was due to the elastic deformation and not slippage of the rail through the rail fastener.
- v. Push-pull test:
- 1) Test load: 4,000 pounds cycling longitudinally or sufficient load to move rail plus or minus 1/8 inch.
 - 2) Points of application: Centroids of the rail at both ends.
 - 3) Procedure:
 - a) Push and pull with the test load for one million complete cycles.
 - b) Repositioning or retorquing of the rail hold-down assembly will be allowed after every 250,000 cycles but not for the last 250,000 cycles.
 - 4) Test acceptance criteria: rail fastener shall withstand one million cycles of loading with no evidence of failure. Upon visual examination no component of the rail fastener shall exhibit any evidence of failure by yielding, abrasion, slippage or fracture. The rail shall exhibit no evidence of wear or grooving contributing to a failure of the rail.
- w. Dynamic to static stiffness ratio test
- 1) Initial static vertical downward test load: 5,000 pounds to deflect the fully assembled fastener 0.03 inch.
 - 2) Rate of application: 10 cycles per second.
 - 3) Procedure:
 - a) Apply initial dynamic vertical downward test load to the rail head over the centerline of fully assembled rail fastener for 1,000 cycles.
 - b) Increase the dynamic test load in increments 1,000 pounds to 12,000 pounds maximum. Record the dynamic load corresponding to each load increment.

- c) Immediately after completing the dynamic load measurements, measure and record the static deflection of 3,000-pound increments for loading of 5,400 pounds to 12,000 pounds. Allow rail fastener to stabilize for at least one minute before each increment of testing is applied.
- d) Measure the deflections within an accuracy of 0.005 inch, and measure the test loads within an accuracy of 2.5 percent.
- 4) Test acceptance criteria: The dynamic and static stiffness shall each be calculated by dividing the difference between each increment of recorded loads by the respective difference between each increment in recorded deflections. The ratio of dynamic to static stiffness shall then be determined by dividing the mean of dynamic stiffness by the means of the static stiffnesses. The ratio shall not exceed 1.5 for neoprene and 1.4 for natural rubber.
- x. Corrosion test
 - 1) Test procedure: Rail fastener body unit without loose components shall be exposed to a five percent chloride solution per ASTM B 117 for 1,000 hours.
 - 2) Test acceptance criteria: There shall be no loss of adhesion from this test at any elastomer and steel boundary deeper than 1/8 inch nor shall there be pitting or corrosion depressions deeper than 1/16 inch measured from plane of the affected surface.
- y. Elastomer
 - 1) General: Have elastomers certified by an independent testing laboratory approved by the Owner to possess the physical properties specified in the following tabulation as determined by the respective ASTM specifications identified therein.
 - a) Test material: Two specimens certified by the accepted independent testing organization to have been taken from a batch of compound used for producing the elastomer component of the fastener and having the same quality cure equivalent to the quality cure of the elastomeric component.
 - b) Test preconditioning: Not less than seven days at 23 degrees C, at 50 percent relative humidity.
 - 2) General test requirements for all elastomer materials:

Test	ASTM Designation	Requirements
Durometer hardness (Shore A)	D 2240	50 plus or minus five
Ultimate elongation	D 412	350 percent minimum
Compression set at minus 10 degrees C. for 70 hours to determine percent compression set 30 minus after release of test load	D 1129	60 percent maximum
Resistance of ozone cracking of specimens prepared in accordance with Procedures A of ASTM D518 and subjected to 40 degrees C for 100 hours in 50 PPM ozone concentration	D 1149	No cracking
Change in Durometer hardness	D 573	10 points maximum
Adhesion of metal test	D 429	Elastomer



Flame propagation index (Is)	Method B E 162	tears before Acceptance criteria not specified but report test results to the Owner.
Smoke generation	NFPA No. 258-T	Allowable drippings: none Acceptance criteria not specified but report test results to the Owner.

3) Neoprene elastomer, additional test requirements:

Test	ASTM Designation	Requirements
High temperature compression set after 22 hours at 100 degrees C	D 395 Method B	35 percent maximum
Tensile strength	D 412	1,500 psi minimum
Accelerated aging after 70 hours at 100 degrees C		
Decrease in tensile strength	D 573	15 percent maximum
Decrease in ultimate elongation	D 573	40 percent maximum
Oil absorption test at 100 degrees C for 70 hours		
ASTM Oil No. 3	D 471	100 percent maximum
ASTM Oil No. 1	D 471	Minus 10 plus 20 percent

4) Natural rubber elastomer, additional test requirements:

Test	ASTM Designation	Requirements
High temperature compression set after 22 hours at 70 degrees C	D 395 Method B	25 percent maximum
Tensile strength	D 412	3000 psi minimum
Accelerated aging 70 hours at 100 degrees C		
Decrease in tensile strength	D 573	25 percent maximum
Ultimate elongation	D 573	25 percent maximum

Change in hardness, measured on the Duro- meter A Scale		10 points maximum
Oil absorption volume change at 100 degrees C for 70 hours		
ASTM No. 3 Oil	D 471	100 percent
ASTM No. 1 Oil	D 471	Minus 10 percent plus 20 percent

4. Production and production testing: Upon the Owner approval of qualification testing as specified in Paragraph 1.2B.3, the Contractor shall begin production of the fasteners. The qualification testing described in Paragraph 1.2B.3 shall serve as the production testing. Contractor shall certify that all rail fasteners produced were manufactured in the same manner as the rail fasteners subjected to the Qualification Testing and that the manufacturing process used for producing each rail fastener is the same. Upon submittal of certification the entire lot of rail fasteners will be released by the Owner for shipment from the Contractor's facility.
5. Identification: Mark sequential lot number, Contractor's name or trademark, and consecutive numbers on each size of rail fastener in a permanent manner.

- C. Product Delivering, Storing, and Handling: Package components required for all special trackwork specified.
- D. Job Conditions:
 1. Provide proper care, maintenance, and condition of rail fasteners installed prior to final acceptance.
 2. Complete installation of rail fasteners prior to operation of work trains.

1.2 PRODUCTS

- A. Materials: As required to satisfy the specified design criteria.

1.3 EXECUTION

- A. Manufacture, Test, And Deliver Rail Fastener Assemblies: As specified and in accordance with the accepted shop drawings.

END OF SECTION 34 01 23 33g



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SECTION 34 01 23 33h - TRACTION POWER

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of products for bonding joints in running rail. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control: Construction Equipment

1. Rail grinder: Have vitrified grinding wheel.
2. Rail cleaner: Nontoxic, and capable of removing grease, rust, scale, and dirt.

1.2 PRODUCTS

- A. Cable For Pin-Type Bond: Consist of 500 MCM, 259 strands, single conductor, insulated, nonshielded cable specified in Division 34 Section "Contact Rail System".

- B. Cable For Welded-Type Bond: Bare, annealed copper 250 MCM, single conductor, and stranding conforming to ASTM B 173 Class G, and have swaged steel sleeve or ferrule type welding lugs designed to enable cable ends to be exothermically welded to running rails; ERICO Products Inc.'s Part No. PBC1-2W-13, or accepted equivalent.

- C. Pin-Type Traction Power Bond: Fit 500 MCM cable and one inch diameter hole in rail; Erico Products, Inc.'s No. B-188-3Q slotted rail terminal having pin, washer, and lock nut, or accepted equivalent.

- D. Protective Coating: Dearborn Chemicals Co.'s NO-OX-ID, or accepted equivalent.

1.3 EXECUTION

- A. Preparation: Grind bonding surfaces of rail; and remove scale, rust, grease, and dirt.

B. Pin-Type Bond

1. Position bond further than six inches from a joint bar, further than 18 inches from center of a welded joint, and further than six inches from each other.
2. Drill one inch diameter hole at the neutral axis of the rail, perpendicular to the vertical and longitudinal axis of the rail, but not through rail brand. Holes shall be bright, clean, dry, and free from rust, burrs, and foreign substances affecting conductivity of joint and soundness of rail.
3. Drive a lubricated tapered punch, of a size recommended by bond manufacturer, through slotted rail terminal; then insert a correctly-sized drift pin. Install washer and torque lock nut in accordance with nut manufacturer's printed recommendation.
4. Connect cable to terminal by either compression method or exothermically welding; connect in accordance with connection manufacturer's printed recommendations.
5. Peen installed bonds.
6. Place cables along bottom flange of running rails and secure cables to flange with cable clips.

C. Welded-Type Bond

1. Position bond on field side of rail heads around bolted joints.
2. Exothermically weld bond in accordance with weld manufacturer's printed instructions, ensuring that weld will be mechanically and electrically continuous.



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3. Apply protective coating to rail head bond in accordance with coating manufacturer's printed instructions.
- D. Field Testing: Test welded bond by hammer and striker test, and in accordance with welding kit manufacturer's printed instructions. If bond is defective, remove bond, furnish and install new products for bonding joints, and test new bond.

END OF SECTION 34 01 23 33h

SECTION 34 01 23 33i - ROADWAY CROSSING CONTROL EQUIPMENT

1.1 GENERAL

A. Description

1. This specification covers the furnishing and installation of products for crosswalk and grade crossing. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Crosswalk

1. Timber: Number 2 pressure-treated yellow pine. Stamp each timber AWPI DRY and AWPI LP-2 before treating timber. Reduce moisture content of decking and decking support members to not more than 19 percent by weight by kiln drying before treating those products. Maintain water-absorbing property which is not greater than that of untreated lumber.
2. Hardware
 - a. Fastener for securing deck timbers to cross beams: Joist hanger nail galvanized in accordance with ASTM A 153; Cleveland Specialty Co., or accepted equivalent.
 - b. Fastener for securing cross beams to support beams: Galvanized dome head drive spike or washer-head timber screw; Lewis Nut and Bolt Co.'s Sealtite, Cancar Div. of Textron Industries, Inc.'s Torx Truss Washer Head, or accepted equivalent.
 - c. Fastener for securing support beams to concrete ties: Threaded hook bolt galvanized in accordance with ASTM A 153 after threading; Lewis Bolt and Nut Co.'s Sealtite having Sealtite washer nut and hook lock plate, or accepted equivalent.
 - d. Fastener for securing flangeway timbers to direct fixation concrete: Anchor bolt, conforming to ASTM A 307 and hot-dip galvanized in accordance with ASTM A 153, and concrete insert.
3. Preservative solution for treating field-cut timber: 0.9 Osmose Solution, or accepted equivalent.
4. Anti-slip coating: Two-part epoxy resin and graded aggregate dispersed throughout epoxy. Not less than 100 percent of aggregate shall pass the No. 30 sieve and not less than 95 percent shall pass the No. 50 sieve; Tasa Corp., or accepted equivalent.
5. Sealant: Asphalt mastic conforming to ASTM D 491, or accepted equivalent.
6. Bonding agent: Preco Co.'s Rockweld C, or accepted equivalent.
7. Concrete formwork: CONCRETE FORMWORK.
8. Concrete reinforcement: CONCRETE REINFORCEMENT.
9. Portland cement concrete: Class 3000 PORTLAND CEMENT CONCRETE.
10. Grout: Nonshrink type conforming to CRD C621.
11. Asphaltic concrete
 - a. Bituminous prime coat: Cutback asphalt MC250.
 - b. Bituminous tack coat.
 - c. Base course: Asphaltic Concrete "Base".
 - d. Surface course: Asphaltic Concrete "Surface".
12. Fabrication
 - a. Orient timber heartwood face downward.
 - b. Cut beams square. Bevel outside ends of timber decking and flangeway timbers four inches at 45 degrees.
 - c. Drill holes for anchor bolts; countersink ends of holes for washers and nuts. Drill no holes the centerline of which is less than two inches from edge of timber.
 - d. Pressure-treat cut and drilled timbers by the Osmose K-33 method in accordance with AWPI; develop preservative retention of not less than 0.25 pound per cubic foot.

- e. Assemble crosswalk with heartwood facing downward and ends of decking timbers, cross-beams, and support beams being aligned. Nail decking to cross-beams with two nails per timber.

B. Grade Crossing

- 1. Timber: Maple, gum, or birch.
- 2. Fastener for securing timber flangeway to wood tie: Dome-head drive spike; Lewis Nut and Bolt Co.'s Sealite, or accepted equivalent.
- 3. Preservative: Creosote type.
- 4. Asphaltic concrete
 - a. Bituminous prime coat: Cutback asphalt MC250.
 - b. Base course: Asphaltic Concrete "Base".
 - c. Surface course: Asphaltic Concrete "Surface".
- 5. Fabrication
 - a. Orient flangeway timber heartwood to face downward.
 - b. Cut timbers square except bevel ends of flangeway timbers, which will not abut other timber, four inches at 45 degrees. Notch flangeway timber to clear tie plate hardware by not less than 1/2 inch.
 - c. Pressure-treat cut and drilled timbers in accordance with AREA MRE Chapter 3, Part 9.

1.3 EXECUTION**A. Examination: Examine surfaces on which crosswalk and grade crossing will be placed.**

- 1. Ensure that track has been raised and aligned to its final alignment and profile and has been accepted by the Owner.
- 2. Ensure that ballast has been dressed to final cross section.

B. Surveying: Survey installed CWR; determine its horizontal and vertical track alignments.**C. Preparation**

- 1. Remove loose material from tie, rail, and rail fastenings.
- 2. If wood products have been field-drilled and field-cut, coat drilled and cut surfaces with preservative solution immediately after holes have been drilled and surfaces have been cut.

D. Installation

- 1. Anchor timbers; seat solidly.
- 2. Drive spikes and nails, and torque screws; make timber connections rigid.
- 3. Fill space between countersunk timber and bolt and washer with sealant.
- 4. Apply not less than 1/16 inch of anti-slip compound to wearing surfaces of flangeway timber and crosswalk timber decking in accordance with anti-slip manufacturer's printed instructions.
- 5. Place concrete formwork in accordance with CONCRETE FORMWORK. Place concrete reinforcement in accordance with CONCRETE REINFORCEMENT. Place concrete in accordance with CAST-IN-PLACE CONCRETE. Broom- finish concrete surface in accordance with UNFORMED- CONCRETE FINISHES.
- 6. Tolerances
 - a. Top of flangeway and timber, vertical depression below top of rail: plus 1/4 inch, minus zero.
 - b. Clearance between sides of flangeway and timbers and edge of rail: plus 1/4 inch, minus zero.
 - c. Difference in elevation between surfaces of flangeway and timber and surface of abutting paving: 1/8 inch.



END OF SECTION 34 01 23 33i



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Task	Specification	Specification Description
34 01 23 33	34 11 00 00	Rail Tracks
34 01 23 33	34 11 93 00	Track Appurtenances and Accessories
34 05 43 00	03 01 30 00	Maintenance of Cast-in-Place Concrete
34 05 43 00	03 41 00 00	Precast Structural Concrete
34 05 43 00	05 12 00 00	Structural Steel Framing
34 05 43 00	05 40 00 00	Cold-Formed Metal Framing
34 05 43 00	05 50 00 00	Metal Fabrications



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SECTION 34 11 00 00 - RAIL TRACKS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of railroad track and accessories. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit the following.

1. Shop Drawings
 - a. Turnouts
 - b. Road crossings
 - c. Car bumper
 - d. Railroad crossings
 - e. Layout drawings
2. Product Data
 - a. Rails
 - b. Wood ties
 - c. Precast concrete ties
 - d. Tie plates
 - e. Tie pads
 - f. Track bolts, nuts, and spring washers
 - g. Standard, compromise, and insulated joint bars
 - h. Rail anchors
 - i. Rail clips and fasteners
 - j. Track spikes
 - k. Turnouts
 - l. Pre-manufactured road crossings crossing surfaces
 - m. Car bumper
 - n. Wheel stops
 - o. Derails
 - p. Gage rods
 - q. Switch point protectors
 - r. Switch stands
 - s. Geotextile fabric
3. Test Reports
 - a. Ties preservative treatment
 - b. Ballast tests
4. Certificates
 - a. Rail welding procedures
5. Operation and Maintenance Data
 - a. Rails
 - b. Accessories
 - c. Pre-manufactured road crossings
 - d. Turnouts

- C. Temporary Work: During construction, provide suitable roads and crossing with necessary lights, signs, drainage, and other appurtenances required for safe public and local travel. Erect and maintain suitable temporary fences where required to prevent trespass upon work or damage to adjoining property. Maintain drainage and prevent accumulation of water that might affect roadbed stability.

D. Quality Assurance



1. Layout Drawings: Layout Drawings: Submit for approval by the Owner before work is started. Do not prepare layout drawings until field surveys and measurements are completed. Do not order materials until layout drawings are approved. Include on layout drawings locations of turnouts, various sizes of rail, compromise joints, and locations of rail accessories.
2. Ties Preservative Treatment: Ties shall be marked in accordance with American Wood-Preservers' Association (AWPA) M6 and inspected in accordance with AWPA M2, for conformance with the specified AWPA Standards, by an independent inspection agency approved by the Owner. The agency's report of inspection shall accompany delivery of the ties, and shall be provided to the Owner's representative.

1.2 PRODUCTS

A. Ballast, Subballast and Geotextile

1. Ballast: Crushed stone Size No. 3, 4, 4A, 5, or 57 conforming to American Railway Engineering and Maintenance-of-Way Association (AREMA) Ch. 1 for quality, soundness and gradation. Ballast materials shall meet the property requirements shown in Table I.

TABLE I - MINIMUM PROPERTY REQUIREMENTS - BALLAST

<u>Property</u>	<u>Test Method</u>	<u>Max. Value</u>	<u>Min. Value</u>
Percent Passing (No. 200) Sieve	ASTM C 136	1.0 percent	
Bulk Specific Gravity - Rock	ASTM C 127		2.60
Absorption - Rock	ASTM C 127		2.0 percent
Clay Lumps and Friable Particles	ASTM C 142	0.5 percent	
Degradation	ASTM C 131	35 percent	
Soundness	ASTM C 535		
Sodium Sulfate - 5 Cycles	ASTM C 88	10 percent	

2. Subballast: Consists of aggregate-soil mixtures conforming to an ASTM D 1241 Type I, Gradation A **OR** B, **OR** C, **OR** D, **as directed**, mixture as approved.
3. Geotextile Fabric: Consists of a needle-punched nonwoven material that provides a permeable layer, planar flow, and tensile reinforcement, while retaining the soil matrix. Fabric shall be inert to commonly encountered chemicals, mildew, rot, insects, rodents and shall be treated to resist degradation caused by exposure to sunlight. Fabric will conform to the properties in Table II.

TABLE II - MINIMUM PROPERTY REQUIREMENTS - GEOTEXTILE FABRIC

Fabric Property	Fabric Requirement	
	Test Method	Minimum Value
Grab Tensile Strength, (lbs)	ASTM D 4632	175
Grab Tensile Elongation, percent	ASTM D 4632	20
Coefficient of Water Permeability, (cm/sec)	ASTM D 4491	0.10
Puncture Strength, (lbs)	ASTM D 3787*	110
Mullen Burst Strength, (psi)	ASTM D 3786	400
Apparent Opening Size (AOS) (U.S. Standard Sieve)	COE CW 02215	70

*Tension testing machine with ring clamp; steel ball replaced with a 5/16-inch diameter solid steel cylinder, with flat tip and beveled edges, centered within the ring clamp.

B. Rails: New, minimum 115 pound RE section conforming to AREMA Ch. 4. Provide in 39 **OR** 78, **as directed**, foot lengths. Provide no closure pieces less than 13 feet. Bend in shop curved rail to proper radii, where degree of curvature exceeds 18 degrees.

1. Relayer Rail: Ninety pounds or heavier up to 136 pounds. Characteristics shall conform to requirements of MIL-R-3911 as modified in Table III:

TABLE III - RELAY RAIL CHARACTERISTICS

Minimum Weight per Yard	(original (lbs):	(90 to 136)
Wear:	Max. top wear (in.):	(3/16)
	Max. side wear (in.):	(1/8)
	Length:	As ordered but not less than (13 feet).
Defects permitted:	None	
Max. Lip (in.):	(1/16)	

2. Relayer rail shall be of the same section and drilling pattern throughout the project, except that the drilling pattern for bolt holes at turnouts shall be as indicated. No mingling of new and relayer rail will be permitted, and all relayer rail of the same section and drilling pattern shall be kept together in one area.

C. Wood Ties: Except as otherwise noted, ties shall be in accordance with FS MM-T-371, Types II cross ties and III switch ties, treated in accordance with AWPA C6. Species shall be as listed in FS MM-T-371 except that species shall not be mixed in a charge or bundle. Each treated piece shall be permanently marked or branded, by the producer, in accordance with AWPA M6. All ties except Southern, red, and ponderosa pine shall be incised prior to treatment. Splits shall not be longer than 4 inches nor wider than 1/4 inch at either end. Splits longer than 4 inches but not longer than the width of the face in which the split appears shall be acceptable if anti-splitting devices are installed with splits compressed. S-irons, dowels, and end plates are acceptable anti-splitting devices. Treatment shall be verified by an approved independent inspection agency report. Note: When the Owner inspections result in product rejection, the Contractor shall promptly segregate and remove rejected material from the premises. the Owner may also charge the Contractor additional cost of inspection or test when prior rejection makes reinspection or retest necessary.

1. Cross Ties: Size: 7 inches thick by 9 inches wide. Length: 8 feet 6 inches.

2. Switch Ties: Size: 7 inches thick by 9 inches wide. Length and quantities as indicated.

3. Tie Plugs: Conform to AREMA Ch. 30. Treat plugs with creosote-coal-tar solution of 8 pounds per cubic foot in accordance with AWPA C6. Provide plugs to fit holes from which spikes are drawn.

D. Precast Concrete Ties: Provide in the dimensions indicated, designed and manufactured in accordance with AREMA Ch. 8. Provided by manufacturers regularly engaged in the manufacture of precast concrete ties and essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening.

1. Tie Plates: Provide new or used tie plates in good condition conforming to AREMA Ch. 5-1. Provide plates of the dimensions and punching pattern to fit the rail. Relayer (used) tied plates provided shall have no deformities or cracks, a minimum amount of surface rust, no pitting in excess of 1/16 inch deep, no cutters (bottom ribs), 1:40 cant on rail seat area, a maximum of 1/8 inch wear on seat section and physical dimensions in accordance with AREMA Ch. 5-1. The relayer tie plates may be repunched to accept base of existing rails but no slotting shall be accepted. New holes must have one inch clearance from closest existing hole and no hole shall be punched on the shoulder side of tie plate. Relayer tie plates shall be approved on individual basis by the Owner.
- E. Tie Pads: Conform to AREMA Ch. 30-2 for use with precast concrete ties.
- F. Track Bolts, Nuts, And Spring Washers: Provide new throughout the project. Provide oval-neck, heat-treated, carbon-steel track nuts and carbon-steel track bolts conforming to AREMA 4-2. Spring washers shall conform to AREMA 4-2 and shall be of the size to fit the bolt and nut used and a minimum of 1/2 inch thick.
- G. Joint Bars: Provide new or used joint bars in good condition conforming to AREMA Ch.4-3. For new construction, provide bars of the "toeless" head free type, of the size, shape, and punching pattern to fit the rail. Joint bars shall be 24 inches **OR** 36 inches, **as directed**, long and have four **OR** six, **as directed**, bolt holes. For repair work, provide head-contact joint bars. Contractor shall verify the punching pattern of existing rail before ordering joint bars.
- H. Compromise Joint Bars: Provide new, conforming to AREMA Ch.4-3, for changes in rail size or where rail drilling differs. Compromise joints shall be angle bar type of forged or cast steel accurately machined to properly align the combination of rail sections indicated. Steel shall have physical properties equal to or exceeding AREMA specifications for those of standard rolled steel joints. Joints shall be manufactured by an established track appliance manufacturer.
- I. Track Spikes: AREMA Ch. 5-2 for track spikes, size 6 by 5/8 **OR** 5 1/2 by 9/16, **as directed**, inches. Provide new spikes throughout the project.
- J. Rail Clips And Fasteners: Provide single tight fit clips with fillers as necessary to fit rail section furnished. Clip or fastener design shall anchor rail against longitudinal movement.
- K. Accessories
1. Rail Anchors: Standard manufacture as approved and of the size to fit the rail section. Where special installation tools are required, furnish a minimum of one tool for each 2,000 anchors.
 2. Gage Rods: Provide Type A gage rods of 1 1/4 inch round steel rods with double adjustable clamps at both ends, suitably sized for use with the standard rail section furnished. Provide Type B gage rods of 1 1/4 inch round steel rods with a hook at one end and a single adjustable clamp at the other end, suitably sized for use with the standard rail section furnished. Use the product of a manufacturer who is regularly engaged in the manufacture of steel gage rods.
 3. Switch Point Guard-Rail Type Protectors: Guard-rail type, standard manufacturer's product of heat-treated rail **OR** manganese steel, **as directed**, and of size to fit rail section furnished. Protectors shall be bolted to rails.
 4. Flangeway Guard: Flangeway guard assembly shall include steel casting blocks, hook bolts, set bolts, and steel angle. The steel casting blocks and hook bolts shall be sized and provided to fit the rail section furnished and shall be a standard manufacturer's product, designed and constructed for use as a flangeway guard in railroad applications in pavement. Provide and secure steel angles to the steel casting blocks by the set bolts as indicated; other steel shapes shall not be substituted for steel angles shown. Prior to paving, the flangeway guard shall be coated with two coats of an asphalt varnish applied to a dry-film thickness of at least two mils total thickness.

5. Wheel Stops: Cast steel of double wedge design, and of standard commercial manufacture for the purpose.
 6. Derails: Conform to MIL-D-11302 and satisfactory for use with the weight rail specified. Provide derails at locations and in numbers indicated or specified. Complete unit shall weigh not less than 100 pounds.
 7. Car Bumper Post: Standard product of a commercial manufacturer of railroad accessories. Post shall be made from structural steel sections arranged for attachments to the rails by bolting, and located so that the thrust will be transmitted through the cross ties to ballast and earth. Post shall consist of a head to accept horizontal thrust of the car couple and transmit it to tension members and compression members having at least a moment of inertia not less than 17.1. Complete unit shall weigh not less than 800 pounds.
- L. Oil: Oil for rail and other track materials, except joints, shall conform to the following:
1. Flash point: minimum 130 degrees F, ASTM D 1310.
 2. Asphalt: 100 penetration, minimum 45 percent.
 3. Viscosity: Saybolt Universal, 130 degrees F, 240 to 350 seconds, ASTM D 88.
- M. Electrodes: Provide AWS low-hydrogen, high-tensile 140-16 (extrapolation) or 25-20 electrode, Grade 310-16 and 310-15 stainless steel rod welding electrodes. Provide electrodes of the smallest practical diameter worked at the lowest compatible current. Coating on low-hydrogen type electrodes shall be thoroughly dry when the electrode is provided. Use electrodes taken from hermetically sealed packages within one hour of the time the package is opened. Electrodes not used within this one-hour period and electrodes taken from non-hermetically sealed packages shall be dried for at least one hour between 700 and 800 degrees F. Electrodes so dried may be stored at temperatures between 225 and 400 degrees F until used, or, if not stored and not used within one hour after this drying is completed, shall be re-dried before use. Do not use electrodes which have been wet.
- N. Turnouts: Component parts of the turnouts to be furnished shall be the products of manufacturers regularly engaged in the manufacture of such products, and shall essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. The parts need not all be made by the same manufacturer, but each turnout shall be the product of a single firm. Provide complete, including all track materials and switch ties in accordance with appropriate area trackwork plan. Switch assemblies, stands, rigid bolted frogs, and guard-rail assemblies shall conform to AREMA PTWP (Portfolio of Trackwork Plans). One switch point in each turnout shall be manganese tipped in accordance with AREMA PTWP Plan governing manganese tipped switch points, installed on the side opposite the turnout side of the switch. Rail used in turnout shall be new end hardened, minimum 115 pound RE section, drilled for four **OR** six, **as directed**, holes. Bend in stock rail shall be in accordance with AREMA.
1. Turn Out Plates: Provide plates and rail braces in strict accordance with the current AREMA trackwork plan governing the turnout with respect to the number of the turnout. Provide turnout plate system complete with slide plates, heel plates, guard rail tie plates, hook twin tie plates, including those for the frog, rail braces, standard tie plates or other accessories required to complete the installation. Hook twin tie plates shall be in accordance with AREMA PTWP governing hook twin tie plates. Gage plates shall be solid. Rail braces shall be either fixed or adjustable type of standard manufacture.
 2. Switch Stands: Low-stand type, adjustable from top with shims through a moveable cover and a replaceable double crank of malleable iron, complete with reflectorized red and white aluminum target minimum thickness 14 gage, self-locking connecting rod, reversible target tip arm crank, parallel throwing latch and interchangeable parts. Each stand shall be equipped with one of the following switch lamps as indicated:
 - a. Reflecting type: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses but without day signal targets.
 - b. Reflecting type with daylight disk: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses, and with approved day signal targets.

- c. Illuminated type: Approved illuminated lamps with primary battery, battery housing, and cable.

O. Road Crossings

- 1. Bituminous, Wood or Treated Timber Crossings: Wood and treated timber material for road crossing shall conform to AWPA C6. Bituminous crossings shall conform to Division 2 Section "Hot-Mix Asphalt Paving."
- 2. Rubber Railroad Crossings: Manufacturers standard product for a rubber railroad crossing consisting of manufactured panels of full depth rubber or partial depth panels of rubber and steel conforming to the following requirements:
 - a. Partial depth panels shall be reinforced with steel plates, arches, or post tensioned cable fully encased in the rubber. Post tensioned cables shall be encased with a polycarbon material before rubber encasement.
 - b. Rubber hardness of 55 to 80 (tested in accordance with ASTM D 2240, Durometer A).
 - c. Rubber tensile strength of 1000 psi to 2500 psi (tested in accordance with ASTM D 412).
 - d. Rubber elongation of 100 to 400 percent (tested in accordance with ASTM D 412).
 - e. Headers shall be manufacturer's standard rubber header.
 - f. Shims shall be hardwood, treated with creosote in accordance with AREMA Ch 3, for lumber and timber in ground contact.
 - g. Materials for securing the crossing shall be as recommended by the rubber crossing manufacturer.
 - h. Provide components pertinent to each manufacturer's system to provide each rubber railroad system complete and ready for use.

1.3 EXECUTION

- A. General Trackwork: Perform track construction not covered specifically herein in accordance with AREMA MRE (Manual for Railway Engineering (Fixed Properties) recommended practices.
- B. Subgrade Preparation: Obtain approval of roadbed surface, grade, and drainage prior to distribution of construction material. Provide equipment that will not form ruts or water pockets when distributing material over the finished road bed. Where subgrade or road bed surface is damaged, perform repairs including regrading and recompaction in accordance with Division 2 Section "Earthwork."
- C. Ties
 - 1. Wood Ties: Space cross ties 24 to the 39 foot rail for mainlines, access tracks or other tracks where the movement may be classified as heavy. Space cross ties 20 to the 39 foot rail for body tracks in yards, sidings, running tracks and access tracks where the movement is not classified as heavy. Space switch ties and bridge ties as indicated. Use oak cross ties in road crossings. All curved track should have oak ties installed. All curved track should have a minimum 6 oak ties spaced uniformly among the number of ties required. Lay ties normal to the centerline of the track with the wide heartwood face down. Provide the best ties at rail joints. Do not move or place ties with picks, shovels, mauls, sledges, or spiking hammers. Make ends of ties on one side of the track parallel to the rail so that center of tie will be on the approximate centerline of the track. Align the ends on the inside of curves and continue on that side until reaching a curve in the opposite direction. On double tracks, align the ties on the outside ends. Provide full bearing for tie plates. Restrict adzing to that necessary to provide a sound true bearing for the tie plate. Where necessary to adz, dap or drill holes in the timber tie. Saturate cut surface with creosote or other approved preservatives.
 - 2. Precast Concrete Ties: Provide ties in accordance with AREMA Ch. 30.
- D. Tie Plates: Place tie plates with full bearing on the tie. Tie plates shall be free of dirt and other foreign material when installed. Set tie plates at right angles to the rail with the outside shoulder against the

base of the rail, and centered on the tie. Place tie plates so that the rails will have full bearing on the plate and the plate will have full bearing on the tie.

- E. Tie Pads: Place pad on concrete tie so that rail will have full bearing on tie pad.
- F. Rails: Clean base of rail and tie plate prior to laying. Lay rails without bumping or striking to standard gage 4 feet 8 1/2 inches on tangents and on curves up to 12 degrees. Widen gage on curves greater than 12 degrees, 1/8 inch for each additional increment of 2 degrees above 12 degrees to a maximum gage of 4 feet 9 inches. Gage the track normal to the rails at joints, centers, and quarters as spikes are being driven. Stagger joints in opposite rails not less than 13 feet apart, except closer joints may be required at turnouts or insulated joints. Rails of less than standard length may be used, but no less than 13 feet, to space the joints on curves. No joint shall be less than 6 feet from the ends of open-deck bridges, or less than 3 feet from switch points. Do not install joints within 20 feet of a road crossing, outer perimeter of structure, or location which restricts access to the joint. Where joints are required in these areas, the joints shall be welded. Provide allowance for thermal expansion at bolted rail joints by using rail-expansion shims of wood, fiber, or metal. Remove shims to within 12 rails of the laying. Provide shims of the thickness, based upon rail temperature during construction, as shown in Table IV. Determine the temperature of the rail by use of a thermometer placed on the base of the rail in the shade. Use rail saws to cut rail. Drill new holes. Holes cut with a torch will not be acceptable. Adjacent relayer rails shall be matched to prevent lipped or uneven joints, and any mismatched rail ends shall be ground or built-up welded.



TABLE IV - SHIM THICKNESS

33 Foot Rail		39 Foot Rail		78 Foot Rail	
Rail Temperature, Degrees F	Shim Thickness, Inches	Rail Temperature, Degrees F	Shim Thickness, Inches	Rail Temperature, Degrees F	Shim Thickness, Inches
Below -10	5/16	Below 6	5/16	Below 35	5/16
10 to 14	1/4	6 to 25	1/4	35 to 47	1/4
15 to 34	3/16	26 to 45	3/16	48 to 60	3/16
35 to 59	1/8	46 to 65	1/8	61 to 73	1/8
60 to 85	1/16	66 to 85	1/16	74 to 85	1/16
Over 85	None	Over 85	None	Over 85	None

G. Joint Bars: Coat clean joint bars with petroleum or petroleum based compound with a corrosion inhibitor. Rail joints shall be installed so that the bars are not cocked between the base and head of the rail. Base shall be properly seated in the rail and the full number of correct-size bolts, nuts, and spring washers installed. Apply corrosion resistant grease to the bolt threads prior to application of nuts. Place bolts with nuts alternately on inside and outside of rail and draw tight before spiking. Bolts shall be tightened at the center of the joint and working both ways to the ends of the joint. At initial tightening, make bolt tension 20,000 to 30,000) lbs/bolt. After track has been in service and before acceptance of the work, check all bolts and tighten. Allow two threads of all bolt lengths to protrude from the nut after tightening. Connect rails of different sections by properly fitting compromise joint bars. The mismatch for compromise joints for either tread surface or gage side alignment shall not exceed 1/16 inch.

H. Welding Joints

1. Welded Rail Joints: Properly clean rails of foreign substances such as dirt, grease, loose oxide, and slag, prior to welding. Rail ends shall be properly aligned with the provisions for proper joint gap, and lateral and vertical positioning of the rail ends. Proper joint gap and positioning of rail ends shall be in accordance with the recommendations and specifications of the manufacturer and supplier of the particular welding process used, all subject to prior approval by the Owner. Weld rail in an approved manner and by workmen familiar with the welding method used. Do not weld when the rail temperature is lower than that recommended for the welding method used. Welding together of rails which have been drilled for bolted joints will not be permitted. Rail joints except those joints at fittings shall be welded. Use the thermite self-preheat method **OR** manual shielded-arc welding method, **as directed**.
 - a. Thermite Self-Preheat Method: See Division 34 Section "Welding Crane And Railroad Rail-thermite Method" for specifications.
 - b. Manual Shielded-Arc Welding Method: Use this process in accordance with applicable provisions of the AWS WHB-2 CH 2 and the following instructions:
 - 1) Rail end preparation: Bevel the ends of the rails at approximately 35 degrees full bevel on the head, 35 degrees double bevel on the web, and 35 degrees full bevel on the upper side of the base. Retain a narrow "nose", approximately 1/16 inch, of the original rail-end face across the base and up the web following the beveling operation, to permit proper alignment of rail ends. When beveling with a torch, first preheat each rail end to 500 degrees F. After torch cutting, grind off scale and oxides. Grind level faces only after preheating. Use proper grinding wheel and speed to avoid grinding "burns" or formation of "hard spots" from localized overheating.
 - 2) Alignment of rails: Align the beveled rail ends, allowing approximately 1/8-inch root clearance, and place a copper shim under the joint opening. Clamp the rails during the welding with up to 1/4-inch vertical camber (ends high) in four feet, centered over the joint to compensate for contractional distortion.

- 3) Preheating joints: Preheat the joint area to approximately 500 degrees F for a distance of 6 to 8 inches on each side of the joint, using a suitable heat source such as an oxy-acetylene or propane torch.
 - 4) Arc welding: Initiate welding of the joint immediately after preheating in the following sequence: base, web and head. Weld alternately on both sides of the base and web. Do not entrap foreign material, such as slag, in the weld. Ground, chip, or arc-air the root of the initial weld to sound metal before welding is started from the second side. Maintain a 500 degrees F to moderately higher interpass temperature. Proceed with welding until the joint is completed and sufficient metal has been deposited to permit grinding to finish contour in the head area. Provide slight reinforcement of the web and top of base areas.
 - 5) Postheating of welds: Postheat the joint area to approximately 700 degrees F immediately after the welding operation, using the same technique for preheating. After postheating, protect the weld area against rain and snow and cool as slowly as possible by covering with an insulating blanket.
 - 6) Grinding of welds: Remove the excess deposited weld metal from the sides and top of the rail head using a heavy-duty grinder. Grind the area smooth, finishing closely as practical to the original contour. Use proper grinding wheel, speed, and rate of metal removal to avoid grinding "burns" or formation of "hard spots" from localized overheating. Exercise care to prevent grinding cracks.
 - 7) Temperatures: Measure the temperatures as indicated herein by temperature pencils.
- c. Electric Flash-Butt Method: Welding process shall conform to applicable provisions of AREMA Ch. 4-3.
- I. Spiking Wood Ties: Spike rail promptly after laying. Do not remove gage until spikes are driven. Start and drive spikes vertically and square with the rail and allow about 1/8 inch space between spike head and rail base. Provide four rail-holding spikes on each tie on tangent track and on curved track up to 6 degrees of curvature; spikes being staggered with outside spikes in each tie near the same edge, and inside spikes near opposite edge of tie with position of spikes the same on ties requiring four spikes. Provide six rail-holding spikes on each tie on curves of larger than 6 degrees of curvature, one on outside and two on inside of each rail. Provide eight rail-holding spikes on each tie through road crossings. At joints, hold rail in place by reversing the normal position of the spike when it is driven.
1. Plate Holding Spikes: Plate holding spikes shall have pilot holes predrilled in accordance with AREMA Ch. 30. Swab field-drilled pilot holes with creosote prior to spiking.
 2. Tie Plugs: If spikes are withdrawn, swab the holes with creosote and plug with creosoted tie plugs of proper size to fit the hole. If spikes are withdrawn and spikes are to be re-inserted in existing spike holes, the holes shall be swabbed with creosote and plugged with creosoted tie plugs prior to re-driving the spike.
- J. Fastening Concrete Ties: Install fastenings for concrete ties in accordance with manufacturer's recommendations. Protect exposed portions of fasteners from corrosion.
- K. Turnouts And Crossovers: Locate turnouts and crossovers as indicated. Frog, switch, and guard-rail assemblies shall be complete. Accurately bend stock rails. A switch point protector shall be provided at each switch, on the rail as required to meet project requirements. Place headblocks at right angles to the main track and securely spike. Except where directed otherwise, set switch stands on the closed-point side when the switch is in normal position. Adjust switches properly. Swab turnout fixtures with oil. Changes in rail section will not be permitted within the limits of switch ties.
- L. Accessories
1. Rail Anchors: Locate as indicated. Apply 16 anchors per 39 feet of rail in the pattern indicated in accordance with AREMA recommendations for "Light Density Lines" in AREMA Ch. 5. Distribute anchors uniformly along rail without application on joint ties. Install rail anchors on gage side of rail against same tie face on opposite rails. Rail anchors shall grip the base of the rail firmly and shall have full bearing against face of tie. Rail anchors shall not be removed by driving them

along the rail. Rail anchors shall not be applied to track on an open-deck bridge. Where anchors are applied on track approaching an open-deck bridge, every third tie shall be box anchored for at least two rail lengths off each end of the bridge.

2. Guard Rails: Install guard rails on curves, bridges and trestles in accordance with AREMA PTWP. Bridge guard rails shall be approximately 11 inches from gage side of track rails, and shall extend a minimum of 30 feet beyond the structure. Ends shall be curved inward and beveled. Fully bolt guard rails. Guard rails shall not be higher than the running rails, and shall not be more than one inch lower than the running rail. Each guard rail shall be spiked with two spikes to each tie, but shall not be tie-plated. Unfit track rail in short lengths can be used for guard rails. Relay rail of the same size as the running rail may be used if it meets the requirements of MIL-R-3911.
3. Derails: Install derails where indicated. Place derails so that derailed equipment will not foul other tracks.
4. Bumpers and Wheel Stops: Install bumpers and wheel stops where indicated.

M. Ballast Distribution

1. Subballast shall be installed if required and as required to meet project requirements.
2. Geotextile fabric shall be installed if required and as required to meet project requirements.
3. Ballast shall not be distributed until area where ballast is to be installed has been approved by the Owner. No ballast shall be distributed without the Owner's approval. Ballast distribution shall be to depth indicated and may be from either trucks or railroad cars. Take care when distributing ballast from automotive equipment to prevent forming of ruts that would impair proper roadway drainage. Ruts formed that would impair drainage shall be leveled and graded to drain. Excess ballast shall be picked up and redistributed at the Contractor's expense. If additional ballast is required for dressing, it shall be added by the Contractor at no increase in price. No ballast cars shall be released until they have been inspected by the Owner. Cars may be weighed by the Owner at no cost to the Contractor.
4. Install Size No. 3, 4, or 4A for mainline ballast and Size No. 5 or 57 for yard and house tracks. Depth shall be as required to meet project requirements.

N. Surfacing

1. Superelevation: Superelevate curves as shown unless otherwise as required to meet project requirements. Obtain superelevation by raising outside rail of curve. Maintain inside rail at grade. Maximum superelevation shall be 6 inches. Full superelevation shall be carried throughout each curve, unless otherwise directed or shown. Superelevation runoff shall be at a uniform rate, and shall extend at least the full length of the spirals. The normal rate of superelevation runoff will be 1/2 inch in 31 feet; however, this may be increased to one inch in 31 feet with prior approval of the Owner.
2. Preliminary Surfacing: Perform preliminary alignment and surfacing after unloading of ballast. After preliminary alignment, bring the track to grade and surface in lifts not exceeding 6 inches each. After each lift, tamp the ballast. Place jacks close enough together to prevent undue bending of rail or stress of rail and joint. Raise both rails uniformly except where superelevation is required. Power tamp ballast under both sides of cross ties from each end to a point 15 inches inside each rail. Fill the center with ballast, but do not tamp the center between the above stated limits. Tamp both ends of the cross ties simultaneously, including tamping inside and outside of the rail. Regardless of the kind of ballast or the kind of power tamper used, work tamping tools opposite each other on the same tie. Tamp ballast under switch ties for the entire length of each switch tie. After tamping has been completed and jacks removed, re-spike loose ties securely in proper position with full bearing on tie plates.
3. Final Surfacing: After preliminary surfacing has been completed, or for track being repaired, where preliminary surfacing is not required, check line and grade stakes, operate engine and equipment over track, and align track. Bring track to grade and re-tamp ballast in the manner described for preliminary surfacing. Decrease tamping distance inside rail on cross ties from 15 to 13 inches. Give track a final lining conforming to established track centers. Dress ballast to section indicated and bring subgrade shoulders to line and surface.

4. Final Adjustments: Sixty calendar days after track has been accepted and put in operation, the Contractor shall perform necessary resurfacing adjustments without cost, to leave the track in alignment and on grade.
- O. Tolerance: Completed track shall meet the following tolerances. Repair track not meeting the tolerances specified below to meet the requirements at no additional cost to the Owner.
 1. Alignment: Shall not deviate from uniformity more than the following prescribed amounts:
 - a. Tangent Track: Change between any adjacent 31 foot stations measured at the mid offset from a 62 foot line may not be more than 1/2 inch from the gage line. (The gage line shall be defined as the line on the gage side of the line rail, 5/8 inch below the top of the centerline of the railhead. Either rail may be used as the line rail; however, the same rail must be used for the full length of the tangential segment of track.)
 - b. Curved Track: Change between any adjacent 31 foot stations measured at the mid-ordinate from a 62 foot chord may not be more than 3/8 inch for 36 degree curves and flatter. For curves greater than 36 degrees, change between any adjacent 15 1/2 foot stations measured at the mid-ordinate from a 31 foot chord may not be more than 1/2 inch. (The ends of the chord must be at points on the gage side of the outer rail, 5/8 inch below the top of the railhead.)
 2. Track Surface: May not deviate from uniformity more than the amount prescribed below:
 - a. Runoff in any 31 foot of rail at the end of a raise may not be more than 1/2 inch.
 - b. Deviation from uniform profile on either rail at the mid-ordinate of a 62 foot chord may not be more than 1/2 inch.
 - c. Deviation from designated elevations on a spiral may not be more than 1/2 inch.
 - d. Deviation in cross level in spirals in any 31 foot may not be more than 1/2 inch.
 - e. Deviation from zero cross level at any point on tangent or from designated elevation on curves between spirals may not be more than 1/2 inch.
 - f. Difference in cross level between any two points less than 62 foot apart on tangents and curves between spirals may not be more than 5/8 inch.
 3. Gage
 - a. Track Gage: Within plus 1/4 inch of standard gage in tangent track and curves less than 12 degrees.
 - b. Curved Track: For curves larger than 12 degrees, lay rail to within plus 1/4 inch or minus 1/8 inch of required gage.
 - c. Guard Face Gage: Distance between guard lines measured across the track at right angles to gage line, and is measured at the point of frog on both sides of the turnout. Design value for guard face gage is 52-3/4 inches. Guard face gage shall be within plus or minus 1/4-inch of design value.
 - d. Guard Check Gage: Distance between gage line of a frog and guard line of its guard rail, or guarding face, measured across the track at right angles to the gage line. The design value for guard check gage is 54-5/8 inches. Guard check gage shall be within plus or minus 1/8-inch of design value.
- P. Railroad Crossing: Install bituminous, wood plank, prefabricated sectional treated timbers, or rubber crossing as indicated, and in accordance with manufacturer's recommendations and specifications.
- Q. Bonding And Grounding Track: Track shall be bonded and grounded as indicated. Where track is designated for bonding and grounding, rails shall be bonded electrically continuous and effectively grounded. The grounding system shall consist of ground conductors and ground rods. Make connections by the exothermic weld process in accordance with manufacturer's instructions. Maximum resistance to ground from grounded rail or structure shall not exceed 10 ohms. When work, in addition to that indicated or specified, is directed in order to obtain the specified ground resistance, the provision of the contract covering "changes" shall apply.
 1. Rail Joint Bond: Bond rail joints on both rails of each track. Bond rails together with not less than No. 1/0 AWG 3/8-inch diameter bare stranded soft drawn copper conductor. Track to be bonded and grounded shall be electrically isolated from the remaining track.

2. Rail Cross-Bond and Ground: Rail cross-bond and ground shall be as indicated. Make connections between grounding system or ground rods and rails with a minimum No. 1/0 AWG bare stranded soft drawn copper cable, installed at least 12 inches below the bottom of the ties. Ground rods shall be 3/4-inch diameter copper-clad steel rods. Rods shall have a hard, clean, smooth, continuous copper surface and the portion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.013 inch at any point in the rod. Each ground rod shall be die-stamped near the top with the name or trademark of the manufacturer and the length of rod in feet. Connection of conductors to the ground rods shall be by all bronze, U bolt type ground clamp. Ground rods shall be a minimum of 10 feet long and shall be driven vertically full length. Provide one cross-bond and ground for each section of bonded and grounded track.
- R. Supplementary Installations: Furnish and install permanent signs and signals such as crossing, clearance, derail and other safeguards in accordance with recommended practice of the AREMA.
- S. Field Quality Control
1. Inspection of Rail Welds
 - a. Visual Inspection: Inspect new rail fittings thoroughly. Pay particular attention to any defect that might hinder satisfactory operation. Inspect bolted joints for loose bolts and smooth transitions between rails of different sections. Inspect each welded joint thoroughly after removal of mold and grinding of excess metal. Pay particular attention to surface cracking, slag inclusion, gas pockets, and lack of fusion. Correct or replace parts of welds found defective. Method of correction shall be as approved by the Owner.
 - b. Ultrasonic Inspection of Welded Rail Joints: Inspect each weld ultrasonically following the visual inspection. the Owner will test each weld ultrasonically following the visual inspection. Inspect and test in accordance with MIL-STD-1699. Clean rails at testing locations as directed by the Owner. The Contractor is responsible for the correction or replacement of defective parts or welds. The method of correction shall be as approved by the Owner.
 2. Inspection of Track: Perform tests to verify gage, alignment, cross level and grade at least once every 100 feet or less of track centerline length. Measure gage between points on inside of rails, 5/8-inch below top of railhead.

END OF SECTION 34 11 00 00

SECTION 34 11 93 00 - TRACK APPURTENANCES AND ACCESSORIES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of buffers. Products shall match existing materials and/or shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Quality Control

1. Field quality control
 - a. Before installing insulated joints, have each joint installing crew prepare two samples of that joint.
 - b. Have an independent testing laboratory test each insulated joint sample for resistance to longitudinal pull-apart.
 - c. Record and certify that rail has been re-anchored within the zero stress temperature range.
2. Testing: In lieu of qualification testing of insulated joints, Contractor may submit certification by an independent testing laboratory that insulated joints have passed either the tests specified in this Article or equivalent tests. Test two samples for resistance to longitudinal pull apart, and test one sample for electrical resistance.
 - a. Longitudinal pull apart test
 - 1) Preparation
 - a) Assemble bonded insulated joint complete, on two pieces of 115-pound RE rail each two feet long.
 - b) Saw joint assembly in half where rails are butted together and at right angles to centroid of rail.
 - c) Ensure that sawing does not overheat and damage prebonding adhesive.
 - d) Affix a device which will confine the reaction at the sawn end to the face of the joint bar when a load is applied at the centroid of the rail at the opposite end.
 - 2) Testing
 - a) Apply test longitudinally in increments of 25,000 pounds maintaining each increment until longitudinal deflection of rail ceases before increasing load to next increment.
 - b) Increase load in increments until a total load of 650,000 pounds is attained or failure occurs.
 - c) At each increment of loading, measure and record load, and differential movement of rail and joint bars, to nearest 0.001 inch.
 - 3) Acceptance criteria
 - a) Stability: No indication of slippage of rail joint before total test load reaches 650,000 pounds.
 - b) Differential movement in all directions: not more than 1/8 inch.
 - c) Difference between original position of joint bar and rail and final position thereof after final test load has been released: not more than 1/32 inch.
 - d) Basis of rejection: Failure of joint to satisfy above requirements.
 - b. Stroke rolling loading test
 - 1) Preparation: Mount bonded joint on a 33-inch stroke rolling load test machine and support on 36-inch centers; center joint.
 - 2) Testing: Apply 44,400 pound load on rail for 2,000,000 cycles. Measure and record deflection at rail centerline to nearest 0.001 inch when wheel load is over points A and B for every 500,000 cycles.
 - 3) Develop moment diagram.
 - 4) Acceptance criteria

- a) Moment diagram envelope generated by methods other than those specified and submitted in accordance with this Section.
- b) After 2,000,000 cycles: Exhibit no evidence of failure by bending of bonded insulated joint.
- c) Deflection exhibited by bonded insulated joint: Not further than 0.065 inch.
- c. Electrical resistance test: If specimen satisfies mechanical acceptance criteria of preceding tests, test specimen for electrical resistance; record results.
 - 1) Preparation: Assemble bonded insulated joint complete, in accordance with manufacturer's instructions, on two pieces of 115 pound RE rail, one rail 24 inches long, the other 42 inches long. Support both rails on electrically nonconductive material.
 - 2) Testing
 - a) Apply 500 volts DC to rail across bonded insulated joint for three minutes. During that time, measure and record, to nearest 0.1 ampere, current flow through joint.
 - b) Apply 50 volts AC to rail across joint for three minutes for each increment of measurement at frequencies of 20 hertz to 10 kilohertz in increments of 20 hertz to 100 hertz, 200 hertz to 1,000 hertz, and two kilohertz to 10 kilohertz. After three minutes, measure and record impedance within accuracy of plus or minus two percent.
 - 3) Acceptance criteria
 - a) Resistance for 500 volts DC: Not less than 10 megohms.
 - b) Impedance for all frequencies between 20 hertz and 10 kilohertz with 50 volts AC not less than 10 megohms.

1.2 PRODUCTS

A. Insulated Joint

1. Joint bar: 36 inches long; quenched and tempered carbon steel; fabricated in accordance with AREA MRE Chapter 4, Part 1, Table 1, for 115-pound RE rail; have six, 1-1/4-inch diameter holes spaced in accordance with AREA MRE Chapter 4, Part 1, Table 1; have a length tolerance of 1/8 inch; have a straightness tolerance of 1/32 inch on 36 inches along contact surface; and have no marking on contact surface. Modify bar for rail restrained by direct-fixation fasteners.
2. Adhesive: Allegheny Drop Forge Co.'s "Temprange" or accepted equivalent.
3. Mesh: Fiberglass; Allegheny Drop Forge Co., or accepted equivalent.
4. Pin bolts and insulation for bonded insulated joint
 - a. Bolt: 9-1/8-inch by 1-1/8-inch diameter pin-type; ASTM A 325; Huck Corp's C50LR-BR-36-68, or accepted equivalent.
 - b. Washer: ASTM A 325, flat, 2-1/4 inches O.D. by 1-3/16 inches I.D. by 1/8 inch thick.
 - c. Collar: 1-1/8-inch diameter; ASTM A 325; Huck Corp.'s LC- 2R36, or accepted equivalent.
 - d. Bushing: Fiberglass conforming to NEMA LI-1, Grade G10.
 - e. Post: High-pressure laminate conforming to NEMA LI-1, Grade CE.
5. Pin-bolts for unbonded insulated joints
 - a. Bolt: ASTM A 490, 1-1/8-inch diameter, hex head type, six inches long.
 - b. Washer: ASTM A 325, spring steel, 1/8 inch thick, 2-1/4-inch O.D.
 - c. Nut: ASTM A 490, hex head locknut.

B. Buffer: Friction type having head modified for the Owner anti-climber; Godwin Warren Engineering Inc.'s Type 12/4, or accepted equivalent.

1. Type A: Capable of controlling the stopping of an eight-car train under the following conditions:
 - a. Impact force: Not more than 130,000 pounds;
 - b. Impact speed: 15 mph;
 - c. Weight per car: 81,000 pounds;
 - d. Rotational inertial weight per car: 7,800 pounds; and

- e. 98 feet of track available for buffer installation.
 2. Type B: Capable of controlling the stopping of a two-car train in the yard when that train, decelerating at a rate of not more than 0.3 g's, strikes the buffer at 15 mph; and capable of controlling the stopping of a four-car train under the following conditions:
 - a. Impact force: Not more than 130,000 pounds;
 - b. Impact speed: 15 mph;
 - c. Weight per car: 81,000 pounds;
 - d. Rotational inertial weight per car: 7,800 pounds; and
 - e. 38 feet of track available for buffer installation.
 3. Paint for structural steel surfaces not facing transit vehicle
 - a. Primer: Either Pratt and Lambert Co.'s Rust-Inhibiting Effecto Enamel, PPG Corp.'s No. 6-208, Porter Paint Co.'s No. 297, Sherwin-Williams Co.'s Kem Kromik, or Tnemec Co.'s No. 10-99, or accepted equivalent.
 - b. Enamel: Color international orange; either Pratt and Lambert Co.'s Effecto Enamel, PPG Corp.'s No. 6-252, Porter Paint Co.'s No. 400, Sherwin-Williams Co.'s Industrial Enamel B54 Series, or Tnemec Co.'s Series 2H, or accepted equivalent.
 4. Paint for structural steel surfaces facing transit vehicle: Reflective type; Ferro Corp., Cataphote Division's Alert- Reflective Yellow, 3M Co.'s Scotchlite Brand Reflective Liquid, or accepted equivalent.
- C. Bumper: Capable of controlling the stopping of a two-car train under the following conditions.
1. Impact force: Not more than 150,000 pounds.
 2. Impact speed: 10 mph
 3. Weight per car: 81,000 pounds.
 4. Rotational inertial weight per car: 7,800 pounds.
 5. Striking block
 - a. Adapter plate: Mild steel.
 - b. Rubber block: 70 to 80 shore hardness, and adhered to adapter plate.
 6. Shock absorber: Hydraulic type having 31-1/2-inch stroke; Gantrex Corp.'s Type 15 Oleo, or accepted equivalent.
 7. Post
 - a. Structural steel plates, shapes, and bars: Carbon steel; ASTM A36.
 - b. Welding electrodes: AWS D1.1; E70XX.
 - c. Anchor bolts: 5/8 inch and 3/4 inch diameter; ASTM A 325.
 - d. Concrete forms: CONCRETE FORMWORK
 - e. Concrete: PORTLAND CEMENT CONCRETE.
 - f. Reinforcing bars: CONCRETE REINFORCEMENT.
 8. Paint
 - a. Primer: Either Pratt and Lambert Co.'s Rust-Inhibiting Effecto Enamel, PPG Corp.'s No. 6-208, Porter Paint Co.'s No. 297, Sherwin-Williams Co.'s Kem Kromik, or Tnemec Co.'s No. 10-99, or accepted equivalent.
 - b. Enamel: Color international orange; either Pratt and Lambert Co.'s Effecto Enamel, PPG Corp.'s No. 6-252, Porter Paint Co.'s No. 400, Sherwin-Williams Co.'s Industrial Enamel B54 Series, or Tnemec Co.'s Series 2H, or accepted equivalent.
- D. Rail Lubricator: Moore and Steele Corp.'s Model No. DR-4 (561), or accepted equivalent.
- E. Car Stop: L. B. Foster Co.'s Figure X, or accepted equivalent.
- 1.3 EXECUTION
- A. Insulated Joints
1. Preparation: If rail brand exists where joint bar will touch CWR, remove rail brand. Calibrate bolt-tightening and -swaging tool by testing three typical bolts in a device capable of indicating actual bolt tension.

2. Installation
 - a. Drilling: Position holes in accordance with AREA MRE Chapter 4, Part 1, Table 1. Drill 1-3/8-inch diameter holes; use template as a drilling guide.
 - b. Install joint bar, adhesive, fasteners, and insulating materials in accordance with manufacturer's printed recommendations except install no adhesive at joints at Stations.
 - 1) Bonded insulated joint: Drive pin bolts with tool capable of swaging collars to the extent that bolts may be adjusted. Set tool to produce not less than 56,000 pounds tension in pin bolts, to swage collars into annular locking grooves, to form collar, and to ensure that bolts will conform to grip range limits recommended by bolt manufacturer.
 - 2) Unbonded insulated joint: Tighten each track bolt to 25,000 pounds, starting from middle of joint and working to the ends.
 - c. Ensure that joint products and rail fasteners do not touch each other.
 - d. Center insulated joints not less than five inches from edge of tie and rail fastener.
 - e. Attach grounding cable, to base of each CWR, immediately adjacent to joint at Stations.
 - f. Tolerances from design dimensions.
 - 1) Bonded insulated joint bar
 - a) Finishing height: 1/64 inch.
 - b) Length: 1/8 inch.
 - c) Straightness, as determined by use of a 36-inch straightedge: 1/32 inch.
 - 2) Bonded insulated joint end post
 - a) Thickness: Plus 1/16 inch, minus zero inch.
 - b) Projection below base of rail: 1/16 inch
 3. Joint bolt hole: AREA MRE, Chapter 4.
 - a. Testing: Measure continuity across joint.
 4. Remove clamps, flexible ground cables, fasteners, and joint bars from joints at Stations; deliver those products to the Owner 's Yard.
- B. Buffers: Install buffers in accordance with manufacturer's printed instructions, and with four sets of trailing shoes set at a torque of 100-foot pounds, except that friction buffer at Station shall be installed with two sets of trailing shoes set at a torque of 150-foot pounds. Installed buffers shall be inspected by manufacturer's representative and, if approved by that representative, commissioned by that representative.
1. Dismantle buffer at Stations , and temporarily install buffer at Station .
 2. Install new buffers at Stations .
 3. Install friction buffer at Station .
 4. Cleaning and painting
 - a. Clean surfaces to be painted; wash surfaces with mineral spirits, and dry. Open drain holes in structural framework. Wire brush or blast unpainted ferrous surfaces to white metal.
 - b. Apply paint with clean and operable equipment and tools as soon as practicable after surfaces have been prepared; wet film shall cure to specified dry film thickness.
- C. Bumper
1. Weld in accordance with AWS D1.1.
 2. Form concrete in accordance with CONCRETE FORMWORK. Place concrete reinforcement and concrete in accordance with CONCRETE REINFORCEMENT, and CAST-IN-PLACE CONCRETE, respectively. Finish exposed concrete in accordance with UNFORMED-CONCRETE FINISHES.
 3. Cleaning and painting: Clean and paint posts and framework as specified.
- D. Rail Lubricator: Install lubricator in accordance with manufacturer's printed instructions.



- E. Car Stops: Install stops in accordance with stop manufacturer's printed installation instructions. Install one stop three feet from end of shorter rail behind each buffer, and install one stop directly opposite that stop.

END OF SECTION 34 11 93 00



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Task	Specification	Specification Description
34 11 93 00	34 11 00 00	Rail Tracks
34 11 93 00	34 01 23 33	Welded Track Rails
34 11 93 00	34 01 23 33a	Thermite Welded Track Rail
34 11 93 00	34 01 23 33b	Direct Fixation Track
34 11 93 00	34 01 23 33c	Ballasted Track Rail
34 11 93 00	34 01 23 33d	Concrete Track Cross Ties
34 11 93 00	34 01 23 33e	Timber Track Cross Ties
34 11 93 00	34 01 23 33f	Resilient Track Cross Ties
34 11 93 00	34 01 23 33g	Direct-Fixation Fasteners
34 11 93 00	34 01 23 33h	Traction Power
34 41 13 00	26 27 26 00	Wiring Devices
34 43 13 16	26 05 13 00	Medium-Voltage Cables



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SECTION 34 71 13 00 - ACTIVE VEHICLE BARRIERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for active vehicle barriers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Shop Drawings: Installation, Equipment, and Electrical Work
 - a. Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. For Federal work, detail drawings shall include a copy of the Department of State certificate of barrier performance.
2. Product Data:
 - a. Vehicle Barriers: A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.
 - b. Spare Parts: Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.
3. Test Reports
 - a. Field Testing: Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.
4. Operation and Maintenance Data
 - a. Vehicle Barriers: Operating and Maintenance Instructions
 - 1) Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F (minus 34 degrees C) to 150 degrees F (plus 66 degrees C) to cover winter operation, summer operation, and ambient temperature ranges in between.

C. General Requirements

1. Performance levels shall be based on the following:
 - a. The Department of State (DOS) publication SD-SDT-02.01 Specification for Vehicle Crash Testing of Perimeter Barriers and Gates (April 1985) in which:
 - 1) Impact Conditions:



Condition Designation	Vehicle Weight	Impact Speed	Kinetic Energy
K4	15,000 lb (6,800 kg)	30 mph (48 km/h)	450,000 ft-lb (610 kJ)
K8	15,000 lb (6,800 kg)	40 mph (65 km/h)	800,000 ft-lb (1084 kJ)
K12	15,000 lb (6,800 kg)	50 mph (80 km/h)	1,250,000 ft-lb (1695 kJ)

2) Performance Levels:

- a) L 3.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 3 feet (1 m) permitted.
- b) L 2.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 20 feet (6 m) is permitted.
- c) L 1.0 Vehicle is disabled and does not travel more than 50 feet (15 m) after impact.

2. Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated and except for bollards which have a diameter based on a required crash rating. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

D. Nameplates

- 1. Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:
 - a. Manufacturer's name.
 - b. Model number.
 - c. Serial number.
 - d. Date of manufacture.

E. Delivery And Storage

1. Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

F. Spare Parts

1. A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

G. Manufacturer's Services

1. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.2 PRODUCT

A. Retractable Barriers: When in the raised position, the total retractable barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be 144 inches (3.66 m) wide. When in the lowered position, the retractable barrier shall extend no more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) wheel load. Design for this load shall be in accordance with AASHTO HB-17.

1. Powered Retractable Barrier: The retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable

of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being lowered from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

- a. Failure Modes of Operation: The system shall be designed to remain in the last commanded position in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic barriers without power.
 - b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed **OR** totally enclosed fan cooled, **as directed**, enclosures. All couplings, motor shafts, gears, and other moving parts shall be fully guarded in accordance with 29 CFR 1910 Subpart O. Guards shall be removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase.
 - c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure. The system shall not require continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so.
 - d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
 - 1) Flexible hydraulic lines shall be in accordance with SAE J517.
 - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
 - e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Retractable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Barrier should be capable of being locked in the down position.
- B. Retractable Bollards: The total bollard height when in the raised position shall be no less than 30 inches (750 mm) above the roadway surface and shall have an outside diameter of no less than 8 inches (200 mm). A bollard system shall consist of a minimum of 3 bollards spaced no more than 36 inches (915 mm) from centerline to centerline of bollards across a 10 foot (3.0 m) roadway. Bollards in the lowered position shall be capable of supporting a 16,000 pound (71 kN) wheel load each. Design for this load shall be in accordance with AASHTO HB-17. Retractable bollards shall withstand a K4 **OR** K8 **OR** K12, **as directed**, Impact Condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

1. Powered Retractable Bollards: The retractable bollard shall be capable of 300 complete up/down cycles per hour. Bollards shall be capable of being raised or lowered within a 3 to 15-second range during normal use and within 2.5 seconds for emergency operations.
 - a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic and/or mechanical barriers without power.
 - b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. For multiple barriers being operated from a hydraulic power unit it is highly recommended that the electric motor be 3-phase.
 - c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for period of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
 - d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range, if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
 - 1) Flexible hydraulic lines shall be in accordance with SAE J517.
 - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
 - e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
 2. Manual Retractable Bollards: Manual bollards shall be capable of being raised and lowered utilizing a recessed handle on the top surface of the bollard or a manual hydraulic pump, either requiring a maximum 60 pounds (267 N) of force. A mechanism, that is lockable, shall be provided to secure the bollard in either the full "UP" or full "DOWN" position.
- C. Crash Gate: The crash gate shall consist of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate shall be a minimum of 84 inches (2.1 m) from the road surface to the top of the gate frame. The length shall close and protect a minimum 120 inch (3.0 m) clear opening. The maximum clear opening between the gate frame and end posts, between the bottom of the gate and finished grade, and between any grill work shall be 3 inches (75 mm).
1. Powered Crash Gate: The gate movement shall be controlled by an electro-mechanical gate operator **OR** a hydraulic gate operator, **as directed**, consisting of an operator unit with required control circuits and operator station. The control and operating voltage shall be 24 vac (nominal) or, as an option 24 vdc. A remote control master station shall be capable of driving the gate at minimum 48 fpm (14.6 m per minute) for a slide gate or 6 degrees per second for a swing gate. Unless otherwise indicated, motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. Crash gate shall withstand a 15,000 pound (6804 kg) vehicle at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum barrier deflection or vehicle penetration of 3 feet (1 m).

- a. Failure Mode of Operation: The system shall be designed to prevent opening of the crash gate in the event of electrical or mechanical failure. A disconnect system for the gate drive shall be provided to allow manual operation of the barrier in the event of a power outage.
 - b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity within its operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
 - 1) Flexible hydraulic lines shall be in accordance with SAE J517.
 - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
 - c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Crash Gate: The manual crash gate shall be capable of being hinged from either side. Hinge points of both buttresses shall each contain a locking pin with padlock acceptance for securing the crash gate in the closed position. The crash gate shall withstand a 10,000 pound (4535 kg) vehicle at impact speed of 50 mph (80 km/hour), with maximum gate deflection or vehicle penetration of 10 feet (3 m) 15,000 pound (6804 kg) vehicle traveling at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with a maximum gate deflection or vehicle penetration of up to 3 feet (1 m).
- D. Crash Beam: The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum vehicle penetration of 20 feet (6 m) 10,000 pound (4535 kg) vehicle at impact speed of 15 mph (24 km/hour), with a maximum vehicle penetration of 10 feet (3 m).
1. Powered Crash Beam: The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
 - a. Failure Mode of Operation: A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
 - b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

- 1) Flexible hydraulic lines shall be in accordance with SAE J517.
 - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
 - c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
 2. Manual Crash Beam: The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 60 pounds (267 N) of force.
- E. Portable Retractable Barrier: The portable retractable barrier shall be transportable and capable of manual and/or electro-mechanical operation. When in the raised position, the total barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be up to 144 inches (3.66 m wide). The barrier shall be equipped with entrance/exit ramps when the barrier extends more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) pound wheel load. Design for this load shall be in accordance with AASHTO HB-17.
1. Powered Portable Retractable Barrier: The portable retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being closed from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Portable retractable barrier, when impacted by a 15,000 pound (6,800 kg) vehicle at impact speed of 50 mph (80 km/hour) shall disable the vehicle and allow it to travel no more than 50 feet (15.2 m) after impact. Portable power assisted retractable barriers shall be equipped with on and off ramps for smooth transition between surfaces when the barrier extends more than 5/8 inch (16 mm) above the roadway surface.
 - a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. A manual pump shall be included for operation of hydraulic and/or mechanical barriers without power.
 - b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures.
 - c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
 - d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
 2. Manual Retractable Portable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and shall also be capable of being locked in the

"DOWN" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**

- F. Portable Crash Beam: The portable crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 mph (48 km/hour), with maximum vehicle penetration and/or barrier deflection of 20 feet (6 m).
1. Powered Portable Crash Beam: The portable crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
 - a. Failure Mode of Operation: A disconnect system for the portable crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
 - b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
 - c. Hydraulic Power Unit Enclosure: A weather resistant enclosure shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
 2. Manual Portable Crash Beam: The crash beam shall be manually operated by means of a counter balanced system requiring approximately 60 pounds (267 N) of force.
- G. Electrical Work: Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with YYY597YYY. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with YYY597YYY.
- H. Control Panel: A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding **OR** swinging, **as directed**, gate limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.
1. Voltage: The control circuit shall operate from a 120 volt 60 **OR** 50, **as directed**, Hz supply. The control circuit voltage shall be 12 **OR** 24, **as directed**, ac **OR** dc, **as directed**, for all external control panels.

2. Main Control Panel: A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier **OR** set of barriers, **as directed**, shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier **OR** set of barriers, **as directed**. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.
 3. Remote Control Panel: A remote control panel, one panel for the inbound lane(s) and a separate panel for the outbound lane(s), shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. Activation of either EFO will operate all barriers. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.
- I. Miscellaneous Equipment
1. Safety Equipment
 - a. Barrier Systems Sensors: The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system. The barrier system sensors shall consist of the following:
 - 1) Suppression Loops - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
 - 2) Speed Loops - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph (11.2 m/sec) or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
 - 3) Wrong Way Loops - Two inductive loops whose output shall be used to signal the barrier control panel to enunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.
 - b. Traffic Lights: Red/yellow 8 inch (200 mm) traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet (1.4 m) above the roadway pavement on a 3.5 inch (90 mm) outside diameter metal post or mounted directly on the crash gate.
 2. Warning Annunciator: Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.
 3. Heater: A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F (minus 40 degrees C). For retractable bollards, a 250-watt heater shall be provided for each bollard.
 4. Signage: Signage shall read "Axle Weight Limit 9 Tons" and shall conform to FHWA SA-89-006 sign (R12.2).

5. Vertical Arm Gates (Traffic Arms): Vertical arm gates shall have an opening and closing time of less than or equal to 5 seconds. The gates shall be capable of 500 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each entry lane shall be provided with a vertical arm gate. Each gate shall be capable of being operated from a remote open-close push button station in each guard booth and the gatehouse for the respective entry lane. Gates shall have a hand-crank, or other means, which will allow manual operation during power failures. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch (406 mm) wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.
 6. Vehicle Barrier Vertical Arm Gate (Traffic Arm): A traffic arm, as a separate piece of equipment, will be included with each non-portable active vehicle barrier as part of the barrier safety operating system. This traffic arm shall automatically deploy (close) when the emergency up button is activated and open when the vehicle barrier is reset. This traffic arm will not be equipped with an automatic obstruction detector.
- J. Finish: Surfaces shall be painted in accordance with requirements of YYYY267|268YYYY, as applicable. The roadway plate shall have a nonskid surface painted white with reflective red 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide red reflective stripes 4 inches (100 mm) apart. The barrier front shall be painted white and have 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide reflective red stripes 4 inches (100 mm) apart. The diagonal striping should point down and outward from the center of the device. Bollards shall be painted white with 2 **OR** 3, **as directed**, inch (50 **OR** 75, **as directed**, mm) wide reflective red diagonal stripes. The barrier crash gate shall be painted as specified by purchaser and the crash beam shall be painted white with 3 inch (75 mm) wide reflective red diagonal stripes.
 - K. Concrete: The concrete shall conform to YYYY73YYYY.
 - L. Welding: Welding shall be in accordance with AWS D1.1/D1.1M.
 - M. Pavement: After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.
- 1.3 EXECUTION
- A. Installation: Installation shall be in accordance with manufacturer's instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.
 - B. Hydraulic Lines: Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.



- C. Pit Drainage: A drain connection and oil/water separator, **as directed**, shall be provided in each barrier that requires pit/vault type construction. Hookups between the storm drains shall be made. The self-priming sump pump shall have the capacity to remove minimum 150 gallons per minute (34 cubic meters per hour).
- D. Electrical: All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.
- E. Field Testing: Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. The Owner shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Owner. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Owner. Adjustments and repairs shall be done by the Contractor under the direction of the Owner. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.
- F. Field Training: A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours (for electrical/hydraulic operated units) or 1 hour (for manually operated units) of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

END OF SECTION 34 71 13 00



Task	Specification	Specification Description
34 71 13 13	34 71 13 26	Vehicle Guide Rails
34 71 13 13	34 71 13 00	Active Vehicle Barriers
34 71 13 16	34 71 13 26	Vehicle Guide Rails
34 71 13 16	34 71 13 00	Active Vehicle Barriers



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SECTION 34 71 13 26 - VEHICLE GUIDE RAILS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for beam-type guardrail. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Rail Elements, End Sections, and Fasteners

1. ARTBA technical bulletin No. 268-B.
2. Provide galvanized steel W-beam in accordance with AASHTO M-180, class A, type 1.
3. Shop curve rail elements when required radius of installation on horizontal curve is 150 ft (46 m) or less. Provide W-beam rail (ARTBA RE-3) with a flared end section (ARTBA RE-5), rounded end section (ARTBA RE-6) at each end of installations.
4. Provide standard back-up plates behind rail elements at all intermediate, non-splice posts when steel posts and blocks are used.
5. Galvanize the rail sections, including end sections, in accordance with ASTM A 525, coating G-210.

B. Posts

1. Wood: Provide wood posts with blocks, size as required by State DOT. Rough sawn or S4S timber of Douglas Fir or any other locally approved species that is either No. 1 grade or Select Structural grade when graded in accordance with the requirements for Timber and Posts as set forth in WWPA-01 may be used. Give all wood posts and blocks a preservative treatment in accordance with the requirements of AASHTO M-133. Cut to length and bore posts and blocks for bolt holes before treatment.
2. Steel: Provide steel posts with blocks. Fabricate posts and blocks from W6X9 structural steel shapes complying with the requirements of ASTM A 36. Fabricate in the shop, grind smooth all corners and edges, galvanize posts and blocks after fabrication in accordance with ASTM A 123.

C. Bolts, Nuts, and Washers

1. Provide galvanized bolts, nuts, and washers that meet common ARTBA standards, designed to develop the required joint strength. Provide bolts with rounded heads to provide minimum obstruction.
2. Provide galvanized steel bolts conforming to the requirements of ASTM A 307, nuts conforming to the requirements of ASTM A 563, Grade A or better and galvanized steel washers, all galvanized in accordance with the requirements of ASTM A 153. Provide high strength bolts conforming to the requirements of ASTM A 325 where needed.

D. Reflectors: Provide guardrail reflectors as indicated. Place the galvanized steel tabs with reflective sheeting at every post except no reflectors are to be placed along the guardrail end flares.

E. Breakaway Cable Terminal (BCT) Assemblies: Provide BCT assemblies in accordance with the ARTBA details and standards referenced on the details.

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- F. Concrete and Reinforcement for the Post Footings: In accordance with applicable sections of Division 3 Section "Cast-in-place Concrete".

1.3 EXECUTION

- A. Guardrail: Erect steel beam-type guardrail in locations and to lines and grades as directed and in accordance with details indicated.
- B. Erection
1. Firmly set posts spaced at 6 ft. 3 in. (1.9 m) centers to the required depth. Set posts by placing in hand or mechanically dug holes or by driving, with or without pilot holes. Backfill gaps around posts with approved material that is moistened and thoroughly compacted. Repair damaged roadway surfacing where pavement is disturbed.
 2. Position the top of W-beam rail at 27 in. (0.69 m) above the finished roadway surface. Align rail both vertically and horizontally within 1/4-in. (6 mm) from the theoretical alignments. Lap the rail sections at posts, in the direction of traffic in the adjacent lane, and lap end sections on the face of the rail.
 3. Exercise care to avoid damage to treated wood and galvanized steel parts. Repair or replace damaged parts at the Contractor's expense. Securely tighten all bolts in the finished guardrail. Toenail the wood blocks to wood posts with two 16 penny galvanized nails, one on each side of the top of the block.

END OF SECTION 34 71 13 26



Task	Specification	Specification Description
34 71 13 26	34 71 13 00	Active Vehicle Barriers
34 71 16 00	34 71 13 26	Vehicle Guide Rails
34 71 16 00	34 71 13 00	Active Vehicle Barriers
34 71 19 16	11 12 00 00	Parking Control Equipment
34 71 19 16	13 34 23 16	Fabricated Control Booths



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SECTION 35 22 26 00 - SLUICE GATES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of sluice gate. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Sluice Gates: The sluice gate shall conform to the latest edition of AWWA 501 Sluice Gate Standards. Gate and accessories shall be as manufactured by Rodney Hunt Company or Hydrogate, or approved equal.

1. Sluice gates shall be cast iron, fully bronze mounted, and will have side wedges for seating head conditions and side, top and bottom wedges for unseating head conditions, where scheduled.
2. Liberal safety factors shall be used in the design of all the equipment. Working stresses shall not exceed the lower value of one-third (1/3) of the yield strength or one-fifth (1/5) of the ultimate strength of the material. The slide or disc shall be designed with a minimum safety factor of six (6). The sluice gates and operators shall be completely shop-assembled, inspected and tested to ensure proper fit and adjustment of all parts.
3. The sluice gate shall be substantially watertight under the design head conditions. The leakage shall not exceed 0.10 gallons per minute per foot of periphery for either the rated seating or unseating of the gate. The gate shall be rated for 60 feet of seating head and 35 feet of unseating head.
4. All materials used in the construction of the gates and appurtenances shall be designed for the application and shall conform to the following specifications.
5. Iron casting for wall thimbles, frame, disc, and guides, stem guides, floor stands and other items - ASTM A 126, Class B.
6. Bronze castings for wedges, thrust nut, and lift nut - ASTM B 584, Alloy 86500 or 87200.
7. Bronze for seat facings in frame and disc - ASTM B 21, Alloy 48200, extruded or ASTM B 139, Alloy 510, extruded.
8. Stainless steel for stems, stem couplings and fasteners - ASTM A 276, Type 304.
9. Silicon bronze for fasteners - ASTM B 98, Alloy 651, or 661.
10. Rubber for flush bottom seal - ASTM D 2000, grade AA625.

B. Frame: The frame shall be of cast iron, one-piece construction, flanged with rectangular or circular. All contact surfaces of the frame shall be machined. The frame shall have machined dovetailed grooves on the front face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. The back flange of the frame shall be machined to bolt directly to the machined face of the "F" type wall thimble. Frames for the sluice gates subject to unseating heads shall have integrally cast pads machined with keyways to receive top and bottom wedge seats.

C. Disc: The disc shall be of cast iron, one-piece construction rectangular with integrally cast vertical and horizontal ribs. The disc shall have a minimum thickness of 3/4 inch on gates which are 18 inches in diameter or larger. A heavy vertical reinforcing rib along each side shall be provided to ensure rigidity between the side wedges. All interior vertical ribs shall be of equal depth and shall not have any horizontal jogs along their entire length. Spacing of horizontal ribs shall not exceed 12 inches. The maximum deflection of horizontal ribs based on a working stress of 6,000 pounds per square inch for cast iron shall not exceed 0.07 inch under design pressure. The disc shall have machined dovetailed grooves on the seating face into which bronze seat facings shall be driven and machined to a 63 micro-inch finish. A tongue on each side, extending the full length of the disc, shall be machined on all sides

with a 1/8 inch clearance maintained between the disc tongue and the gate guide groove. Wedge pads for side wedges and for top and bottom wedges when required, shall be cast integrally on the disc and machined to receive the adjustable bronze wedges. A heavily reinforced nut pocket shall be cast integrally on the vertical centerline and above the horizontal center and be of such shape as to receive the square backed bronze thrust nut.

- D. Guides: The guides shall be one piece, integrally cast type, designed to withstand the total thrust due to the water pressure and the wedging action. The guides shall be either bolted onto or integrally cast with the frame. The guides shall be machined on all contact surfaces and a groove shall be machined along the entire length of the guide to allow not more than 1/8 inch clearance between the disc tongue and the guide groove. The guides shall be of such length as to retain and support at least one-half (1/2) of the disc in the full open position. The bolt-on guides shall be attached to the frame with silicon bronze or stainless steel studs and nuts and shall be doweled to prevent any relative motion between the guides and the frame. The integrally cast guides shall have wedge blocks which are attached to the guide with silicon bronze fasteners. Gates having integrally cast frames, guides and wedge blocks shall be unacceptable. Both the integrally cast and bolt-on blocks shall have machined dove-tailed grooves in which the bronze wedge seats shall be driven and machined. Wedge seats which are bolted onto the wedge block or guide shall be unacceptable.
- E. Wedges: Each gate shall be provided with a sufficient number of wedging devices to assure its compliance with the leakage requirements. Side wedges shall be designed to make full metal-to-metal contact with the wedge seats mounted on the guide wedge blocks. The wedges shall be solid cast bronze, machined on all contact surfaces, and keyed to the cast iron pads on the disc to prevent rotation and lateral motion. The wedges shall be attached to the disc with silicon bronze studs and nuts to lock them securely in position after they have been adjusted.
1. Adjustable top and bottom wedges, where applicable, shall be attached to the disc either by tongue-and-groove arrangement with a signal fastener or by two fasteners. All mating and contact surfaces on the wedging devices shall be fully machined.
- F. Seat Facings: The extruded seat facings shall be of a special shape to fill and permanently lock in the machined dovetail grooves on the frame and disc when pneumatically impacted into place. Attaching pins and screws shall not be acceptable. The installed seat facings shall be machined to a 63 micro-inch finish or better. Maximum clearance between seating faces shall not exceed 0.004 inch when the disc is in the fully closed position.
- G. Stem
1. The operating stem shall be of a size to safely withstand the stresses induced by normal operating forces without buckling or permanent distortion. The stem shall be designed to transmit in compression at least two (2) times the rated output of the floorstand or benchstand with a 40-pound effort on the crank or handwheel. The sluice gate manufacturer shall submit these calculations, if required by the Owner. The threaded portion of the stem shall have machined cut or rolled threads.
 2. Acme type. The contact surfaces of the threads shall have a maximum 16 micro-inch finish. Stems of more than one (1) section shall be jointed by stainless steel couplings threaded and keyed or bored and pinned to the stems. All threaded and keyed couplings of the same size shall be interchangeable. Manually operated, rising stem gates shall be provided with an adjustable bronze stop collar on the stem above the floorstand lift nut.
- H. Stem Guides: Stem guides shall be cast iron, bronze brushed, mounted on cast iron brackets. They shall be adjustable in two (2) directions and shall be spaced at sufficient intervals to adequately support the stem. Stem guide spacing shall not exceed 10 feet, or an L/R ratio of 200.
- I. Pipe Covers: Provide fabricated galvanized steel stem cover w/position indication on all rising stems.

- J. Crank Operators: All gates shall have crank-operated floorstands or benchstands. Crank handle shall be removable. Crank operated type shall be geared and shall have a weatherproof housing with a solid bronze operating nut mounted on high-strength cast iron pedestals or base plates. The operating nut shall be internally threaded with threads corresponding to stem threading. Tapered roller or ball bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. All gears shall be constructed of steel and shall be accurately machine cut and of proper design to provide smooth operation and to support load conditions. Lubrication fittings shall be provided in the gear housing to permit lubrication of all gears and bearings. All reduction gear cases shall be precision machined and equipped with tapered rolled or needle bearings and sealed about all reduction shafts. Geared hoists shall have a 4:1 ratio. Each hoist shall be supplied with a 2-inch square operating nut, and a removable cast iron crank arm with revolving brass grip. Floorstands shall include a cast iron pedestal designed to position the input shaft approximately 36 inches above the operating floor. Where called for, the floorstand shall be mounted on a cast iron wall bracket which is specifically designed for the particular operator being used. An arrow with the word "Open" will be permanently attached or cast in the floorstand indicating the direction of rotation to open the gate.
- K. All geared and handwheel floorstands shall operate with a maximum effort not to exceed 40 pounds on the crank or handwheel.
- L. Painting - All submerged ferrous metal components (i.e., gate and frame, thimble, stem guides) shall be shop painted as follows: prepare surfaces to SSPC-SP-6; Primer - Amer Lock 400 by Ameron International Inc. Performance Coatings and Finishes Group, or approved equal, 5.0 mil dry film thickness; Top Coat - Amer Lock 400, or approved equal, 5.0 mil dry film thickness.
- M. All exposed ferrous metal components (i.e., crank operator and floor stand) shall be shop painted as follows: prepare surfaces to SSPC-SP-3; Primer - Amer Lock 400, or approved equal, 5.0 mil dry film thickness, Top Coat - Amer Lock 450 HS, or approved equal, 2.0 mil dry film thickness
- N. All bolts, studs and nuts required for setting the sluice gates, frames and operating stands shall be stainless steel and shall be supplied by the manufacturer.

1.3 EXECUTION

- A. Provide and deliver cast iron thimble to be cast into wall as per manufacturer's recommendations and as specified herein. Install the sluice gate with all appurtenances in strict conformance with manufacturer's instructions.

END OF SECTION 35 22 26 00



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Task	Specification	Specification Description
35 22 59 00	35 22 26 00	Sluice Gates
35 22 63 00	35 22 26 00	Sluice Gates



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SECTION 35 24 00 00 - DREDGING

1.1 GENERAL

A. Description Of Work

1. This specification covers dredging. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definition

1. Hard material is defined as material requiring blasting or the use of special equipment for economical removal, and includes boulders or fragments too large to be removed in one piece by the dredge.

C. Submittals: Submit the following:

1. Shop Drawings: Indicate pipeline location and installation details. Submit drawings of surveys during progress of work by soundings or sweepings.
2. Protection plan: If blasting will be allowed, submit a plan for protection of surrounding structures, equipment, and vessels.

D. Material to be Removed

1. The material to be removed is silt and mud **OR** new material, **as directed**, applicable to the specific project.
 - a. Hard Material: Remove hard material. Blasting will not be permitted **OR** Blasting shall be performed only by experienced persons, **as directed**. Conduct operations in strict accordance with applicable regulations. Protect exposed structures from the effects of the blast in accordance with the protection plan

E. Artificial Obstructions

1. Except as indicated, the Owner has no knowledge of cables, pipes, or other artificial obstructions or of any wrecks, wreckage, or other material that would necessitate the use of explosives or the employment of additional equipment for economical removal. If actual conditions differ from those stated or shown, or both, an adjustment in contract price or time for completion, or both, will be made.

OR

The Owner has knowledge of debris such as, but not limited to, metal bands, pallets, pieces of broken cable, rope, fire hose, and broken piles. The Owner has no knowledge of existing wrecks, wreckage, or other material of such size or character as to require the use of explosives or special or additional plant for its economical removal. Prior to dredging, the Contractor shall rake the dredge areas and shall remove debris encountered. Debris removed from the dredged area shall be removed from the water. Disposal shall be the responsibility of the Contractor and disposal shall be outside the limits of government property. In case the actual conditions differ from those stated or shown, or both, an adjustment in contract price or time of completion, or both, will be made.

F. Side Slopes

1. Dredging on side slopes shall follow, as closely as practicable, the lines indicated or specified. An allowance will be made for dredging beyond the lines indicated or specified for side slopes. The allowance will be determined by projecting a line upwards, paralleling the project design side slopes, from the intersection of the overdepth dredging limit (at a point located vertically below the limit of dredging at the top of slope). The amount of material excavated from side slopes will be determined by either cross-sections or computer, or both.



G. Permit

1. The Contractor shall comply with conditions and requirements of State or Federal permits. the Owner will secure the permit for dredging and disposal of material as indicated. Make arrangements for disposal of excavated materials.

H. Environmental Protection Requirements

1. Provide and maintain during the life of the contract, environmental protective measures. Also, provide environmental protective measures required to correct conditions, such as oil spills or debris, that occur during the dredging operations. Comply with Federal, State, and local regulations pertaining to water, air, and noise pollution.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. Conduct Of Dredging Work

1. Order of Work Interference with Navigation: Minimize interference with the use of channels and passages. the Owner will direct the shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary.
2. Compensation for Interruption of Operations: If dredging operations are interrupted due to the movement of vessels or floating equipment, an adjustment in the contract price or time for completion, or both, will be made as provided by the contract. the Owner will notify the Contractor 7 days prior to ship movements that will affect dredging operations.
3. Lights: Each night, between sunset and sunrise and during periods of restricted visibility, provide lights for floating plants, pipelines, ranges, and markers. Also, provide lights for buoys that could endanger or obstruct navigation. When night work is in progress, maintain lights from sunset to sunrise for the observation of dredging operations. Lighting shall conform to United States Coast Guard requirements for visibility and color.
4. Ranges, Gages, and Lines: Furnish, set, and maintain ranges, buoys, and markers needed to define the work and to facilitate inspection. Establish and maintain gages in locations observable from each part of the work so that the depth may be determined. Suspend dredging when the gages or ranges cannot be seen or followed. the Owner will furnish, upon request by the Contractor, survey lines, points, and elevations necessary for the setting of ranges, gages, and buoys.
5. Plant: Maintain the plant, scows, coamings, barges, pipelines, and associated equipment to meet the requirements of the work. Promptly repair leaks or breaks along pipelines. Remove dredged material placed due to leaks and breaks.
6. Disposal of Excavated Material: Provide for safe transportation and disposal of dredged materials. Transport and dispose of dredged material in the area designated for disposal of dredged material.

OR

The Contractor may, at his option, dispose of dredge material at an approved disposal area. The deposit of dredged materials in unauthorized places is forbidden. Comply with rules and regulations of local port and harbor governing authorities.

- a. Method of Disposal: Deposit dredged material by the hydraulic process **OR** hopper dredge **OR** self-dumping scow or barge, **as directed**. Pipeline for hydraulic dredging shall discharge into the disposal area.
- b. Disposal in Indicated Fill Areas: In depositing excavated material for fill, uniformly grade and allow for shrinkage. Provide and maintain necessary bulkheads, dikes, ditches, weirs, spillways, and other construction necessary to confine and retain the fill in the dredge fill area.
- c. Operation of Sluiceways: Sluiceways on the disposal area levees will be operated and maintained by the Owner. The Contractor will be relieved of operations thereof.

- d. Submerged Pipeline: If a leak occurs in the discharge pipeline, immediately discontinue using the line until leaks are repaired. Remove material placed due to leaks or breaks.
 7. Navigation Warnings: Furnish and maintain navigation warning signs along the pipeline.
 8. Method of Communication: Provide a system of communication between the dredge crew and the crew at the disposal area. A portable two-way radio is acceptable.
 9. Salvaged Material: Anchors, chains, firearms, and other articles of value, which are brought to the surface during dredging operations, shall remain or become the property of the Owner and shall be deposited on shore at a convenient location near the site of the work, as directed.
 10. Safety of Structures: The prosecution of work shall ensure the stability of piers, bulkheads, and other structures lying on or adjacent to the site of the work, insofar as structures may be jeopardized by dredging operations. Repair damage resulting from dredging operations, insofar as such damage may be caused by variation in locations or depth of dredging, or both, from that indicated or permitted under the contract.
 11. Plant Removal: Upon completion of the work, promptly remove plant, including ranges, buoys, piles, and other markers or obstructions.
- B. Measurement
1. Contractor shall take soundings before and after dredging.
 - a. Method of Measurement: The material removed will be measured by means of soundings taken before and after dredging. The drawings represent existing conditions based on current available information, but will be verified and corrected, if necessary, by soundings taken before dredging in each locality. Soundings will be taken by lead line or 200 kHz sonic methods, or both, as determined by the Owner; results of soundings by either or both methods will be the basis for payment. Areas sounded more than 30 days prior to dredging will be re-sounded when requested by the Contractor. The Contractor has the option of being present when such soundings are made.
 - b. Surveys During Progress of Work: Contract depth will be determined by soundings or sweepings taken behind the dredge as work progresses. The Contractor shall take progress soundings or sweepings.
- C. Final Examination And Acceptance
1. As soon as practicable after the completion of areas, which in the opinion of the Owner, will not be affected by further dredging operations, each area will be examined by the Owner by sounding or sweeping, or both. Remove shoals and lumps by dragging the bottom or by dredging. However, if the bottom is soft and the shoal areas form no material obstruction to navigation, removal may be waived at the discretion of the Owner. The Contractor will be notified when soundings or sweepings are to be made and will be permitted to accompany the sounding or sweeping party and to inspect the data and methods used in preparing the final estimate. When areas are found to be in a satisfactory condition, the work therein will be accepted as complete. Final estimates will be subject to deductions or correction of deductions previously made because of excessive overdepth, dredging outside or authorized areas, or disposal of material in an unauthorized manner.

END OF SECTION 35 24 00 00



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35 - Waterway and Marine Construction

Task	Specification	Specification Description
35 24 23 00	35 24 00 00	Dredging
35 24 26 00	35 24 00 00	Dredging



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Task	Specification	Specification Description
40 05 19 00	33 42 00 00	Stormwater Conveyance
40 05 23 23	21 05 00 00	Common Work Results for Fire Suppression
40 05 23 23	22 05 00 00	Common Work Results for Plumbing
40 05 23 23	23 05 00 00	Common Work Results for HVAC
40 05 23 23	33 11 13 00a	Potable Water Supply Wells
40 05 41 00	21 05 00 00	Common Work Results for Fire Suppression
40 05 41 00	22 05 00 00	Common Work Results for Plumbing
40 05 41 00	23 05 00 00	Common Work Results for HVAC



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SECTION 41 22 23 00 - HOISTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with air motor powered hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions

1. The Contractor shall be responsible for the coordination of his work with the work of all trades involved and as it relates to the building structure. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the the Owner of any discrepancy before order to the monorail manufacturer is finalized.

C. Submittals

1. Shop Drawings
2. Design Data
3. Test Reports
4. Certificates
5. Operation and Maintenance Data

D. Quality Assurance

1. Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, air system details, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Certificates: Submit certification of minimum wire rope breaking strength for each hoist. Where applicable, submit factory certification of the load chain rated capacity.
3. Design Data: Submit design calculations verifying the size of structural members, structural supports (fittings, rods, brackets, and components), and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

- E. Maintenance: Submit data package for the entire monorail system.

1.2 PRODUCTS

A. Fabrication And Construction

1. The hoist and trolley shall conform to ANSI/ASME HST-5M or ANSI/ASME HST-6M, **2 OR 3 OR 5, as directed**, ton (2 **OR 3 OR 5, as directed**, metric ton), for general service **OR** protected indoor **OR** all weather outdoor, **as directed**, (0 degrees to 100 degrees F (-18 to 38 degrees C)) working conditions. 2 ton (2 metric ton) design criteria shall apply to hoists of 2 ton (2 metric ton), or less, rated lifting capacity. Hoists of 2, 3, or 5 ton (2, 3, or 5 metric ton) rated capacity, shall be equipped with an automatic mechanical load lowering brake.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: Shall be the manufacturer's standard within the limits specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M. The hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a minimum as required to meet project requirements below the finished floor.



OR

B. Fabrication And Construction

1. The 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist and trolley shall meet the design requirements specified in ANSI/ASME HST-5M or ANSI/ASME HST-6M for the 2 ton (2 metric ton) hoist trolley.
2. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
3. Hook Lift and Speed: For 1/4 **OR** 1/2 **OR** 1, **as directed**, ton (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) hoist(s), the hook lift shall be at its highest point a minimum height as required to meet project requirements above the finished floor and at its lowest point a maximum **OR** minimum, **as directed**, as required to meet project requirements above **OR** below, **as directed**, the finished floor. The hook lift and speed limits for 1/4 **OR** 1/2, **OR** 1 ton, **as directed**, (1/4 **OR** 1/2 **OR** 1, **as directed**, metric ton) rated capacity hoists shall be within the limits shown in the following table.

Standardized hoist lift ranges and rated lifting speed ranges for 1/4, 1/2, and 1 metric ton rated capacity

Rated load Capacity (metric tons)	Hoist lift range (meter)	Hoist lifting speed range (mm/s)	
		Low	High
1/4	3 to 15	120	350
1/2	3 to 12	80	250
1	3 to 10	40	225

Standardized hoist lift ranges and rated lifting speed ranges for 1/4-, 1/2-, and 1-ton rated capacity

Rated load capacity (tons)	Hoist lift range (feet)	Hoist lifting speed range (feet per minute)	
		Low	High
1/4	10 to 50	24	70
1/2	10 to 40	16	50
1	10 to 30	8	45

4. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.
5. Hoist Wire Rope: Rope lengths shall be sufficient to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in its lowest indicated position.
6. Hoist Chain: Chain hoists of 10 foot (3 m) lift or more shall be equipped with a load chain bucket.
7. Hoist Limit Switch: Hoists shall be equipped with upper and lower hoist limit switches/devices.
8. Control Pendant: Shall extend as required to meet project requirements below the underside of the track beam.
9. Trolley: Shall have a manual **OR** geared manual **OR** air motor powered, **as directed**, drive and shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.

C. Monorail Track Beam System

1. Shall conform to MMA MH27.1, for powered hoists. The maximum allowable deflection shall not exceed 1/600 of the unsupported span, with the hoist(s) at rated load(s) and at any location(s). The track beam system shall have trolley stops at all open end locations. The stops shall be designed to retain the hoist on the track. Wheel stops shall interface with the trolley wheel treads on both sides of the track web simultaneously and shall not interface with the trolley wheel flanges. The air supply valve specified shall be of the quick shutoff type, readily accessible from the floor, and located within proximity to the monorail system.
2. Color of Finished Equipment: Shall be the manufacturer's standard brilliant yellow.
3. Identification Plates: The manufacturer shall furnish and install identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

1.3 EXECUTION

A. Erection And Installation

1. The Contractor shall erect and install the hoist and monorail system in accordance with of MMA MH27.1. The monorail supplier shall provide supervisory erection services.

B. Field Inspection And Tests

1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and detail drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.
2. Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be tested in operation as specified, carrying 125 percent of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. The air equipment will not necessarily operate at rated speed with a 125 percent overload. For hoists that incorporate mechanical load brakes, the mechanical load brake shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and other apparatus as necessary to conduct field tests on hoist and monorail. The test and final adjustments of the equipment shall be under the supervision of the the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 00



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SECTION 41 22 23 00a - SPECIALTY HOISTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material handling hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals

1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Electric Chain Hoists

1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Hoists shall employ AC motor brakes employing single or multiple all-steel disks. Controls shall be hand-held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks.

B. Manual Chain Hoists

1. Load capacity of hoist shall be as specified. Load chain shall be grade 80 alloy, case hardened and zinc plated sized for the intended load. Load hook shall be heavy-duty drop forged with safety latch. Hoist mechanism shall be double pawl ratchet system with Weston type brake using a non-asbestos friction disk. Hoist shall have swivel top and bottom hooks. Hoist shall require between 50 and 80 pounds effort to move load.

C. Electric Wire Rope Hoists

1. Hoist motors shall be H4 duty classification. Class F insulation shall be used in hoist motor for 30 minute operation. Lift range shall be between 20 and 150 feet. Lifting cable shall be pre-formed wire rope, of hoisting service construction, made of extra improved steel (XIP) with an independent wire rope center. Load hook shall be heavy-duty drop forged with safety latch. Hoist shall have swivel top and bottom hooks. Controls shall be hand held, low voltage electrical, with emergency shut off and enclosed in NEMA 3R rated weatherproof enclosure. Hoist shall include fail-safe limit switches in the hoist enclosure. Hoist shall meet requirements of ANSI B30.16 standard.

1.3 EXECUTION

A. Installation

1. The Contractor shall complete the assembly of any equipment furnished partially assembled and place the items in position as directed. The hoists shall be assembled and securely bolted in position, hoisting chain or wire rope installed, and the hoist made ready for regular operation. The Contractor shall furnish all miscellaneous hardware items required to complete the installation of all equipment and components. Equipment shall be primed and finish painted with a suitable corrosion-resistant paint on all parts and components not made of corrosion-resistant materials or otherwise protected.

41 - Material Processing and Handling Equipment



END OF SECTION 41 22 23 00a



SECTION 41 22 23 00b - MONORAILS WITH ELECTRIC POWERED HOISTS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with electric powered hoists. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. System Description

1. Provide a monorail system with electric powered hoist(s) and plain type (hand operated) **OR** hand chain operated **OR** electric powered, **as directed**, trolley(s) complete, tested and ready for operation. Monorails, hoist(s), trolley(s), equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME/ANSI B30.11, ASME/ANSI B30.16, ASME HST-1M, ANSI/ASME HST-4M, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "the Owner."

C. Submittals

1. Shop Drawings: Monorail system
2. Product Data: Monorail track system including switches, suspension system and other components; Electric wire rope hoist; Electric chain hoist; Trolley; Pendant pushbutton station; Electrification.
3. Design Data: Load and sizing calculations.
4. Test Reports
5. Certificates
6. Operation and Maintenance Data

D. Delivery, Storage, and Handling

1. Delivery and Storage: Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.
2. Handling: Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to the Owner.

E. Quality Assurance

1. Certificates: Overload Test Certificate: Submit a statement that the monorail system can be periodically load tested to 125 percent (plus 5 minus 0) of rated load.
2. Drawings: Monorail System: Show the general arrangement of all components, clearances and principal dimensions, assemblies of hoist, trolley, track, track suspension system, and electrical schematic drawings.
3. Design Data: Load and Sizing Calculations: Submit calculations verifying the sizing of any track, track suspension device and additional supports which are not the monorail system manufacturer's standard cataloged product.

1.2 PRODUCTS

- A. Overhead Monorail System: Provide overhead monorail system conforming to MMA MH27.1, Class C, for indoor **OR** outdoor, **as directed**, service, with an electric wire rope or chain hoist mounted on a movable trolley. Trolley shall be plain type (hand operated) **OR** hand chain operated **OR** motor operated, **as directed**. Monorail system shall operate on AC voltage as required to meet project requirements, 60 Hz, single **OR** three, **as directed**, phase power source.
1. Capacity: The monorail system shall have a minimum rated capacity as required to meet project requirements. Mark the hoist capacity in pounds (kg) on both sides of the hoist or load block.
 2. Speeds: The hoist shall have two operating speeds, **unless directed otherwise**, and shall be capable of hoisting and lowering the rated load at a high speed of 20 feet per minute (fpm) (100 mm/s). The trolley shall have two operating speeds, **unless directed otherwise**, and shall be capable of moving the rated load at a high speed of 50 fpm **OR** 100 fpm, **as directed**, (250 mm/s **OR** 500 mm/s, **as directed**,). Low speed(s) shall be one quarter to one third of high speed(s). Actual speed(s) shall be within plus or minus 15 percent of those specified.
 3. Material Limitations: Shafts, keys, couplings, sprockets, and chains shall be steel. All gears shall be steel except for worm gears, which shall be bronze or steel. Cast iron and aluminum used to support components of the hoist power transmission train shall be ductile.
 4. Safety: Comply with the mandatory and advisory safety requirements of ASME/ANSI B30.11, ASME/ANSI B30.16, and 29 CFR 1910.179.
- B. Monorail Track System: MMA MH27.1. Track beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam.
1. Track Suspension System: Monorail suspension shall be flexible **OR** rigid, **as directed**, type. Make bolted connections to supporting structure, excluding hanger rods, with ASTM A 325/A 325M bolts, ASTM A 563/A 563M nuts, and ASTM F 959/F 959M load indicator washers. ASTM A 325/A 325M bolts shall be fully pre-tensioned in accordance with AISC S329. Support monorail track system from the structural members shown. Provide additional supports as required to carry monorail track system loads to the structural members shown. Materials for additional supports shall conform to the material requirements contained in Division 5 Section "Structural Steel Framing".
- C. Electric Wire Rope Hoist: ANSI/ASME HST-4M, Class H3, except as modified herein. Hoist shall be double reeved, **unless directed otherwise**.
1. Hoisting Ropes: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide proof of wire rope breaking strength test report.
 2. Sheaves: Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.
 3. Drum: Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.
- D. Electric Chain Hoist: ASME HST-1M, Class H3, except as modified herein. Provide load chain proof test.
- E. Trolley: Trolley shall meet all applicable requirements of MMA MH27.1, ASME HST-1M and ANSI/ASME HST-4M. Trolley shall have elastomeric bumpers to engage runway stops.
- F. Motors: NEMA MG 1. Hoist motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Trolley motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Motor insulation shall be Class B minimum. Provide totally enclosed non-ventilated (TENV) motor enclosures. Maximum motor speed shall not exceed 1800 RPM.

- G. Controls: Provide single **OR** two, **as directed**, speed magnetic control for the hoist. Provide single **OR** two, **as directed**, speed magnetic controls for the trolley. Provide reduced voltage starting, acceleration and deceleration for the trolley drive.
- H. Limit Switches: Provide upper and lower limit switches which de-energize the hoist motor.
- I. Brakes: Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake. Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of 100 percent (for outdoor monorails) or 50 percent (for indoor monorails) of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.
- J. Load Block And Hook: Construct load blocks of steel. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device. Hook throat opening shall not be less than as required to meet project requirements. Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted. Permanently mark hook and hook nut with an identification number.
1. Hook and Hook Nut Magnetic Particle Inspection: Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 1/8 inch (3 mm) long whose length is equal to or greater than three times its width.
- K. Bearings: All bearings except those subject to a small rocker motion shall be anti-friction type. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.
- L. Pendant Pushbutton Station: Hoist and trolley, **unless directed otherwise**, shall be controlled from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME/ANSI B30.11 recommendations. Locate station 4 feet (1.2 m) above the finished floor
- M. Electrification: Runway electrification shall be of the flat festooned type **OR** enclosed safety bar type, **as directed**, with four continuous copper conductors. Provide electrical work for the monorail system in accordance with NFPA 70.
- N. Identification Plates: Provide identification plates of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in pounds, and other essential information or identification.
- O. Painting System: Painting shall be manufacturers standard. Provide a primer and a finish coat. For outdoor monorail systems, blast clean all components prior to painting and prime with inorganic zinc type primer; finish coat shall be an epoxy formulated for marine environments. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.
- 1.3 EXECUTION:
- A. Erection And Installation: Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.
- B. Erection Services: Provide supervisory erection services from the monorail system manufacturer.
- C. Field Quality Control
1. Post-Erection Inspection: After erection, the Contractor and the the Owner shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and

- approved submittals. The Contractor shall notify the the Owner 3 days before the inspection. Provide a report of the inspection indicating the monorail system is considered ready for operational tests
2. Operational Tests: After erection and inspection, test the hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational. The Contractor shall furnish loads for testing, operating personnel, instruments, and all other necessary apparatus. The the Owner will furnish loads for testing; the Contractor shall receive and transport the loads from a location not more than 100 miles (161 km) from the job site and shall return them to that location after the tests have been completed.
 3. Test Data: Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist and trolley speeds during each test cycle.
 4. Hook Test: Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch (0.4 mm)). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.
 5. No-Load Test
 - a. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. Operate the hoist at low and high speed in both directions.
 - b. Trolley: Operate trolley assembly the full length of the monorail in both directions. Operate trolley at low and high speed in each direction. Verify satisfactory operation and verify trolley speed. Operate all rail switches.
 6. Load Test: 125 Percent (plus 5 percent minus 0) of rated capacity
 - a. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
 - b. Hoist Dynamic Test: Raise the test load to approximately 5 feet (1.5 m) above the floor using both speed points in the process. Lower the load back to the floor using both speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
 - c. Load Brake Test: Raise test load approximately 5 feet (1.5 m). With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. NOTE: It is not necessary for the load brake to halt the downward motion of the test load.
 - d. Loss of Power Test: Raise the test load approximately 3 feet (1 m) and while lowering test load at low speed, cut main power to hoist. Load should stop.
 - e. Trolley Test: With test load hoisted to a height of one foot (300 mm) above the floor, operate trolley the full distance of the monorail in both directions using both speed points in the process. Observe for any malfunctioning of the trolley assembly and monorail system. Operate all rail switches.
 - f. Rated Load Speed Test: With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified. With the hoist loaded to rated capacity, operate trolley along the monorail beam verifying that the trolley



speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially travelling at high speed and carrying the rated capacity load. Record voltage, amperage, hoisting and lowering speeds, trolley travel speed, and motor speed for each motor.

END OF SECTION 41 22 23 00b



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SECTION 41 22 23 00c - MONORAILS WITH MANUAL HOIST

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with manual hoist. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Verification Of Dimensions:

1. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the Owner of any discrepancy before the order to the monorail manufacturer is finalized.

C. Submittals

1. Shop Drawings: Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.
2. Design Data: Structural design calculations.
3. Test Reports
 - a. Hook and hook nut magnetic-particle tests.
 - b. Monorail system load tests
4. Certificates: Manual hoist load chain
5. Operation and Maintenance Data
 - a. Track beam system
 - b. Hoist and trolley

D. Quality Assurance

1. Certifications: Submit factory certification of load chain rated capacity.
2. Design Data: Submit design calculations verifying the size of structural members, structural support fittings, rods, brackets, components, and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

1.2 PRODUCTS

- A. Fabrication And Construction: Provide manual hoist and trolley, ANSI/ASME HST-2M, ANSI/ASME HST-3M, trolley suspension. Trolley and wheels shall be suitable for operation on the steel monorail track beam provided, and shall have not less than four wheels.

1. Capacity: The hoist shall have a minimum rated capacity as required to meet project requirements. The monorail system shall have a minimum rated capacity as required to meet project requirements.
2. Hook Lift: Shall be the manufacturer's standard. The hoist lift shall be at its highest point a minimum of 8 feet (2400 mm) above the finished floor and at its lowest point a minimum of 2 feet (600 mm) below the finished floor.
3. Hooks: Shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the entire area in accordance with ASTM A 275/A 275M. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle

inspection that is greater than 1/8 inch (3 mm) long whose length is equal to or is greater than three times its width.

4. Trolley: Shall be designed to operate from track beam section. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.
5. Load Chain: High strength steel links, flexible; minimum safety factor of 5 to 1 based on ratio of minimum chain breaking load to the calculated load on the chain when the hoist is assumed loaded to rated capacity. Certification from hoist manufacturer of provided chain's breaking strength shall be submitted to the Owner and approved prior to final acceptance of hoist. Do not paint or coat the load chain.
6. Load Hooks and Load Hook Components
 - a. Hook: Forged steel; complete with spring-loaded steel throat opening safety device. The hook shall be carried on suitably sealed or shielded anti-friction thrust bearings and shall swivel freely through 360 degrees rotation with full load without twisting chain.
 - 1) Disassembly. Hook and hook nut shall be capable of complete disassembly that enables access to all surfaces of the hook, including shank and hook nut for inspection purposes. Provision shall be made for the hook nut, or other hook-to-block fastener, to be keyed to hook shank by means of a set screw or similar, easily removable, securing device.
 - 2) Hook Non-Destructive Test. Each hook, including shank and hook nut, shall be inspected over the entire surface areas by magnetic particle inspection. If hook nut is not used, any device that functions the same as the hook nut shall be inspected by magnetic particle inspection.
 - a) Procedure: Magnetic particle inspection shall be conducted in accordance with ASTM A 275/A 275M. This inspection shall be conducted at the factory of the hook manufacturer or hoist manufacturer. Alternately, a recognized independent testing lab may conduct the inspections if equipped and competent to perform such a service, and if approved by the the Owner.
 - b) Acceptance Criteria: Defects found on the hook or hook nut shall result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear or non-linear indication for which the largest dimension is greater than 1/8 inch (3 mm). Weld repairs for defects on hook or hook nut will not be permitted.
 - c) Test Report: A test report of the magnetic particle inspection of each hook and hook nut provided shall be submitted to and approved by the the Owner prior to final acceptance of hoist installation. Test reports shall be certified by the testing organization.

B. Monorail Track Beam System: Comply with MMA MH27.1 except as modified and supplemented herein.

1. Patented Track: Provide specially designed trackage, e.g., patented track beam, curves, and switches constructed from welded steel components. The lower flange of the track section shall have flat wheel treads; minimum lower flange width of 3.25 inches (80 mm); chemical composition of 0.45 to 0.60 percent carbon content, 0.60 to 1.1 percent manganese content; and wheel treads shall be hardened to a minimum Brinell Hardness Number of 225. Upper flange and web of the track section shall be steel, continuously welded together or provided as one monolithic piece.
2. Track Suspension: Provide means of suspending the monorail track system, including curves and switches from the structural supports. The suspension system shall be the sole responsibility of the track supplier; however, design shall be subject to the requirements specified herein.
 - a. Cataloged Products: If possible, provide track manufacturer's standard cataloged devices for connection of the track to the indicated supporting structures. If track manufacturer's cataloged devices are not provided for this suspension system, complete shop drawings and calculations for the custom suspension device shall be submitted for review and approval by the the Owner. Track suspension devices which are not the track

- manufacturer's cataloged products shall meet the additional requirements specified in YYYY99YYYY.
- b. Design: The suspension system shall be designed and constructed to ensure no impairment of the strength of track or the structural support. A hanger or suspension shall be located at each rack splice joint. Provide bracing to hold track sections in rigid alignment at all joints.
 - c. Suspension of Curves and Switches: Provide steel framing (structural supports), in addition to that indicated, as required by monorail curve and switch manufacturer to support curves and switches. The additional steel framing shall be the sole responsibility of the monorail supplier. Submit shop drawings and framing design calculations to the the Owner for approval.
 - d. Sway Bracing: Where the track is suspended from hanger rods, track shall be braced laterally and longitudinally to prevent sway.
 - e. Lock Nuts: Where the track is suspended from hanger rods, lock nuts or other means shall be provided to prevent the nuts from backing off the rods.
 - f. Multiple Suspension Devices: Where more than one suspension device attached to the track at a single point, the suspension devices shall be provided so that the loads shall be induced in each in proportion to the device's size.
3. Identification Plates: Provide identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.
- C. Painting Of System: Provide manufacturer's standard painting or shop painting of components specified in this section; comply with the requirements specified in YYYY578YYYY. Do not paint, coat, or galvanize load chain, load, hook nut, or load chain sheave.

1.3 EXECUTION

- A. Erection And Installation: The Contractor shall erect and install the hoist trolley and monorail system in accordance with manufacturers written instructions, MMA MH27.1, and the contract drawings. The monorail supplier shall provide supervisory erection services. Welding new sections of monorail track to existing shall conform to AWS D1.1.
- B. Field Inspection And Tests
1. Pre-Erection Inspection: Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and shop drawings as approved. The Contractor shall notify the the Owner 3 days before the inspection.
 2. Operational Inspection and Load Tests: Upon completion, and before final acceptance, the hoist, trolley, and monorail shall be given the rated load test specified in ASME/ANSI B30.11, carrying 125 percent (plus 5 percent, minus 0 percent) of the rated capacity, and with the units spaced to obtain maximum possible loads in the monorail track beam systems. Hoists shall hold a static, as well as control a dynamic, 125 percent rated load. The systems shall be thoroughly tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall furnish test loads, operating personnel, instruments, and all other necessary apparatus at no additional cost to the Owner. The test and final adjustments of the equipment will be under the supervision of the Owner. The Contractor shall rectify any deficiencies found and completely retest work affected by such deficiencies.

END OF SECTION 41 22 23 00c



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41 - Material Processing and Handling Equipment

Task	Specification	Specification Description
41 22 23 13	41 22 23 00	Hoists
41 22 23 13	41 22 23 00a	Specialty Hoists
41 22 23 13	41 22 23 00b	Monorails With Electric Powered Hoists
41 22 23 13	41 22 23 00c	Monorails With Manual Hoist



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01 66 00 00	01 00 00 00, 01 60 00 00

Cross Reference

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01 66 23 00	01 00 00 00, 01 60 00 00
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