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- f. Multipole units enclosed in a single housing with a single handle.
- g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

### 2.5 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

### 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407 or NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407 or NEMA PB 1.1.
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- I. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
  - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- J. Install filler plates in unused spaces.
- K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate APE final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

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- D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

- C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Instruments and Equipment:
    - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- D. Panelboards will be considered defective if they do not pass tests and inspections.

- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

**3.6 PROTECTION**

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

**END OF SECTION 26 24 16**

**DIVISION 31  
EARTHWORK**

**SECTION 31 23 00.00 20  
EXCAVATION AND FILL**

**PART 1 GENERAL**

**1.1 SUMMARY**

- A. Description: This Section describes the requirements for excavating and backfilling trench for utilities.

**1.2 REFERENCES**

A. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C600 (2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

B. ASTM INTERNATIONAL (ASTM)

1. ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Course Aggregates
2. ASTM D 1140 (2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
3. ASTM D 1556 (2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
4. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>) (2700 kN-m/m<sup>3</sup>)
5. ASTM D 2321 (2005) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
6. ASTM D 2487 (2006e1) Soils for Engineering Purposes (Unified Soil Classification System)
7. ASTM D 2922 (2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
8. ASTM D 3017 (2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
9. ASTM D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
10. ASTM D 698 (2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft.)

(600 kN-m/cu. m.)

C. U.S. ARMY CORPS OF ENGINEERS (USACE)

1. EM 385-1-1 (2008) Safety and Health Requirements Manual

D. U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

1. EPA 530/F-93/004 (1993; Rev O; Updates I, II, IIA, IIB, and III)  
Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)

**1.3 DEFINITIONS**

A. Degree of Compaction

1. Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698 or ASTM D 1557, for general soil types, abbreviated as percent laboratory maximum density.

B. Hard Materials

1. Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

C. Rock

1. Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

**1.4 SUBMITTALS**

- A. ASPA approval is required for submittals. Submit the in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-01 Preconstruction Submittals
  - a. Shoring and Sheeting Plan
  - b. Dewatering work plan
  - c. Submit 15 days prior to starting work.
2. SD-06 Test Reports

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- a. Borrow Site Testing
- b. Fill and backfill test
- c. Density tests
- d. Moisture Content Tests
- e. Copies of all laboratory and field test reports within 24 hours of the completion of the test.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Perform in a manner to prevent contamination or segregation of materials.

### **1.6 QUALITY ASSURANCE**

#### A. Shoring and Sheeting Plan

1. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

#### B. Dewatering Work Plan

1. Submit procedures for accomplishing dewatering work.

#### C. Existing Utilities to be located

1. Locate existing underground utilities within the area of excavation by examination of ASPA records, toning and potholes prior to excavation.
2. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Excavation made with power-driven equipment is not permitted within two feet of known ASPA-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the APE. Report damage to utility lines or subsurface construction immediately to the APE.

## **PART 2 PRODUCTS**

### **2.1 SOIL MATERIALS**

#### A. Satisfactory Materials

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

1. Any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, CL, ML, CL- ML, CH, MH free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and deleterious, or objectionable materials. Unless specified otherwise, the maximum particle diameter shall be one-half the lift thickness at the intended location.

### B. Unsatisfactory Materials

1. Materials which do not comply with the requirements for satisfactory materials. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, and stones larger than 3 inches. The APE shall be notified of any contaminated materials.

### C. Cohesionless and Cohesive Materials

1. Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are non-plastic (plasticity index equals zero). Materials classified as GM and SM will be identified as cohesive only when the fines have a plasticity index greater than zero.

### D. Common Fill

1. Approved, unclassified soil material with the characteristics required to compact to the soil density specified for the intended location.

### E. Backfill and Fill Material

1. ASTM D 2487, classification GW, GP, GM, GC, SW, SP, SM, SC with a maximum ASTM D 4318 liquid limit of 35, maximum ASTM D 4318 plasticity index of 12, and a maximum of 25 percent by weight passing ASTM D 1140, No. 200 sieve.

### F. Topsoil

1. Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

## 2.2 PIPE BEDDING MATERIAL

- A. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density.

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B. Plastic piping shall have bedding to spring line of pipe. Provide ASTM D 2321 materials as follows:

1. Class I: Angular, 0.25 to 1.5 inches, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.
2. Class II: Course sands and gravels with maximum particle size of 1.5 inches, including various graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

### 2.3 PIPE TRENCH SEAL MATERIAL

Type S4C gravel. Grading: Percent passing sieve  $\frac{1}{2}$ "=100,  $\frac{3}{8}$ "=90-100, #16=25-45, #100 5-15.

### 2.4 BORROW

A. Obtain borrow materials required in excess of those furnished from excavations from sources outside of ASPA property.

## PART 3 EXECUTION

### 3.1 PROTECTION

A. Shoring and Sheeting

1. Provide shoring and sheeting where needed. In addition to Section 25 A and B of EM 385-1-1, include provisions in the shoring and sheeting plan that will accomplish the following:
  - a. Prevent undermining of pavements.
  - b. Prevent slippage or movement in banks or slopes adjacent to the excavation.
  - c. Allow for the abandonment of shoring and sheeting materials in place in critical areas as the work is completed. In these areas, backfill the excavation to within 3 feet of the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

B. Drainage and Dewatering

1. Provide for the collection and disposal of surface and subsurface water encountered during construction.
  - a. Dewatering
    - 1) Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave

in the excavation.

- 2) Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

#### C. Underground Utilities

1. Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor shall scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered.

#### D. Machinery and Equipment

1. Movement of construction machinery and equipment over pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

### 3.2 SURFACE PREPARATION

#### A. Clearing and Grubbing

1. Unless indicated otherwise, remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations within the clearing limits. Remove stumps entirely. Grub out matted roots and roots over 2 inches in diameter to at least 18 inches below existing surface.

#### B. Stripping

1. Strip suitable soil from the site where excavation is indicated and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be stockpiled and used for backfilling. Locate topsoil so that the material can be used readily for the finished grading. Where sufficient existing topsoil conforming to the material requirements is not available on site, provide borrow materials suitable for use as topsoil. Protect topsoil and keep in segregated piles until needed.

### 3.3 EXCAVATION

- A. Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shall be removed as directed. Refill with satisfactory material and compact to 90 percent of ASTM D 698 or

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

ASTM D 1557 maximum density. Determination of elevations and measurements of approved over depth excavation of unsatisfactory material below grades shall be done under the direction of the APE.

### B. Pipe Trenches

1. Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

### C. Temporary cover and patching.

1. Provide temporary cover or patching for open trenches in accordance with construction notes on the plans.

### D. Excavated Materials

1. Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Paragraph "DISPOSITION OF SURPLUS MATERIAL."

## 3.4 FILLING AND BACKFILLING

### A. Backfill and Fill Material Placement Over Pipes

1. Backfilling shall not begin until sanitary sewer or wastewater systems have been inspected, tested and approved, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Backfill material up to an elevation of 2 feet above sewer lines shall be free from stones larger than 1 inch in any dimension.

### B. Trench Backfilling

1. Backfill as rapidly as construction, testing, and acceptance of work permits. Place and compact backfill in 6 inch lifts to top of trench.

## 3.5 BORROW

- A. Where satisfactory materials are not available in sufficient quantity from required excavations, approved borrow materials shall be obtained as specified herein.

## 3.6 COMPACTION

- A. Determine in-place density of existing subgrade; if required density exists, no compaction of existing subgrade will be required. Density requirements specified

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herein are for cohesionless materials. When cohesive materials are encountered or used, density requirements may be reduced by 5 percent.

### 1. General Site

- a. Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area to 90 percent of ASTM D 698 or ASTM D 1557.

### 2. Paved Areas

- a. Compact top 12 inches of subgrades to 95 percent of ASTM D 698 or ASTM D 1557. Compact fill and backfill materials to 95 percent of ASTM D 698 or ASTM D 1557.

## 3.7 FINISH OPERATIONS

### A. Grading

1. Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

### B. Protection of Surfaces

1. Protect newly backfilled, graded, and tops oiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

## 3.8 DISPOSITION OF SURPLUS MATERIAL

- A. Remove from the Project Site surplus or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber.

## 3.9 FIELD QUALITY CONTROL

### A. Sampling

1. Take the number and size of samples required to perform the following tests.

### B. Testing

1. Perform one of each of the following tests for each material used. Provide additional tests for each source change.
2. Fill and Backfill Material Testing
  - a. Test fill and backfill material in accordance with ASTM C 136 for conformance to ASTM D 2487 gradation limits; ASTM D 1140 for material finer than the No. 200 sieve; ASTM D 4318 for liquid limit and for plastic limit; ASTM D 698 or ASTM D 1557 for moisture density relations, as

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applicable.

3. Density Tests

a. Test density in accordance with ASTM D 1556, or ASTM D 2922 and ASTM D 3017.

1) Bedding and backfill in trenches: One test per 50 linear feet in each lift.

**END OF SECTION 31 23 00**

**DIVISION 32  
EXTERIOR IMPROVEMENTS**

**SECTION 32 11 23  
AGGREGATE BASE COURSE**

**PART 1 GENERAL**

**1.1 SUMMARY**

A. Description: This Section includes the furnishing and placing of aggregate base course for restoration to its original condition as a result of sewer pipes trenching.

**1.2 REFERENCES**

A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. AASHTO T 180 (2009) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
2. AASHTO T 224 (2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

B. ASTM INTERNATIONAL (ASTM)

1. ASTM C 117 (2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
2. ASTM C 127 (2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregates
3. ASTM C 128 (2007a) Standard test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregates
4. ASTM C 131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
5. ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
6. ASTM C 29/C 29M (2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
7. ASTM D 1556 (2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
8. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil

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Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>) (2700 kN-m/m<sup>3</sup>)

9. ASTM D 2167 (2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
10. ASTM D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
11. ASTM D 6938 (2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
12. ASTM D 75/D 75M (2009) Standard Practice for Sampling Aggregates
13. ASTM E 11 (2009) Wire Cloth and Sieves for Testing Purposes

### 1.3 DEFINITION

- A. Degree of compaction required is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum dry density. One exception is as follows: Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

### 1.4 SYSTEM DESCRIPTION

- A. All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. Provide equipment which is adequate and has the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

### 1.5 SUBMITTALS

- A. ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES:
  1. SD-03 Product Data
    - a. List of proposed equipment to be used in performance of construction work, including descriptive data.
    - b. Copies of waybills and delivery tickets during the progress of the work.
  2. SD-06 Test Reports
    - a. Sampling and Testing

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- b. Field Density Tests
- c. Certified copies of test results for approval not less than 30 days before material is required for the work.
- d. Calibration curves and related test results prior to using the device or equipment being calibrated.
- e. Copies of field test results within 24 hours after the tests are performed.

### 1.6 QUALITY ASSURANCE

A. Sampling and testing are the responsibility of the Contractor, to be performed by an approved testing. Perform tests at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements.

#### 1. Sampling

- a. Take samples for laboratory testing in conformance with ASTM D 75/D 75M. When deemed necessary, the sampling will be observed by the APE.

#### 2. Tests

##### a. Sieve Analysis

- 1) Make sieve analysis in conformance with ASTM C 117 and ASTM C 136. Complete particle-size analysis of the soils in conformance with ASTM D 422. Sieves shall conform to ASTM E 11.

##### b. Liquid Limit and Plasticity Index

- 1) Determine liquid limit and plasticity index in accordance with ASTM D 4318.

##### c. Moisture-Density Determinations

- 1) Determine the laboratory maximum dry density and optimum moisture in accordance with ASTM D 1557.

##### d. Field Density Tests

- 1) Measure field density in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 6938. For the method presented in ASTM D 1556, use the base plate, as shown in the drawing. For the method presented in ASTM D 6938, check and adjust the calibration curves, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 6938 result in a wet unit weight of soil and ASTM D 6938 will be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D

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6938. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration, in ASTM D 6938, on each different type of material to be tested at the beginning of a job and at intervals as directed.

### e. Wear Test

- 1) Perform wear tests in conformance with ASTM C 131.

### f. Weight of Slag

- 1) Determine weight per cubic foot of slag in accordance with ASTM C 29/C 29M.

## 3. Testing Frequency

### a. Initial Tests

- 1) Perform one of each of the following tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation.
  - a) Sieve Analysis including 0.02 mm size material
  - b) Liquid limit and plasticity index
  - c) Moisture-density relationship
  - d) Wear
  - e) Weight per cubic foot of Slag

### b. In-Place Tests

- 1) Perform one of each of the following tests on samples taken from the placed and compacted rigid pavement, and asphalt concrete pavement base course. Samples shall be taken and tested at the rates indicated.
  - a) Perform density tests on every lift of material placed and at a frequency of one set of tests for every 500 square yards, or portion thereof, of completed area.
  - b) Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 500 square yards, or portion thereof, of material placed.
  - c) Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.
  - d) Measure the thickness of each course at intervals providing at least one measurement for each 500 square yards or part

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thereof. The thickness measurement shall be made by test holes, at least 3 inches in diameter through the course.

### 4. Approval of Material

- a. Select the source of materials 30 days prior to the time the material will be required in the work. Tentative approval will be based on initial test results. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted course.

## 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Perform construction when the atmospheric temperature is above 86 degrees F. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

## PART 2 PRODUCTS

### 2.1 AGGREGATES

#### A. Aggregate Base Course for Asphalt Paving.

1. Provide aggregate base course consisting of clean, sound, durable particles of crushed stone, crushed slag, crushed gravel, angular sand, or other approved material. Aggregate base course shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve is known as coarse aggregate; that portion passing the No. 4 sieve is known as fine aggregate.

#### 1.1 Coarse Aggregate

Provide coarse aggregates with angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

- a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.
- b. Crushed Stone: Provide crushed stone consisting of freshly mined quarry rock, meeting all the requirements specified below.
- c. Crushed Slag: Crushed slag shall be an air-cooled blast-furnace product having an air dry unit weight of not less than 1120 kg/cubic meter 70 pcf as determined by ASTM C 29/C 29M, and shall meet all the requirements specified below.

#### 1) Aggregate Base Course

Aggregate base course shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall

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not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces determined in accordance with ASTM D 5821. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in Table 1.

### 1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

#### a. Aggregate Base Course

Aggregate base course fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

### 1.3 Gradation Requirements

Apply the specified gradation requirements to the completed base course. The aggregates shall be continuously well graded within the limits specified in Table 1. Sieves shall conform to ASTM E 11.

TABLE 1 GRADATION OF AGGREGATES  
Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1
1-1/2 inch	70-100
1 inch	45-80
1/2 inch	30-60
No. 4	20-50
No. 10	15-40
No. 40	5-25
No. 200	0-8

Note 1: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C 127 and ASTM C 128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected as directed by the APE.

### Liquid Limit and Plasticity Index

Apply liquid limit and plasticity index requirements to the completed course and to any component that is blended to meet the required gradation. The portion of any

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component or of the completed course passing the No. 40 sieve shall be either non-plastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

### **PART 3 EXECUTION**

#### **3.1 OPERATION OF AGGREGATE SOURCES**

Clearing, stripping and excavating are the responsibility of the Contractor. Operate the aggregate sources to produce the quantity and quality of materials meeting the specified requirements in the specified time limit. Aggregate sources on private lands shall be conditioned in agreement with local laws and authorities.

#### **3.2 STOCKPILING MATERIAL**

Prior to stockpiling of material, clear and level storage sites. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the APE to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

#### **3.3 PREPARATION OF UNDERLYING MATERIAL**

Prior to constructing the base courses, clean the underlying course or subgrade of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Correct ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and re-compacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the overlying course. Accomplish stabilization by mixing the overlying course material into the underlying course, and compacting by approved methods. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the overlying course is placed.

#### **3.4 GRADE CONTROL**

The finished and completed course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

#### **3.5 MIXING AND PLACING MATERIALS**

Mix and place the materials to obtain uniformity of the material at the water content specified. Make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory aggregate base courses.

#### **3.6 LAYER THICKNESS**

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The compacted thickness of the completed course shall be as indicated. When a compacted layer of 6 inches is specified, the material may be placed in a single layer; when a compacted thickness of more than 6 inches is required, no layer shall be thicker than 6 inches nor be thinner than 3 inches when compacted.

### **3.7 COMPACTION**

Compact each layer of the material, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus 2 percent of optimum water content, as determined from laboratory tests, as specified in this section. In all places not accessible to the rollers, compact the mixture with hand-operated power tampers. Compaction of the base courses shall continue until each layer is compacted through the full depth to at least 95 percent of laboratory maximum density. Make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory sub-base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

### **3.8 SMOOTHNESS TEST**

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 12 foot straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50 foot intervals. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

### **3.9 THICKNESS CONTROL**

The completed thickness of the course(s) shall be in accordance with the thickness and grade indicated on the drawings. The completed course shall not be more than 1/2 inch deficient in thickness nor more than 1/2 inch above or below the established grade. Where any of these tolerances are exceeded, correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 1/2 inch or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements as specified above but within 1/4 inch of the thickness shown.

### **3.10 MAINTENANCE**

Maintain the completed course in a satisfactory condition until accepted.

**END OF SECTION 32 11 23**

**SECTION 32 12 13.16  
ASPHALTIC TACK COATS**

**PART 1 GENERAL**

**1.1 SUMMARY**

Description: This Section includes the furnishing and application of asphaltic tack coats as shown on the drawings and as specified herein.

**1.2 REFERENCES**

**A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)**

1. AASHTO M 82 (1975; R 2008) Standard Specification for Cut-Back Asphalt (Medium-Curing Type)
2. AASHTO T 102 (2009) Spot Test of Asphaltic Materials
3. AASHTO T 40 (2002; R 2006) Sampling Bituminous Materials

**B. ASTM INTERNATIONAL (ASTM)**

1. ASTM D 140/D 140M (2009) Sampling Bituminous Materials
2. ASTM D 2027 (2010) Cutback Asphalt (Medium-Curing Type)
3. ASTM D 2995 (1999; R 2009) Determining Application Rate of Bituminous Distributors
4. ASTM D 977 (2005) Emulsified Asphalt

**1.3 SYSTEM DESCRIPTION**

**A. General Requirements**

1. Plant, equipment, machines and tools used in the work are subject to approval and shall be maintained in a satisfactory working condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, should have been recalibrated by a calibration laboratory within 12 months prior to commencing work.

**B. Bituminous Distributor**

1. Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 650 psi of tire width to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the

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specified rate of not more than plus or minus 5 percent, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.

### C. Heating Equipment for Storage Tanks

1. The equipment for heating the bituminous material shall be steam, electric, or hot oil heaters. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot get into the material. Fix an armored thermometer to the tank with a temperature range from 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times.

### D. Power Brooms and Power Blowers

1. Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

## 1.4 SUBMITTALS

A. ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-03 Product Data
  - a. Waybills and delivery tickets, during progress of the work.
  - b. Documentation indicating distance between manufacturing facility and the project site.
2. SD-06 Test Reports
  - a. Sampling and Testing
    - 1) Copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating temperature viscosity relationship for cutback asphalt, compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

## 1.6 ENVIRONMENTAL REQUIREMENTS

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Apply bituminous coat only when the surface to receive the bituminous coat is dry. Apply bituminous coat only when the atmospheric temperature in the shade is 77 degrees F or above and when the temperature has not been below 59 degrees F for the 12 hours prior to application, unless otherwise directed.

### **PART 2 PRODUCTS**

#### **2.1 TACK COAT**

Provide asphalt conforming to ASTM D 2027 or AASHTO M82 Grade MC-70.

1. Cutback Asphalt
  - a. Provide cutback asphalt conforming to ASTM D 2027, Grade MC-70.
2. Emulsified Asphalt
  - a. Provide emulsified asphalt conforming to ASTM D 977, Type SS1h. Dilute the emulsified asphalt with equal parts of water. The base asphalt used to manufacture the emulsion shall show a negative spot when tested in accordance with AASHTO T 102 using standard naphtha.

### **PART 3 EXECUTION**

#### **3.1 PREPARATION OF SURFACE**

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. The surface shall be dry and clean at the time of treatment.

#### **3.2 APPLICATION RATE**

A. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the APE.

1. Tack Coat
  - a. Apply bituminous material for the tack coat in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

#### **3.3 APPLICATION TEMPERATURE**

A. Viscosity Relationship

1. Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the APE.

#### **3.4 APPLICATION**

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### A. General

1. Following preparation and subsequent inspection of the surface, apply the bituminous tack coat with the Bituminous Distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots missed by the distributor with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the ASPA. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are 3.4.1a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

### B. Tack Coat

1. Apply tack coat at the locations shown on the drawings. Apply the tack coat when the surface to be treated is dry. Immediately following the preparation of the surface for treatment, apply the bituminous material by means of the bituminous distributor, within the limits of temperature at a rate of not less than 0.05 gallon nor more than 0.15 gallon of diluted emulsion per square yard. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor with the bituminous material. Following the application of bituminous material, allow the surface to cure without being disturbed for period of time necessary to permit setting of the tack coat. Apply the bituminous tack coat only as far in advance of the placing of the overlying layer as required for that day's operation. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

## 3.5 CURING PERIOD

- A. Following application of the bituminous material and prior to application of the succeeding layer of pavement, allow the bituminous coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas.

## 3.6 SAMPLING AND TESTING

- A. Perform sampling and testing by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

### 1. Sampling

- a. The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140/D 140M or AASHTO T 40. Sources from which bituminous materials are to be obtained shall be selected and notification furnished the APE within 15 days after the award of the contract.

2. Calibration Test

- a. Furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibrate the bituminous distributor in accordance with ASTM D 2995.

**3.7 TRAFFIC CONTROLS**

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

**END OF SECTION 32 12 13.16**

**SECTION 32 12 13.23  
ASPHALTIC PRIME COATS**

**PART 1 GENERAL**

**1.1 SUMMARY**

Description: This Section includes the furnishing and application of asphaltic prime coat to prepared base course as indicated on the drawings and as specified herein.

**1.2 REFERENCES**

**A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)**

1. AASHTO M 82 (1975; R 2008) Standard Specification for Cut-Back Asphalt (Medium-Curing Type)
2. AASHTO T 40 (2002; R 2006) Sampling Bituminous Materials

**B. ASTM INTERNATIONAL (ASTM)**

1. ASTM D 140/D 140M (2009) Sampling Bituminous Materials
2. ASTM D 2027 (2010) Cutback Asphalt (Medium-Curing Type)
3. ASTM D 2995 (1999; R 2009) Determining Application Rate of Bituminous Distributors
4. ASTM D 977 (2005) Emulsified Asphalt

**1.3 SYSTEM DESCRIPTION**

**A. General Requirements**

1. Plant, equipment, machines and tools used in the work are subject to approval and shall be maintained in a satisfactory working condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, should have been recalibrated by a calibration laboratory within 12 months prior to commencing work.

**B. Bituminous Distributor**

1. Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 650 psi of tire width to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars,

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tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.

### C. Heating Equipment for Storage Tanks

1. The equipment for heating the bituminous material shall be steam, electric, or hot oil heaters. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot get into the material. Fix an armored thermometer to the tank with a temperature range from 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times.

### D. Power Brooms and Power Blowers

1. Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

## 1.4 SUBMITTALS

- A. ASPA is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

Waybills and delivery tickets, during progress of the work.

#### SD-06 Test Reports

##### Sampling and Testing

Copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating temperature viscosity relationship for cutback asphalt, compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

## 1.6 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. Apply bituminous coat only when the atmospheric temperature in the shade is 77 degrees F or above and when the temperature has not been below 59 degrees F for the 12 hours prior to application, unless otherwise directed.

## **PART 2 PRODUCTS**

### **2.1 PRIME COAT**

- A. Provide asphalt conforming to AASHTO M 82, Grade MC-70 and specified in the following two subparagraphs.
  - 1. Cutback Asphalt
    - a. Provide cutback asphalt conforming to ASTM D 2027, Grade MC-70.
  - 2. Emulsified Asphalt
    - a. Provide emulsified asphalt conforming to ASTM D 977, Type SS1h.

## **PART 3 – EXECUTION**

### **3.1 PREPARATION OF SURFACE**

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. The surface shall be dry and clean at the time of treatment.

### **3.2 APPLICATION RATE**

- A. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the APE.
  - 1. Prime Coat
    - a. Apply bituminous material for the prime coat in quantities of not less than 0.15 gallon nor more than 0.40 gallon per square yard of pavement surface.

### **3.3 APPLICATION TEMPERATURE**

- A. Viscosity Relationship
  - 1. Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the APE.

### **3.4 APPLICATION**

- A. General
  - 1. Following preparation and subsequent inspection of the surface, apply the bituminous prime tack coat with the Bituminous Distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots missed by the distributor with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost

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to the ASPA. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

### B. Prime Coat

1. Apply prime coat on the prepared aggregate base course. The prime coat is required if it will be at least 7 days before the surfacing (Asphalt cement hot mix concrete) layer is constructed on the underlying (base course) compacted material. The type of liquid asphalt and application rate will be as specified herein. Protect the underlying from any damage (water, traffic, etc.) until the surfacing is placed. If the Contractor places the surfacing within seven days, the choice of protection measures or actions to be taken is at the Contractor's option. Repair (re-compact or replace) damage to the underlying material caused by lack of, or inadequate, protection by approved methods at no additional cost to the ASPA. If the Contractor opts to use the prime coat, apply as soon as possible after consolidation of the underlying material. Apply the bituminous material uniformly over the surface to be treated at a pressure range of 25 to 75 psi and at the rate of not less than 0.20 gallon not more than 0.30 gallon per square yard. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application remove and destroy the building paper.

### 3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, allow the bituminous coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough sand to effectively blot up and cure excess bituminous material.

### 3.6 SAMPLING AND TESTING

- A. Perform sampling and testing by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

1. Sampling

- a. The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140/D 140M or AASHTO T 40. Sources from

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which bituminous materials are to be obtained shall be selected and notification furnished the APE within 15 days after the award of the contract.

### 2. Calibration Test

- a. Furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibrate the bituminous distributor in accordance with ASTM D 2995.

### 3.7 TRAFFIC CONTROLS

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

**END OF SECTION 32 12 13.23**

**SECTION 32 12 16  
ASPHALT PAVING**

**PART 1 GENERAL**

**1.1 SUMMARY**

Description: This Section includes the furnishing and reconstructing of the existing asphalt road pavement for restoration to its original condition as a result of sewer utilities trenching.

**1.2 REFERENCES**

**A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)**

1. AASHTO MP 1a (2004) Performance Graded Asphalt Binder

**B. ASPHALT INSTITUTE (AI)**

1. AI MS-02 (6th Edition; 1997) Mix Design Methods for Asphalt

**C. ASTM INTERNATIONAL (ASTM)**

1. ASTM C 117 (2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
2. ASTM C 127 (2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
3. ASTM C 128 (2007a) Standard Test Method for Density, relative Density (Specific Gravity), and Absorption of Fine Aggregate
4. ASTM C 131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
5. ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
6. ASTM C 188 (1995; R 2003) Standard Test Method for Density of Hydraulic Cement
7. ASTM C 29/C 29M (2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
8. ASTM C 88 (2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or

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### Magnesium Sulfate

9. ASTM D 1073 (2007) Fine Aggregate for Bituminous Paving Mixtures
10. ASTM D 1188 (2007) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
11. ASTM D 1559 (1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
12. ASTM D 2041 (2003a) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
13. ASTM D 2172 (2005) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
14. ASTM D 242/D 242M (2009) Mineral Filler for Bituminous Paving Mixtures
15. ASTM D 2726 (2009) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
16. ASTM D 4867/D 4867M (2009) Effect of Moisture on Asphalt Concrete Paving Mixtures
17. ASTM D 546 (2005) Sieve Analysis of Mineral Filler for Bituminous Paving Mixtures
18. ASTM D 692/D 692M (2009) Coarse Aggregate for Bituminous Paving Mixtures
19. ASTM D 70 (2009e1) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
20. ASTM D 75/D 75M (2009) Standard Practice for Sampling Aggregates
21. ASTM D 854 (2006e1) Specific Gravity of Soil Solids by Water Pycnometer
22. ASTM D 979 (2001; R 2006e1) Sampling Bituminous Paving Mixtures
23. ASTM D 995 (1995b; R 2002) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

### 1.3 SUBMITTALS

ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

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### SD-05 Design Data

#### Job-mix formula

Submit a job-mix formula, prepared specifically for this project, for approval by the ASPA prior to preparing and placing the bituminous mixture. Design mix using procedures contained in Chapter V, Marshall Method of Mix Design, of AI MS-02. Formulas shall indicate physical properties of the mixes as shown by tests made by a commercial laboratory approved by the APE, using materials identical to the materials used in the existing asphalt concrete pavement to be provided on this project. Submit formulas with material samples. Job-mix formula for each mixture shall be in effect until modified in writing by the Contractor and approved by the APE. Provide a new job-mix formula for each source change. Submittal shall include all tests indicated in MIX DESIGN section of this specification.

### SD-06 Test Reports

Specific gravity test of asphalt

Coarse aggregate tests

Weight of slag test

Percent of crushed pieces in gravel

Fine aggregate tests

Specific gravity of mineral filler

Bituminous mixture tests

Aggregates tests

Bituminous mix tests

## 1.4 QUALITY ASSURANCE

### A. Safety Requirements

1. Provide adequate and safe stairways with handrails to the mixer platform, and safe and protected ladders or other means for accessibility to plant operations. Guard equipment and exposed steam or other high temperature lines or cover with a suitable type of insulation.

### B. Required Data

1. Job-mix formula shall show the following:

- a. Source and proportions, percent by weight, of each ingredient of the mixture;

- b. Correct gradation, the percentages passing each size sieve listed in the

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specifications for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture;

- c. Amount of material passing the No. 200 sieve determined by dry sieving;
- d. Number of blows of hammer compaction per side of molded specimen;
- e. Temperature viscosity relationship of the asphalt cement;
- f. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight;
- g. Asphalt absorption by the aggregate;
- h. Effective asphalt content as percent by weight of total mix;
- i. Temperature of the mixture immediately upon completion of mixing;
- j. Asphalt performance grade, viscosity grade, penetration range; and

### C. Charts

1. Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

### D. Selection of Optimum Asphalt Content

1. Base selection on percent of total mix and the average of values at the following points on the curves for each mix:
  - a. Stability: Peak
  - b. Unit Weight: Peak
  - c. Percent Air Voids: Median

## 1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

## 1.6 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 45 degrees F for course thicknesses greater than one.

## 1.7 CONSTRUCTION EQUIPMENT

- A. Calibrated equipment, such as scales, batching equipment, spreaders and similar

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equipment, shall have been recalibrated by a calibration laboratory approved by the APE within 6 months of commencing work.

### 1. Mixing Plant

- a. Design, coordinate, and operate the mixing plant to produce a mixture within the job-mix formula tolerances and to meet the requirements of ASTM D 995, including additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures.
- b. Cold Aggregate Feeder
  - 1) Provide plant with a feeder or feeders capable of delivering the maximum number of aggregate sizes required in their proper proportion. Provide adjustment for total and proportional feed and feeders capable of being locked in any position. When more than one cold elevator is used, feed each elevator as a separate unit and install individual controls integrated with a master control.
- c. Dryer
  - 1) Provide rotary drum-dryer which continuously agitates the mineral aggregate during the heating and drying process. When one dryer does not dry the aggregate to specified moisture requirements, provide additional dryers.
- d. Plant Screens and Bins for Batch and Continuous Mix Plants
  - 1) Use screen to obtain accurate gradation and allow no bin to contain more than 10 percent oversize or undersize. Inspect screens each day prior to commencing work for plugged, worn, or broken screens. Clean plugged screens and replace worn or broken screens with new screens prior to beginning operations. Divide hot aggregate bins into at least three compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.
- e. Testing Laboratory
  - 1) Provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.
- f. Surge and Storage Bins
  - 1) Use for temporary storage of hot bituminous mixtures will be permitted under the following conditions:

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- a) When stored in surge bins for a period of time not to exceed 3 hours.
  - b) When stored in insulated and heated storage bins for a period of time not to exceed 12 hours. If it is determined by the APE that there is an excessive amount of heat loss, segregation and oxidation of the mixture due to temporary storage, discontinue use of surge bins or storage bins.
- g. Drum-Dryer Mixer
- 1) Do not use drum-dryer mixer if specified requirements of the bituminous mixture or of the completed bituminous pavement course cannot be met. If drum-dryer mixer is prohibited, use either batch or continuous mix plants meeting the specifications and producing a satisfactory mix.
- ### 2. Paving Equipment
- a. Spreading Equipment
    - 1) Self-propelled electronically controlled type, unless other equipment is authorized by the APE. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.
  - b. Rolling Equipment
    - 1) Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

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- c. Hand Tampers
  - 1) Minimum weight of 25 pounds with a tamping face of not more than 50 square inches.
- d. Mechanical Hand Tampers
  - 1) Commercial type, operated by pneumatic pressure or by internal combustion.

## **PART 2 PRODUCTS**

### **2.1 AGGREGATES**

- A. Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.
  - 1. Coarse Aggregates
    - a. ASTM D 692/D 692M, except as modified herein. At least 75 percent by weight of aggregate retained on the No. 4 sieve shall have two or more fractured faces. Percentage of wear, Los Angeles test, except for slag, shall not exceed 40 in accordance with ASTM C 131. Weight of slag shall not be less than 70 pounds per cubic foot. Soundness test is required in accordance with ASTM C 88; after 5 cycles, loss shall not be more than 12 percent when tested with sodium sulfate or 18 percent when tested with magnesium sulfate.
  - 2. Fine Aggregate
    - a. ASTM D 1073, except as modified herein. Fine aggregate shall be produced by crushing stone, slag or gravel that meets requirements for wear and soundness specified for coarse aggregate. Where necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. Quantity of natural sand to be added shall be approved by the APE and shall not exceed 15 percent of weight of coarse and fine aggregate and material passing the No. 200 sieve.
  - 3. Mineral Filler
    - a. Non-plastic material meeting the requirements of ASTM D 242/D 242M.
  - 4. Aggregate Gradation
    - a. The combined aggregate gradation shall conform to gradations specified in Table I, when tested in accordance with ASTM C 136 and ASTM C 117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table I. Aggregate Gradations

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

Sieve Size, inch	Gradation Percent Passing by Mass
1/2	100
3/8	76 – 96
No. 4	58 – 78
No. 8	40 – 60
No. 16	28 – 48
No. 30	18 – 38
No. 50	11 – 27
No. 100	6 – 18
No. 200	3 – 6

### 2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to AASHTO M320, Performance Grade. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the APE for approval.

### 2.3 MIX DESIGN

A. The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in MS-02 and the criteria shown in Table II. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an anti-strip agent is required, it shall be provided by the Contractor at no additional cost.

#### B. JMF Requirements

1. The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:
  - a. Percent passing each sieve size.
  - b. Percent of asphalt cement.
  - c. Percent of each aggregate and mineral filler to be used.

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- d. Asphalt viscosity grade, penetration grade, or performance grade.
- e. Number of blows of hammer per side of molded specimen.
- f. Laboratory mixing temperature.
- g. Lab compaction temperature.
- h. Temperature-viscosity relationship of the asphalt cement.
- i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.
- j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-02.
- k. Specific gravity and absorption of each aggregate.
- l. Percent natural sand.
- m. Percent particles with two or more fractured faces (in coarse aggregate).
- n. Fine aggregate angularity.
- o. Percent flat or elongated particles (in coarse aggregate).
- p. Tensile Strength Ratio.
- q. Anti-strip agent (if required) and amount.
- r. List of all modifiers and amount.

Table II. Marshall Design Criteria

Test Property	75 Blow Mix	50 Blow Mix
Stability, pounds minimum	*2150	*1350
Flow, 0.01 inch	8 - 16	100
Air voids, percent	3 - 5	76 - 96
Percent Voids in mineral aggregate (minimum)	See Table III	See Table III
TSR, minimum percent	75	75

\* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Table III. Minimum Percent Voids in Mineral Aggregate (VMA)\*\*

Aggregate (See Table I)	Minimum VMA, percent
Gradation 1	15

\*\* Calculate VMA in accordance with MS-02, based on ASTM D 2726 bulk

specific gravity for the aggregate.

C. Adjustments to JMF

1. The JMF for each mixture shall be in effect until a new formula is approved in writing by the APE. Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the JMF within the limits specified below to optimize mix volumetric properties. Adjustments to the JMF shall be limited to plus or minus 3 percent on the 1/2 inch, No. 4, and No. 8 sieves; plus or minus 1.0 percent on the No. 200 sieve; and plus or minus 0.40 percent binder content. If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table I; this is acceptable.

**2.4 SOURCE QUALITY CONTROL**

A. Employ a commercial laboratory approved by the APE to perform testing. The laboratory used to develop the JMF and the laboratory used to perform all sampling and testing shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the APE prior to the start of construction. The certification shall contain as a minimum:

1. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
2. A listing of equipment to be used in developing the job mix.
3. A copy of the laboratory's quality control system.
4. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

B. Tests

1. Perform testing in accordance with the following:
  - a. Specific Gravity Test of Asphalt: ASTM D 70
  - b. Coarse Aggregate Tests:
    - 1) Bulk Specific Gravity: ASTM C 127
    - 2) Abrasion Loss: ASTM C 131
    - 3) Soundness Loss: ASTM C 88
  - c. Weight of Slag Test: ASTM C 29/C 29M
  - d. Percent of Crushed Pieces in Gravel: Count by observation and weight

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- e. Fine Aggregate Tests:
  - 1) Bulk Specific Gravity: ASTM C 128
  - 2) Soundness Loss: ASTM C 88
- f. Specific Gravity of Mineral Filler: ASTM C 188 or ASTM D 854
- g. Bituminous Mixture Tests:
  - 1) Bulk Specific Gravity: ASTM D 1188 or ASTM D 2726
  - 2) Theoretical Maximum Specific Gravity: ASTM D 2041
  - 3) Tensile Strength Ratio: ASTM D 4867/D 4867M

### **PART 3 EXECUTION**

#### **3.1 PREPARATION**

##### **A. Preparation of Asphalt Binder Material**

1. The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 325 degrees F when added to the aggregates. Modified asphalts shall be no more than 350 degrees F when added to the aggregate.

##### **B. Preparation of Mineral Aggregates**

1. Store different size aggregate in separate stockpiles so that different sizes will not mix. Stockpile different-sized aggregates in uniform layers by use of a clam shell or other approved method so as to prevent segregation. The use of bulldozers in stockpiling of aggregate or in feeding aggregate to the dryer is prohibited. Feed aggregates into the cold elevator by means of separate mechanical feeders so that aggregates are graded within requirements of the job-mix formulas and tolerances specified. Regulate rates of feed of the aggregates so that moisture content and temperature of aggregates are within tolerances specified herein. Dry and heat aggregates to the temperature necessary to achieve the mixture determined by the job mix formula within the job tolerance specified. Provide adequate dry storage for mineral filler.

##### **C. Preparation of Bituminous Mixture**

1. Accurately weigh aggregates and dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. In batch mixing, after aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods and continue mixing for a period of not less than 20 seconds, or as long as required to obtain a

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homogeneous mixture. The time required to add or spray asphalt into the mixer will not be added to the total wet-mixing time provided the operation does not exceed 10 seconds and a homogeneous mixture is obtained. When a continuous mixer is employed, mixing time shall be more than 35 seconds to obtain a homogeneous mixture. Additional mixing time, when required, will be as directed by the APE) When mixture is prepared in a twin-pug mill mixer, volume of the aggregates, mineral filler, and asphalt shall not extend above tips of mixer blades when blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch or continuous mix plant produced mixtures, waste the mix and withdraw the aggregates in the hot bins immediately and return to the respective stockpiles; for drum-dryer mixer plants, waste the mix, including that in surge or storage bins that is affected by free moisture.

### D. Transportation of Bituminous Mixtures

1. Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck. If air temperature is less than 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

### E. Surface Preparation of Underlying Course

1. Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary. During the placement of multiple lifts of bituminous concrete, each succeeding lift of bituminous concrete shall have its underlying lift cleaned and provided with a bituminous tack coat if the time period between the placement of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty.

## 3.2 PLACEMENT

### A. Machine Spreading

1. The range of temperatures of the mixtures at the time of spreading shall be between 250 degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling,

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and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where the edge lanes require strips less than 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than 30 feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

### B. Shoveling, Raking, and Tamping After Machine-Spreading

1. Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct irregularities in alignment left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

### C. Hand-Spreading in Lieu of Machine-Spreading

1. In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 250 and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread hot mixture with rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

## 3.3 COMPACTION OF MIXTURE

- A. Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as

necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least 96 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D 1559. During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

### 3.4 JOINTS

A. Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

#### 1. Transverse

a. Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. Transverse joints in adjacent lanes shall be offset a minimum of 2 feet.

#### 2. Longitudinal Joints

a. Space 6 inches apart. Do not allow joints to coincide with joints of existing placed lanes 2 to 3 inches and be of such height to permit compaction to produce a smooth dense joint. With a lute, push back mixture placed on the surface of previous lanes to the joint edge. Do not scatter mix. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

### 3.5 FIELD QUALITY CONTROL

#### A. Sampling

##### 1. Aggregates At Source

- a. Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D 75/D 75M at the source or from each stockpile. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

##### 2. Cold Feed Aggregate Sampling

- a. Take two samples daily from the belt conveying materials from the cold feed. Collect materials in three increments at random to make a representative composite sample of not less than 50 pounds. Take samples in accordance with ASTM D 75/D 75M.

##### 3. Coarse and Fine Aggregates

- a. Take a 50 pound sample from the cold feed at least once daily for sieve analysis and specific gravity tests. Additional samples may be required to perform more frequent tests when analysis shows deficiencies, or unacceptable variances or deviations. The method of sampling is as specified herein for aggregates.

##### 4. Mineral Filler

- a. ASTM D 546. Take samples large enough to provide ample material for testing.

##### 5. Pavement and Mixture

- a. Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D 979.

#### B. Testing

##### 1. Aggregates Tests

- a. Gradation: ASTM C 136.

- b. Mineral Filler Content: ASTM D 546.

- c. Abrasion: ASTM C 131 for wear (Los Angeles test). Perform one test

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initially prior to incorporation into the work and each time the source is changed.

### 2. Bituminous Mix Tests

- a. Test one sample for each 50 tons, or fraction thereof, of the un-compacted mix for extraction in accordance with ASTM D 2172; perform a sieve analysis on each extraction sample in accordance with ASTM C 136 and ASTM C 117. Test one sample for each 50 tons or fraction thereof for stability and flow in accordance with ASTM D 1559. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D 4867/D 4867M.

### 3. Pavement Courses

- a. Perform the following tests:

- 1) Density: For each 100 tons of bituminous mixture placed, determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D 1559. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record in a manner approved by the APE the project areas represented by the laboratory densities. From each representative area recorded, determine field density of pavement by averaging densities of 4 inch diameter cores obtained from leveling, binder, and wearing courses; take one core for each 2000 square yards or fraction thereof of course placed. Determine density of laboratory prepared specimens and cored samples in accordance with ASTM D 1188 or ASTM D 2726, as applicable. Separate pavement layers by sawing or other approved means. Maximum allowable deficiency at any point, excluding joints, shall not be more than 2 percent less than the specified density for any course. The average density of each course, excluding joints, shall be not less than the specified density. Joint densities shall not be more than 2 percent less than specified course densities and are not included when calculating average course densities. When the deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.
- 2) Thickness: Determine thickness of binder and wearing courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.
- 3) Smoothness: Straightedge test the compacted surface of leveling, and wearing courses as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Unevenness of leveling course shall not vary more than 1/4 inch in 10 feet; variations in the wearing course shall not vary more than 1/8 inch in 10 feet.

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Correct each portion of the pavement showing irregularities greater than that specified.

- 4) Finished Grades: Finish grades of each course placed shall not vary from the finish elevations, profiles, and cross sections indicated by more than 1/2 inch. Finished surface of the final wearing course will be tested by running lines of levels at intervals of 25 feet longitudinally and transversely to determine elevations of completed pavement. The APE will inform the Contractor in writing of paved areas that fail to meet the final grades indicated within the specified tolerances. Correct deficient paved areas by removing existing work and replacing with new materials that meet the specifications. Skin patching for correcting low areas is prohibited.
5. Finish Surface Texture of Wearing Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be removed and replaced with new materials.

### 3.6 PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

**END OF SECTION 32 12 16**

**SECTION 32 16 13  
CONCRETE SIDEWALKS AND CURBS AND GUTTERS**

**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS (AASHTO)

1. AASHTO M 182 (2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

2. ASTM A1064/A1064M (2013) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
3. ASTM A615/A615M (2013) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. ASTM C143/C143M (2012) Standard Test Method for Slump of Hydraulic-Cement Concrete
5. ASTM C171 (2007) Standard Specification for Sheet Materials for Curing Concrete
6. ASTM C172/C172M (2010) Standard Practice for Sampling Freshly Mixed Concrete
7. ASTM C173/C173M (2012) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
8. ASTM C231/C231M (2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
9. ASTM C309 (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
10. ASTM C31/C31M (2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
11. ASTM C920 (2011) Standard Specification for Elastomeric Joint Sealants
12. ASTM D1751 (2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

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- |                       |  |
|-----------------------|--|
| 13. ASTM D1752        | (2004a; R 2013) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion                     |
| 14. ASTM D5893/D5893M | (2010) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements |

### 1.2 SUBMITTALS

ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 - SUBMITTAL PROCEDURES.

Product Data

Concrete

Test Reports

Field Quality Control

### 1.3 ENVIRONMENTAL REQUIREMENTS

#### 1.3.1 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

## PART 2 PRODUCTS

### 2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 05 15 Portland Cement Concrete and Section and Section 03 30 53 Miscellaneous Cast-In-Place Concrete except as otherwise specified. Concrete shall have a minimum compressive strength of 3000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

#### 2.1.1 Slump

The concrete slump shall be 3 inches plus or minus 1 inch where determined in accordance with ASTM C143/C143M.

#### 2.1.2 Reinforcement Steel

Reinforcement bars shall conform to ASTM A615/A615M.

### 2.2 CONCRETE CURING MATERIALS

ESV Wastewater Collection System Ph 2

Concrete Sidewalks and Curbs and Gutters

32 16 13 - 2

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### 2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C171, type optional, except that polyethylene film, if used, shall be white opaque.

### 2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

### 2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C309, Type 2.

## 2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

## 2.4 JOINT FILLER STRIPS

### 2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

### 2.4.2 Expansion Joint Filler, Pre-molded

Expansion joint filler, pre-molded, shall conform to ASTM D1751 or ASTM D1752, 1/2 inch thick, unless otherwise indicated.

## 2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C920 or ASTM D5893/D5893M.

## 2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for

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use with steel forms.

### 2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

### 2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

## **PART 3 EXECUTION**

### **3.1 SUBGRADE PREPARATION**

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted as directed by APE.

#### 3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

#### 3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

#### 3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

### **3.2 FORM SETTING**

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms

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shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

### 3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section.

After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope as indicated [1/4 inch per foot] with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

### 3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

## 3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

### 3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated by tamping and spading or with an approved vibrator, and the surface shall be finished to grade with a strike off.

### 3.3.2 Concrete Finishing

After straight edging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

### 3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

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### 3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

## 3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

### 3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

### 3.4.2 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

### 3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

### 3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

## 3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

### 3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness,

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using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

### 3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color.

### 3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

## 3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

### 3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

- a. Contraction joints shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

### 3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not less than 30 feet nor greater than 120 feet. Expansion joints shall be provided in non-reinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit.

### 3.7 CURING AND PROTECTION

#### 3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

##### 3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

##### 3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

##### 3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be re-sprayed by the method and at the coverage specified above.

Areas where the curing compound is damaged by subsequent construction operations

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within the curing period shall be re-sprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is re-sprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

### 3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

### 3.7.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

## 3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

### 3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

### 3.8.2 Concrete Testing

#### 3.8.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 100 cubic yards or fraction thereof of concrete. The samples for strength tests shall be taken in accordance with ASTM C172/C172M. Cylinders for acceptance shall be molded in conformance with ASTM C31/C31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and

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no individual strength test result falls below the specified strength by more than 500 psi.

### 3.8.2.2 Slump Test

Two slump tests shall be made on randomly selected batches for every 100 cubic yards, or fraction thereof, of concrete. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

### 3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine.

### 3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

## 3.9 SURFACE DEFICIENCIES AND CORRECTIONS

### 3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

### 3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

### 3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the APE and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

**END OF SECTION 32 16 13**

**SECTION 32 17 23  
PAVEMENT MARKINGS**

**PART 1 GENERAL**

**1.1 SUMMARY**

A. Description: This Section includes the furnishing and applying of paint on restored pavement surfaces as shown on the drawings and as specified herein.

**1.2 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND  
TRANSPORTATION OFFICIALS (AASHTO)

1. AASHTO M 247 (2009) Standard Specification for Glass Beads Used  
in Pavement Markings

B. ASTM INTERNATIONAL (ASTM)

1. ASTM D 4280 (2008) Extended Life Type, Non-plowable, Raised, Retro-  
reflective Pavement Markers

2. ASTM D 4505 (2005) Preformed Retro-reflective Pavement Marking Tape  
for Extended Service Life

3. ASTM D 792 (2008) Density and Specific Gravity (Relative  
Density) of Plastics by Displacement

4. ASTM E 28 (1999; R 2009) Softening Point of Resins Derived from  
Naval Stores by Ring and Ball Apparatus

C. U.S. GENERAL SERVICES ADMINISTRATION (GSA)

1. FS TT-B-1325 (Rev D) Beads (Glass Spheres) Retro-Reflective  
(Metric)

**1.3 SYSTEM DESCRIPTION**

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads shall display low speed traffic markings and traffic warning lights.

1.3.1 Paint Application Equipment

1.3.1.2 Hand-Operated, Push-Type Machines

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Applicator machine shall be

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equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

### 1.3.2 Surface Preparation Equipment

#### 1.3.2.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

#### 1.3.2.2 Water-blast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

## 1.4 SUBMITTALS

ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-03 Product Data

#### Equipment

Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section.

#### Composition Requirements

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

#### Qualifications

Documentation on personnel qualifications, as specified.

### SD-06 Test Reports

#### Sampling and Testing

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

### SD-07 Certificates

#### Volatile Organic Compound (VOC)

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

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### **1.5 QUALITY ASSURANCE**

#### 1.5.1 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of chemicals.

#### 1.5.2 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines to control traffic and prevent damage to newly painted surfaces. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

#### 1.5.3 Maintenance of Traffic

##### 1.5.3.1 Roads

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flag persons, and related equipment for the safe passage of vehicles shall be provided.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

### **1.7 ENVIRONMENTAL REQUIREMENTS**

Pavement surface shall be free of dirt or foreign matter. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during rainfall, except for water blasting and removal of previously applied chemicals. Water blasting shall cease where surface water accumulation alters the effectiveness of material removal.

## **PART 2 PRODUCTS**

### **2.1 PAINT**

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months.

Paints shall conform to FS TT-P-1952, color to match the existing. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

## **2.2 SAMPLING AND TESTING**

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers in the presence of the APE. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the ASPA for possible future testing should the material appear defective during or after application.

## **PART 3 EXECUTION**

### **3.1 SURFACE PREPARATION**

Thoroughly clean surfaces to be marked before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of tri-sodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be re-cleaned, when work has been stopped due to rain.

#### **3.1.1 Pretreatment for Early Painting**

Where early painting is required on rigid pavements, apply a pretreatment with an aqueous solution, containing 3 percent phosphoric acid and 2 percent zinc chloride, to prepared pavement areas prior to painting.

#### **3.1.2 Cleaning Existing Pavement Markings**

In general, markings shall not be placed over existing pavement marking patterns. Remove existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns. Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

#### **3.1.3 Cleaning Concrete Curing Compounds**

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On new portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

- a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.
- b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.
- c. All remaining curing compound is intact; all loose and flaking material is removed.
- d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.
- e. The surface to be marked is dry.

### 3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

#### 3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified. Provide guide lines and templates as necessary to control paint application. Edges of markings shall be sharply outlined.

##### 3.2.1.1 Rate of Application

Non-reflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet/gallon.

##### 3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

**END OF SECTION 32 17 23**

**SECTION 32 31 13  
CHAIN LINK FENCES AND GATES**

**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A116	(2005) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A121	(2007) Standard Specification for Metallic Coated Carbon Steel Barbed Wire.
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A702	(1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A90/A90M	(2009) Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM C 94/C 94M	(2010a) Standard Specification for Ready-Mixed Concrete
ASTM F 1043	(2011) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(2010) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F 567	(2011) Standard Practice for Installation of Chain Link Fence
ASTM F 883	(2009) Padlocks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191	(Rev K) Fencing, Wire and Post Metal (and Gates, Chain- Link Fence Fabric, and Accessories)
FS RR-F-191/1	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)

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FS RR-F-191/2 (Rev E) Fencing, Wire and Post, Metal (Chain-Link  
Fence Gates)

FS RR-F-191/3 (Rev E; Am 1) Fencing, Wire and Post, Metal (Chain-Link  
Fence Posts, Top Rails and Braces)

FS RR-F-191/4 (Rev F) Fencing, Wire and Post, Metal (Chain-Link  
Fence Accessories)

## 1.2 SUBMITTALS

ASPA approval is required for submittals. Submittals determined by APE as not requiring ASPA approval will be for Contractor Quality control approval. Submit the following in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES.

### SD-02 Shop Drawings

Fence Assembly

Location of Gate, Corner, End, and Pull Posts

Gate Assembly

Gate Hardware and Accessories

Erection/Installation Drawings

### SD-03 Product Data

Fence Assembly

Gate Assembly

Barbed Wire

Gate Hardware and Accessories

Zinc Coating

Fabric

Tension Bars

Concrete

### SD-07 Certificates

Certificates of Compliance

### SD-08 Manufacturer's Instructions

Fence Assembly

Gate Assembly

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Hardware Assembly

Accessories

### 1.3 ASSEMBLY AND INSTALLATION INSTRUCTIONS

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, gate, hardware and accessories.

Submit erection/installation drawings along with manufacturer's catalog data for complete fence assembly, gate assembly, hardware assembly and accessories.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

### 1.5 QUALITY ASSURANCE

#### 1.5.1 Required Report Data

Submit reports of listing of chain-link fencing and accessories regarding weight in ounces for PVC coating.

#### 1.5.2 Certificates of Compliance

Submit certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following:

- a. PVC coating
- b. Fabric
- c. Tension bars
- d. Gate hardware and accessories
- e. Concrete

## PART 2 PRODUCTS

### 2.1 GENERAL

Provide fencing materials conforming to the requirements of ASTM A116, ASTM A702, ASTM F 626, and as specified.

### 2.2 ZINC COATING

Provide hot-dip galvanized (after fabrication) ferrous-metal components and accessories, except as otherwise specified.

Provide zinc coating of weight not less than 1.94 ounces per square foot, as determined from the average result of two specimens, when tested in accordance with ASTM A90/A90M.

Provide zinc coating conforming to the requirements of the following:

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- a. Pipe: FS RR-F-191/3 Class 1 Grade A in accordance with ASTM F 1083.
- b. Hardware and accessories: ASTM A153/A153M, Table 1.
- c. Surface: ASTM F 1043
- d. External: Type B-B surface zinc with organic coating, 0.97 ounce per square foot minimum thickness of acrylated polymer.
- e. Internal: Surface zinc coating of 0.97 ounce per square foot minimum.

Provide galvanizing repair material that is cold-applied zinc-rich coating conforming to ASTM A780/A780M.

### 2.3 FABRIC

FS RR-F-191 and detailed specifications as referenced and other requirements as specified. *FS RR-F-191/1; Type IV, Polyvinyl chloride (PVC) coated with green over zinc coated steel.*

Provide fabric consisting of No. 9-gage wires woven into a 2-inch diamond mesh, with dimensions of fabric and wire conforming to ASTM A116, ASTM A702 and ASTM F 626, with 2.0 ounces per square foot.

Provide one-piece fabric widths for fence heights.

### 2.4 TOP AND BOTTOM SELVAGES

Provide knuckled selvages at top and bottom.

### 2.5 POSTS, TOP RAILS, BOTTOM RAILS AND BRACES

FS RR-F-191/3 line posts; Class 1, steel pipe, Grade A. End, corner, and pull posts;

Class 1, steel pipe, Grade A. Braces and rails; Class 1, steel pipe, Grade A, in minimum sizes listed in FS RR-F-191/3 for each class and grade. Provide PVC green color coating with minimum thickness of 0.01 inch.

### 2.6 LINE POSTS

Grade A: 2 inch pipe weighing 3.65 pounds per linear foot. *All posts are painted field green.*

### 2.7 END, CORNER, AND PULL POSTS

Provide minimally acceptable end, corner, and pull posts as follows:

Grade A: 2 inch pipe weighing 5.79 pounds per linear foot *painted with field green.*

### 2.8 SLEEVES

Provide sleeves for setting into concrete construction of the same material as post sections, sized as indicated on the drawings. Weld flat plates to each sleeve base to provide anchorage and prevent intrusion of concrete.

**2.9 TOP RAIL**

Provide a minimum of 1 1/4 inch diameter pipe rails. Grade A weighing 2.27 pounds per linear foot. Provide expansion couplings 6-inches long at each joint in top rails.

**2.10 CENTER RAILS BETWEEN LINE POSTS**

Provide 1 5/8 inch outside diameter pipe center rails; Grade A weighing 2.27 pounds per linear foot.

**2.11 BOTTOM RAIL**

Provide bottom rail conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized.

**2.12 POST-BRACE ASSEMBLY**

Provide bracing consisting of 1 1/4 inch diameter pipe Grade A weighing 2.27 pounds per linear foot and 3/8 inch adjustable truss rods and turnbuckles.

**2.13 TENSION WIRE**

Provide galvanized wire, No. 7-gage, coiled spring wire, provided at the top and bottom of the fabric. Provide zinc coating that weighs not less than 2.0 ounces per square foot.

**2.14 TENSION (STRETCHER) BARS**

Provide bars that have one-piece lengths equal to the full height of the fabric with a minimum cross section of 1/4 by 3/4 inch, in accordance with ASTM A116, ASTM A702 and ASTM F 626.

**2.15 POST TOPS**

Provide tops that are steel, wrought iron, or malleable iron designed as a weathertight closure cap. Provide one cap for each post, unless equal protection is provided by a combination post-cap and barbed-wire supporting arm. Provide caps with an opening to permit through passage of the top rail.

**2.16 TENSION BAR BANDS**

Provide bar bands for securing stretcher bars to posts that are steel, wrought iron, or malleable iron spaced not over 16 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Provide bands with projecting edges chamfered or eased.

**2.17 GATE POSTS**

Provide a gate post for supporting each gate leaf as follows:

3 1/2 inch diameter pipe Grade A weighing 9.11 pounds per linear foot and painted with field green.

## **2.18 GATES**

FS RR-F-191/2; Type II, double swing. Shape and size of gate frame, as indicated. Framing and bracing members, round of steel alloy. Steel member finish, zinc-coated. Provide gate frames and braces of minimum sizes as shown on the drawings. Gate fabric, is as specified for fencing fabric. Coating for steel latches, stops, hinges, keepers, and accessories, galvanized. Provide plunger rod type gate latches. Attach gate fabric to gate frame in accordance with manufacturer's standards, except that welding is not permitted. Arrange padlocking latches to be accessible from both sides of gate, regardless of latching arrangement.

Provide gate frame assembly that is welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections. Install fabric with stretcher bars at vertical edges; stretcher bars may also be used at top and bottom edges. Attach stretcher bars and fabric to gate frames on all sides at intervals not exceeding 15 inches. Attach hardware with rivets or by other means which provides equal security against breakage or removal.

Provide diagonal cross-bracing, consisting of 3/8-inch diameter adjustable-length truss rods on welded gate frames, where necessary to obtain frame rigidity without sag or twist. Provide non-welded gate frames with diagonal bracing.

## **2.19 GATE HARDWARE AND ACCESSORIES**

Provide gate hardware and accessories that conforms to ASTM A116, ASTM A702, ASTM F 626, and as specified:

Provide malleable iron or pressed steel hinges to suit gate size, non-lift-off type, offset to permit 180-degree opening.

Provide latch that permits operation from either side of the gate, with a padlock eye provided as an integral part of the latch.

Provide stops and holders of malleable iron for vehicular gates. Provide stops that automatically engage the gate and hold it in the open position until manually released.

Provide double gates with a cane bolt and ground-set keeper, with latch or locking device and padlock eye designed as an integral part.

## **2.20 MISCELLANEOUS HARDWARE**

Provide miscellaneous hot-dip galvanized hardware as required.

## **2.21 TIE WIRES**

Provide 12-gage galvanized steel wire for tying fabric to line posts, spaced 12 inches on center. For tying fabric to rails and braces, space tie wires 24 inches on center. For tying fabric to tension wire, space 0.105-inch hog rings 24 inches on center.

Manufacturer's standard procedure will be accepted if of equal strength and durability. FS RR-F-191/4. Provide wire ties constructed of the same material as the fencing fabric.

## **2.22 BARBED WIRE**

ASTM A121 zinc-coated, Type Z, Class 3, 4-point barbs spaced no more than 5 inches apart.

## **2.23 CONCRETE**

Provide concrete conforming to ASTM C 94/C 94M, and obtaining a minimum 28-day compressive strength of 2,500 psi.

## **2.24 GROUT**

Provide grout of proportions one part Portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

## **2.25 PADLOCKS**

Provide padlocks conforming to ASTM F 883, with chain.

## **PART 3 EXECUTION**

Provide complete installation conforming to ASTM F 567.

### **3.1 GENERAL**

Ensure final grading and established elevations are complete prior to commencing fence installation.

### **3.2 EXCAVATION**

Provide excavations for post footings of minimum sizes as indicated.

Space footings for line posts 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 3-inches below the bottoms of the posts. Set bottom of each post not less than 36-inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

Uniformly spread soil from excavations adjacent to the fence line or on areas of the project site, as directed.

When solid rock is encountered near the surface, drill into the rock at least 12 inches for line posts and at least 18 inches for end, pull, corner, and gate posts. Drill holes at least 1 inch greater in diameter than the largest dimension of the placed post.

If solid rock is below the soil overburden, drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

### **3.3 SETTING POSTS**

Remove loose and foreign materials from holes and the soil moistened prior to placing concrete.

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Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved.

Grout all posts set into sleeved holes in concrete with an approved grouting material. Maintain vertical alignment of posts set in concrete construction until concrete has set.

### 3.3.1 Earth and Bedrock

Provide concrete bases of dimensions indicated except in bedrock. Compact concrete to eliminate voids, and finish to a dome shape. In bedrock, set posts with a minimum of 1 inch of grout around each post. Work grout into hole to eliminate voids, and finish to a dome shape.

### 3.3.2 Bracing

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 12 inches below top of fence, and a diagonal tension rod.

## 3.4 CONCRETE STRENGTH

Provide concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires or hang gates until the concrete has attained its full design strength.

Take samples and test concrete to determine strength as specified.

## 3.5 TOP RAILS

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

## 3.6 CENTER RAILS

Provide single piece center rails between posts set flush with posts on the fabric side, using special offset fittings where necessary.

## 3.7 BRACE ASSEMBLY

Provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with the horizontal brace located at mid-height of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension. Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

## 3.8 TENSION WIRE INSTALLATION

Install tension wire by weaving them through the fabric and tying them to each post

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with not less than 7-gage galvanized wire or by securing the wire to the fabric with 10-gage ties or clips spaced 24 inches on center.

### **3.9 FABRIC INSTALLATION**

Provide fabric in single lengths between stretch bars with bottom barbs placed approximately 2 1/2-inches above the ground line. Pull fabric taut and tied to posts, rails, and tension wire with wire ties and bands. Install fabric on the security side of fence, unless otherwise directed. Ensure fabric remains under tension after the pulling force is released.

### **3.10 TENSION BAR INSTALLATION**

Thread tension bars through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 16 inches on center.

### **3.11 GATE INSTALLATION**

Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

### **3.12 TIE WIRES**

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

### **3.13 FASTENERS**

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

### **3.14 ZINC-COATING REPAIR**

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

### **3.15 TOLERANCES**

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

### **3.16 SITE PREPARATION**

#### **3.16.1 Clearing and Grading**

Clear fence line of trees, brush, and other obstacles to install fencing. Establish a graded, compacted fence line prior to fencing installation.

### **3.17 FENCE INSTALLATION**

Install fence on prepared surfaces to line and grade indicated. Secure fastening and

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hinge hardware in place to fence framework by peening or welding. Allow for proper operation of components. Coat peened or welded areas with a repair coating matching original coating. Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

### 3.17.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feet on center. Provide gate posts spaced as necessary for size of gate openings. Provide corner or pull posts, with bracing in both directions, for changes in direction of 15 degrees or more, or for abrupt changes in grade. Provide drawings showing location of gate, corner, end, and pull posts.

### 3.17.2 Top and Bottom Tension Wire

Install top and bottom tension wires before installing chain-link fabric, and pull wires taut. Place top and bottom tension wires within 8 inches of respective fabric line.

## 3.18 ACCESSORIES INSTALLATION

### 3.18.1 Post Caps

Install post caps as recommended by the manufacturer.

### 3.18.2 Padlocks

Provide padlocks for gate openings and provide chains that are securely attached to gate or gate posts. Provide padlocks keyed alike, and provide two keys for each padlock.

## 3.19 Supporting Arms and Barbed Wire

Install barbed wire supporting arms and barbed wire as indicated on the drawings and as recommended by the manufacturer. Anchor supporting arms to the posts with 3/8 inch diameter plain pin rivets or, at the Contractor's option, with studs driven by low-velocity explosive-actuated tools for steel, wrought iron, ductile iron, or malleable iron. Studs driven by an explosive-actuated tool shall not be used with gray iron or other material that can be fractured. Use a minimum of two studs per support arm. Pull barbed wire taut and attach to the arms with clips or other means that will prevent easy removal.

## 3.20 CLEANUP

Remove waste fencing materials and other debris from the work site.

**END OF SECTION 32 31 13**

**DIVISION 33  
UTILITIES**

**SECTION 33 05 23.19  
TRENCHLESS EXCAVATION USING MICROTUNNELING**

**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 13A                      (2010) Specification for Drilling-Fluid Materials

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4                (2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C111/A21.11              (2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C150/A21.50              (2008) Thickness Design of Ductile-Iron Pipe

AWWA C151/A21.51              (2009) Ductile-Iron Pipe, Centrifugally Cast, for Water

ASTM INTERNATIONAL (ASTM)

ASTM D 1248                      (2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

**1.3 DESIGN REQUIREMENTS**

**1.3.1 Pipe Casing**

Provide pipe casings and casing sizes as required to accommodate the sewer line sizes indicated in the plans of polyvinyl chloride (PVC) plastic pipe. Provide utility line accessories, connections, and manholes as specified and where indicated. Submit design calculations of pipe casing.

**1.4 SUBMITTALS**

ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Micro-tunneling Boring Machine equipment to be used

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### SD-03 Product Data

Piping casing, joints, fittings, valves, and couplings

Bentonite

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts.

### SD-05 Design Data

Design calculations of pipe casing

### SD-07 Certificates

Piping casing piping, fittings, joints, valves, and coupling

Shop-applied linings

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal or certificates on the same type, class, grade, and size of material as is being provided for the project.

### SD-08 Manufacturer's Instructions

Installation procedures for pipe casing

## **1.5 DELIVERY, STORAGE, AND HANDLING**

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

### **1.5.1 Handling**

Handle pipe, fittings, and other accessories in a manner to ensure delivery to the excavation in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation. Store plastic piping, jointing materials and rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

## **1.6 QUALITY ASSURANCE**

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### 1.6.1 Design Calculations of Pipe Casing

Submit design calculations of pipe casing demonstrating that the pipe casing selected has been designed to support the maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on the pipe casing.

## **PART 2 PRODUCTS**

### **2.1 PIPING CASING MATERIALS**

#### 2.1.1 Piping Casing

##### 2.1.1.1 Ductile-Iron Piping

- a. Pipe and Fittings: Pipe, except flanged pipe, AWWA C151/A21.51 Thickness Class 52. The outside diameter of ductile iron micro-tunneling pipe shall be in accordance with AWWA C150/A21.50.
  - (1) Deflection: The maximum allowable deflection shall not exceed three percent of the outside diameter of the pipe barrel for pipe manufactured with a rigid lining and/or rigid coating nor five percent for pipe manufactured with a flexible lining and/or flexible coating.
  - (2) Linings: Cement mortar shall be in accordance with latest version of AWWA C104/A21.4 Polyethylene lining shall be virgin polyethylene complying with ASTM D 1248 compounded with inert filler and with sufficient carbon black to resist ultraviolet rays.
  - (3) End Squareness: The ends of the pipe shall be perpendicular to the longitudinal axis of the pipe with a maximum deviation of not more than 0.25 inches.
  - (4) Hydrostatic Test: Each pipe section shall be subject to a hydrostatic test of not less than 500 psi as per the requirements of AWWA C151/A21.51. Non-standard joint lengths shall be cut only from full length pipe having satisfactorily passed the required 500 psi hydrostatic test.
  - (5) Material Properties: The following are representative minimum values for the physical properties of ductile iron for use as micro-tunneling pipe for pressure or gravity service.
    - (a) Tensile strength: Minimum 60,000 psi
    - (b) Tensile yield strength: Minimum 42,000 psi
    - (c) Compressive strength: The compressive yield strength of ductile iron is 10 to 20 percent higher than the tensile yield strength. The ultimate strength in

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compression is not normally determined for ductile metals, though apparent strength in tests may be several times the tensile strength value.

(d) Elongation: Minimum 10 percent.

(e) Modulus of Elasticity: 24,000,000 psi (tension or compression).

(f) Poisson's ratio: 0.28

(6) Spigot End Outside Diameter: The Spigot end outside diameter must be within the following ranges: 3 to 12 inches, plus 0.06 inches 14 to 24 inches, plus 0.05 inches.

### b. Joints and Jointing Material:

Joints: Pressure and gravity micro-tunneling pipe shall have either an integral-bell push-on or rubber gasket coupled joint meeting the following criteria:

(1) Integral-bell push-on joint micro-tunneling pipe shall consist of a rubber-gasket joint manufactured to conform with AWWA C111/A21.11 and the dimensions shown in AWWA C151/A21.51. The exterior of the pipe shall be coated with a durable cement-mortar or concrete coating applied in such a manner as to provide a uniform outside diameter.

(2) Cement-mortar or concrete strength, reinforcement and method of placement shall be in accordance with manufacturer's recommendations.

## 2.2 CONCRETE

Concrete shall be 3000 psi and conform with Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE of this specification.

## 2.3 BENTONITE

Bentonite shall conform with API Spec 13A and have the capacity of mixing with water to form a stable and homogeneous suspension.

## 2.4 BACKFILL

Reuse excavated sand for backfill that conforms with Section 31 23 00.00 20 EXCAVATION AND FILL.

## PART 3 EXECUTION

### 3.1 PREPARATION

#### 3.1.1 Access Shafts

A. Construction methods required to provide access shafts for micro-tunneling shall be subject to approval of the Contracting Officer. Acceptable construction methods

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- may include the use of interlocked steel sheet piling or precast circular concrete segments lowered in place during excavation.
- B. Final dimensions of access shafts selected by the Contractor shall be modified as required following installation of pipe casings to the size and shape of acceptable manhole designs shown on the Contract Drawings to permit installation of conveyance piping.
  - C. Shafts shall be of a size commensurate with safe working practices and located as shown on plans. With the approval of the APE, the Contractor may relocate shafts to better suit the capabilities of the micro-tunneling method proposed. Where no locations are given, the Contractor shall determine such locations with the approval of the APE.
  - D. Shaft locations shall, where possible, be kept clear of road intersections and within a single traffic lane, in order to minimize disruption to the flow of traffic. Support equipment, spoil piles, and materials shall also be located such as to minimize disruption to traffic and are subject to the approval of the Contracting Officer.
  - E. The Contractor shall properly support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. The Contractor shall furnish, place and maintain sheeting, bracing, and lining required to support the sides and floor of all pits and to provide adequate protection of the work, personnel, and the general public. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.
  - F. Construct a starter shaft to accommodate the installation of pipe casings, slurry shield and piping jacking device. Install thrust block as required and consolidate the ground (grout) where the casings exit the shaft.
  - G. Construct a receiver shaft to accommodate the installation of pipe casings and the slurry shield. Consolidate the ground (grout) where the casings enter the shaft.
  - H. The Contractor shall furnish, install, and maintain equipment to keep the jacking shaft free of excess water. The Contractor shall also provide surface protection during the period of construction to ensure that surface runoff does not enter driving shaft(s). Groundwater dewatering shall comply with the approved dewatering plan and shall not affect surrounding soils or structures beyond the tolerances stated in paragraph entitled "Settlement, Alignment and Tolerances."
  - I. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.
  - J. Design of the jacking and receiving pit supports should also take into account the loading from shield or pipe jacking where appropriate, as well as special provisions and reinforcement around the breakout location. The base of the pits shall be

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designed to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.

- K. Where a thrust block is required to transfer jacking loads into the soil, it shall be properly designed and constructed by the Contractor. The backstop shall be normal (square) with the proposed pipe alignment and shall be designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.0. It shall also be designed to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. If a concrete thrust block or treated soil zone is utilized to transfer jacking loads into the soil, the tunnel boring is not to be jacked until the concrete or other materials have attained the required strength.
- L. Pit Backfill and Compaction: Upon completion of the pipe drive and approval of the installed pipeline by the Contracting Officer, remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Backfilling, compaction and pavement repairs shall be completed in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.
- M. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, the sealing slabs shall be of sufficient thickness to provide a factor of safety equal to 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

### 3.2 INSTALLATION

#### 3.2.1 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

#### 3.2.3 Settlement, Alignment and Tolerances

- A. Settlement or heave of ground surface along centerline of micro-tunneling alignments during and after installation of pipe casings shall not exceed one inch.
- B. No more than six inches lateral and one inch vertical deviation shall be permitted in the position of the completed jacked pipe casings.
- C. Overcut shall not exceed one inch on the radius of the pipe being installed. The annular space created by the overcut may be filled with the lubrication material that is used to reduce soil friction drag on the pipe.

#### 3.2.4 Micro-tunneling

- A. Only tunneling equipment capable of fully supporting the face of the tunnel shall be used for pipe jacking work described.

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- B. Tunneling equipment selected for the project shall be compatible with the geotechnical information contained in this contract. The tunneling equipment shall be capable of tunneling through mixed face conditions without exceeding the settlement tolerances specified in paragraph "Settlement, Alignment and Tolerances."
- C. Face pressure exerted at the heading by the tunneling machine shall be maintained as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.
- D. Dewatering for groundwater control shall be allowed at the jacking and receiving pits only.
- E. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in starter and receiving shafts have attained the required strength.
- F. The pipe casing shall be jacked in place without damaging the pipe casing joints or completed pipe casing section.
- G. After completion of the jacking operation between starter and receiver shafts, the lubricate material shall be displaced from between the pipe casing exterior and the surrounding ground by a cement grout. Pressure and the amount of grout shall be controlled to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Settlement, Alignment and Tolerances." Grouting shall be accomplished promptly after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.
- H. Any pipe casing which has been damaged during installation shall be replaced by the Contractor at no additional cost. If a new replacement pipe casing is required extending from the starter to the receiver shaft, it shall be installed in conformance with the contract drawings and this section.
- I. Monitor ground movements associated with the project and make suitable changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.
- J. Install instrumentation, take readings and provide the APE with weekly reports containing measurements data with weekly reports to inspector. These actions are meant to supplement the Contractor's monitoring system and do not relieve the Contractor of his responsibility, nor place on the APE, responsibility for control of ground movement and protection of the project and adjacent structures. Instrumentation readings shall be continued for a period of four weeks after pipe casings have been installed to establish that detrimental settlement has not occurred.

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- K. Unprotected mining of the tunnel bore is not permitted. The tunnel face and bore shall be fully supported at all times.

### 3.2.5 Ventilation

Adequate ventilation shall be provided for all cased tunnels and shafts. Follow confined space entry procedures. Local burn permit regulations must be obeyed and complied with. The design of ventilating system shall include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system. The minimum amount of fresh air to be supplied shall depend on the tunnel and shaft volumes being installed.

### 3.2.6 Lighting

Adequate lighting shall be provided for the nature of the activity being conducted by workers for the micro-tunneling. Both power and lighting circuits shall be separated and thoroughly insulated with ground fault interrupters are required. Lights shall comply with requirements with regards to shatter resistance and illumination requirements.

### 3.2.7 Spoil Transportation

The soil transportation system shall match the excavation rate with rate of spoil removal. The system must also be capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of this project.

### 3.2.8 Pipe Jacking Equipment

The main jacking equipment installed must have a capacity greater than the anticipated jacking load. Intermediate jacking stations shall be provided by the Contractor when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

### 3.2.9 Jacking Pipe

In general, pipe used for jacking shall be smooth, round, have an even outer surface, and joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are minimized when the pipe is jacking. Pipe used for pipe jacking shall be capable of withstanding the jacking forces that will be imposed by the process or installation, as well as the final place loading conditions. The driving ends of the pipe and intermediate joints shall be protected from damage.

- A. Any pipe showing signs of failure may be jacked through to the receiving shaft and removed. Other methods of repairing the damaged pipe may be used, as

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

recommended by the manufacturer and subject to approval by the Contracting Officer.

- B. The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads.

### **3.3 FIELD QUALITY CONTROL**

#### 3.3.1 Field Tests and Inspections

The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor will provide evidence, when required, that any item of work has been constructed in accordance with drawings and specifications.

#### 3.3.2 Testing Requirements

For pressure test, conduct testing in accordance with Section 33 34 00 SANITARY UTILITY SEWERAGE FORCE MAIN. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

**END OF SECTION 33 05 23.19**

**SECTION 33 30 00  
SANITARY SEWERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

Description: This Section includes furnishing and installation of sewer pipes to the lines and grades indicated on the drawings and as specified herein.

**1.2 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SAMOA EPA

ASEPA Water Standards      American Samoa EPS Safe Drinking Water Standards

ASTM INTERNATIONAL (ASTM)

ASTM A 48	(1998) Standard Specification for Gray Iron Fittings
ASTM A 746	(2009) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C 443	(2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478	(2013) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 969	(2002; R 2009) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 990	(2009; R2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D 2241	(2009) Standard Specification for Poly Vinyl Chloride (PVC) Pressure Rated Pipe (SDR Series)
ASTM D 2321-18	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2412	(2002; R 2008) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D 2683	(2004) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter- Controlled Polyethylene Pipe and Tubing

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

ASTM D 3212	(2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals
ASTM D 3261	(2003) Standard Specification for Butt Heat Fusion
ASTM D 3034	(2014) Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM D 3035	(2010a) Standard Specifications for Polyethylene (PE) Plastic Pipe (DR - PR) Based on controlled Outside Diameter
ASTM D 3350	(2010a) Polyethylene Plastics Pipe and Fittings Materials
ASTM F477	(2002) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	(2001) Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM A 746-09	(2014) Standard Specification for Ductile Iron Gravity Sewer Pipe.
ASTM F714	(2010) Standard Specifications for Polyethylene (PE) Plastic Pipe (DR – PR) Based on Outside Diameter
ASTM F 894	(2007) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 905-04	(2018) Standard Practice for Qualification of Polyethylene Saddle-Fused Joints

### UNI-BELL PVC PIPE ASSOCIATION

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
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### U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-60005	(Basic) Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
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## 1.3 SYSTEM DESCRIPTION

### A. Sanitary Sewer Gravity Pipeline

1. Provide 4, 6, 8, 10, and 18 inches diameter PVC, HDPE or Ductile Iron.

### B. Sanitary Sewer Gravity Pipeline for Special Protection Area

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

1. Provide 8, 10 and 18 inches diameter HDPE.

### 1.4 SUBMITTALS

- A. ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-01 Preconstruction Submittals

Drawings of existing condition.

#### SD-02 Shop Drawings

Installation and As-Built drawings, as specified.

Precast concrete manholes

Metal items

Frames and covers

Details

Installation Drawings

Work Plan for Manholes

Installation on Steep Slope

#### SD-03 Product Data

Pipeline materials

Submit manufacturer's standard drawings or catalog cuts. SD-06 Test Reports

Test and inspection report, as specified. SD-07 Certificates

Certificate of compliance stating the type of cement used in the manufacturing of precast manholes.

Certificates of compliance stating that the fittings or gaskets used for waste drains or lines on the plans as are oil resistant.

#### SD-06 Tests

Pre-cast Manholes Tests

### 1.5 QUALITY ASSURANCE

Install specified materials by a licensed underground utility Contractor licensed for such work in American Samoa where the work is to be performed. Installing Contractor's License shall be current.

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

### A. Drawings

1. Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.
2. Submit As-Built Drawings for the complete sanitary sewer system showing complete detail with all dimensions, both above and below grade, including invert elevation.
3. Sign and seal As-Built Drawings by a Professional Surveyor and Mapper. Include the following statement: "All potable waterlines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

## 1.6 DELIVERY, STORAGE, AND HANDLING

### A. Delivery and Storage

#### 1. Piping

- a. Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

#### 2. Metal Items

- a. Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

#### 3. Cement, Aggregate and Reinforcement.

As specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACED CONCRETE.

### B. Handling

1. Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Carry, do not drag, pipe to trench.

## 1.7 PROJECT/SITE CONDITIONS

- A. Submit drawings of existing conditions, after a thorough inspection of the area in the presence of the APE. Details shall include the environmental conditions of the site and adjacent areas. Submit copies of the records for verification before starting work.
- B. Alignment and avoidance of existing utilities or structures – the drawings have attempted to avoid or minimize relocation or interference with existing utilities or

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

Structure. It is recognized that field conditions may present other opportunities to avoid relocation of existing utilities. The contractor is encouraged to identify such opportunities and propose field adjustment of alignment when appropriate at no additional cost to ASPA.

- C. Special protection area – locations where HDPE pipe is used in lieu of PVC. These locations are places that are the minimum separation distances cannot be achieved. Fused joint HDPE pipe is used as indicated.

## PART 2 - PRODUCTS

### 2.1 PIPELINE MATERIALS

- A. Pipe shall conform to the respective specifications and other requirements specified below.
  - 1. PVC Plastic Gravity Sewer Piping
    - a. Polyvinyl-Chloride (PVC) gravity sewer pipes and fittings size 4, 6, 8 and 18 inches in diameter shall meet the requirements of ASTM Standard D3034 SDR 35, Type PSM with flexible elastomeric gasket seals conforming to ASTM Standard F477.
    - b. Polyvinyl-Chloride (PVC) gravity sewer pipes and fittings size 18 inches in diameter shall meet the requirements of ASTM F679 wall thickness T-1, PS 46 with flexible elastomeric seals conforming to ASTM Standard F477.
    - c. Joints shall conform to ASTM D 3212.
  - 2. HDPE pipe for Special Protection Area ; Refer to Section 33 34 00 subsection 2.2
  - 3. Ductile Iron Pipe:
    - a. ASTM A 746-09 (2014) Standard Specification for Ductile Iron Gravity Sewer Pipe.
      - 1) Markings: Legibly marked green to identify as sewer pipe at intervals of 4 feet maximum with manufacturer's name, trademark, pipe size (nominal size and OD base IPS), PE 3408, SDR-11 appropriate legend such as
      - 2) HDPE, ASTM D 3035 or ASTM F 714, date of manufacture, and point of origin.
      - 3) Pipe not marked as specified herein will be rejected.
    - b. Pipe and fittings, approved manufacturers:
      - 1) CP Chem, Division of Chevron Phillips Chemical Company, LP.
      - 2) Rinker Materials Poly Pipe Division.
      - 3) Or Equal.

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- c. Pipes: Standard Dimension Ratio (SDR) of 11 with corresponding operating pressure of 100 psi, unless noted otherwise.
- d. Fittings: ASTM D 3261, use injected molded fittings with ends suitable for Butt fusion unless otherwise specified.
  - 1) Where fittings are installed in trench, socket fusion, saddle/sidewall fusion and electro-fusion jointing technique fittings may be used instead of Butt fusion fittings, when approved by the APE..
  - 2) Socket fusion fittings: ASTM D 2683.
  - 3) Saddle/sidewall fusion fittings: ASTM F 905.
  - 4) Socket and saddle/sidewall fusion fitting supplied by manufacturer of pipe.
  - 5) Electro-fusion fittings supplied by Central Plastics Company or equal.
  - 6) Pressure rating of fittings same as adjacent pipe.
  - 7) Mechanical Joint fittings for Air Release Valves (ARV) and similar joints.
- e. Pipe joints:
  - 1) Fusion techniques: Unless otherwise noted, use butt fusion joints between pipes or fittings.
    - a) Where jointing of pipe is required in trench, electro-fusion or socket fusion jointing techniques may be used instead of butt fusion jointing technique, when approved by the APE.
    - b) Make electro-fusion couplings by computer controlled automatic electro-fusion system. Electro-fusion consists of couplings containing integral heating source which is computer controlled for time, temperature and jointing pressure for consistent joint.
      - (1) Couplings rated for same pressure as pipe.
        - (a) Build-in identification feature to automatically set fusion times and to include current monitoring feature.
        - (b) Manufactured by Central Plastics Company or equal.
      - (2) No threaded or solvent welded/glued HDPE joints permitted.
      - (3) Joints between PVC and HDPE shall be as recommended by the pipe manufacturer and as approved by the APE.

## 2.2 MISCELLANEOUS MATERIALS

### A. Manholes

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

1. Comply with provisions of Section 03 40 00, Precast Concrete. Manholes shall be constructed of precast reinforced concrete manhole sections in accordance with the requirements of ASTM C478 and detailed as shown on the drawings.
  2. A maximum of two lift holes per manhole section may be provided.
  3. Provide tongue and groove type joints in manhole sections with a pre-formed groove in the tongue for placement of sealing gaskets.
    - a. Bituminous mastic or butyl rubber gaskets shall comply with requirements of ASTM C990 or C443, respectively.
    - b. Gaskets shall provide the sole element in sealing the joint from either internal or external hydrostatic pressure.
  4. Sealant for manhole frames shall be a one-component polyurethane sealant similar to Sika "Sikaflex" Type 1a.
  5. Manhole steps shall be corrosion-resistant and shall be one-inch square cast iron, rubber-covered steel or aluminum. The steps shall conform to the dimensions shown on the drawings.
  6. Manhole frames and covers shall be molded of gray cast iron conforming to ASTM A48, Class 30. Castings shall be coated with a coal tar pitch varnish, to which sufficient oil has been added to make a smooth coating, tough and tenacious when cold, but not tacky or brittle. Seating surfaces between frame and cover shall be machined. The dimensions and weights shall conform to the requirements shown on the drawings.
    - a. Standard Manhole Frame and Cover shall be similar to East Jordan Iron Works, Inc. Catalog No. 1045Z2 frame and Catalog No. 1040C cover.
    - b. Watertight Manhole Frame and Cover shall be similar to East Jordan Iron Works, Inc. Catalog No. 1045Z2PT frame and Catalog No. 1040APT cover.
- B. Cleanout riser and cover:
1. Paved areas – cast iron as indicated. Traffic rated in roads and driveways.
  2. Lawn or non-paved area – PVC threaded with recessed key plug.
- C. Inflow Protector
1. HDPE inflow protector for manholes located in paved areas. Model RX as furnished by Odor Knocker Company, Denver, CO.
- D. Epoxy Coating
1. Epoxy coating where required: Hydro--Pox 212 GL, or Standard 4553 Epoxy Coating or approved equal.

## 2.3 REPORTS

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- A. Submit Test Reports. Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear feet.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION**

- A. General Requirements for Installation of Pipelines: These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

1. Earthwork

- a. Perform earthwork operations in accordance with Section 31 23 00 EXCAVATION AND FILL.

2. Pipe Laying and Jointing

- a. Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batter-boards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batter-boards for the same purpose.

3. Connections to Existing Lines

- a. Obtain approval from the APE before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

4. Separation of Lines from existing utilities

- a. Refer to Construction Notes on the plans for separation requirements from existing utilities. Conform to the requirements of ASEPA Drinking Water Standards.

- B. Special Requirements

1. Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipeline" of this section and with the requirements of ASTM D 2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D 2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

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2. Place a No. 8 gauge copper or aluminum tracer wire in trench over and parallel to new PVC mains.

### C. Manhole Construction

1. Make inverts in precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.
2. Apply epoxy coating to manholes and drop manholes as required by Sewer Note No. 19 on the drawings.

### D. Miscellaneous Construction and Installation

#### 1. Connecting to Existing Manholes

- a. Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping.

The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

#### 2. Manhole excavations

- a. Contractor shall exercise extreme caution when excavating deep manhole on steep slopes and hillsides. Provide an advance work plan to the APE prior to commencement of work on hillside locations.

#### 3. Metal Work

- a. Workmanship and finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

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- b. Field painting: After installation, clean cast-iron frames, covers, and steps not buried in concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

### E. Installations of Wye Branches

Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence shall be installed at no additional cost to ASPA. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

- F. Relocation of Telephone/power poles: Relocations of telephone/power poles may be avoided by shifting the alignment (realignment) of sewer lines and lateral services.

- G. Adjustments of elevations at connection points (tie-ins). Verifications should be made with existing utilities and make necessary adjustments as approved by APE.

## 3.2 EXTERIOR COATING-PAINTING

All exposed piping, valves; metal supports shall be painted with two coats exterior alkyd semi-gloss enamel. Colors: Exposed pipe and supports – field green; valves – red. Do not paint valve stems or moving parts.

## 3.3 FIELD QUALITY CONTROL

### A. Field Tests and Inspections

1. The contractor's quality control organization shall conduct all pre-tests of the work prior to final testing by the APE. The APE will conduct final field inspections and witness field tests specified in this section. Perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

### B. Tests for Gravity Sewer Lines

1. Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

#### a. Leakage Tests

- 1) Test lines for leakage by either infiltration tests or exfiltration tests, or by

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low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

- a) Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials in accordance with ASTM C 969.

Make calculations in accordance with the Appendix to ASTM C 969.

- b) Low pressure air tests: Perform tests as follows:

- (1) PVC plastic pipelines: Test in accordance with UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

### b. Deflection Testing

- 1) Perform a deflection test on entire length of installed pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D 2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

- a) Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

- (1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
- (2) Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface Brinell hardness of not less than 150.
- (3) Center bored and through-bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.

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- (4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.
- b) Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.
- c) Pull-through device procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.
- d) Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

### C. Test for Precast Manholes.

1. Perform vacuum tests in accordance with Section 03 40 00.

## 3.4 Separation to Water Mains (Pipe Protection)

- A. Horizontal Separation. When conditions prevent a lateral separation of **6 feet** between the proposed sewer and existing water lines, the sewer line shall be closer than 6 feet to the existing waterline under the following conditions;
  1. It is laid in a separate trench or it is laid in the same trench with the water main located to one side on a bench of undisturbed earth.
  2. The elevation of the top (crown) of the sewer is at least **18 inches** below the bottom of the invert of the water main. The horizontal separation shall not be less than **6 feet**.
  3. Concrete Jacket is an alternative shall be considered .
- B. Vertical Separation. Whenever Sewer Line crosses Water mains, the Sewer Line must be jacketed with reinforced concrete for a minimum of **6 feet on both sides of the point crossing** if the sewer line is above the water main and for **3 feet on both sides** if the sewer is below the water main. Jacketing is not required if the sewer line is below the water main and the separation is greater than 2 feet and structural requirements are met.

**END OF SECTION 33 30 00**

**SECTION 33 32 13.13  
PACKAGED SEWAGE LIFT STATIONS, WET WELL TYPE**

**PART 1 GENERAL**

**1.1 SCOPE**

This section includes furnishing and installation of complete electric powered sewage pump stations complete with all elements required for a fully functional lift station with Variable Frequency Drive as indicated. Contractor is responsible for furnishing, installation, testing, and commissioning all pump station components.

**1.2 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS (AASHTO)

AASHTO M 198                      (2010) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4                (2013) Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water

AWWA C100/A21.10              (2012) Ductile-iron and Gray-Iron Fittings for Water

AWWA C111/A21.11              (2012) Rubber-Gasket Joints for Ductile- Iron Pressure Pipe and Fittings

AWWA C115/A21.15              (2011) Flanged Ductile-Iron Pipe with Ductile- Iron or Gray-Iron Threaded Flanges

AWWA C151/A21.51              (2009) Ductile-Iron Pipe, Centrifugally Cast, for Water

AWWA C207                      (2013) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 in. through 144 in.

ASME INTERNATIONAL (ASME)

ASME B16.1                      (2010) Gray Iron Threaded Fittings Classes 25,125 and 250

ASME B16.11                      (2011) Forged Fittings, Socket-Welding and Threaded

ASME B16.3                      (2011) Malleable Threaded Fittings, Classes and 300

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ASME B31.3 (2012) Process Piping

### ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M (2013) Standard Specification for Carbon Steel Forgings for Piping Applications

ASTM A123/A123M (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A36/A36M (2008) Standard Specification for Carbon Structural Steel

ASTM A536 (1984; R 2009) Standard specification for Ductile Iron Castings

ASTM C 443 (2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

ASTM C 443M (2012) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)

ASTM C 478 (2013) Standard Specification for Precast Reinforced Concrete Manhole Sections

ASTM C 478M (2013) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)

ASTM C 618 (2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C989/C989M (2013) Standard Specification for Slag Cement for use in Concrete and Mortars

### HYDRAULIC INSTITUTE (HI)

HI M100 (2009) HI Pump Standard Set

### INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1 (2003; Cor 2005) Mechanical Vibration- Balance Quality Requirements for Rotors in a Constant (Rigid) State – Part 1: Specification and Verification of Balance

ISO 2858 (1975) End Suction Centrifugal Pump (Rating 16 Bar) Designation Nominal Duty Point and Dimensions – International Restrictions

ISO 5199 (2002) Technical Specifications for Centrifugal Pumps, Class II

ISO 7005-2 (1988) Metallic Flanges Part 2: Cast Iron Flanges

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### MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-70	(200116) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-86	(2009) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

### NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Minimum)
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## 1.3 SUBMITTALS

ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 – SUBMITTAL PROCEDURES.

### SD-01 Preconstruction Submittals

Package Lift Station manufacturer's qualifications and references.

Material, Equipment, and Fixtures List of all major components including catalog numbers, specification and drawing reference number, warranty information, and fabrication site.

### SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "Design Requirements," of this section.

Fabrication Drawings

Erection/Installation Drawings

### SD-03 Product Data

Submit manufacturer's catalog data and equipment and performance data for all products and equipment furnished for the lift station.

Submit Spare Parts Data for the following:

Manhole Chambers

EPA-CPG

Compliance

Entrance Covers

Sump Pumps

Sewage Pumps

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- Pump Controls Impellers
- Couplings Bearings
- Stuffing Boxes
- Valves
- VFD
- Piping
- Flow Meter
- Blowers
- Electric Motors

### SD- 05 Design Data

Submit Design Data of Motor for the following:

- Rotor Bars
- Stator Slots
- Speed of Rotation
- Cooling Fan Blades
- Bearing
- Bearing Style
- Bearing Type
- Balls/Elements
- Commutator Bars
- Commutator Brushes
- SCR Firing Frequencies (for variable speed motors)
- Pump Impellers

### SD-07 Certificates

Submit certificates for the following items in accordance with the applicable reference standards and description of this section.

- Manhole Chambers
- Entrance Covers
- Sump Pumps
- Bearings
- Pump Controls
- Impellers
- Couplings

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- Stuffing Boxes
- Valves
- Piping
- Blowers
- Dehumidifier
- Electric Motors

### SD-08 Manufacturer's Instructions

Submit operating instructions, including standard operating procedures with startup, shutdown, and emergency operation for Package Lift Station, and the following:

- Manhole Chambers
- Entrance Covers
- Sump Pumps
- Sewage Pumps
- Pump Controls
- Impellers
- Couplings
- Stuffing Boxes
- Valves
- Piping
- Blowers
- Dehumidifier
- Electric Motors

### SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for package lift stations including the following in accordance with paragraph entitled, "Operation and Maintenance," of this section.

- Equipment Description
- Assembly and Installation Procedures
- Adjustment and Alignment
- Checkout Procedures
- Troubleshooting
- Preventative Maintenance and Inspection

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

Special Tools

Posted Instructions

### 1.4 MANUFACTURER'S QUALIFICATIONS

The package lift station manufacturer shall have a minimum of five (5) years' experience in complete lift station design and supply. The manufacturer shall demonstrate that it has designed, engineered, produced and delivered a minimum of ten (10) functioning pump stations of similar type and size. Submit project completion date, owner and contact person for each project.

### 1.5 DESIGN REQUIREMENTS

- A. The equipment and system described herein is based on packaged lift stations manufactured and furnished by Romtec Utilities, 18249 North Bank Road, Roseburg, OD 97470. Telephone: (541) 496-9676. Design service life shall be 15 years.
- B. Pumps- Provide each station with pumps with variable frequency drive (VFD) and controls capable of operating the pumps either simultaneously or individually. The triplex stations shall be capable of pumping the peak flow with two pumps and the duplex station shall be capable of pumping peak flow with one pump.. Refer to Specification Sections 33 32 16 and 33 32 16.10.
- C. Furnish and install each lift station as a complete unit with necessary appurtenances factory installed within a pump chamber and a vertical entrance tube cover and access ladder. Wet well and valve boxes shall be precast concrete. All designed for the following:

Lift Station Data:

Location	No. of pumps	Peak Flow GPM	Design Average Flow GPM	Total Dynamic Head Ft.(1)	Pump
<i>Lift Station #4</i>	<i>2-20HP</i>	<b>505</b>	<i>118</i>	<b>95.70</b>	<i>Flygt NP3153 HT</i>
<i>Lift Station #5</i>	<i>2-5HP</i>	<b>300</b>	<i>70</i>	<b>37.80</b>	<i>Flygt NP3102 MT</i>
<i>Lift Station #6</i>	<i>2-5HP</i>	<b>71</b>	<i>17</i>	<b>50.30</b>	<i>Flygt NP3102 MT</i>

(1) Based on piping layout indicated.

- D. Wet Well – Precast sections fabricated with watertight joints capable of withstanding external infiltration from submergence below the water table. Wet well shall be sized using the design average flow with a maximum retention time of 30 minutes.
- D. Fabrication Drawings – Submit fabrication drawings after receiving tentative approval of the equipment and the materials list but before installation, Contractor to submit drawings covering necessary or recommended changes to accommodate the equipment offered. Show clearly on the drawings the design of the chamber, with

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- dimensions, types, and thickness of materials, and elevation levels with reference to those elevations indicated.
- F. Erection/Installation Drawings – Submit Erection/Installation Drawings for the wet well chamber with the required equipment and accessories that are included. Precast reinforced concrete sections are to conform to ASTM C 478M/ASTM C 478, and AASHTO M 198. Show clearly on the drawings the design of the chamber, with dimensions, types, and thickness of materials, and elevation levels with reference to those elevations indicated.
  - G. Provide the following motor/pumps design data prior to final turnover – number of motor rotor bars and stator slots; number of cooling fan blades; RPM of motor; bearings, bearing manufacturer, bearing type, bearing style and number of balls/elements; number of commutator bars and commutator brushes; SCR firing frequencies; and number of pump impellers.
  - H. Engineer’s Seal – Design shall be accomplished under the supervision of a professional engineer currently licensed to practice in one of the 50 United States in the applicable discipline. Actual range in capacities may vary from that stipulated if the minimum and maximum capacities specified are included.

### **1.6 PROTECTION FROM MOVING PARTS**

Locate and guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts in accordance with applicable OSHA standards and so that personnel are properly protected from injury.

### **1.7 NAMEPLATES**

Provide the manufacturer’s name or trademark on a corrosion-resistant identification plate or cast integrally, on each item of equipment, stamped, or otherwise permanently marked in conspicuous place. Include on the pump identification plate, the pump capacity in gallon per minute (gpm), pump head in meter per feet and speed of rotation. Cast on the body of the pump the direction of rotation. Indicate all necessary information to complete identification such as the manufacturer.

### **1.8 FIELD REPRESENTATIVE**

A representative of the lift station manufacturer is to direct the startup of the station and instruct ASPA in startup and operation procedure.

### **1.9 SPARE PARTS DATA**

Submit spare parts data, including a complete list of parts and supplies with current unit prices and source of supply. List parts and supplies that are either normally furnished at no extra cost with the purchase of equipment, or specified to be furnished as a part of the contract, and list additional items recommended by the manufacturer to ensure an efficient operation for a period of one year.

## **PART 2 PRODUCTS**

Verify conformance of materials and equipment for package lift station to the referenced publications or as specified. Submit produce data sheets, catalog cuts and

ESV Wastewater Collection System Ph 2                      Package Sewage Lift Stations, Wet Well type  
33 32 13.13 - 7

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

fabrication drawing for all products listed below. Products listed by manufacturer name or model number are those furnished by Romtec Utilities, Inc. and are considered pre-approved. Items manufactured or provided by others may be submitted for approval as an exception to this specification.

### **2.1 WET WELL CHAMBER**

Fabricate chamber, including base, walls, and entrance tube with 4,500 psi precast reinforced concrete designed to form an integral unit. Fabricate wet well as an integral part of the unit with a separate manhole entrance. Minimum chamber diameter shall be 10 Ft. Chamber joints shall be designed to be waterproof to prevent infiltration of ground water into the chamber. The chamber shall be designed to resist all buoyant uplift forces. Include ladder, pipe supports, brackets, and other miscellaneous components of steel conforming to ASTM A36/A36M, ASME B16.3, ASME B16.11. All fabricated steel shall be hot-dipped galvanized in accordance with ASTM A123/A123M.

Fabricate manhole chamber, including base, entrance tube, air ducts, and similar structural parts, with steel conforming to ASTM A36/A36M, ASTM A615/A615M. Protect steel from corrosion by means of hot-dip galvanizing conforming to ASTM A123/A123M epoxy-resin coatings.

### **2.2 DISCHARGE VALVE VAULT AND METER BOX ASSEMBLY**

Provide a complete precast concrete valve vault and meter box assembly including base, walls, entrance hatch, and valves and piping. Design vaults to prevent uplift from buoyant forces. Provide ball or plug type valves as indicated. Hatch shall be pedestrian rated.

Discharge piping beyond the wet well shall be Ductile Iron.

### **2.3 CONTROL PANEL BACKER AND SUPPORT**

Provide pump control panel and electric box support on a concrete pad as indicated. Refer to Section 33 32 16.

### **2.4 ENTRANCE COVERS**

Fabricate entrance-tube cover of reinforced fiberglass or steel. Secure steel covers with bolts to the shaft flanges. Hatch shall be pedestrian rated with hinged safety grate and fall through protection per OSHA standards. Hatch shall accommodate pump guide brackets and lifting chains.

### **2.5 DAVIT CRANE**

Provide a davit lift hoist boom and mounting brackets at the wet well entrance capable of supporting removal of the pumps from the station wet well. Crane shall be removable for storage and transport. Fabricate crane in stainless steel. Furnish worm gear hand winch with 2,000 lb. working load capacity. Provide hand cranked stainless steel wire rope 48 Ft long. Therm Model 524 pedestal base with Model 5124 davit crane.

### **2.6 SUMP PUMPS**

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

Provide a submersible, direct-motor-driven unit with a capacity of not less than those indicated on the drawings. Enclose sump and pump in 1/4 -inch mesh of corrosion-resistant metal. Automatically actuate sump pump by a built-in float responsive to an inch head differential.

### **2.7 SEWAGE PUMPS**

Provide submersible pumps of the non-clogging, centrifugal type designed to pump unscreened sewage. Each pump is to have a rated capacity as specified and be capable of passing 3-inch solids. Conform to the requirements of ISO 2858 and ISO 5199 HI M100. Pump speed is not to exceed 1,800 revolutions per minute. Pumps shall be Flgyt models indicated.

#### **2.7.1 PUMP CONSTRUCTION**

Fabricate castings in cast iron or steel free from injurious defects. Design castings to permit easy replacement of parts. Gasket all joints to prevent leakage under a test pressure equal to 50 percent or more than the pump discharge pressure or total dynamic head, whichever is greater. Design and install passageways to permit the smooth flow of sewage and free from sharp turns and projections. Provide pump castings with cleanout plates in the suction line and drain plugs.

#### **2.7.2 IMPELLERS**

Fabricate impellers in hard iron, cast iron, cast steel, or an alloy suitable for the service required. Provide free flowing impellers which permit objects in the sewage that enter the pump to pass into the discharge pipe. Provide each impeller keyed, splined, or threaded on the shaft and locked in such manner that lateral movement is prevented and reverse rotation cannot cause loosening.

#### **2.7.3 BALANCE**

Balance rotating parts of the equipment mechanically and hydraulically to operate throughout the required range without excessive and thrust vibration, and noise. Conform allowable vibration limits to ISO 1940-1, Table 1. Existence of defects that cannot be eliminated by adjustment will be sufficient cause for rejection of the equipment.

#### **2.7.4 SHAFTS**

Provide high-grade steel shafts of a size and strength to perform the work required. Protect the shaft from the liquid being pumped, points in contact with the stuffing boxes, and other wearing parts with sleeves designed in bronze or a suitable alloy.

#### **2.7.5 BEARINGS**

Provide ball or roller type main bearings to withstand radial and end thrust. Pumps dependent upon hydraulic balance are prohibited.

#### **2.7.6 LUBRICATION**

Provide manufacturer's standard lubrication system.

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

### ELECTRIC MOTORS

Provide 60-hertz, 230 volt, 3-phase motors.

## 2.8 PUMP CONTROLS

See Sections 33 31 16, Pump Controller and Section 33 32 16.10 Liquid Level Controls. Provide automatic type pump operating controls recommended by station manufacturer, including necessary switches, relays, and appurtenances, complete. Mount controls in an enclosed control panel. Make equipment subject to contact with sewage of corrosion-resistant metal. Provide controls with high-level switch for remote monitoring.

## 2.9 VARIABLE FREQUENCY DRIVE

Provide an integrated Variable Frequency Drive, variable torque type, with panel and associated field devices. See Section 33 32 16.10 "Liquid Level Controls" for detailed requirements. The VFD shall be pre wired and factory tested. VFD shall be UL listed for intrinsically safe circuits extensions in hazardous locations. Size VFD as appropriate for the connected pump motors.

### 2.9.1 PERFORMANCE REQUIREMENTS

- a. Electromagnetic Interference Suppression – Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations , shall be certified to comply with requirements for class A computing devices and labeled as set forth in part 15.
- b. Electromechanical and Electrical Components – Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.
- c. Electrical Requirements - Power Line Surge Protection: IEEE C62.41.1 and IEEE C62.41.2, IEEE 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.
- a. Sensor and Control Wiring Surge Protection - I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors.

### 2.9.2 PANEL CONFIGURATION

- a. Mount in NEMA 4X stainless steel cabinet.
- b. Weather tight flashing alarm beacon mounted on panel for local alarm.
- c. Fusible disconnect switches and line reactors.
- d. Pilot lights and manual controls:

Item	Description
Hand-Off-Auto	Switch
Fault light	Red

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

VFD Fault push to reset	Red
Pump Call light	Green

- e. Cooling fan with shrouds
- f. Panel dehumidifier with NEMA 4X vent drain
- g. DC Power Supply
- h. Safety labeling – flash, shock, danger, etc.
- i. All terminals and interconnections.

### 2.10 FLOWMETER

Furnish magnetic flow meter in the station main discharge to the force main. Meter shall have remote readout, totalizer and SCADA interface. Readout shall be mounted near the electrical load center. Meter shall be Endress and Hauser Proline Promag with remote weatherproof readout,

### 2.11 EMERGENCY POWER CONNECTION

See Electrical drawings and specifications

### 2.12 PIPING CONECTIONS

Provide pump suction and discharge with flanged connections of the proper size for the pump type and capacity. Conform pipe flanges to AWWA C104/A21.4, AWWA C110-A21.10, AWWA C111/A21.11, AWWA C115/A21.15, AWWA C151/A21.51, ASTM A53/A53M, and ASTM A536 for ductile iron or gray-iron threaded flanges and piping. Piping is to conform to the requirements of ASME B31.3

### 2.13 VALVES

Conform gate valves to MSS SP-70. Provide horizontal, swing check type check valves. Provide valves permit a free flow of sewage forward and a positive check against backflow. Provide iron body valves with a removable cover for inspection and removal of the gate assembly. Provide bronze gate, gate seats, shaft, studs, and nuts.

### 2.14 PIPING

Terminate discharge lines 5-feet outside the lift station in flanged connections. Include the pipe from the wet well manhole in the suction line. External connection joints for pipe using rubber gaskets are to comply with the standards of ASTM C 44M ASTM C 443. Contractor to connect lift station piping to the sewer gravity lines and force main lines shown in the plans.

### 2.15 PAINT

Treat and paint equipment in accordance with manufacturer's standard practice for sewage pump stations.

## **2.16 FLOW METERS**

Flowmeters and Air Release Valves (ARV) ; shall be as shown or indicated in the drawings.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

Install lift station as indicated, in accordance with drawings and manufacturer's instructions including all accessory items required for a fully operational lift station. Provide a level and stable base that is plumb and will not settle. Furnish Special Tools that are required for maintenance and testing of the lift stations.

### **3.2 SIGNS AND INSTRUCTIONS**

Furnish a complete package of posted Instructions, consisting of labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the package lift stations.

### **3.3 TESTS**

- a. Mechanical and wet well tests - Perform all field tests, and provide all labor, equipment, and incidentals required for testing. Provide services of manufacturer's field representative to conduct tests and startup. Tests shall include hydrostatic leak checking of piping and operation of equipment. Test wet well for infiltration in accordance with ASTM C 497 before backfilling. Allow concrete to cure a minimum of 5 days before testing any section of piping where concrete thrust blocks have been provided.
- b. Evidence, when required, that any item of work has been constructed in accordance with contract requirements.
- c. VFD Tests - A proposed test plan shall be submitted to the ASPA at least 14 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. ASPA reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements.
- d. VFD Performance Verification Tests - "Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests.

### **3.4 OPERATION AND MAINTENANCE**

Furnish Preventative Maintenance and Inspection procedures for the lift stations. Include in procedures the frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

Submit Operation and Maintenance Manuals for the lift stations, including equipment description, assembly and installation procedures, adjustment and alignment, checkout procedures, procedures of operation and troubleshooting.

**END OF SECTION 33 32 13.13**

## **SECTION 33 32 16 PUMP CONTROLLER**

### **PART 1 GENERAL**

#### **1.1 DESCRIPTION**

The pump controller shall consist of all the components, hardware and software to provide a trouble-free pumping station. The system shall be designed and specifically produced for the surveillance of the pump station. The system shall provide for interface to other RTU's and SCADA systems for remote control and data collection. The RTU shall control the pumps as a stand-alone unit in the event of a communications loss. The controller shall be an APP 700 series as manufactured by ITT Flygt and integrate into ASPA's existing SCADA system.

#### **1.2 OPERATION**

Pump controller shall provide continuous monitoring of the wet well level via analog level signal (4-20mADC). The pump controller shall start and stop pump based upon wet well level and operator programmed set points. The controller shall have provision for a float switch backup in event of analog signal failure. The controller shall also have provision for redundant analog level sensor. The pump controller shall alternate pump cycles to ensure equal run times. The pump controller shall monitor pump protection features to provide alarms in event of impending pump failure. It shall also monitor pump performance data to provide operations personnel the ability to evaluate station performance. Flygt to provide appropriate alarm set points as recommend and shown in the construction plans.

### **PART 2 PRODUCTS**

#### **2.1 PUMP CONTROL SYSTEM**

Provide primary level sensing pressure transducer mounted in a perforated tubular stilling well. Provide a secondary sealed mercury float switch control system as indicated. Automatically alternate operation from one pump to the other and start second pump in the event first pump cannot handle incoming flow. Provide manual "on-off" switch for each pump. Provide independent adjustable high and low water level switches. Provide floats, supports, and alarm. Metal parts, if used, must be of bronze or equivalent corrosion resistant material

- A. Secondary Float Assembly - Use a direct acting float switch consisting of a normally-open mercury switch enclosed in a float. Use pipe mounted float assembly. Use float molded of rigid high-density polyurethane foam, color-coded and coated with a durable, water and corrosion-resistant jacket of clear urethane. Provide connecting cable and support pole in accordance with manufacturers recommendations. Provide a cast aluminum NEMA Type 4 junction box to connect float assembly. Use box with a gasketed cover with tapped float fitting and conduit entrance pipe threaded opening.

Mount floats at fixed elevations as shown. Use floats designed to tilt and operate their switches causing sequential turn-on turn-off of the pump, when the liquid level

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being sensed rises or falls past the float.

- B. Alternator - Provide an alternator control switch to operate in connection with each float.

Use alternator control switch to alternate the operation of the pumps and operate both pumps if the water level rises above the second high water level. Incorporate time delay function and devices in the alternator controls such that both sewage pumps cannot be started simultaneously for an adjustable period of 10 to 120 seconds after shutdown. Use delay function designed to operate in any condition of start-up in either normal or emergency operational mode.

- C. Control Panel and Pump Alarm Light - Enclose alarm panel in NEMA 6P panel mount enclosure and with a flashing red light with long life bulb in guarded enclosure. Power the light from 24V DC power supply with battery backup. Provide a rechargeable battery rated to power light for a minimum of two hours upon loss of main power. Provide circuitry to automatically recharge the battery after main power is restored. Full charge of battery must take no more than 20 hours. Use panel with power on light, push to test button for horn and light and push to silence button for horn and light with automatic reset for next alarm. Use alarm designed to activate under the following conditions:

- a. High liquid level as sensed by float switch
- b. Loss of main power
- c. No flow light as sensed by limit switch on the check valve

Any alarm condition shall be transmitted to the SCADA interface panel for relay to the pump operations monitoring station.

## 2.2 CONTROLLER HARDWARE

- A. Operator Interface

The pump controller shall be programmed via built-in operator interface. The interface shall consist of pushbuttons in combination with a 2-line LCD backlit display in English. The front panel shall also include LED indicators for controller operation, communication status, alarm status, pump operation status, and individual critical alarms. The front panel operator interface shall be rated IP65 (applicable to Nema 4 standard).

- B. Processor

The pump controller shall contain a 486CPU, 32 bit 100 MHz processor, with a primary memory of 16 Megabytes D-RAM and a flash memory of 16 Megabytes. The memory shall be protected by a 3 VDC Li battery and have a watchdog function.

- C. Inputs/Outputs

The pump controller shall provide 16 digital inputs, 8 digital outputs (6 relay normally open, 2 solid state normally open), and 4 analog inputs. The inputs/outputs shall meet the following:

1. All inputs/outputs shall be optically isolated.

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2. Digital inputs shall be 11-30vdc, selectable logic.
3. Digital outputs shall have a max load of 2A at 250VAC/DC (relay) or have an output capacity of 100mA at 250VAC/DC (solid state).
4. Analog inputs shall be 4-20mADC with 12bit resolution and inaccuracy of 0.1%  
In addition to the input/output features listed, the controller shall be expandable up to a total of 600 physical I/O points.

### D. Power Supply

Provide controller power supply to furnish the required 24 VDC. The pump controller shall operate from a supply voltage of 24VDC (-15% to +20%), and have a current consumption of 1A (no load). The controller shall be protected internally with a fuse rated at 2A.

### E. Communications

The pump controller shall include 4 communications ports. One port shall be RS-232 and dedicated to service functions (local programming of controller with laptop). The other three ports shall be RS-232 capable, and available for use as communication interface to dialup modem, leased line modem, GPRS cellular modem, or radio. The Contractor shall connect the new SCADA system into ASPA's existing SCADA system.

## 2.3 FUNCTIONS

### A. Operator Interface

The pump controller shall operate the pumps in accordance with operator programmed set-points, as shown in the construction plans and based on the liquid levels of the Multi-trode probe. The controller shall also be capable of remote start-stop functions via network. The following information shall be observed on the front panel display:

1. Wet well level
2. Cross-section areas of the wet well
3. Start-stop pump levels
4. Alarm levels for low level, high level and overflow
5. Nominal capacities of the pumps
6. Current flow and accumulated flow
7. Pumped volume for two days
8. Number of starts for each pump
9. Run time for each pump

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### 10. Amp draws for each pump

The pump controller shall provide for local display, acknowledgement and remote notification of alarm conditions. The controller shall log up to 1000 alarm events. Alarm capability shall include, as a minimum:

- (1) Wet Well High Level
- (2) Wet Well Low Level
- (3) Wet Well Overflow
- (4) Pump Overcurrent
- (5) Pump Undercurrent
- (6) Pump Fail to Start
- (7) Pump Over-temperature
- (8) Pump Seal Fail
- (9) Pump Service Alarm (when pump run time exceeds preset service interval)
- (10) Standby Generator Fail
- (11) Intrusion Alarm
- (12) Personnel Alarm (adjustable time-delay alarm if not acknowledged by on-site personnel)
- (13) Communications Failure
- (14) Test Alarm (periodic test alarm for communications)

### B. Station Blocking Transmit/Receive

The pump controller shall be capable, via telephone modem, of blocking up to six upstream stations should local conditions prevent pumping operations. The transmit blocking conditions shall be selectable from a pre-programmed list, and can be manipulated via "and/or" logic. The pump controller shall also be capable of receiving a station block command, either from another station or directly from the central station (HMI). When blocked, the controller shall continue to monitor level and shall be capable of releasing the pumps to prevent overflow. This feature is not required for current use, but will be setup during this project for future incorporation should ASPA initiate additional SCADA system upgrades.

### C. Flow Calculations

The pump controller shall provide flow calculations based on the geometry of the wet well. Up to five cross-sectional areas shall be used for instantaneous sump volume calculation. The controller shall then derive instantaneous inflow rate, pumped flow rate, totalized inflow volume, and pumped volume. In addition,

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individual pump flow capacity shall be calculated and logged. The controller shall allow a pump capacity set-point to provide alarm in case of diminished pump capacity.

### D. Overflow

The controller shall monitor for station overflow. Overflow recognition shall be achieved either by a set-point from the analog level, or by contact input at the desired overflow point. The controller shall register an overflow alarm when this level is exceeded, as well as record the date and time of overflow occurrence, date and time overflow condition abates, and accumulated overflow duration.

### E. Sump Cleaning

The controller shall provide a sump cleaning function. At preset intervals the pumps shall be allowed lower the wet well level to the bottom of the volute in order to remove built up solid debris in the sump. The controller shall also allow periodic timed pump cycles in low inflow stations to prevent the wet well from becoming septic.

### F. Precipitation Recording

The pump controller shall be capable of receiving a contact pulse input from a rain gauge or tipping bucket. Precipitation totals shall be recorded, and set-points can be provided for precipitation intensity alarms, based on 5 minute or 24 hour intervals. This feature is required for future use, but will not be setup during this project.

### G. Energy Consumption

The pump controller shall provide station energy consumption data. Data shall be obtained either via external power metering device via pulse contact input, or shall be calculated internally by the controller. Calculations shall be derived by instantaneous motor current readings and station voltage provided as a constant input. The controller shall provide kw, kwh, and kwh/MG pumped.

### H. Data Storage

The pump controller shall contain a real-time clock and shall time and date stamp all logged data. The controller shall store logged data for a period of up to 7 days. Stored data shall be accessible via network communication to a central station (HMI), or locally downloadable to an HMI equipped laptop computer. ASPA personnel will keep this data as historical operations data.

## 2.4 COMMUNICATIONS

### A. Type:

The pump controller shall provide 3 RS-232 serial ports for simultaneous communication via leased phone line, dialed phone line, cellular, radio or LAN. The controller shall include pre-programmed modem setups as well as allow for user-input modem settings.

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

### B. Protocols

The pump controller shall be capable of communicating to a central station (HMI) via AquaCom, MODBUS or Comli protocols. The controller shall also be capable of sending SMS text alarm messages via telephone or cellular network. These protocols shall be integrated into ASPA's existing SCADA system and setup during startup operations.

## 2.5 HMI SOFTWARE

The pump controller shall communicate to HMI software that is Windows based with intuitive menu-type navigation. The software shall include templates to facilitate future system expansion by operations personnel. The templates shall allow for a complete system setup without requiring the programming of individual screens or stations. All input/out register tagging shall be included in the template files, requiring no systems integration programming by the end user. The software shall provide the ability to observe station operating conditions, remote control of pumps and other station equipment, observe and change set-points, monitor and acknowledge alarms, log system historical data and generate reports and trend charts. The HMI software shall be AquaView by ITT Flygt. This software will be installed on an ASPA provided computer and Flygt representative shall integrate the outputs into ASPA's existing SCADA system. Acceptance of the system shall include transfer of all software licenses to ASPA.

Historical data trend charts shall be based on 1-30 minute time periods and shall include the following:

- A. Wet well levels
- B. Motor Currents
- C. Calculated capacity of wet well
- D. Inflow
- E. Pumped Volume
- F. Overflow

In addition to the available historical data, the following daily reports shall be provided

- A. Pump run times
- B. Number of pump starts
- C. Average value of pump capacity
- D. Pumped volume
- E. Number of overflow events
- F. Overflow duration Overflow volume

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G. Station blocked events (time and date stamped)

H. Energy consumption

### **PART 3 EXECUTION**

#### **3.1 TESTING**

Field test all controls and interfaces. Demonstrate proper operation of all functions and transmission of data.

#### **3.2 INSTRUCTIONS AND MAINTENANCE**

Provide field instructions for operating personnel. Include instruction and maintenance requirements. Furnish all maintenance manuals.

**END OF SECTION 33 32 16**

**SECTION 33 32 16.10  
LIQUID LEVEL CONTROLS**

**PART 1 GENERAL**

**1.1 RELATED DOCUMENTS**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

A. Section includes liquid level control systems for utility sewage pumping stations, compatible with existing ASPA SCADA system in use, and having following components:

1. Circuit breakers.
2. Control power transformers.
3. Transient voltage surge suppression.
4. Uninterruptible power supplies.
5. Automation controllers.
6. Pump monitors.
7. Relays.
8. Terminal strips.
9. Full-voltage magnetic controllers.
10. Reduced-voltage magnetic controllers.
11. Reduced-voltage, solid-state controllers.
12. VFDs.
13. Instrumentation.
14. Auxiliary devices.

B. Section includes one triplex pump control panel using VFDs to control pumps, and one single pump control panel using line-voltage combination motor starter.

**1.3 DEFINITIONS**

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- A. CPT: Control power transformer.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground fault circuit interrupting.
- D. IGBT: Insulated-gate bipolar transistor.
- E. LAN: Local area network.
- F. LED: Light-emitting diode.
- G. MCCB: Molded-case circuit breaker.
- H. MCP: Motor-circuit protector.
- I. NC: Normally closed.
- J. NO: Normally open.
- K. OCPD: Overcurrent protective device.
- L. PCC: Point of common coupling.
- M. PID: Control action, proportional plus integral plus derivative.
- N. PT: Potential transformer.
- O. PWM: Pulse-width modulated.
- P. RFI: Radio-frequency interference.
- Q. SCR: Silicon-controlled rectifier.
- R. SCADA: Supervision Control and Data Acquisition.
- S. TDD: Total demand (harmonic current) distortion.
- T. THD(V): Total harmonic voltage demand.
- U. TVSS: Transient voltage surge suppression.
- V. UL: Underwriters Laboratory.
- W. VFD: Variable-Frequency Drive.

### 1.4 SUBMITTALS

ASPA approval is required for submittals. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

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Samples of specified materials may be taken and tested for compliance with specification requirements.

### SD-02 Shop Drawings

For each pump control panel, manufacturer's approval, custom and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
  - a. Each installed unit's type and details.
  - b. Factory-installed devices.
  - c. Enclosure types and details.
  - d. Nameplate legends.
  - e. Short-circuit current (withstand) rating of complete pump control panel assembly, and for each VFD.
  - f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
  - g. Specified optional features and accessories.
2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends. Features, characteristics, ratings, and factory settings of each installed unit.

### SD-03 Product Data

For each type of controller and each type of pump control panel. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.

### SD-07 Certificates

Qualifications of liquid level controls representative

### SD-08 Manufacturer's Instructions

Application instructions,

Mixing

Detailed mixing instructions, minimum and maximum application temperature

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and humidity, potlife, and curing and drying times between coats.

### Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials.

### SD-10 Operation and Maintenance Data

Manufacturer's O&M manual

### SD-11 Closeout Submittals

For pump control panels, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Standard Drawings: For each pump control panel, as defined in UL 845.
- B. Production Drawings: For each pump control panel, as defined in UL 845.
- C. Product Certificates: For each pump control panel, from manufacturer.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- H. Testing and Startup procedures

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  2. Indicating Lights: Two of each type and color installed, using ASPA's existing light coloring scheme.
  3. Auxiliary Contacts: Furnish one spare for each size and type of magnetic controller installed
  4. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
  5. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
  6. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside pump control panels; install temporary electric
  7. Ambient Temperature: Less than 0 degree F (minus 18 degree C) or exceeding 104 degree F (40 degree C), with an average value exceeding 95 degree F (35 degree C) over a 24-hour period.
  8. Ambient Storage Temperature: Not less than minus 4 degree F (minus 20 degree C) and not exceeding 140 degree F (60 degree C).
  9. Humidity

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and handle pump controls and VFDs according to the following:
1. heating, with at least 250 W per section.

### 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Up to 100 percent
- B. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility occupied by ASPA or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify ASPA no fewer than two days in advance of proposed interruption of electrical service.

## Wastewater Mains and Lift Station Improvements (Package 5 - Phase 2)

2. Indicate method of providing temporary electrical service.
  3. Do not proceed with interruption of electrical service without ASPA written permission.
  4. Comply with NFPA 70E.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for pump controls, including clearances between pump controls and adjacent surfaces and other items.

### 1.9 COORDINATION

- A. Coordinate features of control panels, VFDs and accessory devices with remote pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each pump control panel, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.

### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace Controllers, Monitors, TVSS and VFDs that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURED UNITS

- A. Subject to compliance with requirements, provide products as follows:
  1. Automation Controllers: ITT Flygt Corp # APP 700 Series.
  2. Pump Monitors: ITT Flygt Corp # MAS 711 Series.
  3. Pump Monitoring Relays: ITT Flygt Corp # MiniCAS II.
  4. Variable Frequency Drive: ABB ACQ 810 series or Danfoss # VLT Aqua series.
  5. Power Supplies: Sola HD # SDN Series.
  6. Power Supplies & Uninterruptible Power Supplies: Sola HD # SDN and SDU Series.
  7. TVSS: Sola HD # STV25K Series.
- B. General Requirements for pump control panels: Comply with NEMA ICS 18 and UL 845.
  1. Pump Control Panel including all internal components, and external VFDs, shall be provided with pumping equipment as part of a single integrated

package.

## **2.2 FUNCTIONAL FEATURES**

Description: Modular arrangement of main units, controller units, control devices, auxiliary devices, and other items mounted in pump control panel.

## **2.3 CIRCUIT BREAKERS**

- A. Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
  - 2. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    - c. Application Listing: Appropriate for application.

## **2.4 AUTOMATION CONTROLLERS**

- A. Description: Remote terminal unit, microprocessor-based with latest standard software, digital inputs, digital outputs, analog inputs, communication ports, and user interface. Compatible with SCADA system in use by ASPA.
- B. Approved Standards:
  - 1. EMC emission standard: EN 61000-6-4
  - 2. EMC immunity standard: EN 61000-6-2
  - 3. LVD: EN 60947-1
  - 4. CSA: C22.2 No. 14-95
  - 5. UL: E302902
- C. Data Processing Power:
  - 1. Processor: Elan SC520 (486)
  - 2. Executed word length, protected mode: 32 bits
  - 3. Clock frequency: 100 MHz
  - 4. Primary memory: 16 Mbytes, D-RAM
  - 5. Secondary memory: 16 Mbytes, flash drive
  - 6. Battery backup: Lithium 3V, replaceable

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- D. Digital Inputs: 16
- E. Digital Outputs: 8
- F. Analog Inputs: 4
- G. Communication:
  - 1. Communication port (RS232): 4
  - 2. Bus communication (optional SIOX driver)
  - 3. Max number of I/O: 600
- H. User Interface:
  - 1. Display: LCD 20x20 character, LED backlight
  - 2. Pushbuttons: 8
  - 3. Alarm indications (LED): 16
  - 4. Pump well indications (LED): var 7-16
  - 5. RTU status indications (LED): 4

### **2.5 PUMP MONITORS**

Description: Pump monitor system, microprocessor-based with standard software, digital inputs, digital outputs, analog inputs, communication ports, and user interface.

Compatible with Automation Controller and with SCADA system in use by ASPA.

- 1. Monitors individual pump status: temperature, leakage, vibration, current and power.
- 2. Contains (2) relays that can be configured as NO or NC to indicate pump stop and pump warning alarms.

### **2.6 PUMP MONITORING RELAYS**

- A. Description: supervisory relay for temperature and leakage sensors, designed for pumps served and for plugging into a standard 11-pin socket.
  - 1. Supply Voltage: 20-30VAC; 23, 5-30VDC.
  - 2. Indication: Yellow LED for presence of supply.
  - 3. Relay contacts rating: 8A 250VAC.
  - 4. Operation principle: Current sensing.

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5. Voltage to sensor: 12VDC  $\pm$ 5%.
6. Red LEDs for alarm indications.
7. External pushbutton reset.

### 2.7 COMBINATION CONTROLLERS

#### A. Full-Voltage Controllers:

1. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
2. Magnetic Controllers: Full voltage, across the line, electrically held.
  - a. Configuration: Non-reversing.

#### B. Disconnecting Means and OCPDs:

1. MCCB Disconnecting Means:
  - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

#### C. Overload Relays:

1. Bimetallic Overload Relays:
  - a. Inverse-time-current characteristic.
  - b. Class 10, Class 20 and Class 30 tripping characteristic.
  - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - d. Ambient compensated.
  - e. Automatic resetting.
2. NC/NO isolated overload alarm contact.
  - a. External overload reset push button.

#### D. Control Power:

1. Control Circuits: 24V ac; obtained from CPT, with primary and secondary fuses, with sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices. Spare capacity is usually available in 100-VA increments. Consult manufacturers for maximum spare capacity and available CPT sizes for different NEMA and enclosure sizes because adding spare capacity and an oversized CPT may require using an enlarged enclosure.

### 2.8 VARIABLE FREQUENCY DRIVE (VFD)

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- A. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Application: Constant torque and variable torque.
- C. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT PWM inverter) factory packaged in an enclosure which Flygt provides, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable- speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
  - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  - 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
  - 4. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type and voltage.
- E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
  - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
  - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
  - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
  - 4. Minimum Efficiency: 98 percent at 60 Hz, full load.
  - 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
  - 6. Overload Capability: 1.1 times the base load current for 60 seconds.
  - 7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
  - 8. Speed Regulation: Plus or minus 5 percent.

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9. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
  2. Maximum Speed: 80 to 100 percent of maximum rpm.
  3. Acceleration: 0.1 to 999.9 seconds.
  4. Deceleration: 0.1 to 999.9 seconds.
  5. Current Limit: 30 to a minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  2. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  3. Under- and overvoltage trips.
  4. Inverter overcurrent trips.
  5. VFD and Motor Overload/Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD over temperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
  6. Critical frequency rejection, with three selectable, adjustable dead bands.
  7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  8. Loss-of-phase protection.
  9. Reverse-phase protection.
  10. Short-circuit protection.

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11. Motor over temperature fault.
- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
  1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
  2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
  3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
  4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  5. NC alarm contact that operates only when circuit breaker has tripped.

### 2.9 VFD CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
  1. Power on.
  2. Run.
  3. Overvoltage.
  4. Line fault.
  5. Overcurrent.
  6. External fault.
  7. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  8. Keypad: In addition to required programming and control keys, include

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keys for HAND, OFF, and AUTO modes.

9. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
  10. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
- B. Historical Logging Information and Displays:
1. Running log of total power versus time.
  2. Total run time.
  3. Fault log, maintaining last four faults with time and date stamp for each.
- C. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters, including, but not limited to:
1. Output frequency (Hz).
  2. Motor speed (rpm).
  3. Motor status (running, stop, fault).
  4. Motor current (amperes).
  5. Motor torque (percent).
  6. Fault or alarming status (code).
  7. PID feedback signal (percent).
  8. DC-link voltage (V dc).
  9. Set point frequency (Hz).
  10. Motor output voltage (V ac).
- D. Control Signal Interfaces:
1. Electric Input Signal Interface:
    - a. A minimum of two programmable analog inputs: 0- to 10-V dc, 4- to 20-mA dc.
    - b. A minimum of six multifunction programmable digital inputs.
  2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
  3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

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- a. 0- to 10-V dc.
  - b. 4- to 20-mA dc.
  - c. Potentiometer using up/down digital inputs.
  - d. Fixed frequencies using digital inputs.
4. Output Signal Interface: A minimum of two programmable analog output signals, which can be configured for any of the following:
- a. Output frequency (Hz).
  - b. Output current (load).
  - c. DC-link voltage (V dc).
  - d. Motor torque (percent).
  - e. Motor speed (rpm).
  - f. Set point frequency (Hz).
  - g. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - h. Motor running.
    - i. Set point speed reached.
    - j. Fault and warning indication (over temperature or overcurrent).
    - k. PID high- or low-speed limits reached.
- E. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of pumps for pressure and flow.
1. Number of Loops: One.
- F. SCADA Interface: Factory-installed hardware and software to enable the SCADA system to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multi-drop LAN configuration; settings retained within VFC's nonvolatile memory. Contractor shall integrate new controls and outputs into ASPA's existing SCADA system.
1. Network Communications Ports: Ethernet and RS-422/485.
  2. Built-in Protocols for Network Communications: FC Protocol, Modbus RTU; protocols accessible via the communications ports.
  3. Optional Protocols for Network Communications: Profibus, LonWorks, Device Net; protocols accessible via the communications ports.

## **2.10 VFD LINE CONDITIONING AND FILTERING**

- A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 5 percent and THD (V) to 3 percent.
- B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

## **2.11 CONTROL POWER**

- A. Control Circuits: 24V ac, obtained from CPT, with primary and secondary fuses, with sufficient capacity to operate all pilot, indicating, and control equipment.
- B. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
- D. Power Supply and Uninterruptible Power Supply:
  - 1. Description: UL508; Industrial microprocessor-controlled 24VDC uninterruptible power supply and 24VDC power supply.
    - a. Automatic self-test feature.
    - b. Power module wide operation temperature range.
    - c. Overload protection in normal and battery modes.
    - d. LED status indicators.
    - e. Monitoring, diagnostics, and remote turn-on and shut-off capabilities.
    - f. Dry contact relays for remote signaling.
    - g. Include battery module with replaceable batteries.
- E. Transient Voltage Surge Protection: IEEE C62.41-compliant, solid-state, with sine-wave tracking suppression and filtering modules, UL 1449, third edition.
  - 1. Input Voltage: 120VAC.
  - 2. Maximum Continuous Operating Voltage: 120VAC – 150V RMS.
  - 3. 47-63 Hz.
  - 3. Input Current Rating: 20A.
  - 4. Phase Configuration: 2 wire + ground.

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5. Modes of Protection: All Mode: L-N, L-L, L-G, N-G.

6. Status Indication: Green LED, Form C contacts.

F. Peak Surge Current Capability (8x20ms):25kA.

### 2.12 ENCLOSURES

A. Outdoor Enclosures: Type 4X stainless steel.

Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.

### 2.13 AUXILIARY DEVICES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Pilot Lights, and Selector Switches: Heavy-duty, oil tight type.

a. Pilot Lights: LED types.

b. Selector Switches: Rotary type.

2. Elapsed-Time Meters: Heavy duty with digital readout in hours; resettable.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Spare control-wiring terminal blocks; unwired.

### 2.14 CHARACTERISTICS AND RATINGS

A. Wiring: NEMA ICS 18, Class II or Class II-S, Type B, for starters above Size 3 or Type B-D, for starter Size 3 and below and Type B-T, for starter Size 3 and below or Type C.

B. Control and Load Wiring: Factory installed, with bundling, lacing, and protection

C. included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

D. Nominal System Voltage: 120/240V, three phase, four wire.

E. Short-Circuit Current Rating for Each Unit: *Combination series rated; 22, 42, 65 and 100 kA.*

F. Environmental Ratings:

1. Ambient Temperature Rating: Not less than 0 degree F (minus 18 degree C) and not exceeding 104 degree F (40 degree C), with an average value not exceeding 95 degree F (35 degree C) over a 24-hour period.

2. Ambient Storage Temperature Rating: Not less than minus 4 degree F (minus

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20 degree C) and not exceeding 140 degree F (60 degree C)

3. Humidity Rating: Up to 100 percent.
- G. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit equipment grounding conductors.
- H. Fungus Proofing: Permanent fungicidal treatment for OCPDs and other components including instruments and instrument transformers.

### **2.15 SOURCE QUALITY CONTROL**

- A. Testing: Inspect and test according to requirements in NEMA ICS 18.
- B. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
  1. Test each VFC while connected to its specified motor.
  2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- C. Controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and surfaces to receive control systems, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Coordinate layout and installation of control panels and equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install fuses in control circuits if not factory installed.
- C. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- D. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-

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driven equipment.

E. Comply with NECA 1.

### 3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" for identification of control panels, components, and wiring.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label control panel with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

4. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer and ASPA for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for control panels, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount as directed by ASPA.

### 3.4 CONTROL WIRING INSTALLATION

A. Install wiring between master terminal boards and remote devices and facility's existing SCADA system. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Division 26 Section "Raceway and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 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.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify ASPA before starting the motor(s).
  - 5. Test each motor for proper phase rotation.
  - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters and submit to ASPA.
  - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 8. Perform the following infrared (thermo-graphic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of

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Substantial Completion in accordance with the contract provisions.

- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
10. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer and ASPA for inclusion in Record Drawings.
- E. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.7 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Submit startup schedule and information on names and company of the representative. Coordinate this startup work with ASPA personnel.

### **3.8 ADJUSTING**

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload- relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify ASPA before increasing settings.
- D. Program microprocessors in VFDs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- F. Set field-adjustable circuit-breaker trip ranges

**3.9 PROTECTION**

- A. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

**3.10 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train ASPA's maintenance personnel to adjust, operate, and maintain controls. Submit a detailed on-site demonstration plan and O&M Manual for inclusion into ASPA's master O&M Manual.

**END OF SECTION 33 32 16.10**

**SECTION 33 34 00  
SEWER FORCE MAINS**

**PART 1 GENERAL**

**1.1 SUMMARY**

A. Description: This Section includes the furnishing and installation of sewer force mains to the lines and grades indicated on the drawings and as specified herein.

**1.2 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C909 (2009) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, and Fabricated Fittings, 4 in. through 24 in. for Water, Wastewater and Reclaimed Water Service.

ASTM INTERNATIONAL (ASTM)

ASTM C 443 (2005a) Standard Specifications for Joints for Concrete Pipe and Manhole, Using Rubber Gaskets

ASTM C 478 (2013) Standard Specification for Precast Reinforced Concrete Manhole Sections

ASTM D1785 (2012) Standard Specification for Poly (Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80 and 120.

ASTM D2241 (2009) Standard Specification for Poly (Vinyl Chloride) (PVC), Pressure-Rated Pipe (SDR Series)

ASTM D2564 (2012) Standard Specification for Solvent Cement for Poly(Vinyl Chloride ) (PVC) Plastic Piping Systems

ASTM D2657 (2007) Heat Fusion Joining Polyolefin Pipe and Fittings

ASTM D 3035 (2010) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

ASTM D 3350 (2010a) Standard Specification for Polyethylene Plastics Pipe and Fittings

ASTM F 714 (2010a) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND  
FITTINGS INDUSTRY (MSS)

MSS SP-78 (2011) Cast Iron Plug Valves, Flanged and Treaded Ends.

### 1.3 SUBMITTALS

A. ASPA approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

- a. Hydrostatic Tests.
- b. Copies of test results.

SD-08 Manufacturer's Instructions

- a. Pipe manufacturer's installation instructions: HDPE pipe with butt fusion, socket fusion, saddle fusion, and electro-fusion jointing techniques and flange joints.
- b. Letter from manufacturer giving brand name of compatible fittings offered with pipe.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Do not damage pipe, fittings and accessories during delivery, handling, and storage.

### 1.5 QUALITY ASSURANCE

Contractors quality control organization shall pre-test all pipeline and devices prior to final test and inspection by the APE.

## PART 2 PRODUCTS

### 2.1 PIPE AND FITTINGS

Piping for force mains shall be HDPE. Piping for force main that will be installed on the side/ abutment of the bridge shall be of ductile iron pipe. Pipes shall conform to the respective specifications and other requirements specified below.

### 2.2 HDPE PIPE: ASTM D 3035 or ASTM F 714

A. General

1. Material:
  - a. ASTM D 3350 cell classification PE345434C.
  - b. Minimum thermal stability: ASTM D 3350.

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2. Markings: Legibly marked in green to identify as sewer pipe at intervals of 5 feet maximum with manufacturer's name, trademark, pipe size (nominal size and OD base IPS), PE 3408, SDR-11 appropriate legend such as HDPE, ASTM D 3035 or ASTM F 714, date of manufacture, and point of origin.
  3. Pipe not marked as specified herein will be rejected.
- B. Pipe and fittings, approved manufacturers:
1. CP Chem, Division of Chevron Phillips Chemical Company, LP.
  2. Rinker Materials Poly Pipe Division.
  3. Or Equal.
- C. Pipes: Standard Dimension Ratio (SDR) of 11 with corresponding operating pressure of 160 psi, unless noted otherwise.
- D. Fittings: ASTM D 3261, use injected molded fittings with ends suitable for Butt fusion unless otherwise specified.
1. Where fittings are installed in trench, socket fusion, saddle/sidewall fusion and electro-fusion jointing technique fittings may be used instead of Butt fusion fittings, when approved by the APE.
  2. Socket fusion fittings: ASTM D 2683.
  3. Saddle/sidewall fusion fittings: ASTM F 905.
  4. Socket and saddle/sidewall fusion fitting supplied by manufacturer of pipe.
  5. Electro-fusion fittings supplied by Central Plastics Company or equal.
  6. Pressure rating of fittings same as adjacent pipe.
- E. Pipe joints:
1. Fusion techniques: Unless otherwise noted, use butt fusion joints between pipes or fittings.
    - a. Where jointing of pipe is required in trench, electro-fusion or socket fusion jointing techniques may be used instead of butt fusion jointing technique, when approved by the APE.
    - b. Make electro-fusion couplings by computer controlled automatic electro-fusion system. Electro-fusion consists of couplings containing integral heating source which is computer controlled for time, temperature and jointing pressure for consistent joint.
      - 1) Couplings rated for same pressure as pipe.

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- a) Build-in identification feature to automatically set fusion times and to include current monitoring feature.
  - b) Manufactured by Central Plastics Company or equal.
- 2) No threaded or solvent welded/glued HDPE joints permitted.

### 2.3 AIR RELEASE VALVES AND VALVE BOX

- A. Air release valves shall be designed to permit release of air from an empty pipe during filling and shall be capable of discharging accumulated air in the line while the line is in operation and under pressure. Valves shall be attached by means of threaded pipe connections. Valves shall be vented to the atmosphere.
1. Automatic Air Release Valve: Automatic air release valves shall be of the compound lever type capable of withstanding operating pressures of 150 psi. The valves shall have a 1/2 inch outlet. The body and cover of the valve shall be of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit back flushing without dismantling the valve. Valve box shall be provided. Shop drawings shall be submitted to APE for approval prior to ordering material. Air release valve shall be as manufactured by APCO, Crispin Vent-o-Mat or approved equal.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Pipe, pipe fittings, and appurtenances shall be installed at the locations indicated. Excavation, trenching, and backfilling shall be as specified in Section 31 00 00 EARTHWORK.
1. Force mains
    - a. Installation of force mains and inverted siphons near adjacent facilities shall be as specified in Section 33 30 00 SANITARY SEWERS.
  2. Cutting
    - a. Pipe shall be cut in a neat manner with mechanical cutters. Wheel cutters shall be used where practicable. Sharp and rough edges shall be ground smooth and loose material removed from the pipe before laying.
  3. Laying
    - a. Before lowering and while suspended, the pipe shall be inspected for defects.  
  
Defective material shall be rejected. Pipe shall be laid in compliance with the following:

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1) HDPE: Manufacturer's instructions.

### 4. Jointing

#### a. Joints for HDPE Pipe

1) Butt fusion joints shall comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time.

### 5. Thrust Restraint

a. Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, shall be provided with thrust restraint. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

#### 1) Thrust Blocks

a) Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

### 6. Air relief valves

a. Air relief valves shall be placed in concrete boxes as indicated. A valve box and cover located in a road or driveway shall be traffic rated.

## 3.2 HYDROSTATIC TESTS

A. The pipeline shall be subjected to both a pressure test and a leakage test. The method proposed for disposal of waste water from hydrostatic tests shall be approved by the APE. Testing is the responsibility of the Contractor. Perform testing using an approved independent testing laboratory or the Contractor, subject to approval. The test may be witnessed by the APE. The APE shall be notified at least 7 days in advance of equipment tests. The final test report shall be delivered to the APE within 30 days of the test.

### 1. Pressure Test

a. After the pipe has been installed, joints completed, thrust blocks have been in place for at least five days, and the trench has been partially

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backfilled, leaving the joints exposed for examination, the pipe shall be filled with water to expel all air. The pipeline shall be subjected to a test pressure of 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Each valve shall be opened and closed several times during the test. The exposed pipe, joints, fitting, and valves shall be examined for leaks. Visible leaks shall be stopped or the defective pipe, fitting, joints, or valve shall be replaced.

### 2. Leakage Test

- a. The leakage test may be conducted subsequent to or concurrently with the pressure test. The amount of water permitted as leakage for the line shall be placed in a sealed container attached to the supply side of the test pump. No other source of supply will be permitted to be applied to the pump or line under test. The water shall be pumped into the line by the test pump as required to maintain the specified test pressure as described for pressure test for a 2 hour period. Exhaustion of the supply or the inability to maintain the required pressure will be considered test failure. PE pipe can experience diametric expansion and pressure elongation during initial testing. The manufacturer shall be consulted prior to testing for special testing considerations. Allowable leakage shall be determined by the following I-P formula:

$$L = NDP/K$$

Where:

- L = Allowable leakage in gallons per hour.
- N = Number of joints in length of pipeline tested.
- D = Nominal diameter of the pipe in inches.
- P = Square root of the test pressure in psig.
- K = 7400 for pipe materials.

At the conclusion of the test, the amount of water remaining in the container shall be measured and the results recorded in the test report.

### 3. Retesting

- a. If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be re-conducted until the results of the tests are within specified allowances, without additional cost to the ASPA.

**END OF SECTION 33 34 00**