

SECTION 33 46 01 – A  
DAM SUBDRAINAGE SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes provisions for installing subsurface drainage systems for dam embankments (SMP-01, SMP-11, TEMP-SMP-01, TEMP-SMP-02) and includes the following items:
1. Furnishing, placing, and compacting filter sand for filter diaphragms and strip drains.
  2. Furnishing, placing, and compacting drain stone for filter diaphragm drainage.
  3. Furnishing and installing drain pipe including slotted and solid High-Density Polyethylene (HDPE) drain pipes and associated ancillary features as shown on the Drawings.
  4. Video inspection of completed drain pipes upon completion of backfilling.

1.2 REFERENCES

- A. Meet or exceed the requirements of the latest edition of the following codes, regulations, and standards.
- B. ASTM International (ASTM)
1. ASTM C33/C33M Standard Specification for Concrete Aggregates
  2. ASTM C117 Standard Test Method for Materials finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
  3. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
  4. ASTM D75/D75M Standard Practice for Sampling Aggregates
  5. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
  6. ASTM D2488 Standard Practice for Description and Identification of Soils (Visual Manual Procedures)
  7. ASTM D6913/D6913M Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
  8. ASTM D1140 Standard Test Method for Determining Amount of Material Finer than 75- $\mu$ m (No. 200) Sieve in Soils by Washing
  9. ASTM D4253 Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
  10. ASTM D4254 Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
  11. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
  12. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
  13. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

- 14. ASTM F714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
- 15. ASTM F2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

### 1.3 DEFINITIONS

- A. Fines: Soil particles finer than the No. 200 sieve size.
- B. Prepared Ground Surface: Ground surface after clearing, grubbing, stripping, excavation, demolition, and scarification and/or compaction.
- C. Coverage: One coverage is defined as the result of successive passes by a piece of compaction equipment, which by means of sufficient overlap, will ensure that all areas of the layer or lift being compacted have been subjected to one pass of the compaction equipment.
- D. Relative Density: The relative density in-place shall be calculated as described in ASTM D4254 using the following equation:

$$R_d(\%) = \frac{\gamma_{d,max}(\gamma_{d,measured} - \gamma_{d,min})}{\gamma_{d,measured}(\gamma_{d,max} - \gamma_{d,min})} * 100 \text{ where } \gamma_d \text{ is dry density}$$

- E. Unsuitable Materials: Materials that contain waste, debris, roots, organic matter, frozen matter, or any other materials determined by the Engineer to not meet the specifications for the required fill.

### 1.4 SUSTAINABLE DESIGN REQUIREMENTS

- A. Comply with Section 01 81 13 – Sustainable Design Requirements.

### 1.5 SUBMITTALS

- A. Refer to Submittal Schedule at end of Part 3 for a list of submittal requirements for this Section.

### 1.6 QUALITY ASSURANCE

- A. Perform work in conformance, except as modified in this Section, with current edition of New York State Department of Transportation Standard Specifications, referred to here as Standard Specifications.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. HDPE DRAIN PIPE

1. Manufacturers shall have a minimum of five years of experience in the design and manufacture of the specific pipe to be supplied.
2. Furnish pipe in the nominal sizes shown on the Drawings. All HDPE pipes shall have a designation code of PE4710 or higher. The material shall meet or exceed a cell classification of 445574C/E as defined in ASTM D3350.
  - a. Slotted Pipe: Slotted pipe shall conform to ASTM F714, Dimension Ratio (DR) 17 circular pipe sized using Ductile Iron Pipe Sizing (DIPS) criteria. Slots shall be clean and completely free of burrs, cuttings, frayed edges, tears and cracks, and other defects. Slot geometry, spacing, and quantity are as specified on the Drawings. Pipe not meeting these requirements will be rejected. Fabrication of slotted HDPE pipe shall be completed by the supplier before delivery to the site. Pipe shall be homogeneous throughout and free of visible cracks, holes, inclusions, or other defects. It shall be uniform in color, opacity, density, and other physical characteristics.
  - b. Solid Pipe: Solid pipe shall conform to ASTM F714, Dimension Ratio (DR) 17 circular pipe sized using Ductile Iron Pipe Sizing (DIPS) criteria. Pipe shall be homogeneous throughout and free of visible cracks, holes, inclusions, or other defects. It shall be uniform in color, opacity, density, and other physical characteristics.
3. Fittings: HDPE pipes to be fused using butt fusion techniques, as appropriate, in accordance with ASTM F2620. All fittings are to be supplied by pipe manufacturer and may not be fabricated on site.
4. Slots: perforated pipe sections shall be shop fabricated in accordance with the slotted conduit detail in the drawings.
5. End Plugs or Caps: End plugs or caps shall be the manufacturer's standard end plugs or caps to provide a watertight seal suitable for use in perforated and non-perforated drain pipe, subject to the approval of the Engineer.

## 2.2 ANIMAL GUARDS

- A. As specified on the Drawings.
- B. Provide ARGI Drain Corporation 6-inch Stainless Steel Rat Guard or Approved Equal.

## 2.3 FILTER SAND

- A. Designed Filter Sand based on NYSDOT Mortar Sand, with a tighter filter band at the No. 50 sieve and allowing 5 percent fines passing the No. 200 sieve. Comparison of the designed filter sand and NYSDOT Mortar Sand filter bands is in the table below. This gradation represents the in-place gradation after placement and compaction at the project site.

Sieve Size	NYSDOT Mortar Sand Gradation) (Percent Passing)		Designed Filter Gradation (Percent Passing)	
	Coarse	Fine	Coarse	Fine
No.4 (4.75 mm)	100	100	100	100
No. 8 (2.36 mm)	95	100	95	100
No. 50 (0.3 mm)	10	40	25 <sup>1</sup>	40
No. 100 (0.15 mm)	0	15	0	15
No. 200 (0.075 mm)	-	-	0	5 <sup>1</sup>

<sup>1</sup>Modified from NYSDOT Mortar Sand gradation

- B. Filter sand shall be imported, natural (not manufactured), processed, granular material.

- C. A list of required material approval testing for Filter Sand is presented below. The tests shall be conducted by the Contractor's independent testing firm at the frequencies designated unless otherwise directed by the Engineer.

Test	Test Method (Current Version)	Test Frequency
Classification	ASTM D2487	Minimum 4 tests per source
Gradation with No. 200 Wash and Hydrometer	ASTM D6913 and D1140	Minimum 4 tests per source
Laboratory Moisture-Density (Relative Density)	ASTM D4253 and D4254	Minimum 2 tests per ASTM test method per material

## 2.4 DRAIN STONE

- A. Drain Stone in accordance with ASTM C33 No. 8 Coarse Aggregate utilized for drainage material. This gradation includes a maximum limit for fines content in addition to the requirements from the standard gradation. The table below represents the in-place gradation after placement and compaction.

U.S. Standard Sieve Size	ASTM C33 No. 8 Coarse Aggregate	
	Coarse	Fine
1/2 inch	100	100
3/8 inch	85	100
No. 4	10	30
No. 8	0	10
No. 16	0	5
No. 200 (0.075 mm)	0	3

- B. A list of required material approval testing for Drain Stone is presented below. The tests shall be conducted by the Contractor's independent testing firm at the frequencies designated unless otherwise directed by the Engineer.

Test	Test Method (Current Version)	Test Frequency
Classification	ASTM D2487	Minimum 4 tests per source
Gradation with No. 200 Wash and Hydrometer	ASTM D6913 and D1140	Minimum 4 tests per source

## 2.5 EQUIPMENT

- A. **Compaction Equipment:** Use suitable compaction equipment to obtain specified relative density. Operate compaction equipment in strict accordance with manufacturer's instructions and recommendations. Maintain equipment in such condition that it will deliver manufacturer's rated compactive effort. If inadequate densities are obtained, provide larger and/or different types of additional equipment appropriate for the materials being compacted.
- B. **Moisture Control Equipment:** Use equipment for applying water of a type and quality adequate for work, that does not leak and is equipped with a distributor bar or other approved device to assure uniform application. Use equipment consisting of blades, discs, or other approved equipment for mixing and drying out material.

- C. Other Materials and Equipment: Select other materials and equipment not specifically described but required for a complete and proper installation subject to review by A/E prior to use.

## PART 3 EXECUTION

### 3.1 INSPECTION

- A. Imported Material Acceptance: Imported materials specified in this Section are subject to the following requirements:
  - 1. Test acceptable sources for each imported material. Submit certification that material conforms to Specification requirements along with copies of test results from a qualified commercial testing laboratory as required by Submittals Schedule. Furnish material samples by Contract or at Contractor's sole expense. Clearly mark samples to show source of material and intended use on project. Perform sampling of material source in accordance with ASTM D75. Coordinate sampling schedule at least 24 hours in advance with A/E and Owner so they observe sampling procedures.
  - 2. Tentative acceptance of material source based on observation of source by Owner and/or certified test results submitted by Contractor to Owner at Owner's discretion.
  - 3. Deliver no imported materials to site until proposed source and material test submittal(s) has been reviewed by A/E and returned marked "No Exceptions Noted".
  - 4. Final acceptance will be based on tests made on samples of material taken from a completed and compacted course.
  - 5. Testing for final acceptance will be performed by Owner or Owner's representative.
  - 6. If tests conducted by Contractor or Owner indicate that material does not meet Specification requirements, material placement will be terminated until corrective measures are taken.
  - 7. Remove and replace material which does not conform to Specification requirements at the Contractor's sole expense.
  - 8. Sampling and testing performed by Contractor at Contractor's sole expense.

### 3.2 FILTER SAND AND DRAIN STONE

- A. Excavation required for drains shall be in accordance with Section 31 00 00 "Earthwork."
- B. Before placing filter sand material, verify that the prepared foundation has been inspected by the Engineer. Do not place fill without approval from the Engineer.
- C. Control and conduct all operations including but not limited to transporting, stockpiling, excavating, producing, and placing the materials to minimize waste, contamination, segregation, and particle breakdown.
- D. Place filter sand and drain stone to the locations, lines, grades, and thicknesses shown on the drawings. Install filter sand and drain stone materials in loose lifts not exceeding 8 inches in thickness prior to compaction for full size compaction equipment and 5 inches in thickness prior to compaction for smaller walk-behind compaction equipment.
- E. Do not place drain materials when filter sand, drain stone, or the foundation on which it would be placed is frozen. Stop fill placement temporarily during unsuitable weather conditions, as directed by the Engineer.

- F. Filter Sand and Drain Stone Compaction Equipment: Hand-operated vibrating plate compactors having a minimum static weight of 300 pounds and a minimum dynamic force of 1,000 pounds, or other compaction equipment acceptable to the Engineer. All compaction equipment used for filter sand and drain stone should be maintained clean and shall be restricted to operation only on the filter sand and drain stone zones. Other compaction equipment may be approved if demonstrated by the Contractor to achieve suitable results. Proposed compaction equipment for filter sand and drain stone must be submitted to the Engineer before use.
- G. Thoroughly wet filter sand immediately before compaction using moisture application procedures as approved by the Engineer. Moisture conditioning is not required for drain stone. The moisture content of the filter sand and drain stone shall be distributed uniformly throughout each layer of material prior to and during compaction.
- H. Compact with a smooth drum vibratory roller or hand-operated tamper to achieve a relative density of at least 50 percent and not more than 70 percent. A test section must be performed, either separate from the work or part of the work, to demonstrate the proposed placement, watering, and compaction methods to achieve suitable compaction results (in-place density testing and gradation results). Visual observation of compaction may be deemed acceptable by the Engineer in confined areas on a case-by-case basis. Hand-operated equipment is required within two feet of all structures.
- I. Coordinate filter sand and drain stone material installation with other conduit construction including spillways and inlets/outlets.
- J. Filter sand and drain stone shall be tested for gradation and density in-situ in accordance with the following requirements.

Test	Test Method (Current Version)	Test Frequency
Gradation with No. 200 Wash and Hydrometer	ASTM D6913 and D1140 <sup>(1)</sup>	One (1) test for every 100 cubic yards of sand placed and compacted. The test shall be performed on compacted material. If any change is noted in placement methods, an additional test will be performed at no cost to the Owner. Coordinate gradation testing with in-place density testing.
In-place Density	ASTM D6938	Minimum of one (1) test for every 100 cubic yards of filter sand or drain stone placed and compacted. A minimum of one (1) test shall be performed for each day of placement regardless of quantity of material placed.

### 3.3 DRAIN PIPE

- A. Construct HDPE drain pipes in accordance with this Section, manufacturer's recommendations, and ASTM D2321. In case of a conflict, this specification shall govern.
- B. Fusion Joining Methods:
  1. Use only appropriately sized and outfitted fusion machines that have been approved by the manufacturer in the fusion process.
  2. All fusion joints shall be made in accordance with the manufacturer's recommendations.
  3. All fusion joints shall be made by a qualified fusion technician as determined by the manufacturer.

4. Any fusion joints made by non-qualified technicians will be rejected and replaced at no additional cost to the Owner.
- C. Install pipes to the lines and grades shown on the Drawings. Installed pipe shall not deviate from the design grade by more than 1 inch per 100 feet unless approved by the Engineer. Record grade and alignment measurements for each piece of pipe installed and at each turn, junction, or change in grade. Furnish measurements to the Engineer upon completion of the Work.
- D. Drain stone material shall be carefully placed about the drain pipes so as not to disturb the drain pipe and to hold it securely in position while the overlying material is being placed. Blocking or wedging of the pipe is not allowed. Adjustments shall be done by scraping away or filling the material beneath the pipe.
- E. Due to the drainage pipe's light weight and buoyancy, special care shall be exercised in laying the drainage pipe and placing materials adjacent to the pipe to ensure that the pipe is laid, and remains, on grade and in alignment.
- F. The method of laying the drainage pipe shall prevent stretching of the pipe during laying operations.
- G. Any drainage pipe which is broken, cracked, or otherwise unsuitable for use, as determined by the Engineer, shall be removed and replaced at the cost of and by the Contractor and at no additional cost to the Owner. HDPE pipe sections with gouges, scrapes, or other damage resulting in a loss of 10 percent of the wall thickness shall be cut out, removed, and replaced at no additional cost to the Owner.
- H. Keep the drainage pipe free from deposits of snow, ice, mud, sand, gravel, concrete, or other foreign matter, and in good working condition until the contract is complete and accepted. Do not store pipe materials in direct sunlight. Drainage pipe that is improperly stored will be rejected by the Engineer and replaced at no additional cost to the Owner.
- I. The Contractor is responsible for any damages to any installed drains. Damaged sections of drains or outfall pipe shall be removed and replaced at the cost of and by the Contractor and at no additional cost to the Owner.
- J. Handle materials to ensure delivery to installation locations in sound, undamaged condition. Do not drag pipe.
- K. Use straight pipe sections and elbows not exceeding 22.5° unless otherwise shown on the Drawings.
- L. Do not drop drain materials directly on pipe.
- M. Do not compact drain material or fill material with full-sized compaction equipment for at least 2 feet directly over the drain pipe.
- N. Support drain pipe circumferentially with drain material prior to backfilling above pipe.
- O. Prevent introduction of contaminants into the drain material.
- P. Install animal guards as indicated on the Drawings after completion of cleaning and video inspection and with the approval of the Engineer.

### 3.4 SUBDRAINAGE INSPECTIONS AND TESTS

- A. Do not place fill over the embankment subdrain system until it has been inspected, and approved by the Engineer.
- B. Video Inspection of Completed Drain Pipe
  - 1. After all drain elements are installed, backfilled, cleaned, and in good working order, perform cleaning and video inspection performed using equipment with the ability to pan and tilt to a 90-degree angle with the axis of the pipe and rotate 360 degrees. During the video inspection provide a continuous 360 degree pan of every pipe joint.
  - 2. Document locations of all observed defects and distresses including cracking, exposed reinforcing steel, sags, joint offsets, joint separations, deflections, improper joints/connections, blockages, leaks, rips, tears, buckling, deviation from line and grade, and other anomalies not consistent with a properly installed pipe.
  - 3. Submit all recorded video files.

3.5

SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
	HDPE PIPE MANUFACTURER CERTIFICATIONS		
	FILTER SAND AND DRAIN STONE MANUFACTURERS CERTIFICATION		
	FILTER SAND AND DRAIN STONE MATERIAL SAMPLES AND LAB TEST RESULTS		
	FILTER SAND AND DRAIN STONE INSTALLATION PLAN		
	CERTIFIED TRUCKLOAD WEIGH BILLS		
	VIDEO INSPECTION RESULTS AND VIDEO FILES		
	ANIMAL GUARD PRODUCT DATA		

END OF SECTION