

SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. 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. This Section includes subdrainage systems for the following:
  - 1. Foundations.
  - 2. Underslab areas.
  - 3. Plaza decks.
  - 4. Retaining walls.
  - 5. Landscaped areas.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PP: Polypropylene plastic.
- E. PS: Polystyrene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Perforated-wall pipe and fittings.
  - 2. Solid-wall pipe and fittings.
  - 3. Drainage conduits.
  - 4. Drainage panels.
  - 5. Geotextile filter fabrics.
- B. Approval of waterproofing manufacturer's service agent for use of drainage panels against and for waterproofing membrane protection.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 PIPING MATERIALS

- A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

## 2.3 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
  2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
  3. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

## 2.4 SOLID-WALL PIPES AND FITTINGS

- A. Cast-Iron Soil Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes, hub-and-spigot ends, gray, for gasketed joints.
1. Gaskets: ASTM C 564, rubber, of thickness matching class of pipe.
- B. PE Drainage Tubing and Fittings: AASHTO M 252, Type S, corrugated, with smooth waterway, for coupled joints.
1. Couplings: AASHTO M 252, corrugated, band type, matching tubing and fittings.
- C. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.
1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.
- D. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
1. Gaskets: ASTM F 477, elastomeric seal.

## 2.5 SPECIAL PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
  - 1. Sleeve Materials:
    - a. For Concrete Pipes: ASTM C 443, rubber.
    - b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    - c. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - d. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  - 2. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant metal tension band and tightening mechanism on each end.
  - 3. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

## 2.6 CLEANOUTS

- A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.
- B. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

## 2.7 DRAINAGE CONDUITS

- A. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
  - 1. Available Manufacturers:
    - a. Varicore Technologies, Inc.
  - 2. Nominal Size: 6 inches high by approximately 1-1/4 inches thick.
    - a. Minimum In-Plane Flow: 15 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - 3. Filter Fabric: Nonwoven, needle-punched geotextile.
  - 4. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
  - 5. Couplings: HDPE.
- B. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
  - 1. Available Manufacturers:

- a. Advanced Drainage Systems.
2. Nominal Size: 12 inches high by approximately 1 inch thick.
  - a. Minimum In-Plane Flow: 30 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
3. Nominal Size: 18 inches high by approximately 1 inch thick.
  - a. Minimum In-Plane Flow: 45 gpm at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
4. Filter Fabric: Nonwoven, PP geotextile.
5. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
6. Couplings: Corrugated HDPE band.

## 2.8 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches wide with drainage core faced with geotextile filter fabric.
  1. Available Manufacturers:
    - a. American Wick Drain Corporation.
    - b. Cosella-Dorken.
    - c. Eljen Corp.
    - d. Greenstreak, Inc.
    - e. JDR Enterprises, Inc.
    - f. LINQ Industrial Fabrics, Inc.
    - g. Midwest Diversified Technologies Incorporated.
    - h. TC Mirafi.
  2. Drainage Core: Three-dimensional, nonbiodegradable, molded PP or PS.
    - a. Minimum Compressive Strength: 10,000 lbf/sq. ft. when tested according to ASTM D 1621.
    - b. Minimum In-Plane Flow Rate: 2.8 gpm/ft. of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig when tested according to ASTM D 4716.
  3. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
    - a. Survivability: Class 2.
    - b. Apparent Opening Size: No. 60 sieve, maximum.
    - c. Permittivity: 0.2 per second, minimum.
  4. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:

- a. Survivability: Class 2.
  - b. Apparent Opening Size: No. 60 sieve, maximum.
  - c. Permittivity: 0.02 per second, minimum.
5. Film Backing: Polymeric film bonded to drainage core surface.
- B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Available Manufacturers:
    - a. Colbond Geosynthetics.
  2. Drainage Core: Open-construction, resilient, approximately 0.4-inch- thick, plastic-filament mesh.
    - a. Minimum In-Plane Flow Rate: 2.4 gpm/ft. of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig when tested according to ASTM D 4716.
  3. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. when tested according to ASTM D 4491.

## 2.9 SOIL MATERIALS

- A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

### 3.3 PIPING APPLICATIONS

- A. Underground Subdrainage Piping:
1. Perforated PE pipe and fittings, couplings, and coupled joints.
  2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

- B. Underslab Subdrainage Piping:
  - 1. Perforated PE pipe and fittings, couplings, and coupled joints.
  - 2. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.
- C. Header Piping:
  - 1. PE drainage tubing and fittings, couplings, and coupled joints.
  - 2. PVC sewer pipe and fittings, couplings, and coupled joints.

### 3.4 CLEANOUT APPLICATIONS

- A. In Underground Subdrainage Piping:
  - 1. At Grade in Earth: Cast-iron cleanouts.
  - 2. At Grade in Paved Areas: Cast-iron cleanouts.
- B. In Underslab Subdrainage Piping:
  - 1. In Equipment Rooms and Unfinished Areas: Cast-iron cleanouts.

### 3.5 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.
- B. Place impervious fill on subgrade adjacent to bottom of footing and compact to dimensions indicated, but not less than 6 inches deep and 12 inches wide after concrete footing forms have been removed.
- C. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- D. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- E. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- F. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- G. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- H. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- I. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- J. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

- K. Install vertical drainage panels as follows:
1. Coordinate placement with other drainage materials.
  2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article. Do not install aggregate.
  3. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
  4. Wrap bottom of panel around drainage pipe.
  5. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
  6. If additional panels are required on same row, cut away 4 inches of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
  7. If additional rows of panels are required, overlap lower panel with 4 inches of fabric.
  8. Cut panel as necessary to keep top 12 inches below finish grade.
  9. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
- L. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
- M. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

### 3.6 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.
- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
  - 1. Coordinate placement with other drainage materials.
  - 2. Lay perforated drainage pipe at inside edge of footings.
  - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
  - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

### 3.7 PLAZA DECK DRAINAGE INSTALLATION

- A. See Division 32 Section "Unit Paving."

### 3.8 RETAINING-WALL DRAINAGE INSTALLATION

- A. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches.
- B. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- C. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- D. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- E. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- F. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- H. Install vertical drainage panels as follows:
  - 1. Coordinate placement with other drainage materials.
  - 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
  - 3. Mark horizontal chalk line on wall at a point 6 inches less than panel width above footing bottom. Before marking wall, subtract footing width.
  - 4. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
  - 5. Wrap bottom of panel around drainage pipe.
  - 6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from



- 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away 4 inches of installed panel core and wrap fabric over new panel.
  8. If additional rows of panel are required, overlap lower panel with 4 inches of fabric.
  9. Cut panel as necessary to keep top 12 inches below finish grade.
  10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
  11. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
- I. Fill to Grade: Place satisfactory soil fill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

### 3.9 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

### 3.10 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
  2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
  3. Plaza Deck Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 1.0 percent.
  4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.
  5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
  6. Lay perforated pipe with perforations down.
  7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install ABS piping according to ASTM D 2321.
- D. Install PE piping according to ASTM D 2321.
- E. Install PVC piping according to ASTM D 2321.
- F. Install clay piping according to ASTM C 12 and NCPI's "Clay Pipe Engineering Manual."
- G. Install concrete piping according to ACPA's "Concrete Pipe Handbook."
- 3.11 PIPE JOINT CONSTRUCTION
- A. Cast-Iron Soil Pipe and Fittings: Hub and spigot, with rubber compression gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.
  - B. Join ABS pipe and fittings according to ASTM D 2751.
  - C. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."
  - D. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
  - E. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

- F. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.
- G. Join perforated clay pipe and fittings with gaskets according to ASTM C 425.
- H. Join perforated concrete pipe and fittings with gaskets according to ASTM C 443.
- I. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

### 3.12 CLEANOUT INSTALLATION

- A. Cleanouts for Foundation Retaining-Wall Subdrainage:
  - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - 2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
  - 3. In nonvehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.
- B. Cleanouts for Underslab Subdrainage:
  - 1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - 2. Use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

### 3.13 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of foundation subdrainage to stormwater sump pumps.

### 3.14 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping.
  - 1. Install PE warning tape or detectable warning tape over ferrous piping.
  - 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.15 FIELD QUALITY CONTROL

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

3.16 CLEANING

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

END OF SECTION 334600