

CONTRACT DOCUMENTS  
FOR  
ORANGE COUNTY LANDFILL CELL 11  
BAY 17-19 EXPANSION

CIP NO 4410-038-1107-02-6310 SEQ NO 91526



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PREPARED FOR:

UTILITIES SOLID WASTE DIVISION  
ORANGE COUNTY, FLORIDA  
SPECIFICATIONS  
VOLUME 3 OF 4



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Project No.  
676802

SEPTEMBER 2019

BID DOCUMENTS



**UTILITIES SOLID WASTE DIVISION**

**ORANGE COUNTY, FLORIDA**

**CONTRACT DOCUMENTS**

for the construction of

**ORANGE COUNTY LANDFILL CELL 11  
BAY 17 - 19 EXPANSION**

Contract No. \_\_\_\_\_

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CH2M  
Orlando, Florida  
September 2019

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Project No. 676802

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**DRAWINGS (BOUND SEPARATELY)**

**END OF SECTION**

**SECTION 31 10 00  
SITE PREPARATION**

**PART 1 GENERAL**

1.01 DEFINITIONS

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 1-inch caliper to a depth of 12 inches below subgrade.
- D. Stripping: Removal of topsoil.
- E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SCHEDULING AND SEQUENCING

- A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 1/2 acres.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

3.01 GENERAL

- A. Clear, grub, and strip areas needed for site improvements within limits shown or specified.
- B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

- A. As Follows, but Not to Extend Beyond Project Limits:
  - 1. Excavation Including Trenches: 5 feet beyond top of cut slopes.
  - 2. Fill and Embankment:
    - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
    - b. Stripping 2 feet beyond toe of permanent fill.

3. Structures: 15 feet outside of new structures.
4. Other Areas: As required to perform the Work.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

- A. Clear all areas within the limits shown or specified.
- B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
- C. Cut stumps not designated for grubbing flush with ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

- A. Grub areas within limits shown or specified.

3.05 STRIPPING

- A. Strip areas within limits to minimum depth of 6 inches. Do not remove subsoil with topsoil.
- B. Stockpile strippings for topsoil, separately from other excavated material.

3.06 TREE REMOVAL OUTSIDE CLEARING LIMITS

- A. Remove within Project Limits: Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.
- B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.07 DISPOSAL

- A. Clearing and Grubbing Debris:
  1. When onsite burning is not prohibited by federal, state, or local authorities, debris may be burned onsite. Control burning to prevent fire from spreading. Contractor is responsible for obtaining required permits. Contractor shall provide Owner a copy of the permit prior to beginning operation.
  2. During periods when burning is prohibited by federal, state, or local authorities, debris may be stockpiled until burning ban is rescinded, provided stockpiled material does not constitute a fire hazard or interfere with or delay Work. Stockpiled material shall not remain onsite in excess of 60 days.

3. Dispose of unburned and noncombustible debris offsite.
  4. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
  5. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.
- B. Strippings: Any strippings that are unsuitable for topsoil or that exceed quantity required for topsoil, shall be disposed offsite.

**END OF SECTION**



**SECTION 31 23 13  
SUBGRADE PREPARATION**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this Section:
  - 1. American Society for Testing and Materials (ASTM): D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).

1.02 DEFINITIONS

- A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.
- B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- D. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.
- E. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 10 00, Site Preparation and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

- A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

3.01 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

- A. Under Earthfill: Compact upper 12 inches to a minimum of 92 percent relative compaction as determined in accordance with ASTM D1557.
- B. Under Pavement Structure, Floor Slabs On Grade Embankment, or Granular Fill Under Structures: 15 passes with a 10-ton or heavier vibratory roller.
- C. In Addition, Under Pavement Structure, Floor Slabs on Grade Embankment, or Granular Fill under Structures: Compact the upper 12 inches to a minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

3.03 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout to within 3 percent of the optimum moisture content as determined by ASTM D1557.
- B. Wet Subgrade: Aerate material by blading, disking, harrowing, or other methods, to hasten drying process.

3.04 TESTING

- A. The Engineer will determine in-place density and moisture content.
- B. A minimum of one test per every 10,000 square feet of subgrade where granular fill will be placed, shall be conducted.



- C. A minimum of one test per every 20,000 square feet of subgrade where earth fill will be placed, shall be conducted.
- D. A minimum of one test per miscellaneous structures, such as: manholes, concrete pads for generators, pump stations, slab-on-grade, etc., shall be conducted.

3.05 CORRECTION

- A. Soft or Loose Subgrade:
  - 1. Adjust moisture content and recompact.
  - 2. Over-excavate with the approval of the Engineer, and replace with granular fill, as specified in Section 31 23 23, Fill and Backfill.
- B. Unsuitable Material: Over excavate peat, organic silts, or clay classified as Pt, OL, or OH in accordance with Unified Soil Classification (ASTM D2487) and replace with granular fill, as specified in Section 31 23 23, Fill and Backfill.

**END OF SECTION**



**SECTION 31 23 16  
EXCAVATION**

**PART 1 GENERAL**

1.01 SUBMITTALS

A. Shop Drawings:

1. Excavation Plan and Detailing:
  - a. Methods and sequencing of excavation.
  - b. Details of shoring, bracing, temporary excavation sloping, or other provisions to maintain stability and for worker protection from hazards of caving ground.
  - c. Design assumptions for excavation support and calculations prepared by a licensed Professional Engineer in the State of Florida.
  - d. Proposed locations of stockpiled excavated material.
  - e. Numbers, types, and sizes of equipment proposed to perform excavations.

1.02 ANTICIPATED DIFFICULTIES AND PROPOSED RESOLUTIONS QUALITY ASSURANCE

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

1.03 SEQUENCING AND SCHEDULING

- A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Preparation, prior to excavating.
- B. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.
- C. Excavation Support: Install and maintain, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

1.04 EXCAVATION SAFETY

- A. The Contractor shall be solely responsibility for making all excavations in a safe manner. Provide adequate measures to retain excavation side slopes and prevent sloughing to ensure persons working in or near the excavation are protected. Install and maintain ground support systems as necessary.
- B. Comply with all local State and Federal codes, ordinances, statues and other requirements including OSHA subpart P relating to excavation safety.

1.05 REFERENCES

- A. The following is a list of standards which may be referenced in this section.
  - 1. Orange County Manual of Standards and Specifications for Wastewater and Water Main Construction.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

3.01 GENERAL

- A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1-foot except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. Complete all excavation regardless of the type, nature, or condition of the materials encountered.
- C. Do not overexcavate without written authorization of Engineer.
- D. Remove or protect obstructions as shown and as specified in Section 01 50 00, Construction Facilities and Temporary Controls, Article Protection of Work and Property.

3.02 TRENCH WIDTH

- A. Minimum Width of Trenches:
  - 1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
    - a. Less than 4-Inch Outside Diameter or Width: 18 inches.
    - b. Greater than 4-Inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
  - 2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
  - 3. Increase trench widths by thicknesses of sheeting.
- B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.03 EMBANKMENT AND CUT SLOPES

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

3.04 STOCKPILING EXCAVATED MATERIAL

- A. See Section 31 23 23, Fill and Backfill for stockpiling of fill material.
- B. Stockpile excavated material that is suitable for use as fill or backfill until material is needed. Separate material meeting the requirements of granular fill from the material meeting the requirements of earthfill.
- C. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
- D. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.
- E. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- F. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.05 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable at locations designated by Engineer.
- B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Preparation, for clearing and grubbing debris.

**END OF SECTION**



**SECTION 31 23 19.01  
DEWATERING**

**PART 1 GENERAL**

1.01 WORK INCLUDED

- A. This section covers the Work necessary for handling and removal of surface water from construction areas. This includes all areas where excavation Work is required.

1.02 DESCRIPTION

- A. The dewatering systems and equipment shall be selected and designed by the Contractor in accordance with this section to achieve the required results presented herein.
- B. Relief wells, wellpoints, drain trenches, sumps, or a combination of methods may be used for water control and dewatering.

1.03 SUBMITTALS

- A. Shop Drawings: Water Control Plan.

1.04 WATER CONTROL PLAN

- A. As a Minimum, Include:
  - 1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
  - 2. Drawings showing locations, dimensions, and relationships of elements of each system.
  - 3. Design calculations demonstrating adequacy of proposed dewatering systems and components
- B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

3.01 GENERAL

- A. Remove and control water during periods when necessary to properly accomplish Work.
- B. Manholes, pump stations, foundations, pavements and utilities: Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.
- C. Comply with all laws and regulations regarding dewatering and discharge of removed surface water.

3.02 SURFACE WATER CONTROL

- A. See Section 01 50 00, Construction Facilities and Temporary Controls, Article Temporary Controls.
- B. Subgrades which become disturbed due to surface water shall be reworked, over excavated and backfilled to grade as directed by Engineer at no additional cost to the Owner.
- C. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

- A. Drain the Cell 11-12 areas following construction sequence by constructing stormwater ponds and drainage ditches to drain the groundwater to the ponds first. Lower the groundwater table to at least 2 feet below the bottom grade of the Bays in construction during liner placement.
- B. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade or until 2 feet of drainage sand is placed on top of the liner system.
- C. Pump Stations and Manholes dewatering systems shall include wells or well points, and other equipment and appurtenances installed outside limits of excavations and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation. Coordinate with shoring and sheet piling as necessary for an adequate dry excavation and minimize potential for bottom blow-out.



- D. Dewatering systems shall include wells, well points or drainage ditches, sumps, and other equipment and appurtenances installed outside limits of excavations and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation. Other means and methods of dewatering may be approved by the Engineer upon demonstration that they meet this performance requirements.
- E. Design and Operate Dewatering Systems:
  - 1. To prevent loss of ground as water is removed.
  - 2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
  - 3. To relieve artesian pressures and resultant uplift of excavation bottom.
- F. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
- G. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.
- H. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.
- I. Control seepage along the bottom of excavations, and surrounding sheet piling, at pump stations which may require gravity pipe drains to sumps from which the water shall be pumped.

### 3.04 MONITORING WELLS

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

### 3.05 DISPOSAL OF WATER

- A. Obtain discharge permit for water disposal from authorities having jurisdiction.
- B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

- C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.
- D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

**END OF SECTION**

**SECTION 31 23 23  
FILL AND BACKFILL**

**PART 1 GENERAL**

**1.01 REFERENCES**

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

1. American Society for Testing and Materials (ASTM):
  - a. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
  - b. C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  - c. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
  - d. D75, Standard Practice for Sampling Aggregates.
  - e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
  - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
  - g. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. Florida Department of Transportation (FDOT): FDOT Standard Specifications for Road and Bridge Construction.
3. Natural Resources Conservation Services (NRCS): USDA, National Engineering Handbook, Chapter 26 Gradation Design of Sand and Gravel Filters.

**1.02 DEFINITIONS**

A. Relative Compaction:

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

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

- C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.
- D. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- E. Lift: Loose (uncompacted) layer of material.
- F. Geosynthetics: Geotextiles, geogrids, or geomembranes.
- G. Well-Graded:
  - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
  - 2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
  - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- H. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
  - 1. 1-foot outside outermost edge at base of foundations or slabs.
  - 2. 1-foot outside outermost edge at surface of roadways or shoulder.
  - 3. 0.5-foot outside exterior at spring line of pipes or culverts.
- I. Excavated Material: Material from required excavations or from designated borrow areas on or near site.
- J. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- K. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.
- L. Standard Specifications: When referenced in this section, shall mean FDOT Standard Specification for Road and Bridge Construction (Latest Edition).

1.03 SUBMITTALS

- A. Samples: Imported material taken at source.
- B. Quality Control Submittals:
  - 1. Catalog and manufacturer's data sheets for compaction equipment.
  - 2. Certified test results from independent testing agency.

3. Gradation test, carbonate content, and constant head permeability test results for imported drainage sand.
4. Gradation test, carbonate content, soundness and abrasion test results for Drain gravel.

1.04 QUALITY ASSURANCE

A. Notify Engineer When:

1. Structure or manholes, pump stations are ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 10 00, Site Preparation; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 10, Structural Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.
- C. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

**PART 2 PRODUCTS**

2.01 SOURCE QUALITY CONTROL

- A. Gradation Tests: Gradation analyses at one test for every 10,000 cubic yard, shall be conducted, and the gradation tests shall use a minimum of five sieves ranging from No. 4 to No. 200 sieve.
- B. Permeability: Constant head permeability tests at one test for every 20,000 cubic yard of drainage sand, shall be conducted. The constant head permeability tests shall be in accordance with ASTM D2434. The density of the permeability test samples shall be at 90 percent relative compaction.
- C. Carbonate Content, Soundness and Abrasion: Carbonate content, Sodium Sulfate soundness and abrasion tests at one test for every 25,000 cubic yard of drain gravel, shall be conducted.

- D. Samples: Collected in accordance with ASTM D75:
  - 1. During production of imported material, provide samples as follows:
    - a. Granular Fill.
    - b. Drainage Sand.
    - c. Drain Gravel.
  - 2. Clearly mark to show source of material and intended use.

2.02 EARTHFILL

- A. Earthfill shall be excavated material from required excavations free from rocks larger than 3 inches, ashes, cinders, trash, debris, and other deleterious materials. Roots and other organic material shall not exceed 2 percent organic material by weight and the material shall not contain roots with caliper greater than 2 inches.

2.03 GRANULAR FILL

- A. Granular fill shall be imported or excavated material that is clean sand or crushed limestone with the following properties:
  - 1. Free from dirt, clay balls, and other deleterious material.
  - 2. Maximum size aggregate: 1-inch crushed gravel or crushed rock.
  - 3. Roots and other organic material shall not exceed 2 percent organic material by weight and the material shall not contain roots with caliper greater than 1/2 inch.
  - 4. Well-graded from coarse to fine and containing enough fines to bind material when compacted, but with maximum 20 percent by weight passing No. 200 sieve.
  - 5. Maximum Liquid Limit: 45.
  - 6. Maximum Plasticity Index: 15.

2.04 DRAIN GRAVEL

- A. Drain gravel shall have the following properties:
  - 1. Drain gravel gradation shall conform to No. 5 stone per the Standard Specifications.
  - 2. Drain gravel shall be non-limestone, river-run, clean, hard, durable, well-graded, and free from clay balls, salt, alkali, iron oxides, shell, organic material, and other extraneous substances.
  - 3. Carbonate content shall not exceed 2 percent by weight, testing in accordance with FM-5-514.
  - 4. Drain gravel shall have a loss not to exceed 12 percent after being subjected to 12 cycle sodium sulfate soundness test in accordance with ASTM C88. The drain gravel shall have a percentage of wear not to exceed 45 percent when tested for resistance to abrasion in conformance with ASTM C131.

2.05 DRAINAGE SAND

- A. Drainage sand that is clean silica sand shall be imported material. The sand shall have the following properties:
  - 1. Less than 5.0 percent fines passing the No. 200 sieve and no material retained on the No. 4 sieve.
  - 2. Permeability greater than  $3.5 \times 10^{-3}$  cm/sec. (10 ft/day).
  - 3. Free from clay balls, salt, alkali, iron oxides, shell, organic material, and other extraneous substances.
  - 4. Carbonate content shall not exceed 2 percent by weight, testing in accordance with FM-5-514.
  - 5. Contractor shall import drainage sand from offsite borrow pits.

2.06 RIP-RAP

- A. Rubble, as specified in Section 530 of the FDOT Standard Specifications for Road and Bridge Construction.

2.07 WATER FOR MOISTURE CONDITIONING

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

2.08 BASE COURSE ROCK

- A. As specified in Section 32 11 23, Base Course.

2.09 SOIL COVER OVER GEOTEXTILES

- A. Particle Size: Maximum 1/4-inch.
- B. Free of sharp angular pieces that may damage geotextile.

**PART 3 EXECUTION**

3.01 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. If Pipe, Conduit, Duct Bank, or Cable is to be Laid within Fill or Backfill:
  - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
  - 2. Excavate trench for installation of item.
  - 3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
  - 4. Install item.
  - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- E. Tolerances:
  - 1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
  - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- F. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL

- A. Under Facilities: Within influence area beneath structures, slabs, embankments, earthen dikes, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 8-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D1557.
- B. Roads and Pavement: Place fill in lifts of 8-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D1557.
- C. Under Landfill Cell: Backfill with earthfill to lines and grade shown. Place in lifts of 8-inch maximum thickness and compact to 95 percent relative compaction.
- D. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.



3.03 EARTHFILL

- A. Outside Influence Areas of Structures, Embankments, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
  - 1. Allow for 6-inch thickness of topsoil where required.
  - 2. Maximum 8-inch thick lifts.
  - 3. Place and compact fill across full width of embankment.
  - 4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
  - 5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 PLACEMENT OF DRAINAGE SAND

- A. Place drainage sand above liner system in one 24-inch lift. Compact the upper 6 inches of drainage sand to 90 percent relative compaction.
- B. The Contractor shall exercise caution in keeping construction equipment off the liner system. Track mounted equipment with low ground pressure treads, no larger than a Caterpillar Model D-6, or equal, shall be used for spreading. No tracked equipment shall be allowed to operate on less than 24 inches of cover over the geomembrane. The drainage sand shall be compacted with steel-wheel or pneumatic roller only. The Contractor shall avoid sharp turns, sudden starts or stops, spinning and digging of tracks, or any other operation that could damage the landfill liner system.
- C. The drainage sand shall be placed from toe to the top of embankment and shall be placed in such manner that no air is trapped underneath the geomembrane.
- D. Contractor shall exercise caution throughout placement of the drainage sand above the liner system to protect the liner system from any damage. Contractor shall repair all damaged discovered at no cost to the Owner.

3.05 STOCKPILING

- A. Prior to the start of delivery of soil material to the project Site, the Contractor shall prepare a sketch and a written stockpiling plan, if he plans to stockpile soil instead of direct haul to the project site. The plan shall indicate the location of stockpiling areas for different material (e.g. granular fill, earthfill, drain gravel, drainage sand, etc.). This plan shall also include temporary roads, protection against weather and erosion, protection of the liner, and must be reviewed and approved by the Engineer prior to any delivery to the Site. Engineer's review of the Contractor's plan will not relieve the Contractor of supplying and installing materials as specified.

- B. If the soil material is to be delivered directly to the project Site, the Contractor is required to construct a suitable haul road to protect the geomembrane liner system.
- C. Excavated materials classified as granular fill shall be stockpiled in designated areas free of incompatible soil, debris, roots, or other objectionable materials.
- D. Excavated material classified as spoil shall be segregated from granular fill and stockpiled or disposed of in the manner shown on the Drawings or as specified by the Engineer.
- E. Stockpiles of fill or spoil shall be no steeper than 3:1 (horizontal: vertical), graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the Engineer.
- F. Stockpiles shall be recontoured daily during periods when fill is taken from the stockpile.
- G. The Contractor may cover fill stockpiles with plastic sheeting or other material in order to preserve the moisture content of the fill.
- H. Stockpiles that will remain out of active use for a period greater than three months shall be stabilized.

3.06 SITE TESTING

- A. The Contractor will conduct the following tests.
- B. Gradation and Plasticity Tests for Onsite Excavated Granular Fill:
  - 1. One sample from each 1,000 cubic yard of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
  - 2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
  - 3. Remove material placed in Work that does not meet Specification requirements.
- C. Laboratory Density Tests: Perform applicable laboratory test compaction curve for every 5,000 cubic yard, but no less than 2 tests for each material.
- D. In-Place Density Tests: In accordance with ASTM D1556 or D6938. During placement of materials, test as follows:
  - 1. Granular Fill and Earthfill: One test for every 10,000 square feet or one test per lift.
  - 2. Drainage Sand: One test for every 25,000 square feet or one test per lift.

3. The compaction testing is summarized in the following table.

<b>Summary of Soil Compaction Requirements</b>				
	<b>Lifts Inches</b>		<b>Percent Compaction</b>	<b>Testing Frequency</b>
Drainage Sand	24	ASTM D1557	90 (Upper 6-in.)	One per 25,000 SF or one test per lift.
Granular Fill for Embankment (Berm)	8	ASTM D1557	98	One per 10,000 SF or one per lift
Granular Fill under Roads and around Structures	8	ASTM D1557	98	One per 10,000 SF or one per lift
Earthfill not under Embankment Roads, or around Structures	12	ASTM D1557	90	One per 10,000 SF or one per lift

- 4. For compaction requirements of trench backfill material, see Section 31 23 23.15, Trench Backfill.
- 5. For compaction requirements of base course, see Section 32 11 23, Base Course.

3.07 SITE TESTING FOR QUALITY ASSURANCE

- A. The Engineer may perform quality assurance testing for acceptance of the work and verification of the Contractor's work. If a discrepancy between the Contractor's quality control testing and the Engineer's quality assurance testing arises, the Engineer's quality assurance test results and interpretations shall govern. Acceptance tests made by the Engineer will not relieve the Contractor of his responsibility for testing materials and moisture and density control.
- B. Contractor shall cooperate with and assist the Engineer in making quality acceptance tests, including excavating and backfilling shallow areas as necessary to take density tests. Furnish a safe trench box to protect workers taking density test in trenches.
- C. The Engineer may elect to make additional tests for quality assurance.

3.08 REPLACING OVEREXCAVATED MATERIAL

- A. Replace Excavation Carried Below Grade Lines Shown or Established by Engineer as Follows:
  - 1. Beneath Footings: Granular fill.
  - 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
  - a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
  - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
  - a. Flat to Moderate Steep Slopes (3 to 1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
  - b. Steep Slopes (Steeper than 3 to 1):
    - 1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
    - 2) Following corrective measures, backfill overexcavated areas to a stable condition with compacted Earthfill.

3.09 GRAVEL SURFACING

- A. Place and compact as specified in Section 32 11 23, Base Course.

**END OF SECTION**

**SECTION 31 23 23.15  
TRENCH BACKFILL**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI): Z535.1, Safety Color Code.
  2. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.
  3. American Society for Testing and Materials (ASTM):
    - a. C33, Standard Specification for Concrete Aggregates.
    - b. C94, Specification for Ready-Mixed Concrete.
    - c. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
    - d. D422, Standard Test Method for Particle-Size Analysis of Soils.
    - e. D1140, Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
    - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3    - g. D3776, Standard Test Method for Mass per Unit Area (Weight) of Fabric.
    - h. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
    - i. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
    - j. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
    - k. D4991, Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
    - l. D5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).</sup>
  4. Orange County Utility Standards Manual of Standards and Specifications for Wastewater and Water Main Construction.
  5. Florida Department of Transportation (FDOT): FDOT Standard Specifications for Road and Bridge Construction.

**1.02 DEFINITIONS**

- A. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- B. Imported Material: Material obtained by the Contractor from source(s) offsite.

- C. Lift: Loose (uncompacted) layer of material.
- D. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.
- E. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.
- F. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- G. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.
- H. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
- I. Standard Specifications: When referenced in this section, shall mean FDOT Standard Specification for Road and Bridge Construction (Latest Edition).

1.03 SUBMITTALS

- A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.
- B. Samples:
  - 1. Trench stabilization material.
  - 2. Bedding and pipe zone material.
  - 3. Granular backfill.
  - 4. Earth backfill.
  - 5. Geotextiles.
- C. Mix designs:
  - 1. Bentonite-Cement Slurry Mix
  - 2. Controlled low strength material (CLSM)

- D. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.
  - 1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

**PART 2 PRODUCTS**

2.01 GEOTEXTILE

- A. As specified in Section 31 32 19.16, Geotextile.

2.02 MARKING TAPE

- A. Plastic:
  - 1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
  - 2. Thickness: Minimum 4 mils.
  - 3. Width: 6 inches.
  - 4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
  - 5. Manufacturers and Products:
    - a. Reef Industries; Terra Tape.
    - b. Allen; Markline.
- B. Metallic:
  - 1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
  - 2. Foil Thickness: Minimum 5.5 mils.
  - 3. Width: 6 inches.
  - 4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
  - 5. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
  - 6. Manufacturers and Products:
    - a. Reef Industries; Terra "D."
    - b. Allen; Detectatape.
    - c. Presco; Detectable Tape.

- C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color <sup>a</sup>	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers, leachate, and drain lines
Blue	Water, irrigation, and slurry lines
<sup>a</sup> As specified in ANSI Z53.1, Safety Color Code.	

2.03 TRENCH STABILIZATION MATERIAL

- A. No. 57 Stone as specified in Section 901 of the FDOT Standard Specifications for Road and Bridge Construction.

2.04 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Friable and no clay balls, roots, or other organic material.
- B. Granular fill as specified in Section 31 23 23, Fill and Backfill.

2.05 EARTH BACKFILL

- A. Earthfill as specified in Section 31 23 23, Fill and Backfill.

2.06 GRAVEL SURFACING ROCK

- A. As specified in Section 32 11 23, Base Course.

2.07 BENTONITE-CEMENT SLURRY MIX

- A. Select and proportion ingredients to obtain compressive strength between 40 psi and 100 psi at 28 days in accordance with ASTM D4832.
- B. Grout slurry shall consist of a cement/sand/bentonite slurry as shown.
- C. The density of the slurry mixture shall be monitored prior to placement (using a standard mud balance). Density of the mix shall be between 13 to 16 lb/gal.
- D. Slurry mix shall be at least 30 percent solids. Bentonite/Cement ratio shall be between 5 to 10 percent and fluid enough to self-consolidate under pipe areas.



- E. Consistency and method of mixing shall be approved by the Engineer. The use of special cements or other admixtures (ASTM C494) to reduce permeability, increase fluidity, and/or control set time, and the composition of the resultant slurry shall be approved by the Engineer.
- F. Materials:
  - 1. Cement: Conform to ASTM Designation C150/C150M Type I or II portland cement.
  - 2. Bentonite: High swelling, finely ground, reduced pH, sodium bentonite/montmorillinite.
  - 3. Water: Clean, potable, containing less than 500 ppm of chlorides..
  - 4. Concrete Sand: Commercially available, washed, silica sand.

2.08 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

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

2.09 SOURCE QUALITY CONTROL

- A. Perform gradation analysis in accordance with ASTM C136 for granular fill and earth fill.

**PART 3 EXECUTION**

3.01 TRENCH PREPARATION

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

3.02 TRENCH BOTTOM

- A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any, required. Backfill over excavation as directed or approved by Engineer.

3.03 GEOTEXTILE INSTALLATION

- A. Where shown and as specified in Section 31 32 19.16, Geotextile, except as follows:
  - 1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
  - 2. Anchor geotextile trench walls prior to placing trench stabilization or bedding material.
  - 3. Provide 24-inch minimum overlap at joints.

3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

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

3.05 BEDDING

- A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.
- B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness:
  - 1. As follows:
    - a. Pipe, 15 Inches and Smaller: 4 inches.
    - b. Pipe, 18 Inches to 36 Inches: 6 inches.

- c. Pipe, 42 Inches and Larger: 8 inches.
  - d. Conduit: 4 inches.
  - e. Duct Banks: 4 inches.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

### 3.06 BACKFILL PIPE ZONE

- A. Upper Limit of Pipe Zone Shall Not be Less than Following:
- 1. Pipe: 6 inches, unless shown otherwise.
  - 2. Conduit: 3 inches, unless shown otherwise.
  - 3. Duct Bank: 3 inches, unless shown otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
- 1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to 1/2 pipe-diameter.
  - 2. Pipes Over 10-Inch Diameter: Maximum 6-inch lifts.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.
- E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.
- F. Do not use power-driven impact compactors to compact pipe zone material.

3.07 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of all buried piping, on top of last lift of pipe zone material. Coordinate with piping installation Drawings.
  - 1. Metallic Marking Tape: Install with nonmetallic piping and waterlines.
  - 2. Plastic Marking Tape: Install with metallic piping.

3.08 BACKFILL ABOVE PIPE ZONE

- A. General:
  - 1. Process excavated material to meet specified gradation requirements.
  - 2. Adjust moisture content as necessary to obtain specified compaction.
  - 3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
  - 4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
  - 5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
  - 6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.
- B. Backfill for Areas to Receive Sod or Seed:
  - 1. Place earthfill in lifts not exceeding 8-inch thickness.
  - 2. Mechanically compact each lift to a minimum of 90 percent relative compaction prior to placing succeeding lifts.
- C. Backfill for Areas under Facilities, Gravel Surfacing, and Asphalt Concrete Paving: Backfill trench above the pipe zone with granular backfill in lifts not exceeding 8 inches. Compact each lift to a minimum of 98 percent relative compaction prior to placing succeeding lifts.
- D. Bentonite-Cement Slurry Mix:
  - 1. Thoroughly mix materials and place carefully to avoid segregation and settlement of the solids.
  - 2. Place slurry below and around pipe penetrations as shown on drawings.
  - 3. Do not allow dirt or foreign material to become mixed with slurry during placement.
  - 4. If excessive bleeding (more than 5 percent) is observed during initial set of the mix, mix and placement methods shall be modified with approval of the Engineer.
  - 5. Do not place additional backfill until slurry mix has been set for at least 24 hours and without approval by the Engineer.

E. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Do not allow dirt or foreign material to become mixed with CLSM during placement.
3. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
4. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
5. In other areas fill trench section as shown.

3.09 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Concrete Pavement.
- D. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

3.11 TESTING

- A. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:
  1. One in-place density test for every other lift for each segment of trench or minimum of 750 linear feet, whichever is more frequent.
  2. Additional tests as determined by the Engineer, if tests results indicate compaction does not meet Specifications.

**END OF SECTION**



**SECTION 31 32 19.16  
GEOTEXTILES**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards that may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
    - a. D737, Standard Test Method for Air Permeability of Textile Fabrics.
    - b. D4355, Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
    - c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
    - d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
    - e. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
    - f. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
    - g. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using Constant Head.
    - h. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
    - i. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    - j. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
    - k. D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
    - l. D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
    - m. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
    - n. D6193, Standard Practice for Stitches and Seams.

**1.02 DEFINITIONS**

- A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
- B. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

- C. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.
- D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.
- E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
- F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

A. Shop Drawings:

- 1. Manufacturer material specifications and product literature.
- 2. Installation Drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
- 3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

B. Samples:

- 1. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.
- 2. Field Sewn Seam: 5 feet length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.
- 3. Securing Pin and Washer: 1 each.

C. Quality Control Submittals:

- 1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
- 2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.
- B. Handle products in manner that maintains undamaged condition.



- C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

- A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.
- B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer's approval of underlying materials.

**PART 2 PRODUCTS**

2.01 NONWOVEN GEOTEXTILE FOR FILTRATION

- A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.
- B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.
- C. Unseamed Sheet Width: Minimum 6 feet.
- D. Nominal Weight Per Square Yard: 8 ounces.
- E. Physical Properties: Conform to requirements in Table No. 1.

<b>TABLE NO. 1 PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE</b>		
<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Water Permittivity	1.0 sec. <sup>-1</sup> , MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	70-100 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength	160 lb, MinARV	ASTM D4632
Grab Elongation	50-90 percent, MaxARV	ASTM D4632
Puncture Strength	90 lb, MinARV	ASTM D4833

<b>TABLE NO. 1 PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE</b>		
<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Trapezoid Tear Strength	75 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	80 percent strength retention, MinARV after 500 hours	ASTM D4355

2.02 NONWOVEN GEOTEXTILE FOR PADDING

- A. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.
- B. Unseamed Sheet Width: Minimum 6 feet.
- C. Nominal Weight per Square Yard: 12 ounces.
- D. Minimum Thickness: 120 mils.
- E. Physical Properties: Conform to requirements in Table No. 1.

<b>TABLE NO. 2 PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE</b>		
<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Water Permittivity	0.8 sec. <sup>-1</sup> , MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	70-100 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength	210 lb, MinARV	ASTM D4632
Grab Elongation	50-90 percent, MaxARV	ASTM D4632
Puncture Strength	95 lb, MinARV	ASTM D4833
Trapezoid Tear Strength	75 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	80 percent strength retention, MinARV after 500 hours	ASTM D4355

2.03 SEWING THREAD

- A. Polypropylene, polyester, or Kevlar thread.
- B. Durability: Equal to or greater than durability of geotextile sewn.

**PART 3 EXECUTION**

3.01 LAYING GEOTEXTILE

- A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

- A. In general, orient geotextile with long dimension of each sheet parallel to direction of slope.

3.03 JOINTS

- A. Unseamed Joints: Overlapped; a minimum of 18 inches.
- B. Sewn Seams: Made wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.
  - 1. Seam Efficiency:
    - a. Minimum 70 percent.
    - b. Verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile installed.
    - c. Tested according to ASTM D4884.
  - 2. Types:
    - a. Preferred: "J" type seams.
    - b. Acceptable: Flat or butterfly seams.
  - 3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.
  - 4. Stitch Type: Double-thread chain stitch, Type 401, Federal Standard No. 751a.
  - 5. Sewing Machines: Capable of penetrating four layers of geotextile.
  - 6. Stitch Location: 2 inches from geotextile sheet edges, or more, if necessary to develop required seam strength.

3.04 SECURING GEOTEXTILE

- A. Secure geotextile during installation as necessary with sand bags or other means approved by Engineer.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

- A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.
- B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

- A. Place geotextile in a way that will completely envelope granular drain gravel to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.
- B. After granular drain gravel is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 REPAIRING GEOTEXTILE

- A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
- B. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

**END OF SECTION**

**SECTION 31 41 16  
SHEET PILING****PART 1 GENERAL**

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
    - a. A36, Standard Specification for Carbon Structural Steel.
    - b. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - c. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    - d. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
    - e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
    - f. A328, Standard Specification for Steel Sheet Piling.
    - g. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
    - h. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

## 1.02 DEFINITIONS

- A. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.
- B. Elevations: Referenced to benchmark indicated.
- C. Obstruction: Sudden and significant increase of penetration resistance and deviation of pile out of tolerance resulting from encountering a subsurface or physical condition.
- D. Practical Impact Driving Refusal: Penetration resistance of at least 120 blows per foot for 3 continuous feet, 200 blows per foot for 1 foot, or 50 blows per inch for 2 consecutive inches, whichever comes first, and to continue driving pile would be impractical. These criteria apply only for hammer sizes and operation as specified.
- E. Rated Hammer Energy:
1. Diesel Hammers: Product of rated stroke times ram weight.
  2. Air Hammers: Rated energy from manufacturer's literature.

- F. Vibratory Refusal: Zero rate of penetration for 10 seconds during vibratory pile driving.
- G. Set: Pile penetration in inches per blow.
- H. Sweep: Deviation from straightness measured along two perpendicular faces of pile while not subject to bending forces.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Indicate number of piles required, fabricated corners, and detail dimensions.
- 2. Manufacturer's product data prior to ordering piles.

B. Informational Submittals:

- 1. Pile driving schedule.
- 2. Written sequence of setting and driving operation.
- 3. Drilling: Manufacturer's literature on equipment and operation procedures.
- 4. Driving System: Show details of hammer(s), driving helmets, cap blocks, template, and pile cushions.
- 5. Installer Qualifications.
- 6. Daily Log and Record: At end of each working day, submit two copies of each record for every pile constructed that day.
  - a. Record the pile location, deviations from design location, cross section shape and dimensions, original lengths, ground or mudline elevation, tip elevation, cutoff elevation, number of blows required for each foot of penetration for the entire length.
  - b. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (cap block) and pile cushion used.
  - c. Record retap data and unusual occurrences during pile driving.
  - d. Submit to the Engineer complete and accurate job pile records as specified in this paragraph, within 15 calendar days after completion of driving. Immediately notify Engineer of any pile that does not reach the required tip elevation.

1.04 QUALIFICATIONS

- A. Piling Installer: Minimum of 5 years of past successful experience on 10 projects of sheet pile installation.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Sheet Piles: Lift and handle so that maximum bending stresses shall not exceed 22,500 pounds per square inch.

1.06 SPECIAL TOOLS

- A. Tool checking interlock dimensions.

**PART 2 PRODUCTS**

2.01 SHEET PILES

- A. Manufactured to ASTM A572 Grade 60 with a minimum yield strength of 60 ksi, and meeting the following size requirements:

Nominal Web Thickness/In.	Weight Per Ft-Pounds	Sect. Modulus Per LF/Cu. In.
0.5	69	48.4

- B. Section Modulus: Elastic section modulus based on individual whole piece, not dependent on the interlock friction between pile sections to secure the required section modulus.
- C. Stamp mill heat number on each pile.
- D. Pulling (Handling) Holes: Manufacturer’s standard, additional will not be allowed.
- E. Tolerances: Weight per square foot may not vary by more than 2-1/2 percent over or under that specified.

2.02 ACCESSORIES

- A. Steel Shapes, Plates, Bars, and Washers:
  - 1. General: ASTM A36, provide cut washers for each bolt head and nut.
  - 2. Bolts: ASTM A307, of length to finish 1/4 inch outside the nut and have additional thread to retighten.
  - 3. Hardware: Hot-dip galvanize, ASTM A123.
- B. Weep holes: Install weep holes as shown on Drawings per manufacturer requirements, recommendations, and Specifications.

**PART 3 EXECUTION**

**3.01 DRIVING EQUIPMENT**

- A. Diesel Hammers: Rated energy of at least 53,200-foot-pounds.
- B. Vibratory Driver-Extractor Characteristics:

Eccentric moment	3,400 inch-pounds
Frequency of vibration	700 to 1,020 vpm
Amplitude	5/16" to 1"
Horsepower	100 (minimum)

- 1. Transmission Case: Effectively isolated from suspension system by pneumatic or other means so that the unit has lateral stability during the driving operation.

**3.02 PILE LENGTHS**

- A. Lengths shown are those required below cutoff. Furnish piling with sufficient extra length to provide for fresh heading and to reach from the cutoff elevation up to position of driving equipment.

**3.03 DRIVING GUIDES**

- A. Position sheet piles using temporary guide wales support and anchor guide wales to form rigid structures during the sheet pile setting and driving operation.
- B. Guide Wales: Stationary (not moveable) with fluctuating water stage.

**3.04 SETTING**

- A. Clean pile; inspect for defects and proper interlock dimensions.
- B. Allow pile sufficient clearance in the interlocks to slide, under its own weight, in the interlock of the sheet pile previously placed until the top of existing ground is reached by the tip of the sliding pile. Do not use vibratory or drive hammer to force the interlocking of piles.

**3.05 DRIVING**

- A. Before driving is started, check sheet piles for position and alignment. Locate pile top within 2 inches of location shown.



- B. Drive sheet piles in rotating stages such that the tip of any sheet pile is not more than 5 feet below the tip of any adjacent sheet pile nor more than 8 feet below the tip of any other sheet pile in the bulkhead, except as required by the final tip elevations shown. Drive down piles that are raised during the process of driving adjacent piles.
- C. If refusal is reached before driving to the specified tip elevation, an impact hammer or controlled jetting may be used. Perform jetting on both sides of sheet pile simultaneously with driving.
- D. Remove and replace sheet pile driven out of interlock.
- E. Driving Tolerances:
  - 1. Not more than 1/16 inch per foot from the vertical in all directions. Furnish plumb line or other device for checking vertical alignment. Centroid of pile at cutoff elevation shall not vary from design position shown by more than 2 inches after driving.
  - 2. Not more than 1 percent from vertical or 2 percent from batter shown.

3.06 PILE CUTOFF

- A. Cut square at required elevation with tools that will not damage area below cut surface.
- B. Tolerance: Plus or minus 1/2 inch.

3.07 DAMAGED PILES

- A. Should any section of the sheet pile system become, or be found to be out of interlock, or should an interlock become damaged, the Contractor shall correct the condition to the satisfaction of the Engineer at no additional cost to the Owner. If additional pile sections are found to be needed to correct driving damage or misalignment, they shall be provided by the Contractor at no cost to the Owner.

3.08 CUTTING AND SPLICING PILES

- A. Extend to required grade by welding on additional full length piles driven below grade, and piles with damaged heads which have been cut off to permit further driving.
- B. Pile Splicing: Butt weld, making full penetration of the web. Piles adjoining spliced piles shall be full length piles.

3.09 WALES AND CAPS

- A. After driving sheet piling, install channel wales. Bolt splices in wales with field bolts. Set wales horizontal.
- B. Installation:
  - 1. Weld Splices using a single bevel butt joint, welded on one side on backing structure.
  - 2. Space wales within 1/4 inch for welded splices. Fabricate accessories by welding or as otherwise shown.

3.10 FIELD QUALITY CONTROL

- A. Daily Log and Record:
  - 1. Document for each sheet pile driven, showing as a minimum:
    - a. Pile identification/location.
    - b. Weather/groundwater conditions.
    - c. Date and time start and complete driving.
    - d. Respective depths of penetration.
    - e. Cutoff elevations.
    - f. Driving resistance for each foot of driving over entire pile length.
    - g. Equipment used.
    - h. Installation method.
    - i. Final pile head position (x, y, z coordinates) after cut off indicating if pile is installed within the specified tolerances.
    - j. Nature and location of obstructions encountered.
    - k. Other pertinent pile driving behavior.

**END OF SECTION**

**SECTION 32 11 23  
BASE COURSE**

**PART 1 GENERAL**

1.01 DEFINITIONS

- A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift: Compacted with uniform surface reasonably true to cross-section.
- C. Standard Specifications: When referenced in this section, shall mean the current edition, including all supplements, of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.02 SUBMITTALS

- A. Samples: Submit for specified materials 20 days prior to deliver to site.
- B. Quality Control Submittals:
  - 1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

**PART 2 PRODUCTS**

2.01 BASE COURSE ROCK

- A. As specified for limerock in Section 911 of the Standard Specifications.

2.02 GRAVEL SURFACING ROCK

- A. Limerock as specified in Section 911 of the Standard Specifications.

2.03 SOURCE QUALITY CONTROL

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

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

**PART 3 EXECUTION**

**3.01 SUBGRADE PREPARATION**

- A. As specified in Section 31 23 13, Subgrade Preparation.
- B. Obtain Engineer's acceptance of subgrade before placement of base course rock.
- C. Do not place base materials on soft, muddy, unstable, yielding subgrade.

**3.02 EQUIPMENT**

- A. In accordance with Section 200 of the Standard Specifications.
- B. Compaction Equipment: Adequate in design and number to provide compaction and obtain the specified density for each layer.

**3.03 HAULING AND SPREADING**

- A. Hauling and Spreading: In accordance with Section 200 of the Standard Specifications.

**3.04 CONSTRUCTION OF COURSES**

- A. Construction of Courses: In accordance with Section 200 of the Standard Specifications.
- B. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

**3.05 ROLLING AND COMPACTION**

- A. Rolling and Compaction: In accordance with Section 200 of the Standard Specifications.
- B. Commence compaction of each layer of base after spreading operations and continue until density of 98 percent of maximum density has been achieved as determined by ASTM D1557.

3.06 SURFACE TOLERANCES

- A. Finished Surface of Base Course: Within plus or minus 0.04-foot of grade shown at any individual point.

3.07 FIELD QUALITY CONTROL

- A. In-Place Density Tests: In accordance with ASTM D6938.
  - 1. Construct base course so areas shall be ready for testing.
  - 2. Allow reasonable length of time for Engineer to perform tests and obtain results during normal working hours.
  - 3. Frequency: Perform a minimum of one test on completed course per 2,000 square feet.

3.08 CLEANING

- A. Remove excess material; clean stockpile and staging areas of all excess aggregate.

**END OF SECTION**



**SECTION 31 12 16  
ASPHALT CONCRETE PAVEMENT**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Standard of Testing Materials (ASTM):
    - a. D75, Standard Method of Test for Sampling of Aggregates.
    - b. D140, Standard Method of Test for Sampling Bituminous Materials.
    - c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures
    - d. D2041, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
    - e. D2950 Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
    - f. D3381, Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction.
    - g. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
    - h. E329 Rev A, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction, or Special Inspection.

**1.02 DEFINITIONS**

- A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. RAP: Reclaimed asphalt pavement.
- C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.
- D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.
- E. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also, used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

- F. Standard Specification: Where the term “Standard Specifications” is used, such reference shall mean the current edition, including all supplements, of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this Section of the Specifications. Reference to “Standard Specifications” does not infer nor imply that the “Standard Specifications” are applicable in whole to this Work. Only those sections of the “Standard Specification” specifically reference herein or on the project drawings shall apply. In case of a conflict in the requirements of the “Standard Specifications” and the requirements stated herein, the requirements stated herein shall prevail.
- G. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

1.03 SUBMITTALS

A. Quality Control Submittals:

- 1. Asphalt Concrete Mix Formula: Submit minimum of 15 days prior to start of production.
  - a. Certification that the asphaltic concrete mix supplied is being mixed and supplied from an FDOT-approved asphaltic concrete plant and that the material provided is an FDOT-approved mix design for the specified asphaltic concrete. In lieu of FDOT Certification, submittals as listed in 1(b) is required.
  - b. Submittal to Include the Following Information:
    - 1) Gradation for each of the aggregate constituents used in the mixture and the proposed proportion of each constituent to be used to produce a single gradation of aggregate within specified limits.
    - 2) Bulk specific gravity for each aggregate constituent.
    - 3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
    - 4) Properties as stated in Section 331 of Standard Specification, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
    - 5) Percent of asphalt lost due to absorption by the aggregate.
    - 6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
    - 7) Percentage of asphalt cement, to the nearest 0.1 percent, to be added to the mixture.
    - 8) Optimum mixing temperature.
    - 9) Optimum compaction temperature.



- 10) Temperature-viscosity curve of the asphalt cement to be used.
- 11) Brand name of any additive to be used, and the percentage added to the mixture.
- 2. Test Report for Asphalt Binder:
  - a. Submit minimum 10 days prior to start of production.
  - b. Show appropriate test method(s) for each material and the test results. In accordance with FDOT procedures.
- 3. Manufacturer's Certificate of Compliance, in Accordance with Section 01 43 33, Manufacturer's Services, for the Following Materials:
  - a. Aggregate: Gradation, source test results as defined in Section 331 of Standard Specification.
  - b. Asphalt for Binder: Type and grade and viscosity-temperature curve.
  - c. Prime Coat: Type and grade of asphalt.
  - d. Tack Coat: Type and grade of asphalt.
  - e. Additives.
  - f. Mixes: Conforms to job-mix formula.
- 4. Statement of qualification for independent testing laboratory.
- 5. Test Results:
  - a. Mix Design.
  - b. Asphalt Concrete Cores.
  - c. Uncompacted Mix.
  - d. Field density.

1.04 QUALITY ASSURANCE

A. Qualifications:

- 1. Independent Testing Laboratory: In accordance with ASTM E329.
- 2. Asphalt concrete mix formula shall be prepared by an approved certified independent laboratory under the supervision of a certified asphalt technician.
- 3. Provide certification that the material is being supplied from an FDOT-approved asphaltic concrete plant and the material provided is an FDOT-approved mix design.

1.05 ENVIRONMENTAL REQUIREMENTS

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

**PART 2 PRODUCTS**

2.01 MATERIALS

- A. Prime Coat: Material shall be as allowed in Section 300 of the Standard Specifications and shall conform to Section 916 of the Standard Specifications.
- B. Tack Coat: Material shall be as allowed in Section 300 of the Standard Specifications and shall conform to Section 916 of the Standard Specifications.

2.02 ASPHALT CONCRETE MIX

- A. General:
  - 1. Mix formula shall not be modified except with the written approval of Engineer.
  - 2. Source Changes:
    - a. Should material source(s) change, establish a new asphalt concrete mix formula before the new material(s) is used.
    - b. Perform check tests of properties of the plant-mix bituminous materials on the first day of production and as requested by Engineer to confirm that properties are in compliance with design criteria.
    - c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.
- B. Asphalt Concrete: Type SP-12.5 as specified in Section 334 of the Standard Specifications.
- C. Mineral Filler: In accordance with Section 917 of Standard the Specifications.
- D. Asphalt Cement: Paving Grade AC-20 per ASTM D3381.

**PART 3 EXECUTION**

3.01 GENERAL

- A. Traffic Control:
  - 1. In accordance with Section 01 50 00, Construction Facilities and Temporary Controls.
  - 2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

3.02 LINE AND GRADE

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

3.03 APPLICATION EQUIPMENT

- A. In accordance with Section 320 of the Standard Specifications.

3.04 PREPARATION

- A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.
- B. Existing Roadway:
  - 1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce a smooth riding connection to existing facility.
  - 2. Remove existing material to a minimum depth of 25 mm (1 inch).
  - 3. Paint edges of meet line with tack coat prior to placing new pavement.
- C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 MILLING OF EXISTING ASPHALT PAVEMENT

- A. Milling of existing pavement shall be made in accordance with Section 327 of the Standard Specifications.

3.06 PAVEMENT APPLICATION

- A. General: Place asphalt concrete mixture on an approved, prepared base in conformance with Sections 330 and 334 of the Standard Specifications.
- B. Prime Coat:
  - 1. Heat cut-back asphalt as specified in Section 300 of the Standard Specifications prior to application.
  - 2. Apply uniformly to clean, dry surfaces. Avoiding overlapping of applications.
  - 3. Do not apply when moisture content of upper 75 mm (3 inches) of base exceeds optimum moisture content of base, or if free moisture is present.
  - 4. Application Rate: Minimum 0.68 to maximum 2.28 liters per square meter of surface area.

5. Remove or redistribute excess material.
6. Allow a minimum of 48 hours for curing of primed surface before placing asphalt concrete.

C. Tack Coat:

1. Prepare material, as specified in Section 300 of the Standards Specification, prior to application.
2. Apply uniformly to clean, dry surfaces. Avoiding overlapping of applications.
3. Do not apply more tack coat than necessary for the day's paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.
5. Application Rate: Minimum 0.25-liter to maximum 0.70-liter of asphalt (residual if diluted emulsified asphalt) per square meter of surface area.

D. Pavement Mix:

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

## E. Compaction:

1. Uniformly compact each course to target density arrived at in compaction control strip.
2. Uniformly compact each course until no further evidence of consolidation is visible and roller marks are eliminated. When placement rate exceeds 100 tons per hour, operate minimum of two rollers for compaction.
3. Roll until roller marks are eliminated and a minimum compaction of 96 percent of the measured maximum density determined in accordance with ASTM D2041 is obtained.
4. Joint Compaction:
  - a. Place top or wearing layer as continuously as possible.
  - b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
  - c. Cut back previously compacted mixture when Work is resumed to produce a slightly beveled edge for full thickness of layer.
  - d. Cut away waste material and lay new mix against fresh cut.

## F. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
  - a. Uniform texture, smooth, and uniform to crown and grade.
  - b. Maximum Deviation: 1/8 inch from lower edge of a 3.6 meter (12 feet) straightedge, measured continuously parallel and at right angle to centerline.
  - c. If surface of completed pavement deviates by more than twice the specified tolerances, remove and replace wearing surface.
3. Transverse Slope Maximum Deviation: 1/8 inch in 3.6 meters (12 feet) from the rate of slope shown.
4. Finished Grade: Maximum Deviation: 6 mm (0.02 foot) from the grade shown.

## G. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where the asphalt concrete was placed by hand, patched surfaces, and other areas as directed by the Engineer.
2. Preparation:
  - a. Maintain surfaces that are to be sealed free of holes, dry, and clean of dust and loose material.
  - b. Seal in dry weather and when the temperature is above 2 degrees C (35 degrees F).

3. Application:
  - a. Fill cracks over 1.5 mm (1/16 inch) in width with an asphalt-sand slurry or approved crack sealer prior to sealing.
  - b. When sealing patched surfaces and joints with existing pavements, extend minimum 150 mm (6 inches) beyond edges of patches.

3.07 FIELD QUALITY CONTROL

- A. General: Contractor shall conduct the following tests.
- B. Quality control tests as specified in Section 334 of the Standard Specifications.
- C. Field Density Tests:
  1. Perform tests from cores or sawed samples.
  2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
  3. Maximum Density: In accordance with ASTM D2041, using a sample of mix taken prior to compaction from the same location as the density test sample.
- D. Testing Frequency:
  1. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.
  2. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 500 tons or once every 8 hours, whichever is greater.
  3. Density Tests: Once every 400 tons of mix or once every 4 hours, whichever is greater.

**END OF SECTION**

**SECTION 32 17 23  
PAVEMENT MARKING**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO):
    - a. M247, Standard Specification for Glass Beads Used in Traffic Paint.
    - b. M249, Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
    - c. T250, Standard Method of Test for Thermoplastic Traffic Line Material.
  2. American Society for Testing and Materials (ASTM):
    - a. D7942, Standard Specification for Thermoplastic Pavement Markings in Non Snow Plow Areas.
    - b. D7308, Practice for Sample Preparation of Thermoplastic Traffic Marking Materials.
  3. Federal Specifications (FS): TT-B-1325C, Beads (Glass Spheres); Retroreflective.

**1.02 DEFINITIONS**

- A. Standard Specifications: When referenced in this section, shall mean the current edition, including all supplements, of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

**1.03 SUBMITTALS**

- A. Shop Drawings:
1. Product Data: Thermoplastic Paint.
- B. Quality Control Submittals: Manufacturer's Certificate of Compliance for products specified in this section.
1. Equipment List: Proposed equipment to be used, including descriptive data.

**PART 2 PRODUCTS**

2.01 GENERAL

- A. All products shall conform to Code T-1 traffic paint, suitable for paved surfaces and shall be in accordance with Section 971 of the Standard Specifications.

2.02 PAINT

- A. Color: White, yellow, or blue. Location per plan set striping sheets. Reflective media additive will be required. Reflective pavement markers will not be required.

**PART 3 EXECUTION**

3.01 SURFACE PREPARATION

- A. Cleaning:
  - 1. Thoroughly clean surfaces to be marked before application of pavement marking material.
  - 2. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods.
  - 3. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion.
  - 4. Scrub areas of pavement affected with oil or grease with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application.
  - 5. Surfaces shall be completely free of dry dirt and dry of water at the time of application of any of the materials specified herein.
  - 6. Oil-Soaked Areas: After cleaning, seal with cut shellac to prevent bleeding through the new paint.
  - 7. Reclean surfaces when Work has been stopped due to rain.

3.02 THERMOPLASTIC PAINT APPLICATION

- A. General:
  - 1. Thoroughly mix pigment and vehicle together prior to application and keep thoroughly agitated during application.
  - 2. Do not add thinner.
  - 3. Apply only when air and pavement temperatures are above 40 degrees F.
  - 4. Apply only when surface is dry.



5. Do not apply when conditions are windy to the point of causing overspray or fuzzy line edges.
6. New Asphalt Pavement: Allow a minimum pavement cure time of 30 days before applying paint.
7. Provide guide lines and templates to control paint application.
8. Take special precautions in marking numbers, letters, and symbols.
9. Sharply outline edges of markings and apply without running or spattering.
10. All markings which fail to have a uniform satisfactory appearance shall be corrected by the Contractor at his expense.

B. Rate of Application:

1. Paint: Apply evenly, 105 plus or minus 5 square feet per gallon.

C. Drying:

1. Provide maximum drying time to prevent undue softening of bitumen and pickup, displacement, or discoloration by traffic.
2. If drying is abnormally slow, discontinue painting operations until cause is determined and corrected.

3.03 PROTECTION

- A. Protect markings from traffic until paint is thoroughly dry.
- B. Protect surfaces from disfiguration by paint spatters, splashes, spills, or drips.

3.04 CLEANUP

- A. Remove paint spatters, splashes, spills, or drips from Work and staging areas and areas outside of the immediate Work area where spills occur.

**END OF SECTION**



**SECTION 32 92 00  
LAWNS AND GRASSES**

**PART 1 GENERAL**

1.01 DEFINITIONS

- A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod) and continue for a period of 12 weeks after all planting under this section is completed or 12 weeks after substantial completion of this Project whichever is longer.
- B. Satisfactory Stand: Grass or section of grass of 10,000 square feet or larger that has:
  - 1. No bare spots larger than 3 square feet.
  - 2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
  - 3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

- A. Shop Drawings: Product labels/data sheets.
- B. Quality Control Submittals:
  - 1. Seed: Certification of seed analysis, germination rate, and inoculation:
    - a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery.  
Include with Certification:
      - 1) Name and address of laboratory.
      - 2) Date of test.
      - 3) Lot number for each seed specified.
      - 4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
    - b. Mixtures: Proportions of each kind of seed.
  - 2. Seed Inoculant Certification: Bacteria was prepared specifically for legume species to be inoculated.
  - 3. Certification of sod include source and harvest date of sod, and sod seed mix.
- C. Contract Closeout Submittals: Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Sod:

1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
2. Harvest and deliver sod only after laying bed is prepared for sodding.
3. Roll or stack to prevent yellowing.
4. Deliver and lay within 24 hours of harvesting.
5. Keep moist and covered to protect from drying from time of harvesting until laid.

C. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

- A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

- A. Complete Work under this section within 10 days following completion of soil preparation.
- B. Notify Engineer at least 3 days in advance of:
1. Each material delivery.
  2. Start of planting activity.
- C. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE SERVICE

- A. Contractor: Perform maintenance operations during maintenance period to include:
1. Watering: Keep surface moist.
  2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.

3. Mulch: Replace wherever and whenever washed or blown away.
4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3 1/2 inches.
5. Fences: Repair and maintain until satisfactory stand of grass is established.
6. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
7. Reseed/replant during next planting season if scheduled end of maintenance period falls after September 15.
8. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

**PART 2 PRODUCTS**

**2.01 LIME**

- A. Composition: Ground limestone with not less than 85 percent total carbonate ASTM C602.
- B. Gradation:
  1. Minimum 50 percent passing No. 100 sieve.
  2. Minimum 90 percent passing No. 20 sieve.
  3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

**2.02 FERTILIZER**

- A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.
- B. Mix:
  1. Nitrogen: 10.
  2. Phosphoric Acid: 10.
  3. Potash: 10.
  4. Use either bonemeal or superphosphate. Bonemeal to be commercial, raw, finely ground, with minimum analysis of 4 percent nitrogen and 20 percent phosphoric acid.
  5. Superphosphate to be soluble mixture of phosphate obtained from treated mineral phosphates with minimum analysis of 20 percent available phosphoric acid.
- C. Top Dress Type: As recommended by local authority.

2.03 SEED

- A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.
- B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer's instructions.
- C. Summer Seed Mix:

<u>Species</u>	<u>Proportion By Weight</u>
Argentine Bahia	350 Pounds Per Acre

- D. Winter Protective Seed: Annual ryegrass.

2.04 SOD

- A. Certified, containing grass mix: Species to be Bahia grass.
- B. Strongly rooted pads, capable of supporting own weight and retaining size and shape when suspended vertically from a firm grasp on upper 10 percent of pad.
  - 1. Grass Height: Normal.
  - 2. Strip Size: Supplier's standard.
  - 3. Soil Thickness: Uniform; 1-inch plus or minus 1/4 inch at time of cutting.
  - 4. Age: Not less than 10 months or more than 30 months.
  - 5. Condition: Healthy, green, moist; free of diseases, nematodes, and insects, and of undesirable grassy and broadleaf weeds. Yellow sod, or broken pads, or torn or uneven ends will not be accepted

2.05 STRAW MULCH

- A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.06 HYDROSEEDING MULCH

- A. Wood Cellulose Fiber Mulch:
  - 1. Specially processed wood fiber containing no growth or germination inhibiting factors.
  - 2. Dyed a suitable color to facilitate inspection of material placement.

3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form a homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

2.07 FENCE

- A. Two-inch by 2-inch posts 4-feet high, spaced 10 feet on center, and strung with single strand of No. 12 gauge wire marked with cloth strips at 3-foot intervals.

**PART 3 EXECUTION**

3.01 PREPARATION

- A. Grade areas to smooth, even surface with loose, uniformly fine texture.
  1. Roll and rake, remove ridges, fill depressions to meet finish grades.
  2. Limit such Work to areas to be planted within immediate future.
  3. Remove debris, and stones larger than 1-1/2 inches diameter, and other objects that may interfere with planting and maintenance operations.
- B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.
- C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER AND LIME

- A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 6 inches of top soil.
- B. Application Rate: As determined by soil test results performed by county or state soil testing service, or approved certified independent testing laboratory. Provide a minimum of three (3) samples to the testing laboratory..

3.03 SEEDING

- A. Start within 2 days of preparation completion.
- B. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacker or roller.
  1. Sow seed at uniform rate of 5 pounds per 1,000 square feet.
  2. Use Brillion type seeder.

3. Broadcasting will allow only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
  4. Roll with ring roller to cover seed, and water with fine spray.
- C. Hydroseeding:
1. Application Rate: 8 pounds per 1,000 square feet.
  2. Apply on moist soil, only after free surface water has drained away.
  3. Prevent drift and displacement of mixture into other areas.
  4. Upon application, allow absorption and percolation of moisture into ground.
  5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.
- D. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.
- E. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.
- F. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.
- G. Provide temporary seeding for stockpiled topsoil. Stock piles to be seeded within 14 days of stockpiling.

### 3.04 SODDING

- A. Install sod on the areas as shown on the Drawings.
- B. Do not plant dormant sod.
- C. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap.
  1. Stagger strips to offset joints in adjacent courses.
  2. Work from boards to avoid damage to subgrade or sod.
  3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.
  4. Complete sod surface true to finished grade, even, and firm.
- D. Fasten sod on 4H to 1V or steeper slopes to prevent slippage with wooden pins 6 inches long driven through sod into subgrade, until flush with top of sod. Install at sufficiently close intervals to securely hold sod.
- E. Water sod with fine spray immediately after planting. During first week water daily or more frequently to maintain moist soil to depth of 4 inches.
- F. Apply top dress fertilizer at recommended rate.



3.05 GUARANTEE

- A. If, at the end of the 12-week lawn maintenance period, or at 12 weeks after substantial completion of this Project, whichever is longer, a satisfactory stand of grass has not been produced, the Contractor shall renovate and reseed the grass or unsatisfactory portions thereof immediately. If a satisfactory stand of grass develops within the 12-week maintenance period, it will be accepted. If it is not accepted, a complete replanting will be required during the planting season meeting all of the requirements specified hereinbefore.

3.06 FIELD QUALITY CONTROL

- A. Twelve weeks after seeding or sodding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

3.07 PROTECTION

- A. Protect from traffic by erecting temporary fence around each newly seeded area.

**END OF SECTION**



**SECTION 33 05 01.10  
HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
    - a. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
    - b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
    - c. B211, Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
    - d. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
    - e. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
    - f. D570, Standard Test Method for Water Absorption of Plastics.
    - g. D638, Standard Test Method for Tensile Properties of Plastics.
    - h. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between Minus 30 Degrees C and 30 Degrees C with Vitreous Silica Dilator Meter.
    - i. D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
    - j. D751, Standard Test Methods for Coated Fabrics.
    - k. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
    - l. D816 Standard Test Methods for Rubber Cement.
    - m. D882, Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
    - n. D1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
    - o. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
    - p. D2240, Standard Test Method for Rubber Property-Durometer Harness.
    - q. D4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
    - r. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    - s. D5199, Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.

- t. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
  - u. D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
  - v. D6392, Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
  - w. D6395, Standard Practice for Nondestructive Testing of Geomembrane Seams Using the Spark Test.
- 2. Federal Specifications and Standards: FED-STD 101/2065, Puncture Resistance and Elongation Test (1/8-inch Radius Probe Method).
  - 3. National Sanitation Foundation (NSF): Standard 54 for Flexible Membrane Liners.

#### 1.02 DEFINITIONS

- A. Film Tearing Bond: Failure in ductile mode of one bonded sheet, by testing, prior to complete separation of bonded area.
- B. Geomembrane: Essentially impermeable geosynthetic composed of one or more layers of polyolefin materials fusion bonded into single-ply integral sheet.
- C. Panel: Piece of geomembrane composed of two or more sheets seamed together.
- D. Sheet: Seamless piece of geomembrane.
- E. Watertight: Geomembrane installation free of flaws and defects that will allow passage of water and gases, liquids, and solids to be contained under anticipated service conditions.

#### 1.03 SUBMITTALS

- A. Administrative Submittals:
  - 1. Production dates for geomembrane.
  - 2. Qualification documents for Geomembrane Manufacturer.
  - 3. Qualification documents for Geomembrane Installer and Crew.
- B. Shop Drawings:
  - 1. Manufacturer's specifications, literature for each geomembrane furnished, and products used to complete installation.
  - 2. Compensation allowance calculation and numerical values for temperature induced geomembrane expansion and contraction.
  - 3. Polymer Resin: Product identification and Supplier.

4. Geomembrane sheet layout with proposed size, number, position, and sequence of sheet placement, and location of field seams.
  5. Proposed equipment for material placement.
  6. Procedures for material installation.
- C. Quality Control Submittals:
1. Quality Assurance Program: Written description of geomembrane manufacturer's and installer's formal programs for manufacturing, fabricating, handling, installing, seaming, testing, and repairing geomembrane.
  2. Manufacturer's Certificate of Compliance, in accordance with Section 01 33 00, Submittals.
  3. Factory quality control test results for materials manufactured for this Project.
  4. Friction test results.
- D. Contract Closeout Submittals:
1. Manufacturer's Certificate of Proper Installation.
  2. Record Documents: Include panel and sheet numbers, seaming equipment and operator identification, temperature and speed setting of equipment, date seamed, identity and location of each repair, cap strip, penetration, boot and sample taken from installed geomembrane for testing.
  3. Material and seam test results.
  4. Special guarantee.
- E. Submittal Review Conference:
1. In order to expedite the Shop Drawing submittal and review process, a Submittal Review Conference will be scheduled by the Engineer 7 days after the Contractor's submittal of the Shop Drawings, samples, qualifications, and quality control documents for CDN, HDPE Geomembrane, and GCL.
  2. Engineer will coordinate with the Contractor to set the time and place for this conference. The representatives of Contractor, Installer, and Manufacturers are required to attend this conference to receive review comments, and to discuss with the Engineer, if needed, submittal questions regarding the specification requirements.
  3. The Contractor shall prepare the Shop Drawing re-submittal for CDN, Geomembrane and GCL, if required, based on the final review comments received at this conference.
  4. If the initial submittal for any one of these products (GCL, Geomembrane, CDN) meets the specifications in the opinion of the Engineer and there are no resubmitted required, attendance will not be

needed and discussion of the Shop Drawing for that product will not be included in the conference agenda.

1.04 QUALIFICATIONS

- A. Independent Testing Agency: Certified in the State of Florida, 5 years experience in field of geomembrane testing. Calibrated instruments and equipment and documented standard procedures for performing specified testing.
- B. Manufacturer and Fabricator: Successfully manufactured minimum of 10 million square feet of each type of geomembrane material specified for applications similar to Project.
- C. Installer:
  - 1. Successfully installed a minimum of 10 million square feet of each type of geomembrane product specified in applications for landfill bottom liner projects in Florida similar to this Project.
  - 2. Qualified Installation Crew: Project Manager, Superintendent, Field Supervisor(s), QC officer, Master Seamer(s) with a minimum of 10 million square feet of each type of geomembrane product specified in applications for landfill bottom liner similar to Project.

1.05 COORDINATION MEETINGS

- A. Meet at Least Once Prior to Commencing Each of the Following Activities:
  - 1. Submission of Submittals.
  - 2. Manufacture of geomembrane sheets.
  - 3. Fabrication of panels and boots.
  - 4. Installation of geomembrane.
- B. Attendees:
  - 1. Contractor's designated quality control representative.
  - 2. Engineer.
  - 3. Representatives of geomembrane installer.
  - 4. Others requested by Engineer.
- C. Topics:
  - 1. Specifications and Drawings.
  - 2. Submittal requirements and procedures.
  - 3. Schedule for beginning and completing geomembrane installation.
  - 4. Training for installation personnel.
  - 5. Installation crew size.

6. Establishing geomembrane marking system, to include sheet identification, defects, and satisfactory repairs, to be used throughout Work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Conform to requirements of Section 01 60 00, Material and Equipment.
- B. Geomembrane:
  1. Individually package each sheet and protect from damage during shipment.
  2. Mark each package with identification of material type, size and weight.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not install geomembrane or perform seaming under the following conditions, unless it can be demonstrated to satisfaction of Engineer that performance requirements can be met under these conditions:
  1. Air temperature is less than 35 degrees F or more than 90 degrees F.
  2. Relative humidity is more than 90 percent.
  3. Raining, snowing, frost is in ground, or wind is excessive.
- B. Do not place cover materials on geomembrane when ambient temperature is less than 35 degrees F or more than 90 degrees F, unless it can be demonstrated to satisfaction of Engineer that materials can be placed without damage.

1.08 SEQUENCING AND SCHEDULING

- A. Factory test results must be acceptable to Engineer prior to shipment of geomembrane.
- B. Before placing geomembrane on soil surfaces, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.
- C. Do not attach geomembrane to new concrete surfaces until after concrete has attained 2/3 of design compressive strength specified in Section 03 30 00, Cast-In-Place Concrete.
- D. Do not place geomembrane over concrete surfaces until finish of concrete surfaces, is acceptable to Engineer.

- E. The prequalified installation crew and the position which they were qualified shall not be changed throughout the project without advance written notification to the Engineer and obtaining approval of pre-qualification of the new crew members at least 14 days in advance of needing to make a change in crew. No crew member shall be onsite unless prequalified.

1.09 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty with Owner named as beneficiary, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this Specification section found defective during periods below, commencing on date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.
  - 1. Guaranty geomembrane against manufacturing defects, deterioration due to ozone, ultraviolet, and exposure to leachate and other elements for period of 20 years on pro rata basis.
  - 2. Guaranty geomembrane against defects in material and factory seams for period of 2 years.
  - 3. Guaranty geomembrane against defects resulting from installation for period of 2 years.

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. Geomembrane:
  - 1. GSE Lining Technology, Inc., Houston, TX.
  - 2. AGRU American, Georgetown, SC.
  - 3. Poly-Flex. Houston Texas.
  - 4. Or approved equal.

2.02 HDPE GEOMEMBRANE (40-MIL AND 60-MIL NOMINAL THICKNESS REQUIREMENTS)

- A. Sixty-mil thick HDPE geomembrane to be installed and layered in locations shown in the Drawings and as described in these specifications. Forty-mil HDPE geomembrane to be used for the intermediate berms above 60-mil HDPE between bays 16-17, 17-18 and 18-19, and at the temporary ending berm located at the south end of Bay 19. Separate physical properties tables are provided for 60- mil and 40 mil HDPE material. Refer to Table 33 05 01.10-1 60-mil Thickness HDPE Geomembrane Properties or Table 33 05 01.10-2 40-mil Thickness HDPE Geomembrane Properties. 40-mil thickness will be smooth geomembrane.



- B. Composition: High Density Polyethylene (HDPE) containing no plasticizers, fillers, extenders, reclaimed polymers, or chemical additives, except following:
  - 1. Approximately 2 percent by weight of carbon black to resin for ultraviolet resistance.
  - 2. Antioxidants and heat stabilizers, not to exceed 1.5 percent total by weight, may be added as required for manufacturing.
- C. Furnish in rolled single-ply continuous sheets with no factory seams.
- D. Sheet Thickness: Minimum values determined in accordance with ASTM D5199 and shall not include ridges of rough-surfaced HDPE geomembrane.
- E. Sheet Width: Minimum 22 feet.
- F. Roll Length: Longest that will be manageable and reduce field seams.
- G. Rough-Surfaced HDPE Geomembrane: Manufactured so that surface irregularities that produce specified friction are adequately fused into sheet or are extruded with sheet, on both sides of sheet. Texture is to be in addition to base thickness specified for sheet.
- H. Meet manufacturer's most recent published specifications and required minimum values for 60 mil thickness HDPE geomembrane as specified in Table 33 05 01.10-1.

**Table 33 05 01.10-1 60-mil Thickness HDPE Geomembrane Properties**

Property	60-mil Thickness Required Value	Test Method	MQC Test Interval	CQC Test Interval
Specific Gravity	"≥0.940-0.960 g/cc not more than 15% greater than base resin density	ASTM D792, Method A-1 or ASTM D1505	1 test per 100,000 SF	
<b>Smooth-Surface, HDPE Minimum Properties, Each Direction</b>				
Tensile Stress at Yield	2.1 lb./in-width/mil thickness	ASTM D638	1 test per 100,000 SF	
Elongation at Yield	12% minimum	ASTM D638	1 test per 100,000 SF	
Thickness, Nominal, plus or minus 5%	60 mil	ASTM D5199	1 test per 100,000 SF	
Puncture Resistance	1.80 lb./mil thickness	ASTM D4833	1 test per 45,000 lbs.	

Property	60-mil Thickness Required Value	Test Method	MQC Test Interval	CQC Test Interval
Tear Resistance	0.70 lb./mil thickness	ASTM D1004, Die C	1 test per 45,000 lbs.	
Modulus of Elasticity	80,000 lb./sq. in	ASTM D882, Method A or ASTM D638	1 test per 100,000 SF	
Bonded Seam Strength in Shear	2 lb./in-width/mil thickness, min. and FTB	ASTM D6392		Minimum-One test per 500 LF of seam
Bonded Seam Strength in Peel	1.2 lb./in-width/mil thickness, min. and FTB	ASTM D6392		Minimum-One test per 500 LF of seam
<b>60- mil Thickness Rough-Surfaced, HDPE Minimum Properties, Each Direction</b>				
Thickness, min., for thinner areas of textured sheet	57 mil	ASTM D5199, Modified Note 2, or ASTM D5994	Per Roll	
Tensile Stress at Yield	2 lb./mil thickness	ASTM D638	1 test per 100,000 SF	
Elongation at Yield	12% plus or minus 3%	ASTM D638	1 test per 100,000 SF	
Puncture Resistance	1.50 lb./mil thickness	ASTM D4833	1 test per 45,000 lbs.	
Tear Resistance	0.70 lb./mil thickness	ASTM D1004, Die C	1 test per 45,000 lbs.	
Angle of friction between rough-surfaced HDPE, & soil or geotextile	27, min. (Note 1)	ASTM D5321, state conditions of test		Minimum- Two 3-point tests per interface
Brittleness Temperature	Minus 70° F, no cracks	ASTM D746 (Proc. B)	1 test per 100,000 SF	
Coefficient of Linear Thermal Expansion	1.2 x 10 <sup>-4</sup> in/in/degree C	ASTM D696	1 test per 200,000 SF	
Environmental Stress Crack	1,500 hours	ASTM D1693, Condition B (50°C) and 10% Igepal Solution	1 test per 200,000 SF	
Bonded Seam Strength in Shear	2 lb./in-width/mil thickness, min. & FTB	ASTM D6392		Minimum-One test per 500 LF of seam
Bonded Seam Strength in Peel	1.2 lb./in-width/mil thickness, min. & FTB	ASTM D6392		Minimum-One test per 500 LF of seam

Property	60-mil Thickness Required Value	Test Method	MQC Test Interval	CQC Test Interval
Vacuum Testing				100 Percent of extrusion welded seams
Air Testing				100 percent of wedge welded seams
<p>NOTES</p> <p>1. Provide certified results for angle or coefficient of friction tests between rough-surfaced HDPE and actual soils and geotextiles to be used. Perform tests on Samples of similar length and width of 0.8 to 1 square foot minimum area. Submit test results to Engineer for review prior to shipment of rough-surfaced HDPE. Friction tests are not required for smooth 60-mil HDPE.</p> <p>2. Commercially available micrometers may be used that have a 60-degree taper to a point with a radius of 1/32-inch. Thickness shall be measured at enough locations in thinner areas of textured sheet to develop statistical basis for thickness.</p>				

- I. Meet manufacturer's most recent published specifications and required minimum values for 40 mil thickness HDPE geomembrane as specified in Table 33 05 01.10-2.
- J. HDPE Geomembrane (Smooth-surface) shall meet the Minimum Average Roll Values (MARV) requirements as presented in Table 33 05 01.10-2 40-mil Thick HDPE Geomembrane, except when designated minimum, maximum, or range of values).

**Table 33 05 01.10-2 40-mil Thickness HDPE Geomembrane Properties**

Property	40-mil Thickness Required Value (MARV)	Test Method	MQC Test Interval	CQC Test Interval
Specific Gravity	"≥0.940-0.960 g/cc not more than 15% greater than base resin density	ASTM D792, Method A-1 or ASTM D1505	1 test per 100,000 SF	
<b>Smooth-Surface, HDPE Minimum Properties, Each Direction</b>				
Tensile Stress at Yield	2.1 lb./in-width/mil thickness	ASTM D638	1 test per 100,000 SF	
Elongation at Yield	12% minimum	ASTM D638	1 test per 100,000 SF	
Specific Gravity	"≥0.940-0.960 g/cc not more than 15% greater than base resin density	ASTM D792, Method A-1 or ASTM D1505	1 test per 100,000 SF	
<b>Smooth-Surface, HDPE Minimum Properties, Each Direction</b>				
Tensile Stress at Yield	2.1 lb./in-width/mil thickness	ASTM D638	1 test per 100,000 SF	

Property	40-mil Thickness Required Value (MARV)	Test Method	MQC Test Interval	CQC Test Interval
Elongation at Yield	12% minimum	ASTM D638	1 test per 100,000 SF	
Thickness, Nominal, plus or minus 5%	40 mil	ASTM D5199	1 test per 100,000 SF	
Puncture Resistance	72	ASTM D4833	1 test per 45,000 lbs.	
Tear Resistance	28	ASTM D1004, Die C	1 test per 45,000 lbs.	
Brittleness Temperature	Minus 70° F, no cracks	ASTM D746 (Proc. B)	1 test per 100,000 SF	
Coefficient of Linear Thermal Expansion	1.2 x 10 <sup>-4</sup> in/in/degree C	ASTM D696	1 test per 200,000 SF	
Environmental Stress Crack	300	ASTM 5397	1 test per 200,000 SF	
Bonded Seam Strength in Shear	2 lb./in-width/mil thickness, min. & FTB	ASTM D6392		Minimum-One test per 500 LF of seam
Bonded Seam Strength in Peel	1.2 lb./in-width/mil thickness, min. & FTB	ASTM D6392		Minimum-One test per 500 LF of seam
Vacuum Testing				100 Percent of extrusion welded seams
Air Testing				100 percent of wedge welded seams
<b>NOTES</b>				
1. Commercially available micrometers may be used that have a 60-degree taper to a point with a radius of 1/32-inch. Thickness shall be measured at enough locations in thinner areas of textured sheet to develop statistical basis for thickness.				

2.03 FACTORY TESTING

A. Interface Friction Testing:

1. Minimum peak and residual friction angles between geomembrane and adjacent materials shall be at least 27 degrees as determined by ASTM D5321. Confining pressures should approximate loading conditions in field. Soil in contact with geomembrane shall be the actual soil that is going to be used for this construction in consolidated, undrained state.

2. Test results shall include description of specimen size, supporting substrate conditions, soil installation method, unit weight, and moisture condition, normal loads used, and rate of strain.
3. Rough-Surfaced Geomembrane:
  - a. Perform coefficient of interface friction tests between textured 60 mil-HDPE geomembrane and GCL and textured 60 mil-HDPE geomembrane and composite drainage net with geotextile bonded on both sides. Use Samples of similar length and width.
  - b. Test Results: Include specimen size, supporting substrate, and rate of strain, and normal loads.
  - c. A minimum of two tests shall be conducted for each type of interface.

2.04 PIPE BOOTS AND GEOMEMBRANE SKIRT

- A. A geomembrane skirt fusion welded to the HDPE plate is used for connection to field geomembrane at the pipe penetration location. The pipe penetration is through HDPE flat stock. The pipe penetration through the HDPE sheet is surrounded by a single geomembrane skirt for the secondary pipe penetration and a double geomembrane skirt for the primary pipe penetration.
- B. The geomembrane skirt and geomembrane boots shall be fabricated of same material as geomembrane sheets to fit around penetrations, without folds, stretching, or unsupported areas. The material shall provide a strong bond to the HDPE plate or HDPE pipes.
- C. The HDPE plate, primary pipe and primary/secondary skirts shall be fabricated by the manufacturer as a single unit. All welds shall be vacuum-tested to the greatest extent possible, or by spark testing where vacuum testing is not feasible. Certified testing results will be sent to the Engineer for review and approval prior to shipment.
- D. The HDPE plate, secondary pipe and secondary skirts shall be fabricated by the manufacturer as a single unit. All welds shall be vacuum-tested to the greatest extent possible, or by spark testing where vacuum testing is not feasible. Certified testing results will be sent to the Engineer for review and approval prior to shipment.
- E. The double containment piping used at pipe penetrations shall be air tested at the manufacturer per the requirements of Specification Section 40 80\_01, Piping Leakage Testing prior to shipment. Test results shall be submitted to the Engineer for review and approval prior to shipping the HDPE sheet/ pipe and geomembrane skirt assembly.
- F. Flanges:
  1. Angle: Match slope or bottom where penetration passes through liner.
  2. Width: Minimum 2 feet plus dimension of penetration.

2.05 SEALANT CAULKING

- A. Two-component sealant formulated of 100 percent polyurethane elastomer.
- B. Manufacturer and Product: United Paint and Coatings, Greenacres, WA; Elastuff 120 Mastic, or approved equal.

2.06 STAINLESS STEEL BANDS

- A. As manufactured by Breeze Clamp Products Div., Saltsburg, PA or approved equal.

2.07 MANUFACTURER'S CONFORMANCE TESTING

- A. Resin Quality Documentation: Prior to liner delivery and installation, the manufacturer shall provide Engineer with the following information:
  - 1. The origin (resin supplier's name, resin production plant), (identification brand name, number), and production date of the resin.
  - 2. A copy of the quality control certificates issued by the resin supplier noting results of density and melt index.
  - 3. Reports on the tests conducted by the manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project facility (these tests should include specific gravity (ASTM D792 Method A or ASTM D1505) and melt index (ASTM D1238 Condition 190/2.16).
  - 4. Reports on the tests conducted by the manufacturer to certify the quality of the sheet.
- B. Property Conformance Documentation: Prior to liner delivery and installation, the manufacturer shall provide the Owner's Representative with the following:
  - 1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Specification or equivalent.
  - 2. The Engineer will verify that:
    - a. The property values certified by the geosynthetic manufacturer meet all the Specifications.
    - b. The measurements of properties by the geosynthetic manufacturer are properly documented, and that the test methods used are acceptable.

- C. Geosynthetic Roll Documentations: Prior to shipment, the manufacturer shall provide Engineer with one quality control certificate for every roll of geosynthetic provided. The quality control certificate shall be signed by the manufacturer's responsible party. The quality control certificate shall include at a minimum:
  - 1. Roll numbers and identification.
  - 2. Results of quality control tests. As a minimum, ASTM test methods shall be used to test for thickness, tensile strength, and tear resistance

2.08 EXTRUDATE

- A. Extrudate for Fusion Welding of HDPE Geomembranes: Formulated from same HDPE resin as geomembrane and shall meet applicable physical property requirements.

**PART 3 EXECUTION**

3.01 PREPARATION

- A. Geomembrane Inspection: During unwrapping visually inspect and mark each imperfection for repair.
- B. Do not place geomembrane until condition of subgrade or geosynthetics installed is acceptable to Engineer.
- C. Subgrade: Maintain in smooth, uniform, and compacted condition as specified in Section 31 23 13, Subgrade Preparation, during installation of geomembrane.
- D. Deliver five Rolls of Manufacturer certified 40-mil HDPE to Storage Area directed by the Owner for the Owners use.

3.02 WELDING UNITS

- A. Single or double hot-wedge fusion seam welding.
- B. Extrusion welding systems.
- C. Hot-air welding is not acceptable.

3.03 GEOMEMBRANE INSTALLATION

- A. Do not install membrane or seam unless Contractor can demonstrate successful performance and test results showing seams meet strength Specifications.

B. Protection:

1. Do not use geomembrane surfaces as work area for preparing patches, storing tools and supplies, or other uses. Use protective cover as work surface, if necessary.
2. Instruct workers about requirements for protection of geomembrane, such as, handling geomembrane material in high winds, handling of equipment, and walking on geomembrane surfaces. Shoes of personnel walking on geomembrane shall be smooth bonded sole or be covered with smooth type of overboot. Prohibit smoking, eating, or drinking in vicinity of geomembrane, placing heated equipment directly on geomembrane, or other activities that may damage geomembrane.
3. Do not operate equipment without spark arrestors in vicinity of geomembrane material nor place generators or containers of flammable liquid on geomembranes.
4. Protect from vehicle traffic and other hazards.
5. Keep free of debris during placement. Pick-up all debris and trash at the end of each work day.
6. Prevent uplift, displacement, and damage.
7. Only small rubber-tired equipment, with maximum tire inflation pressure of 5 pounds per square inch, shall be allowed directly on geomembrane unless otherwise approved by Engineer. Demonstrate that proposed equipment can be operated without damaging geomembrane.

C. Placement:

1. Miscellaneous products required for completion of geomembrane installation shall be in accordance with this Specification and geomembrane manufacturer's recommendations.
2. Reduce field seaming to minimum. Horizontal seams on slopes will not be acceptable. Seams parallel to toe shall be at least 5 feet from toe. Align rough-sided sheets in manner that maximizes their frictional capabilities along slope.
3. Prevent wrinkles, folds, or other distress that can result in damage or prevent satisfactory alignment or seaming. Provide for factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage.
4. Temporarily weight sheets with sandbags to anchor or hold them in position during installation. Use continuous holddowns along edges to prevent wind flow under sheet.
  - a. Bag Fabric: Sufficiently close knit to preclude fines from working through bags.
  - b. Bags: Contain not less than 40 nor more than 60 pounds of sand having 100 percent passing No. 8 screen and shall be securely closed after filling to prevent sand loss.



- c. Do not use tires or paper bags, whether or not lined with plastic. Burlap bags, if used, shall be lined with plastic.
- d. Immediately remove damaged or improperly sealed bags from work area and clean up spills.
- 5. Anchor perimeter of geomembrane as shown or as otherwise approved by Engineer. Anchor and seal geomembrane to structures, pipes, and other types of penetrations as shown.
- 6. Place overlying drainage net and composite drainage net immediately following completion of geomembrane installation and field testing as acceptable to Engineer.

D. Field Seams:

- 1. Wipe sheet contact surfaces clean to remove dirt, dust, moisture, and other foreign materials and prepare contact surfaces in accordance with seaming method accepted by Engineer.
- 2. Lap sheet edges to form seams. Adjust edges to be seamed and temporarily anchor to prevent wrinkling and shrinkage.
- 3. Seams shall not go through a boot. Locate seams minimum of 2 feet from boot.
- 4. Avoid seam intersections involving more than three thicknesses of geomembrane material. Offset seam intersections at least 2 feet. Extend seams through anchor trench to sheet edges.
- 5. Seal seam "T" intersections by removing excess material and extrusion welding lap joint.
- 6. Seam sheets together, using fusion-extrusion or hot-wedge welding system, equipment, and techniques.
- 7. Capping of Field Seams: Use 8-inch wide (minimum) cover strip of same thickness as geomembrane (and from same roll, if available). Position strip over center of field seam and weld to geomembrane using extrusion weld each side.

3.04 PLACING PRODUCTS OVER GEOMEMBRANE

- A. Prior to placing material over CDN which overlies geomembrane, notify Engineer and geomembrane installer. Do not cover installed geomembrane until after Engineer provides authorization and geomembrane installer approves to proceed.
- B. During the placement of drainage sand over CDN and geomembrane, a spotter representing geomembrane installer shall be present at all times to observe and approve the placement of drainage sand. The spotter shall be within 100 feet of the sand placement operation, in visual contact of the liner system surface and sand placement and have no other duties that could distract from their spotting responsibility.

- C. Wrinkles greater than 6 inches in height are unacceptable. Do not place CDN over Geomembrane or cover materials over CDN which overlies geomembrane when the height of any wrinkle is greater than 2 inches and spacing between wrinkles is less than 10 feet. Do not place cover materials when the height of any wrinkle is greater than 6 inches. All wrinkles meeting this limitation of this paragraph shall be repaired.
- D. Do not place cover materials in manner that will cause wrinkles to fold over or become confined to form a vertical ridge. Repair all such wrinkles prior to placement of cover material.
- E. Place cover materials when liner is cool and contracted and wrinkles are minimized.
- F. If tears, punctures, or other geomembrane damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geomembrane, and repair damage as specified in Article Repairing Geomembrane.
- G. Geomembrane installer shall provide a spotter for each location where materials are being placed over geomembrane and shall remain onsite and available during placement of overlying products to repair geomembrane if damaged.
- H. Contractor shall provide a certification to the Owner certifying that geomembrane was not damaged during cover material placement.

### 3.05 REPAIRING GEOMEMBRANE

- A. Geomembrane surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade shall be replaced or covered and sealed with an additional layer of geomembrane material of proper size.
- B. Repair damage or rejected seams with pieces of flat and unwrinkled geomembrane material free from defects and seams. Patches shall be tightly bonded on completion of repair Work.
- C. Patch shall be neat in appearance and of size 6 inches larger in all directions than area to be repaired. Round corners of patch to minimum 1-inch radius.
- D. Prepare contact surfaces and seam patch in accordance with paragraph Field Seams.
  - 1. Pull and hold flat receiving surface in area to be patched.
  - 2. Seal each patch by extrusion welding continuous bead along edge, with no free edge remaining. Vacuum box test each patch on completion.

3.06 FIELD QUALITY CONTROL

- A. Identify each test by date of Sample, date of test, Sample location, name of individual who performed test, standard test method used, list of departures from standard test methods, at minimum.
- B. In-Place Observation and Testing:
  - 1. Visually inspect geomembrane sheets, seams, anchors, seals, and repairs for defects as installation progresses and again on completion.
  - 2. Depending on seam welding equipment used, test each seam and repair using vacuum testing device, spark testing device, or air channel pressure test for double wedge welded seams.
  - 3. Perform testing in presence of Engineer.
- C. Field Testing Equipment:
  - 1. Tensiometer:
    - a. Motor driven with jaws capable of traveling at measured rate of 2 inches per minute.
    - b. Equipped with gauge which measures force in unit pounds exerted between jaws.
    - c. Force Tech 5002 DPR portable tensile tester as furnished by Columbine International, Ltd., Placerville, CA.
  - 2. Vacuum Box: Conform to ASTM D5641.
  - 3. High Voltage Spark Detector: Tinker and Razor Holiday Detector, Model AP-W, set at 20,000 volts.
- D. Field Seam Sampling:
  - 1. Verify that seaming equipment and operators are performing adequately. Produce test seam Samples at beginning of each shift for each seaming crew. In addition, if seaming has been suspended for more than 1/2 hour, or if breakdown of seaming equipment occurs, produce test seam Samples prior to resuming seaming.
  - 2. Sample Size: 12 inches wide plus seam width, and 30 inches long.
  - 3. Nondestructive Sampling shall be the Responsibility of the Contractor:
    - a. For boots and seams that cannot be otherwise tested by Air Channel Pressure or Vacuum Box test, insert copper wire for spark test at edge of overlapping sheet in extrudate of weld prior to extrusion welding, Conform to ASTM D6365. Position to within 1/8 inch of sheet edge.

- b. Frequency: One at the beginning of a continuous seam and one at the end of a continuous seam, and minimum one Sample per seaming crew per 4-hour work period. The seaming temperature shall be recorded at the beginning and the end of the seam and once every 500 feet.
  - c. Produce Samples using same materials, equipment, personnel, and procedures as field seams made at time of Work in progress and under same conditions.
  - 4. Destructive Sampling shall be the Responsibility of the Engineer:
    - a. Frequency: Minimum one Sample per 500 feet of field seam.
    - b. Remove Samples from field seams at locations selected by Engineer.
    - c. Repair field seams in accordance with repair procedures specified in these Specifications.
  - 5. Sample Identification:
    - a. Number, date, and identify each Sample as to personnel making seam and location of Sample or location of field seam Work in progress at time Sample is made.
    - b. Mark location of Sample, or location of field seam in progress at time Sample is made, on panel/sheet layout Drawing.
  - 6. Conform to ASTM D6392 and this Specification: Seam testing for HDPE geomembrane includes shear and peel strength tests, vacuum box testing, air channel pressure tests, high voltage spark tests and probing.
- E. Field Seam Strength Sample Testing:
- 1. General:
    - a. Test each Sample for seam peel and tensile strength.
    - b. Save test Samples, including specimens tested, until notified by Engineer relative to their disposal.
    - c. Each Sample that fails under test shall be shipped immediately by express delivery to Engineer for determination of corrective measures required.
  - 2. Field Seam Acceptance Criteria: Seam strength equal to 90 percent of that of parent material. Parent material shall be tested in accordance with ASTM D638.
    - a. Bonded Shear Strength of HDPE:
      - 1) In Shear: Minimum 2 pounds per inch width per mil thickness as determined in accordance with ASTM D6392, and ASTM D816, Method B.
      - 2) In Peel: Minimum 1.5 pounds per inch width per mil thickness as determined in accordance with ASTM D6392 and ASTM D413, Method A.

3. Test Failure: If Sample fails, entire field seam from which it was taken shall be considered a failure and shall be rejected due to nonconformance with Specification requirements. Comply with following corrective measures:
    - a. For nondestructive Sample failure, rerun field weld test using same Sample. If that test passes, Engineer may assume error was made in first test and accept field seam. If second test fails, cap each field seam represented by failed Sample and submit new test Sample made during capping procedure.
    - b. Destructive Sample Failure: Rerun field weld test using new Sample from same seam. If that test passes, Engineer may assume error was made in first test and accept field seam. If second test fails, either cap field seam between two previous passed seam test locations that include failed seam or take another Sample on each side of failed seam location (10-foot minimum), and test both. If both pass, cap field seam between two locations. If either fails, repeat process of taking Samples for test. Each field seam shall be bounded by two passed test locations prior to acceptance.
- F. Vacuum Box Testing of HDPE Welds shall be the Responsibility of the Contractor: Vacuum box test each of these types of welds: Fillet, extrusion lap, and single hot-wedge fusion lap.
1. Testing Procedures: Conforming to ASTM D5641.
- G. Air Channel Pressure Testing of Double Hot-Wedge Seam shall be the Responsibility of the Contractor:
1. Insert needle with gauge in air space between welds. Pump air into space to 30 psi and hold for 5 minutes.
  2. At end of 5 minutes, depressurize seam by placing needle hole in air space between welds at opposite end of seam and observe gauge.
  3. If seam maintains at least 27 psi during 5-minute hold and pressure drops within 30 seconds of depressurization, seam is acceptable.
  4. If pressure drops below 27 psi during test period or does not drop during 30-second depressurization period, repair needle holes and retest seam by same procedure or vacuum box test along entire length of seam. If seam maintains a minimum of 27 psi, seam is acceptable.
  5. If second air pressure test fails, vacuum box test entire length of seam.
    - a. If no bubbles appear in vacuum box, lower weld will be considered defective, and upper seam is acceptable.
    - b. If bubbles appear in vacuum box, repair each defective area by extrusion welding and test again by vacuum box.

6. As alternative to vacuum box testing, apply soap solution to exposed seam edge while maintaining required air channel test pressure.
    - a. If bubbles appear, mark, trim unbonded edge, and extrusion weld defective areas.
    - b. If no bubbles appear and test pressure cannot be maintained, leak is judged to be in bottom or second seam.
  7. If leak is judged to be in bottom seam, cap strip length of seam tested.
  8. Mark and repair needle holes.
- H. High-Voltage Spark Testing of Extrusion Welds: At locations such as at pipe/flange welds and underneath pipe penetration boots or skirts, where extrusion welds cannot be tested vacuum box, welds shall tested by high-voltage spark testing:
1. Testing Procedures: Conforming to ASTM D6365.
  2. Provide each seam to be tested with copper wires properly embedded in seam as shown and with provisions for electrical grounding to test equipment.
  3. Pass spark tester along length of seam containing copper wire.
  4. Presence of a visible spark along tested seam shall be evidence of a faulty seam.
  5. Mark faulty areas for repair and retesting.
  6. Provide full documentation of field vacuum testing and field spark testing of pipe penetrations and geomembrane connections to Pipe penetrations. Submit to Engineer and Engineer CQA representative within 24 hours of field testing. Engineer shall review the test data and if satisfactory approve the field CQC results.
  7. A failed test will not be accepted. Repair faulty interface and retest.

### 3.07 MANUFACTURER'S SERVICES

- A. Provide Representative of Geomembrane Manufacturer Onsite for Technical Supervision and Assistance During the Following:
1. Preparation and inspection of surfaces on which geomembrane is to be placed.
  2. Inspection of geomembrane prior to installation.
  3. Installation of geomembrane.
  4. Installation of pipe penetration assemblies, including attachment of field geomembrane to HDPE pipe penetration skirts, attachment of geomembrane to edges of penetration support slab, and embedment of HDPE flat stock into concrete support slab.
  5. Placement of cover over installed geomembrane.

- B. The manufacturer may provide an affidavit assigning the Geomembrane Installer as their field representative. The affidavit is required to be signed by a principal of the manufacture corporation specifically stating the assignment and including name of the person (i.e. Installer's Site Supervisor) who will be their representative onsite for this Project.

3.08 CLEANUP

- A. Cleanup work area as Work proceeds and remove all trash at the end of each work day. Take particular care to ensure that no trash, tools, and other unwanted materials are trapped beneath geomembrane and that scraps of geomembrane material are removed from work area prior to completion of installation.

3.09 SUPPLEMENT

- A. The supplement listed below, following "END OF SECTION" is a part of this Specification.
  - 1. Supplement 1, HDPE Manufacturer's Certification of Proper Installation.

**END OF SECTION**





# HDPE Manufacturer's Certificate of Proper Installation

---

**Contract Name:** \_\_\_\_\_

**Owner:** \_\_\_\_\_

**Contractor:** \_\_\_\_\_

**Engineer:** \_\_\_\_\_

**Material:** High Density Polyethylene (HDPE) Geomembrane

**Specification Section No.:** 33 05 01.10

I, the undersigned Manufacturer's Representative, hereby certify that I am:

- 1) A duly authorized representative of the Manufacturer.
- 2) Empowered by the Manufacturer to inspect and approve the installation and repair of the material(s) identified above.
- 3) Authorized to make recommendations required to assure that the installation and/or repair of the material(s) furnished by the Manufacturer are complete and functional, except as may be otherwise indicated herein.

I further certify that:

- 1) The above referenced material(s) was installed in accordance with the (i) Owner's plans and specification, (ii) Manufacturer's and Installer's Quality Assurance Programs, and (iii) Manufacturer's Pro-Rata Limited Installation Warranty.
- 2) All repairs to the above referenced material(s) performed by the Manufacturer and/or Installer prior to the Final Completion date of \_\_\_\_\_ were performed in accordance with the (i) Owner's plans and specification, (ii) Manufacturer's and Installer's Quality Assurance Programs, and (iii) Manufacturer's Special Guarantees and warranties.
- 3) All information contained herein is true and accurate.

**Date:** \_\_\_\_\_

**Manufacturer:** \_\_\_\_\_

**Manufacturer's Authorized Representative:** \_\_\_\_\_  
(Authorized Signature)

\_\_\_\_\_  
(Print Name)



**SECTION 33 05 01.20  
CONDENSATE SUMP**

**PART 1 GENERAL**

1.01 WORK INCLUDED

- A. This section covers the Work necessary for the construction of the condensate sump (42-inch diameter).
- B. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of the sump and its associated fittings as specified herein, or as shown in the Drawings.
- C. The Contractor shall coordinate the installation of the sump and its fittings with other construction activities and subcontractors at the site.

1.02 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. C1147, Standard Practice for Determining the Short Term Tensile Weld Strength of Chemical-Resistant Thermoplastics.
    - b. D638, Standard Test Method for Tensile Properties of Plastics.
    - c. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
    - d. D2321, Practice for Underground Installation of Thermoplastic.
    - e. Pipe for Sewers and Other Gravity-Flow Applications.
    - f. D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
    - g. D2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
    - h. D3035, Standard Specification for Polyethylene (PE) Plastics Pipe (DR-PR) Based on controlled Outside diameter.
    - i. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
    - j. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
    - k. F894, Standard Specification for Polyethylene (PE) Large Diameter profile Wall Sewer and Drain Pipe.
    - l. F1759, Standard Practice for Design of HDPE Manholes for Subsurface Applications.
    - m. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

1.03 SUBMITTALS

- A. Certificate of HDPE material meeting the Specifications.
- B. Shop Drawings: The fabricator of the sumps shall submit shop drawings for review and approval as part of the submittal data showing the position of the inlets, outlets and the overall dimensions along with any other special features such as ladders, internal piping, valves, etc.
- C. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
- D. The fabricator shall submit calculations for review by the Engineer, indicating that the vertically installed sumps have been analyzed using the guidance of ASTM F1759, "Design of High Density Polyethylene (HDPE) Manholes for Subsurface Applications". The data shall contain information related to the following areas: Ring Compressive Strain, Combined Ring Compressive and Ring Bending Strain, Ring Buckling, Axial Stain, Axial Buckling, and the thickness of the bottom based on depth and groundwater. Thickness should be based on acceptable stress and deflection limits. Data and calculations are supplied for informational purposes and will be part of the submittal package that are reviewed and approved by the Engineer. Engineer will review any data/calculations submitted for accuracy, including any site specific variables, and confirm the structure is suitable for the intended service including installation and operating conditions.
- E. The fabrication technician shall perform fusions accordance in accordance with ASTM F2620. When required, the fabrication technician will be qualified to perform extrusion and hot air welding per ASTM C1147. The fabricator shall submit the written quality assurance program used during fabrication of the sumps.
- F. Quality Control Submittals:
  - 1. The fabricator shall submit their QA/QC program for fabricating thermoplastic structures prior to beginning work and the qualifications of the fabrication technician upon beginning of work on the structure.
  - 2. Documentation of personnel responsible for fabrication with suitable training and qualification.
  - 3. Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
    - a. Conformance to paragraph 3.04.
  - 4. Test report documentation.

1.04 QUALIFICATIONS

- A. Pipe Manufacturer: Listed with Plastic Pipe Institute as meeting recipe and mixing requirements of resin manufacturer for resin used to manufacture pipe for this Project.

1.05 SAFETY

- A. Perform all work in accordance with local, state, and federal safety requirements for trenching and placement of pipe. The Contractor shall use extreme care in the performance of all work on and around the landfill site. The Contractor's workforce shall be familiar with the potential hazards, provided with the necessary safety equipment and trained in the necessary safety precautions for execution of the work as outlined. Safety precautions must include but not be limited to, the monitoring for oxygen deficiency and explosive levels of methane gas prior to the start off and during all trenching excavation operations.

1.06 APPROVAL AND REJECTION

- A. Engineer will review submittal information and provide written approval or rejection of submittal data, Shop Drawings, and verify proposed sump will meet installation and service requirements.
- B. Rejection: The HDPE sumps may be rejected for failure to meet any of the requirements of this Specification.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Transport and store in accordance with manufacturer's instructions.

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. Pipe and fittings specified in this section shall be products of:
  - 1. ISCO – 800-345-4726.
  - 2. Or approved equal(s).

2.02 MATERIALS

- A. HDPE extruded Solid Wall Pipe Material:
  - 1. Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 3608 material with cell classification of 345464C, or better.
  - 2. Pipe sizes shall conform to ASTM F714. Dimension Ratio (DR) and Outside Diameter (IPS/DIPS) shall be as specified on Drawings.

- B. HDPE extruded Solid Wall Pipe Material:
  - 1. Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 3608 material with cell classification of 334433C, or better.
  - 2. Pipe shall be manufactured to the dimensions and material requirements of ASTM F894
  
- C. HDPE Sheet and Fitting Material: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 3608 material with cell classification of 345464C or better.

**PART 3 EXECUTION**

**3.01 HDPE SUMP FABRICATION**

- A. General:
  - 1. HDPE sump shall be designed, fabricated, shipped, installed, and tested in accordance with ASTM F1759, unless otherwise stated or shown in the Drawings.
  - 2. The HDPE sumps shall be constructed of cylinder with a nominal OD of 42 inches and DR of 17.
  - 3. The sump shall be fabricated with the minimum number of welds practical.
  - 4. The bottom thickness of the sumps will meet the required limits for stress and deflection as required in ASTM F1759 or have additional support and bracing.
  - 5. The inlets and outlets shall be extrusion welded on the inside and outside of the structure using trained welders. Gussets shall be attached at 90 degrees, 180 degrees, 270 degrees, and 360 degrees around the inlets and outlets unless impractical.
  - 6. All sump connections larger than 4-inch nominal OD pipe shall be butt fusion welded, electrofusion welded, or flanged connections. For 4-inch OD pipe and smaller threaded transition fittings can also be used as well as the acceptable connections listed. Mechanical connections may be employed when approved by Engineer.
  - 7. All butt fusion welds shall be made as described in ASTM F2620 and all butt fusion welds performed with hydraulically operated butt fusion equipment shall be recorded using a McElroy Manufacturing DataLogger. The fabricator shall maintain records of the temperature, pressure, and graph of the fusion cycle for a minimum of 3 years.
  - 8. Sumps shall be factory tested with water or with air. The hydrostatic test shall be conducted by filling the structure with water and checking for leaks. Minimum test duration will be one hour. If air is used, a minimum of 1 PSI shall be used for 30 minutes. Structures with a 72-inch inside diameter or smaller may be tested to 2 PSI. Data showing

the structure to be leak-free will be supplied, when testing requirements are agreed to prior to fabrication. Engineer or his representative may request to observe the test.

9. The top of the sump shall be built to meet the requirements of Contract Drawings. Additional bolts to flanged top may be needed to withstand test conditions.
10. Except for when impractical, lifting eyes will be integral to the sump body and located on Shop Drawings.
11. Restraints shall be designed as an integral part of the sump by the fabricator/manufacturer to prevent strain at the inlets or outlets. These restraints shall be cast into a concrete block or collar around the pipe. Anti-flotation and/or anti-settling measures such as anchor lugs, rings, or collars, if required, shall be provided as an integral part of the sump by the fabricator/manufacturer of the sump.

### 3.02 CONSTRUCTION PRACTICES

- A. Handling of Sumps: HDPE sumps shall be stored on clean, level, and dry ground to prevent undue scratching or gouging of the pipe. The handling of HDPE sumps shall be done in such a manner that there is no damage. Nylon slings are often used.
- B. Flanged Connections. Flange adapters (where shown in the drawings) shall be attached to HDPE sump inlets and outlet stubs during fabrication by butt fusion welding per ASTM F2620. A metal back up ring will be used with each flanged connection. The rings will use a standard ANSI 150# bolt pattern. Check the drawings for materials required for corrosive conditions. Bolted connections should follow recommendations for Plastic Pipe Institute ([www.plasticpipe.org](http://www.plasticpipe.org)) TN-38, Bolt Torques For Polyethylene Flanged Joints, including the following recommendation:
  1. Bolts shall be tightened in a “star pattern” to recommended torque values.
  2. Bolts must be tightened a second time after 8-24 hours to insure a positive seal.
  3. Gaskets shall be flat ring 1/8-inch Viton unless otherwise specified by manufacturer.
- C. Pipe Joining: HDPE pipe shall be joined using butt fusion. No solvent or adhesive welding shall be allowed. All butt fusion welds shall be made as described in ASTM F2620. Electrofusion welding can be used for making pipe welds. Hot air and extrusion welding are not permitted for pipe to pipe joining. All connections to the structure made butt fusion welds using hydraulically operated butt fusion equipment shall be recorded using a McElroy Manufacturing DataLogger. The contractor shall maintain records of the temperature, pressure, and graph of the fusion cycle for all welds joining the pipe to the structure at the jobsite.

- D. Handling of Fused Pipe- Fused segments of pipe shall be handled so as to avoid damage to the pipe. Limit bending of the pipe welded to fittings or sumps. Nylon slings are preferred.
- E. Bolting directly to the wall of the HDPE structure is not allowed.

3.03 DIRECT BURIAL INSTALLATION

- A. Trench Construction - The trench and trench bottom shall be constructed in accordance with ASTM D2321 Section 6, Trench Excavation, and Section 7, Installation. The HDPE sump shall be installed on a stable base consisting of 12 inches of Class I materials compacted to 95 percent proctor density per ASTM F1759, Section 4.2. All required safety precautions for sump installation are the responsibility of the Contractor.
- B. Embedment materials- Embedment materials shall be Class I or Class II materials as defined by ASTM D2321 Section 5, Materials. Class I materials are preferred. Backfill and bedding materials shall be free of debris.
- C. Bedding of the sump shall be preformed in accordance with ASTM D2321 Section 7.2. Compaction shall conform to Section 7.5 and 7.51.
- D. Backfilling shall be shall be done to conform to the ASTM F1759 Section 4.2, "Design Assumptions". This Specification indicates that backfill shall extend at least 3.5 feet from the perimeter of the sump for the full height of the sump and extend laterally to undisturbed in situ soils. Compaction shall be to minimum of 90 percent standard proctor density.

3.04 TESTING AND INSPECTION

- A. General:
  - 1. Sumps shall be factory tested with water or with air. The hydrostatic test shall be conducted by filling the structure with water and checking for leaks. Minimum test duration will be one hour. If air is used, a minimum of 1 PSI shall be used for 30 minutes. Structures with a 72-inch inside diameter or smaller may be tested to 2 PSI. Data showing the structure to be leak-free will be supplied, when testing requirements are agreed to prior to fabrication. Engineer or his representative may request to observe the test.
  - 2. After all HDPE sump pipe stubout connections have been completed for HDPE sump, and prior to backfilling, perform separate leakage tests for sumps. Each sump shall be completely filled with water and no leaking shall be allowed from any HDPE joints for a period of 8 hours. Contractor shall provide necessary shoring during leakage testing of sump per manufacturer's recommendations to compensate for lack of backfill.



3. Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions.
4. Test failures shall require the Contractor to find and fix the point(s) of leakage causing the failure.

3.05 CLEANING

- A. Clean all of debris.

**END OF SECTION**



**SECTION 33 05 13  
CONCRETE MANHOLES AND WETWELLS**

**PART 1 GENERAL**

REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
    - a. A36, Standard Specification for Carbon Structural Steel.
    - b. A48, Standard Specification for Gray Iron Castings.
    - c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - d. A536, Standard Specification for Ductile Iron Castings.
    - e. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
    - f. C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
    - g. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
    - h. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
    - i. C923, Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
    - j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
    - k. F594, Standard Specification for Stainless Steel Nuts.

SUBMITTALS

- A. Shop Drawings:
1. Precast Manholes and Wetwells: Details of construction.
  2. Precast Base, Cones, and Top Slab Sections: Details of construction.
  3. Design calculations for structural strength based on depth, and buoyancy calculations assuming water table at top of manhole, signed and sealed by a Professional Engineer in the State of Florida.
- B. Quality Control Submittals:
1. Proposed curing method for cast-in-place concrete structures.
  2. Precast Manhole and Wetwell Sections: Manufacturer's results of tests performed on representative sections to be furnished.

## **PART 2 PRODUCTS**

### GENERAL

- A. All material supplied shall be one of the products specified in Exhibit D "List of Approved Products" appended to these Technical Specifications

### PRECAST CONCRETE SECTIONS

- A. Precast concrete wetwell sections, manhole barrel and eccentric top sections shall conform to specifications for precast reinforced concrete manhole sections, ASTM Designation C478, except as otherwise specified below or as shown on the Drawings. Details of precast sections shown on the Drawings, including thickness and reinforcing, shall supersede ASTM C478 when such details are more stringent than ASTM C478. The method of construction shall conform to the detailed Drawings appended to these Specifications and the following additional requirements:

1. The minimum wall thickness for the various size barrel sections shall be 6 inches, or as indicated in the Drawings.
2. Barrel sections shall have tongue and groove joints. Joints shall be sealed with cold adhesive preformed plastic gaskets set in double rows on the tongue and in the groove prior to setting the next section. Gaskets shall be K.T. Snyder "Ram-Nek", Conseal "CS-102" or acceptable equal. All extension joints shall be sealed with Portland Type II cement after setting of gasket and placement of manhole section into a watertight joint.
3. Type II cement shall be used except as otherwise accepted.
4. Concrete structures shall contain a crystalline waterproofing concrete admix for all new concrete structures including but not limited to manholes, concentric cone sections, ARV vaults, wet wells, and wetwell top slabs. Crystalline waterproofing concrete admix shall be added to the concrete during the batching operation. Admixture concentration shall be added based upon manufacturer's design percent concentration of admixture to the required weight of cement. The amount of cement shall remain the same and not be reduced. A colorant shall be added to verify the admixture was added to the concrete. Colorant shall be added and provided at the admixture manufacturing facility, not at the concrete batch plant. It is recommended that the admixture be added first to the rock and sand and blended thoroughly before adding cement and water or per the manufacturer's recommendations. Concrete structures without crystalline waterproofing admixture or admixture without colorant for field verification shall be rejected. Contractor shall provide certification from the pre-caster that the admixture was added in accordance with the manufacturer's recommendations. Concrete admixture shall be manufactured and supplied by an approved manufacturer as shown in Exhibit D "Orange County Utilities List of Approved Products."

5. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast section. Each section must be inspected and stamped by an accredited testing laboratory.
6. Sections shall be cured by an acceptable method for at least 28 days.
7. Precast concrete slabs over top section, where required, shall be capable of supporting the overburden plus a live load equivalent to ASHTO H 20 loading.
8. The tops of bases shall be suitably shaped to mate with the adjoining precast section.
9. Concrete surfaces shall have form oil, curing compounds, dust, dirt, and other interfering materials removed by brush sand blasting and shall be fully cured prior to delivery.
10. Interior surfaces of leachate collection manholes, leachate detection manholes, leachate pump station wet wells shall be lined with HDPE lining in accordance with Section 44 42 73.01, Thermoplastic Liner for Concrete Structures and Orange County Utilities Exhibit D.

2.03 PRECAST MANHOLES AND PUMP STATION WETWELLS FOR LEACHATE COLLECTION, LEACHATE DETECTION AND TRANSMISSION

- A. Leachate collection and leachate detection system manholes shall be:
1. Precast concrete structures with integral cast HDPE liners on the sidewalls and top frame slab. Leachate collection and Leachate detection manhole shall be:
  2. Six-foot diameter precast manholes in accordance with the leachate collection/ detection manhole schedules on the Drawings.
  3. Sidewalls and all internal surfaces shall be covered with integrally cast HDPE lining for corrosion prevention. The HDPE liner shall be as specified in Section 44 42 73.01, Thermoplastic Liner for Concrete Structures.
  4. Manholes shall be in accordance with Index 200 and 201 of the FDOT-approved Standards for Road and Bridge Construction, latest edition.
  5. Flow through channels shall be formed of non-shrink grout and lined with HDPE half pipe sections.
  6. Pipe connections for HDPE pipe shall be integrally cast or as shown on the Drawings. Integral castings shall be PE 4710 HDPE pipe as specified in Section 47 27 00, Piping General and Supplement. A double wall HDPE pipe system is used from the pipe penetrations in each bay to the corresponding leachate collection or detection manhole.

- B. Leachate collection and Leachate detection pump station wetwells shall be:
1. Eight-foot diameter precast wetwell in accordance with the leachate collection/detection Pump Station Sections as shown on the Drawings.
  2. Pre-cast wetwell sections, base and top shall be manufactured with colored waterproof corrosion-resistant admixture in accordance with Orange County standards. Wetwell exterior joints shall be wrapped in approved shrink-wrap material as listed in Orange County Utilities Approved Products list.
  3. Sidewalls, and all internal surfaces shall be covered with integrally cast HDPE lining for corrosion prevention. The HDPE liner shall be as specified in Section 44 42 73.01, Thermoplastic Liner for Concrete Structures.
  4. Equipped with stainless steel double access hatch, based on hatch Manufacturer's recommendation based on pumps size. Hatch shall be stainless steel checker plate, trim and hinges, Pump access hatch and frame shall be in accordance per Section 44 42 56.04, Submersible Pumps.
  5. Contractor to coordinate hatch size, hatch hardware and hatch placement into concrete with wetwell top.
  6. Pre-Approved Hatches:
    - a. Halliday S2R Series (Stainless Steel).
    - b. U.S. Foundry Fabrication APD Series (Stainless Steel).
    - c. Or approved equal.

#### 2.04 RISER SECTIONS FOR MANHOLES

- A. Minimum 72 inches in diameter.
- B. Fabricate in accordance with ASTM C478.
- C. Minimum Wall Thickness: To be determined by concrete manhole fabrication as a function of manhole depth. Minimum 6-inch thickness for manholes 8 feet deep to 20 foot depth or 1/12 times inside diameter, whichever is greater.
- D. Top and bottom shall be parallel.
- E. Joints: Tongue-and-groove or confined groove with mortar. Outside joints of manholes shall be shrink-wrapped per Orange County Standards.

#### 2.05 BASE SECTIONS AND BASE SLAB FOR MANHOLES

- A. Base Sections: Base slab integral with sidewalls.
- B. Minimum Base slab thickness shall be 12 inches for manhole depths of 8 feet from final grade and 18 inches for manhole and wetwell depths greater than 8-foot depth Actual base slab thickness to be determined by fabricator based on buoyancy calculations. Minimum Safety Factory of 1.10 against uplift is required.. Manhole depth shall be determined from Manhole Structure Schedule as the height from lowest invert to top of manhole frame height.

C. Fabricate in accordance with ASTM C478.

2.06 MANHOLE EXTENSION

A. Concrete grade rings; maximum 6 inches high.

B. Fabricate in accordance with ASTM C478.

2.07 PREFORMED PLASTIC GASKETS

A. Henry, Inc., Ram-Nek, or approved equal.

2.08 SOURCE QUALITY CONTROL

A. All test specimens shall be mat tested and meet the permeability test requirements of ASTM C14.

B. Conduct tests at point of manufacture prior to delivery of any section.

C. Sections to be tested will be selected at random from stockpiled material to be supplied for the Project.

2.09 CAST-IN-PLACE MANHOLES

A. Reinforcing Steel: Furnish as specified in Section 03 30 10, Structural Concrete.

B. Concrete: Furnish as specified in Section 03 30 10, Structural Concrete.

2.10 MANHOLE FRAMES AND COVER

A. Castings:

1. Two-piece FDOT Index 201 cover for three foot-opening size frame.
2. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
3. Cast Iron: ASTM A48 Class 30B.
4. Ductile Iron: ASTM A536, Grade 60-40-12.
5. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Leachate Collection and Detection Manhole Covers: True and seat within ring and frames at all points with the word LEACHATE and CONFINED SPACE in 2-inch raised letters. The covers shall be gas tight up to 20 psi. Gasket shall be Viton or PTFE.

2.11 INFLATABLE PIPE PLUGS

- A. Inflatable pipe plugs will be used in leachate collection and leachate detection manholes to block stormwater flows into the manholes in Bays that have not received solid waste. Additional inflatable pipe plug is required for Bay 18 and Bay 19 leachate collection pipes within the Bays. Plugs shall be inflatable and removable with limited or no entry into leachate manholes. The Contractor shall supply Inflatable plugs to serve a diameter range of 5 inches (deflated) to 12 inches (inflated). Inflatable pipe plugs, air tubing, ports and other accessories shall be made of material that are resistant to municipal landfill leachate and landfill gas (methane, carbon dioxide, water and trace constituents).
- B. Inflatable pipe plugs are required for insertion into 8-inch diameter HDPE SDR 11 solid wall pipe in Bays 18 and 19 leachate collection and detection systems (MH 18-PRI, MH 18-SEC, MH 19-PRI, and MH 19-SEC) and for Bay 17 leachate detection manhole (MH-17-SEC). One plug will be supplied for the 10-inch ID leachate collection pipe serving Bay 17 (MH17-PRI). Plugs are to be installed following pipe cleaning and inspection and are anticipated to remain in place for up to 3 years.
- C. Plugs shall be removable by deflation and use of pull and lift chains.
- D. Inflatable pipe plugs shall have the following properties:
  - 1. Viton or PTFE material for plug outside jacket.
  - 2. Stainless steel internal and external valves.
  - 3. Temperature range 80 to 150 degrees F.
  - 4. 1/4 inch Type 316 stainless steel NPT male fittings for Air tubing connections
  - 5. Viton or PTFE endcap or Type 316 stainless steel end-cap on port and chain connection end.
  - 6. Closed valve capability to maintain air pressure within the plug.
  - 7. Minimum pipeline line pressure resistance: 34 feet.
  - 8. Products:
    - a. Peterson Products Inc Fredonia, Wisconsin (800) 926-1926 Series 134 or Series 137.
    - b. Cherne Industries Inc. (800) 843-7684, Part No. 275088.
    - c. Or approved equal.
- E. Extension Hoses and Accessories (One each for each Manhole unless otherwise noted):
  - 1. Air tubing-3/8-inch diameter, 20-foot minimum length, Minimum pressure rating 100 psi, suitable for organic acid and corrosive environment, 1/4 inch male and female stainless steel quick connect fittings.



2. Type 316 stainless steel non-sparking chain or cabling (16-foot minimum length).
3. Pressure monitoring valve assembly with receptacles for gauge and relief valve (supply four total for attachment to air tubing end valves):
  - a. Products:
    - 1) Petersen Products Model 936-2300-025.
    - 2) Or approved equal.
4. Type 316 stainless steel mount brackets and screws for air tubing support.
5. Type 316 stainless steel cable/chain hanger.

**PART 3 EXECUTION**

3.01 GENERAL

- A. All manholes, wetwells and other precast structures shall be set in the dry.
- B. Remove and keep all water clear from the excavation during construction and testing operations.
- C. Manholes and other precast structures shall be constructed to the dimensions as shown on the Drawings and as specified herein.
- D. Place imported pipe base material on undisturbed earth; thoroughly compact with a mechanical vibrating or power tamper.

3.02 EXCAVATION AND BACKFILL

- A. Excavation: As specified in Section 31 23 16, Excavation.
- B. Backfill: As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES AND WETWELLS

- A. Concrete Base:
  1. Cast-In-Place:
    - a. The concrete structure shall be placed on the required crushed stone base as shown in the Drawings over a dry sub base of structural fill that has been compacted to 95 percent of the maximum dry density as determined by the modified proctor test, ASTM D1557. The tops of the cast in place bases shall be shaped to mate with the precast barrel section and shall be adjusted in grade so that the top of the dome section is at the correct elevation.

- b. Vibrate to densify concrete and screed so first precast manhole or wetwell section to be placed has a level, uniform bearing for full circumference.
  - c. Deposit sufficient mortar on base to assure watertight seal between base and structure wall, or place first precast section in concrete base before concrete has set. Properly locate and plumb first section.
2. Precast Structures:
- a. Place on compacted imported base material (Modified proctor at 95 percent compaction).
  - b. Properly locate, ensure firm bearing throughout, and plumb first section.
  - c. Precast bases conforming to all requirements of ASTM C478 and other requirements for precast sections may be used and shall be set on a sub base as described above.
  - d. Thoroughly clean ends of sections to be joined.
  - e. Precast concrete structure sections shall be set vertically with sections in true alignment with a 1/4-inch maximum tolerance per 5-feet of depth. The outside and inside joint shall be filled with a non-shrink mortar and finished flush with the adjoining surfaces. Allow joints to set for 24-hours before backfilling. Backfilling shall be accomplished bringing the fill up evenly on all sides. If leaks appear in the structures, the inside joints shall be caulked with non-shrink grout to the satisfaction of the Engineer. The Contractor shall install the precast sections in a manner that will result in a watertight joint.
  - f. Preformed Plastic Gaskets (In lieu of Mortar Joints):
    - 1) Carefully inspect precast manhole and wetwell sections to be joined.
    - 2) Do not use sections with chips or cracks in the tongue.
    - 3) Use only pipe primer furnished by gasket manufacturer.
    - 4) Install gasket material in accordance with manufacturer's instructions.
    - 5) Completed manholes and wetwells shall be rigid and watertight.
  - g. Rubber Gasketed Joints: Install in accordance with manufacturer's instructions.

### 3.04 MANHOLE INVERT

- A. Construct with smooth transitions to ensure an unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.
- B. Invert of leachate manhole shall be grouted with non-shrink grout. Flow it through channels shall be fabricated of half section HDPE pipe embedded in grout. Trowel mortar surfaces smooth.

3.05 CAST-IN-PLACE MANHOLE

- A. Reinforcing Steel: Install as specified in Section 03 30 10, Structural Concrete.
- B. Concrete: Install as specified in Section 03 30 10, Structural Concrete.

3.06 MANHOLE AND WETWELL FRAMES AND COVERS

- A. Set frames in bed of mortar with mortar carried over flange as shown.
- B. Set tops of covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.
- C. At locations shown, install exterior manhole frame to structure seals in accordance with manufacturer's instructions.

**END OF SECTION**



**SECTION 33 41 01  
STORM DRAIN PIPING**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:
  - 1. American Society for Testing and Materials (ASTM):
    - a. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
    - b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
    - c. C150, Standard Specification for Portland Cement.
    - d. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
    - e. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
    - f. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
    - g. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
    - h. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.

1.02 SUBMITTALS

- A. Quality Control Submittals: Manufacturer's Certification of Compliance.

**PART 2 PRODUCTS**

2.01 PIPE AND FITTINGS

- A. As specified in the Section 33 41 01.05, Reinforced Concrete Data Sheet following "END OF SECTION."

**PART 3 EXECUTION**

**3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES**

**A. General:**

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe bedding shall form a continuous and uniform bearing and support for the pipe barrel between joints. Pipe shall not rest directly on the bell or pipe joint.
4. Prevent entry of foreign material into gasketed joints.
5. Plug or close off pipes which are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.
6. Install storm drain pipes in accordance with Section 31 23 23.15, Trench Backfill.

**3.02 PRECAST STRUCTURES FOR STORMWATER MANAGEMENT**

- A. Stormwater structures shall be in accordance with FDOT Index shown on the Drawings in accordance with the FDOT-approved Standards for Road and Bridge Construction, latest edition.
- B. Stormwater Energy dissipators and headwalls shall be fabricated by an approved and certified Florida Department of Transportation supplier with at least 10 years of experience in fabrication of concrete manholes.
- C. Pipe connections for influent HDPE pipe to energy dissipators shall use pipe fitting. Pipe fitting shall be grouted in place with non-shrink grout. Solid wall PE4710 HDPE Pipe shall be as specified in Sections 40 27 00, Piping-General and Supplement.
- D. Twenty-four-inch diameter RCP conveys stormwater from the swales to the stormwater pond. The 24-inch diameter RCP Class V pipes shall be grouted into the headwall with non-shrink grout per the Drawings.

**3.03 STORM DRAIN PIPE CLEANING**

- A. Prior to final acceptance and final manhole-to-manhole inspection of the storm drain system by Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the storm system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

- B. Upon Engineer's final manhole-to-manhole inspection of the storm system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.04 SUPPLEMENTS

- A. The supplement listed below, following "END OF SECTION," is part of this Specification.

- 1. Data Sheet.

<u>Number</u>	<u>Title</u>
-05	Reinforced Concrete

**END OF SECTION**





<b>SECTION 33 41 01.05 REINFORCED CONCRETE PIPE</b>	
<b>Item</b>	<b>Description</b>
Pipe	ASTM C76, Wall B, Class III, Class V as shown on the Drawings. Mark each joint with pipe class. Rotating packer or platform not allowed.
Cement	ASTM C150, Type II, or ASTM C150, Type I, with fly ash; maximum 12 percent Tricalcium Aluminate, or ASTM C595 Rev A, Type IP, with fly ash; Cement: ASTM C150. Minimum 564 pounds per cubic yard without fly ash. Minimum 479 pounds per cubic yard with fly ash.
Ratio: Water to Cementitious Materials	Not over 0.49.
Fly Ash	ASTM C618, Class C or Class F, Tables 1 and 2 Modified as Follows:  Loss on Ignition: Maximum 3 percent Water Requirement: Maximum 100 percent of control Ratio Percent CaO/Fe <sub>2</sub> O <sub>3</sub> : Maximum 1.5  or test cement fly ash mix in accordance with ASTM C1012. Mix: Equal to or better than ASTM C150, Type II cement.  85 pounds per cubic yard minimum, 160 pounds per cubic yard maximum.  Test: ASTM C311 and ASTM C618.
Joints	ASTM C443. Captive gasket in groove or step joint with a profile gasket.
Rubber Gaskets	ASTM C443.
Tee Fittings	Reinforced concrete, rubber gasketed. Provide plug when service piping is not required.
Plugs	Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
Circumferential Reinforcement	Not closer than 1 inch to inside surface of pipe. Area of outer circular reinforcing cage not less than 75 percent of inner cage.

<b>SECTION 33 41 01.05 REINFORCED CONCRETE PIPE</b>	
<b>Item</b>	<b>Description</b>
Elliptical Reinforcement	Not allowed.
Source Quality Control Testing	<p>Load Bearing 0.01-inch Crack, Compressive Strength and Absorption: ASTM C76.</p> <p>Load Bearing Ultimate: ASTM C76.</p> <p>Permeability: ASTM C497.</p> <p>Voids: Longitudinally sawcut one pipe from each 100 lengths of pipe manufactured in half with saw that will not damage the concrete or reinforcing steel. Inspect for voids adjacent to circumferential bars. Voids will be considered continuous if a 1/16-inch diameter pin can be inserted 1/4-inch deep. If voids exist adjacent to more than 10 percent of the circumferential bars, two additional pipes shall be tested. If either of the two pipes fail, the entire 100 lengths will be rejected.</p>

**END OF SECTION**

**SECTION 33 46 23.19  
COMPOSITE DRAINAGE NET (CDN)**

**PART 1 GENERAL**

**1.01 REFERENCES**

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

1. American Society for Testing and Materials (ASTM):
  - a. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
  - b. D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
  - c. D3776, Standard Test Method for Mass Per Unit Area (Weight) of Fabric.
  - d. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
  - e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  - f. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
  - g. D5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
  - h. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
  - i. F904, Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials.

**1.02 DEFINITIONS**

- A. Minimum Average Roll Value (MinARV): Minimum of a series of average roll values representative of the product furnished.
- B. Maximum Average Roll Value (MaxARV): Maximum of a series of average roll values representative of the product furnished.
- C. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

1.03 SUBMITTALS

A. Shop Drawings:

1. Material Specifications, descriptive Drawings, and literature.
2. Description of method of tying and joining CDN materials.
3. Layout and installation Drawings.

B. Samples:

1. Sewn or heat seamed joints of geotextile.
2. On request, 2 square yards of geotextile from each shipment.

C. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance.
2. Installation procedures.
3. Report of geonet testing performed and reported in accordance with ASTM D4716 showing tested transmissivity.
4. Mill Certificate or Affidavit:
  - a. Signed by legally authorized official from company manufacturing materials.
  - b. Attest that geosynthetic materials meet chemical, physical, and manufacturing requirements stated in this Specification.

D. Submittal Review Conference:

1. In order to expedite the Shop Drawing submittal and review process, a Submittal Review Conference will be scheduled by the Engineer 7 days after the Contractor's submittal of the Shop Drawings, qualifications, samples and quality control documents for CDN, HDPE Geomembrane, and GCL.
2. Engineer will coordinate with the Contractor to set the time and place for this conference. The representatives of Contractor, Installer, and Manufacturers are required to attend this conference to receive review comments, and to discuss with the Engineer, if needed, submittal questions regarding the specification requirements.
3. The Contractor shall prepare the shop drawing re-submittal for CDN, Geomembrane and GCL, if required, based on the final review comments received at this conference.
4. If the initial submittal for any one of these products (CDN, GCL and Geomembrane) meets the specifications in the opinion of the Engineer and there are no resubmittals required, attendance will not be needed and discussion of the Shop Drawing for that product will not be included in the conference agenda.

1.04 PRE-INSTALLATION MEETING

- A. Preinstallation meeting shall be held prior to placement of CDN. At minimum, Contractor, CDN installer, and Engineer shall be in attendance. Agenda for such meeting shall consist of schedule for beginning and completing Work, projected crew size, details of panel layout and joining, and recognized potential problems associated with installation.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver Marked or Tagged with the Following:
  - 1. Manufacturer's name.
  - 2. Product identification.
  - 3. Lot number.
  - 4. Roll number.
  - 5. Roll dimensions.
- B. Materials shall be wrapped in original, unopened packaging during shipment and storage.
- C. Unload and store materials with minimum handling.
- D. Do not store materials directly on ground. Ship and store products with suitable wrapping for protection against moisture and ultraviolet exposure. Store product in ways that protects it from elements. If stored outdoors, elevate and protect materials with waterproof cover..

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

- A. CDN shall be end product of one manufacturer in order to achieve standardization for performance, appearance, maintenance, and replacement.

2.02 MATERIALS

- A. Geonet:
  - 1. Geonet Component: Shall consist of polyethylene extruded ribs manufactured to form a porous tri-planar net structure of uniform pattern and distinct openings. Shall be manufactured with roll width of at least 6 feet. Polyethylene resin used in geonet production shall have the following minimum properties:
    - a. Specific Gravity: Minimum 0.94 per ASTM D1505.
    - b. Ultraviolet Light Resistance: 2 percent carbon black.

- c. Transmissivity:  $4 \times 10^{-3}$  square meters per second ( $m^2/sec$ ) when tested between two 60-mil HDPE geomembranes, hydraulic gradient of 0.1 and vertical load of 15,000 pounds per square foot (psf) for a duration of 100 hours using ASTM D4716. A minimum of two tests shall be conducted by the Contractor.

B. Composite Drainage Net (CDN):

1. General: Shall consist of geonet drainage layer with geotextile filter layer bonded to either one or both sides of geonet and shall be specifically designed for specified application, as noted on Drawings. The CDN shall have a minimum transmissivity value of at least:
  - a. Single-sided CDN for Leachate Collection System:  $5.0 \times 10^{-3}$  square meters per second ( $m^2/sec$ ) at a hydraulic gradient of 0.02 and  $9 \times 10^{-4}$  square meters per second ( $m^2/sec$ ) at a hydraulic gradient of 1.0, when tested between sand on top and underlain by a 60-mil HDPE geomembrane, vertical load of 15,000 pounds per square foot (psf) for a duration of 100 hours using ASTM D4716. A minimum of two tests shall be conducted by the Contractor.
  - b. Single-sided CDN for Leak Detection System:  $3.3 \times 10^{-3}$  square meters per second ( $m^2/sec$ ) at a hydraulic gradient of 0.02 and  $6 \times 10^{-4}$  square meters per second ( $m^2/sec$ ) at a hydraulic gradient of 1.0, when tested between a GCL on top and underlain by a 60-mil HDPE geomembrane, vertical load of 15,000 pounds per square foot (psf) for a duration of 100 hours using ASTM D4716. A minimum of two tests shall be conducted by the Contractor.
  - c. Double-sided CDN for Leachate Detection System (under GCL):  $1.5 \times 10^{-3}$  square meters per second ( $m^2/sec$ ) when tested between GCL on top and underlain by a 60 mil HDPE geomembrane, hydraulic gradient of 0.1 and vertical load of 15,000 pounds per square foot (psf) for a duration of 100 hours using ASTM D4716. A minimum of one test shall be conducted by the Contractor.
  - d. Double-sided CDN for Leachate Detection System (under geomembrane):  $2.2 \times 10^{-3}$  square meters per second ( $m^2/sec$ ) when tested between two HDPE geomembranes, hydraulic gradient of 0.1 and vertical load of 15,000 pounds per square foot (psf) for a duration of 100 hours using ASTM D4716. A minimum of one test shall be conducted by the Contractor.
2. Geonet Component: Shall consist of polyethylene extruded ribs manufactured to form a porous, tri-planar net structure of uniform pattern and distinct openings. Shall be manufactured with roll width of at least 6 feet. Polyethylene resin used in geonet production shall have the following minimum properties:
  - a. Specific Gravity: Minimum 0.94 per ASTM D1505.
  - b. Ultraviolet Light Resistance: 2 percent carbon black.

3. Geotextile Component: Shall be nonwoven, consisting of polypropylene or polyester filaments oriented into stable network held together by needle-punching so that filaments retain their relative position with respect to each other. Edges shall be selvaged or otherwise finished to prevent outer material from pulling away. Nonwoven geotextile shall also meet the following minimum properties:
  - a. Weight: 6.0 ounces per square yard (MinARV) per ASTM D3776.
  - b. Water Permittivity (Falling Head): 1.3/second to 1 second (MinARV) per ASTM D4491.
  - c. Grab Tensile Strength: 145 pounds (MinARV) per ASTM D4632.
4. Minimum peak and residual friction angles between nonwoven geotextile and overlying and underlying materials shall be at least 27 degrees as determined by ASTM D5321.

### 2.03 FABRICATION

- A. Factory bond nonwoven geotextile to one side or both sides of geonet.
- B. Extend geotextile minimum 3 inches beyond each edge of geonet.
- C. Laminate Bond Strength (Between Geonet and Geotextile): 1 pound per inch, measured in accordance with ASTM F904.
- D. Bonding shall provide full physical joining of planar surfaces without introducing adhesives or other foreign products.

### 2.04 SOURCE QUALITY CONTROL

- A. Factory test for specified physical material properties, except transmissivity, at minimum frequency of one test per 100,000 square feet. The transmissivity test shall be performed at a minimum frequency of one test per 200,000 square feet. Transmissivity test requirements are the same as paragraph 2.02.A.1.a except for duration. Duration for quality control tests shall be 15 minutes.
- B. The specified tests in Table 33 46 23.19-1 are the Contractor's responsibility. Contractor shall be responsible to retain an independent GAI certified laboratory for all CQC - designated testing. The cost to the contractor for all CQC testing shall be included in the lump sum portion of the bid by the Contractor.
- C. Contractor shall provide the Engineer's CQA laboratory with samples of geosynthetic liner and composite drainage materials, granular fill, and drainage sand for required CQA testing. Samples used for Contractor Quality Control and for Engineer's CQA laboratory shall be taken at the same time from the same place/material in quantities necessary to ensure enough material for successful testing. The cost to the contractor to obtain and ship geosynthetic samples, fill and drainage sand for CQA testing shall be included in the lump sum portion of the bid by the Contractor.

TABLE 33 46 23.19-1 GEOCOMPOSITE PROPERTY VALUES

Properties	Qualifiers <sup>(1)</sup>	Units	Values	Test Method	Test Frequency	
					MQC	CQC
Geonet Component						
Resin Density	Minimum	g/cc	0.94	ASTM D 1505	1 per batch	n/a
Resin Polymer Melt Index	maximum	g/10 min.	1.0	ASTM D1238	1 per batch	n/a
Polymer Density	Minimum	g/cc	0.94	ASTM D 1505	1/100,000 SF	
Mass per Unit Area	Minimum	lb/1,000 ft <sup>2</sup>	160 +/-10	ASTM D 3776	1/100,000 SF	1/200,000 SF
Carbon Black	range	%	2.0 - 3.0	ASTM D 1603	1/100,000 SF	n/a
Thickness	Minimum	mils	300 +/- 15%	ASTM D 5199	1/100,000 SF	n/a
Tensile Strength (MD and TD)	minimum	lb/in	145	ASTM D 5035	1/100,000 SF	1/100,000 SF
Geotextile Component						
Polymer Composition	minimum	%	95 Non-woven (polyester or polypropylene needle-punched)	-	n/a	n/a
Mass Per Unit Area	minimum	oz/ yd. <sup>2</sup>	6	ASTM D 3776	1/100,000 SF	n/a
Apparent Opening	maximum	US Sieve	#70	ASTM D 4751	1/100,000 SF	n/a
Flow Rate <sup>(5)</sup>	minimum	gal/min./ft <sup>2</sup>	110	ASTM D 4491	1/500,000 SF	n/a
Permittivity <sup>(5)</sup>	minimum	sec <sup>-1</sup>	1.1-1.3	ASTM D 4491		n/a
Grab Tensile	minimum	lb	145	ASTM D 4632	1/100,000 SF	1/200,000
CBR Puncture	minimum	lb	400	ASTM D 6241	1/100,000 SF	1/200,000
Burst Strength	minimum	lb	280	ASTM D 3786	1/100,000 SF	n/a
UV Resistance	minimum	% retained	70	ASTM D 4355 (after 300 hours)	n/a	n/a
Geocomposite						
In-situ Transmissivity	minimum	m <sup>2</sup> /s	33 46 23.19 Part 2.02B	ASTM D 4716		1/200,000 SF
Index Transmissivity (Ottawa Sand)	minimum	m <sup>2</sup> /s	Mfr. Value	ASTM D 4716	1/ 100,000 SF	n/a
Ply Adhesion	minimum	lb/in.	1.0	ASTM F 904 <sup>(4)</sup>	1/100,000 SF	n/a



**PART 3 EXECUTION**

3.01 EXAMINATION

- A. Prior to installation, inspect materials on site. CDN shall be rejected if it is found to have rips, holes, flaws, deterioration, or damage.

3.02 INSTALLATION

- A. Install in shingle fashion, with long dimensions downslope, and panel upslope overlying panel downslope.
- B. Install smooth and free of tension, stress, folds, wrinkles, or creases.
- C. Overlap geonet minimum width of 4 inches at each longitudinal (side-by-side) joint and minimum 12 inches at each transverse (end-to-end) joint.
- D. Overlap excess geotextile to obtain smooth surface, free of wrinkles and openings, across overlapped panels of geonet.
- E. Joints:
  - 1. Tie at 5-foot intervals along longitudinal joints and 2-foot intervals along transverse joints, using method approved by Engineer.
  - 2. Plastic ties or tying materials shall be of contrasting color to CDN panels for inspection.
  - 3. Metallic connectors shall not be allowed.
- F. Seam geotextile so that no slack material remains between seams.
- G. Use leakproof bags of sand to secure CDN during installation. Securing pins shall not be used.
- H. Protect CDN from contamination by surface runoff. Remove and replace contaminated CDN.
- I. Geotextile Repairs:
  - 1. Repair torn or punctured geotextile with geotextile patch extending minimum of 6 inches in all directions beyond damaged area.
  - 2. Secure by sewing or bonding as approved by Engineer.

3.03 PLACEMENT OF MATERIALS ON CDN

- A. Equipment shall not operate directly on CDN, except to minimum extent necessary to deploy specified geomembrane materials over CDN. Only low ground pressure equipment and methods approved by Engineer shall be used for deployment.

- B. Drainage, sand, GCL and geomembrane to be placed over CDN shall be installed in accordance with cover installation requirements in Section 33 05 01.10, High Density Polyethylene (HDPE) Geomembrane, and Section 33 47 13.07, Geosynthetic Clay Liner.
- C. Drainage sand to be placed directly on CDN shall be placed in an initial loose lift of at least 24 inches, carefully “rolled” onto CDN and lightly compacted using low ground pressure equipment. Do not “push” materials in manner that damages or displaces CDN.
- D. Additional lifts of cover shall be pushed or rolled carefully forward and compacted over initial lift. No sudden or sharp turns or rapid acceleration or deceleration shall occur while equipment is operating over CDN material.
- E. To extent possible, cover sand shall be placed across seams from upper panel to lower panel (e.g., in direction of CDN overlap).
- F. If damage occurs to CDN during spreading operation, clear cover from damaged area and repair as specified.

**END OF SECTION**

**SECTION 33 47 13.07  
GEOSYNTHETIC CLAY LINER**

**PART 1 GENERAL**

**1.01 REFERENCES**

- A. The following is a list of standards that may be referenced in this section:
  - 1. American Society for Testing and Materials (ASTM):
    - a. ASTM D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
    - b. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
    - c. ASTM D4643, Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
    - d. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    - e. ASTM D5084, Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
    - f. ASTM D5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
    - g. ASTM D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
    - h. ASTM D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
    - i. ASTM D5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
    - j. ASTM D5891, Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
    - k. ASTM D5993, Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.

**1.02 DEFINITIONS**

- A. Geosynthetic Clay Liner (GCL): Flexible panel made of layer of domestic, natural, high swelling sodium bentonite clay (montmorillonite) encapsulated between two geotextiles.
- B. Geotextile: Woven or nonwoven permeable manmade textile used with geotechnical engineering related materials.
- C. Minimum Average Roll Value (MinARV): Minimum of a series of average roll values representative of product furnished.

- D. Maximum Average Roll Value (MaxARV): Maximum of a series of average roll values representative of product furnished.
- E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

1.03 SUBMITTALS

- A. Shop Drawings:
  - 1. Product Data:
    - a. Recommended sealing compound.
    - b. Repair adhesive.
  - 2. Layout and Installation Drawings.
  - 3. Panel joining methods.
  - 4. Handling and storage instructions.
- B. Samples: On request from Engineer, 2 square yards of material from each shipment.
- C. Quality Control Submittals:
  - 1. Manufacturer's Certificate of Compliance, in accordance with Section 01 33 00, Submittals.
  - 2. Factory test results certified by manufacturer.
  - 3. Results of interface friction testing as required in this Section.
- D. Manufacturer's Certification of Subgrade Acceptability. GCL Manufacturer's Representative, Geomembrane Manufacturer's Representative, Contractor's Superintendent, Engineer's Field Representative, and County's Representative shall inspect the subgrade and complete the form attached at the end of this Section at the beginning of each day prior to placement of GCL. The manufacturers of GCL and geomembrane may at their discretion appoint and designate an on-site representative of the Geomembrane Installer as their on-site representative. Such assignment of responsibility to a designated person shall be in writing and signed by an authorized signatory of the manufacturer. If the designated person is changed or removed from this project, a new assignment of responsibility for the new on-site representative shall be submitted prior to the change.
- E. Submittal Review Conference:
  - 1. In order to expedite the Shop Drawing submittal and review process, a Submittal Review Conference will be scheduled by the Engineer 7 days after the Contractor's submittal of the Shop Drawings, samples, qualifications and quality control documents for CDN, HDPE Geomembrane, and GCL.

2. Engineer will coordinate with the Contractor to set the time and place for this conference. The representatives of Contractor, Installer, and Manufacturers are required to attend this conference to receive review comments, and to discuss with the Engineer, if needed, submittal questions regarding the specification requirements.
3. The Contractor shall prepare the shop drawing re-submittal for CDN, Geomembrane and GCL, if required, based on the final review comments received at this conference.
4. If the initial submittal for any one of these products (GCL, Geomembrane, CDN) meets the specifications in the opinion of the Engineer and there are no resubmitted required, attendance will not be needed and discussion of the Shop Drawing for that product will not be included in the conference agenda.

#### 1.04 QUALITY ASSURANCE

- A. Prior to packaging finished product, manufacturer shall inspect surface of each roll by using strong light source on one side of panel and observing other side for zones of inadequate bentonite distribution or by using other reliable methods, such as physical measurements or sampling, to detect deficiencies in uniformity of bentonite distribution. Deficient rolls shall be rejected.
- B. Manufacturer shall conduct mass/ unit area testing of the GCL in accordance with the minimum specified frequency of testing, described herein, and provide test results with Manufacturer's Quality Control certificate for each roll of GCL.
- C. Each roll shall be labeled with length, width, and weight, along with lot number and date of manufacture.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store GCL in dry, protected facility or in protected area on pallets off ground and covered with heavy, waterproof membrane that allows free flow of air between membrane and materials.

### **PART 2 PRODUCTS**

#### 2.01 MANUFACTURERS AND PRODUCTS

- A. Needle-Punched GCL Products:
  1. Minerals Technologies, Inc., formerly Colloid Environmental Technologies Co. (CETCO), Hoffman Estates, IL; BENTOMAT.
  2. SOLMAX, Inc., formerly GSE Environmental, Inc., Houston TX; Bentoliner NWL.
  3. Or approved equal products.

2.02 GEOSYNTHETIC CLAY LINING

- A. Panels of bentonite and encapsulating geotextiles manufactured shall perform as continuous lining. Panels shall contain at least 0.75 pounds per square foot of high-swelling sodium bentonite clay at 0 percent moisture content, or equivalent weight at other moisture content using ASTM D5993.
- B. Bentonite Shall Contain:
  - 1. High quality natural sodium bentonite without chemical resistance enhancers or polymers.
  - 2. Minimum Bentonite Swell Index of 24 mL/2g when tested pursuant to ASTM D5890.
  - 3. Maximum fluid loss of 18 mL when based on ASTM D5891 test standard.
- C. GCL shall be manufactured so that bentonite shall be continuously contained throughout GCL and to support geotextile so that no displacement of bentonite occurs when material is unrolled, moved, cut, torn, or punctured. To contain granular bentonite, GCL materials shall be stabilized by process of needle-punching through top and bottom layers of geotextile and bentonite.
- D. Encapsulating geotextile materials shall protect bentonite and be sufficiently porous to allow bentonite flow-through to create positive bentonite-to-bentonite seal at seams.
- E. Manufactured GCL Products Shall Meet the Following Material Properties for Materials delivered to the Project Site.

Property	Test Value	Test Method	Min. Test Interval MQC	Min. Test Interval CQC (Contractor)
Mass/ Area	1 (at 20 % Moisture)	ASTM D5993	One/ 100,000 SF	1/300,000 SF
Bentonite Content, lb/sq ft at 0% moisture content, MinARV	0.75	ASTM D5993	One/100,000 SF	1/300,000 SF
Clay Moisture Content, %, max. Moisture content at time of manufacture as certified by the manufacturer.	10	ASTM D4643	One/100,000 SF	
Woven Carrier Geotextile Weight oz/sq yd, MinARV	3.1	ASTM D5261	One/100,000 SF	
Maximum Fluid Loss	18 mL	ASTM D5891	One/ 200,000 lbs	

Property	Test Value	Test Method	Min. Test Interval MQC	Min. Test Interval CQC (Contractor)
Nonwoven Cover Geotextile Weight oz/sq yd, MinARV	6.0	ASTM D5261	One/100,000 SF	
Minimum Free Swell (mL/ 2mg)	24	ASTM D5890	One/100,000 SF	One/ 300,000 SF
Grab Strength, lbs-width, Tested Dry, MinARV	90	ASTM D4632	One/200,000 SF	
Typical Internal Shear Strength (psf) hydrated	500	ASTM 6243	One/ 500,000 SF	
Peel Strength, lbs- inch width, Tested Dry, MinARV MD	3.5	ASTM D6496	One/200,000 SF	
Index Flux, m <sup>3</sup> /m <sup>2</sup> /sec, max. at 5 psi max. confining stress	1x10 <sup>-8</sup>	ASTM D5887	One/200,000 SF	
Finished GCL Roll Width, Feet, MinARV	15	Linear Measurement	One per roll	N/A
Finished GCL Roll Length, Feet, MinARV	150	Linear Measurement	One per roll	N/A
Maximum Hydraulic Conductivity with site specific leachate	5.0 X 10 <sup>-11</sup> meters/sec	ASTM D5887 @ 5 psi Max. confining stress	N/A	One/300,000 SF

F. Manufacturer shall provide GCL samples for permeability testing. Sample shall be from different lots of the GCL proposed for this Project. Contractor will conduct compatibility tests on each Sample using actual landfill leachate from Cells 9-10 leachate tank at the Orange County Landfill according to ASTM D5887 at 5 psi maximum confining stress. GCL must meet the permeability requirement using site specific leachate. Required maximum permeability is 5.0 X 10<sup>-11</sup> meters/sec.

G. Shear Strength:

1. GCL shall have minimum peak internal friction angle of 27 degrees and as determined in laboratory using ASTM D5321, fully hydrated conditions, and confining pressures approximating those of proposed field conditions.
2. Test Documentation shall include:
  - a. Specimen size.
  - b. Supporting substrate conditions.

- c. Soil installation method.
  - d. Unit weight.
  - e. Moisture condition.
  - f. Normal loads used.
  - g. Rate of strain.
3. The test loading shall be 1,600 psf.

2.03 BENTONITE SEALING COMPOUND

- A. Bentonite sealing compound in granular form shall be same product used in manufacture of GCL materials.
- B. Sealing compound shall be applied to seal around penetrations and structures shown on Drawings and under repair patches. Manufacturer shall recommend minimum amount of sealing compound to use in each instance in order to affect adequate seal.

2.04 MANUFACTURER'S CONFORMANCE TESTING

- A. Property Conformance Documentation: Prior to liner delivery and installation, the Manufacturer shall provide the Engineer with the following:
  1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Specification, for equivalent.
  2. The Engineer shall verify that:
    - a. The property values certified by the GCL manufacturer meet all of the Specifications.
    - b. The measurements of properties by the GCL manufacturer are properly documented, and that the test methods used are acceptable.
- B. GCL Roll Documentations: Prior to shipment, the Manufacturer shall provide the Engineer with one Quality Control Certificate for every roll of GCL provided. The Quality Control Certificate shall be signed by the Manufacturer's responsible party. The Quality Control Certificate shall include at a minimum the MQC results for parameters listed in paragraph 2.02.
  1. Roll numbers and identification.
  2. Results of quality control tests. As a minimum, ASTM test methods shall be used to test for thickness and tensile strength.
  3. The required test frequency for grab tensile strength is one test every 200,000 square feet of material delivered to the project site.
  4. The required test frequency for bentonite content is one test every 100,000 SF material delivered to the project site.



5. An additional test is required when the frequency interval for the previous test is exceeded (e.g., six rolls require two tests, 300,100 square feet requires four tests).

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Inspect GCL materials delivered to project site for damage. Inventory by quantity, lot number, panel size, and weight. Provide copy of inventory to Engineer.
- B. Remove only quantity of material from storage that is to be installed during current work day.

**3.02 SUBGRADE PREPARATION**

- A. Surface on which GCL is to be installed shall be prepared in accordance with Section 31 23 13, Subgrade Preparation and as indicated on Drawings.
- B. Surface on which GCL is to be placed shall be maintained in firm, clean, dry, and smooth condition during GCL installation.

**3.03 PLACEMENT OF GEOSYNTHETIC CLAY LINING**

- A. Only those GCL panels that can be anchored and covered same day shall be unwrapped and placed in position.
- B. Place GCL surface on underlying soil with surface of GCL in contact with soil as recommended by manufacturer.
- C. GCL panels shall not be dragged over surface, except for slight adjustments as may be necessary for obtaining correct overlap of panels. Rolled-up panels shall not be allowed to unroll unrestrained down slope.
- D. Anchor trench for area to receive GCL shall be prepared as shown on Drawings before installation of GCL begins.
- E. Panels shall be placed to provide overlap of 6 to 9 inches on longitudinal seams and 24 inches on transverse seams. No lap seams parallel to slope shall be allowed on slopes steeper than 7H to 1V.
- F. GCL panels shall not be installed in standing water, while it is raining or when rain may begin before panels can be covered with HDPE geomembrane and protected. GCL shall be “dry” when installed and “dry” when HDPE geomembrane is installed over it.

- G. GCL shall be laid smooth without creases or wrinkles and without stretching material to fit area. GCL shall be free of tension or stress upon completion of installation.
- H. GCL shall be covered with required HDPE geomembrane cover as it is installed without getting more than two panel widths or 24 feet beyond cover system over GCL material. GCL is to be completely covered and protected at end of each shift or workday.
- I. Leading edge and panels of GCL left uncovered shall be protected with heavy, waterproof membrane or tarp that is adequately secured and protected with sandbags or other ballast.

3.04 SEAMING GCL PANELS

- A. Mark overlaps 6 and 9 inches from panel edge longitudinally on GCL to assist in obtaining proper overlap.
- B. Prior to lapping, remove dirt, gravel, or other debris from overlap area. Apply 1/4 pound of sealing compound per lineal foot of seam or as otherwise recommended by manufacturer, whichever, represents greatest amount of bentonite. Where soil and sand encroach lap areas after initial application of bentonite sealant, additional bentonite sealant in amount of 1/4 pound per lineal foot evenly shall be spread across longitudinal seam area.
- C. Seam overlap on slopes less than 7H to 1V shall be shingled so that direction of flow is from top panel onto bottom panel. On slopes steeper than 7H to 1V panels shall be placed with long dimension (length) continuous from crest to toe and upper end anchored in trench with soil backfill.
- D. Hot Weather Installation:
  - 1. Provide compensation for shrinkage when ambient temperatures are greater than 85 degrees F. At minimum, longitudinal overlap should be increased to 12 inches and transverse overlap should be increased to 36 inches.
  - 2. Dimensions to use for overlapping during temperatures greater than 85 degrees F shall be approved by Engineer.

3.05 PATCHING AND REPAIRS

- A. Irregular shapes, cuts, or tears in GCL shall be overlapped with additional layer of GCL material minimum of 12 inches in all directions from defect.
- B. Patch seams parallel to slope and secure with repair adhesive recommended by manufacturer.

- C. Patches and repairs shall not be allowed on slopes greater than 7H to 1V.
- D. Complete panels shall be removed and replaced with undamaged panels when damage is extensive as determined by Engineer.

3.06 PLACEMENT OF OVERLYING MATERIALS

- A. Equipment shall not operate directly on GCL, except to minimum extent necessary to deploy specified geosynthetic materials on GCL. Deploy geosynthetic materials with equipment and by methods approved by Engineer.
- B. Geomembrane to be installed over GCL shall be installed in accordance with cover installation requirements in Section 33 05 01.10, High Density Polyethylene (HDPE) Geomembrane.

3.07 SUPPLEMENTS

- A. The supplement listed below, following “END OF SECTION,” is part of this Specification.
  - 1. Manufacturer’s Certification of Subsurface Acceptability.

**END OF SECTION**



**MANUFACTURER’S CERTIFICATION  
OF  
SUBSURFACE ACCEPTABILITY**

Project: \_\_\_\_\_ Contract No.: \_\_\_\_\_

Date: \_\_\_\_\_

Partial: \_\_\_\_\_ Final: \_\_\_\_\_

Geomembrane Manufacturer \_\_\_\_\_  
and GCL Manufacturer \_\_\_\_\_ for  
Orange County Cells 11 and 12 Landfill Expansion, hereby certify that supporting surfaces  
are acceptable for installation of geomembrane and GCL, undersigned having personally  
inspected condition of constructed surfaces. This certification is for areas shown on  
Attachment Drawings or defined as follows:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Condition of supporting surfaces in defined area meets or exceeds minimum requirements for  
installation of geomembrane, GCL, and related products including, but not limited to,  
drainage nets, leachate collection piping, and drainage sand.

Acceptance No.: \_\_\_\_\_ Area Accepted: \_\_\_\_\_ S.F. Total Area Accepted to Date: \_\_\_\_\_ S.F.

**Geomembrane Manufacturer’s Representative**      **GCL Manufacturer or duly authorized  
Representative**  
Signed: \_\_\_\_\_ Signed: \_\_\_\_\_

\_\_\_\_\_  
**Position**      **Position**

Date: \_\_\_\_\_ Date: \_\_\_\_\_

**General Contractor’s Superintendent**  
Signed: \_\_\_\_\_ Date: \_\_\_\_\_

Subgrade surface noted above was observed and has been tested for compaction, as needed, and  
found to be in accordance with project requirements.

**Onsite Engineer’s Field Representative**  
Signed: \_\_\_\_\_ Date: \_\_\_\_\_

**Onsite County Resident Project Representative**  
Signed: \_\_\_\_\_ Date: \_\_\_\_\_



**SECTION 40 05 15  
PIPING SUPPORT SYSTEMS**

**PART 1 GENERAL**

**1.01 REFERENCES**

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

1. American Society for Testing and Materials (ASTM):
  - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
2. Building Officials and Code Administrators (BOCA): Basic Building Code.
3. International Conference of Building Officials (ICBO): Uniform Building Code.
4. Manufacturers' Standardization Society (MSS):
  - a. SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
  - b. SP 69, Pipe Hangers and Supports-Selection and Application.
  - c. SP 89, Pipe Hangers and Supports-Fabrication and Installation Practices.

**1.02 DEFINITIONS**

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

**1.03 SUBMITTALS**

A. Shop Drawings:

1. Drawings of piping support system, locating each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

B. Contract Closeout Submittals: Maintenance information on piping support system.

1.04 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89, or as modified by this section.

B. Pipe Support Systems:

1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.
2. Maximum Support Spacing and Minimum Rod Size:
  - a. Plastic and Fiberglass Piping:
    - 1) Maximum support spacing: As recommended by manufacturer for flow temperature in pipe not greater than spacing shown below.

High Density Polyethylene Piping:

<b>SDR 11, 13.5 &amp; 17 Pipe Size</b>	<b>Maximum Support/ Hanger Spacing</b>
1" – 2"	2 feet 6 inches
4" – 6"	4 feet
8" – 10"	5 feet
≥ 12"	6 feet

Polyvinyl Chloride Piping:

<b>Sch. 316L Pipe Size</b>	<b>Maximum Support/ Hanger Spacing</b>
½"	3 feet
1" – 2"	4 feet
4" – 6"	5 feet
8" – 10"	7.5 feet
≥ 12"	8 feet

- 2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.

C. Framing Support System:

1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
2. Column Members: Size in accordance with manufacturer's recommended method.



- 3. Support Loads: Calculate using weight of pipes filled with water.
  - 4. Maximum Spans:
    - a. Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.
    - b. Other Pipelines and Special Situations: May require supplementary hangers and supports.
  - 5. Electrical Conduit Support: Include in design of framing support system.
- D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
- E. Vertical Sway Bracing: 10-foot maximum centers, or as shown.

**PART 2 PRODUCTS**

2.01 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.
- B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.
- C. Materials: In accordance with Table 1, attached as supplements to this section.

2.02 HANGERS

- A. Clevis Type: MSS SP 58 and SP 69, Type 1 or 6.
  - 1. Grinnell; Figure 104 or 260.
  - 2. B-Line; Figure B3198 or B3100.
  - 3. Or approved equal.
- B. Hinged Split-Ring Pipe Clamp: MSS SP 58 and SP 69, Type 6 or 12.
  - 1. Grinnell; Figure 104.
  - 2. B-Line; Figure B3198H.
  - 3. Or approved equal.
- C. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

D. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.03 SADDLE SUPPORTS

A. Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

1. Nonadjustable Saddle: MSS SP 58 and SP 69, Type 37 with U-bolt.
  - a. Grinnell; Figure 259.
  - b. B-Line; Figure B3090.
  - c. Or approved equal.
2. Adjustable Saddle: MSS SP 58 and SP 69, Type 38 without clamp.
  - a. Grinnell; Figure 264.
  - b. B-Line; Figure B3093.
  - c. Or approved equal.

2.04 WALL BRACKETS

A. Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).

1. Grinnell; Figure 199.
2. B-Line; Figure B3067.
3. Or approved equal.

B. One-Hole Clamp: Grinnell; Figure 126.

C. Channel Type:

1. Unistrut.
2. Grinnell; Power-Strut.
3. B-Line; Strut System.

2.05 PIPE CLAMPS

A. Riser Clamp: MSS SP 58 and SP 69, Type 8.

1. Grinnell; Figure 261.
2. B-Line; Figure B3373.
3. Or approved equal.

2.06 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, 1-1/2-inch wide, minimum FRP.
- B. Members and Connections: Design for all loads with safety factor of 5.
- C. Manufacturers:
  - 1. B-Line; Strut System.
  - 2. Unistrut.
  - 3. Grinnell; Power-Strut.
  - 4. Aickinstrut (FRP System).

2.07 ACCESSORIES

- A. Insulation Shields:
  - 1. Type: Stainless steel, MSS SP 58 and SP 69, Type 40.
  - 2. Manufacturers and Products:
    - a. Grinnell; Figure 167.
    - b. B-Line; Figure B3151.
    - c. Or approved equal.
- B. Welding Insulation Saddles:
  - 1. Type: MSS SP 58 and SP 69, Type 39.
  - 2. Manufacturers and Products:
    - a. Grinnell; Figure Series 160.
    - b. B-Line; Figure Series B3160.
    - c. Or approved equal.
- C. Vibration Isolation Pads:
  - 1. Type: Neoprene Waffle.
  - 2. Manufacturers and Products:
    - a. Mason Industries; Type W.
    - b. Korfund; Korpad 40.
    - c. Or approved equal.
- D. Flush Type Insert Channels: As specified in Section 05 50 00, Metal Fabrications and Castings.

2.08 INTERMEDIATE PIPE GUIDES

A. Piping 6 Inches and Smaller:

1. Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8-inch clearance.
2. Manufacturers and Products:
  - a. B-Line; B3148 or B3180.
  - b. Grinnell; Figure 103.
  - c. Or approved equal.

B. Piping 8 Inches and Larger:

1. Type: Specially formed U-bolts with double nuts to provide 1/4-inch minimum clearance around pipe.
2. U-Bolt Stock Size:
  - a. 8-Inch Pipe: 5/8 inch.
  - b. 10-Inch Pipe: 3/4 inch.
  - c. 12-Through 16-Inch Pipe: 7/8 inch.
  - d. 18-Through 30-Inch Pipe: 1 inch.

2.09 PIPE ALIGNMENT GUIDES

A. Type:

1. Piping 8 Inches and Smaller: Spider or sleeve type.
2. Piping 10 Inches and Larger: Roller type.

B. Manufacturers:

1. Flexonics.
2. Grinnell.
3. B-Line.

2.10 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturers and Products:

1. Grinnell; Figure 198.
2. B-Line; Figure B3147A or B3147B.
3. Or approved equal.

2.11 ANCHORING SYSTEMS

A. Size: Sized by equipment manufacturer, 1/2-inch minimum diameter.

**PART 3 EXECUTION****3.01 INSTALLATION****A. General:**

1. Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise.
2. Support piping connections to equipment by pipe support and not by equipment.
3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
4. Support no pipe from pipe above it.
5. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
6. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
7. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing to reduce movement after startup.
8. Install lateral supports for seismic loads at all changes in direction.
9. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
10. Repair mounting surfaces to original condition after attachments are made.

**B. Standard Pipe Supports:**

1. Horizontal Piping Supported From Walls:
  - a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
  - b. Stacked Piping:
    - 1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.
    - 2) Piping clamps that resist axial movement of pipe through support not acceptable.
  - c. Wall mounted piping clips not acceptable for insulated piping.
2. Horizontal Piping Supported From Floors:
  - a. Stanchion Type:
    - 1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
    - 2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above floor and for exterior installations.
    - 3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

- b. Floor Mounted Channel Supports:
    - 1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
    - 2) Attach channel framing to floors with anchor bolts.
    - 3) Attach pipe to channel with clips or pipe clamps.
  - c. Concrete Cradles: Use for piping larger than 3 inches along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
  - 3. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
  - 4. Standard Attachments:
    - a. To Concrete Ceilings: Concrete inserts.
    - b. To Steel Beams: I-beam clamp or welded attachments.
    - c. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
    - d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
  - 5. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.
- C. Intermediate and Pipe Alignment Guides:
- 1. Provide pipe alignment guides (or pipe supports that provide same function) at all expansion joints and loops.
  - 2. Guide piping on each side of an expansion joint or loop at 4- and 14-pipe diameters from each joint or loop.
  - 3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.
- D. Accessories:
- 1. Insulation Shield: Install on insulated nonsteel piping. Oversize rollers and supports.
  - 2. Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.
  - 3. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
  - 4. Dielectric Barrier:
    - a. Install between carbon steel members and copper or stainless steel pipe.
    - b. Install between stainless steel supports and nonstainless steel ferrous metal piping.
  - 5. Electrical Isolation: Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.02 SUPPLEMENTS

- A. The supplement listed below, following “END OF SECTION,” is part of this Specification.
  - 1. Table 1, Areas.

**END OF SECTION**





<b>TABLE 1 AREAS</b>	
<b>EXPOSURE CONDITIONS</b>	<b>HANGER MATERIAL</b>
All Areas	Stainless steel

Notes:

1. Stainless steel to be Type 316.



**SECTION 40 27 00  
PIPING - GENERAL**

**PART 1 GENERAL**

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:
1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
  2. American National Standards Institute (ANSI):
    - a. A21.52, Ductile Iron Pipe, Centrifugally Cast, Gas.
    - b. B1.20.1, Pipe Threads, General Purpose (Inch).
    - c. B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
    - d. B16.3, Malleable Iron Threaded Fittings.
    - e. B16.5, Pipe Flanges and Flanged Fittings.
    - f. B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
    - g. B16.11, Forged Fittings, Socket-Welding and Threaded.
    - h. B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
    - i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
    - j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
    - k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500 and 2500.
    - l. B16.25, Butt Welding Ends.
    - m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
  3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
  4. American Society of Mechanical Engineers (ASME):
    - a. Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels.
    - b. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
    - c. B31.1, Power Piping.
    - d. B31.3, Process Piping.
    - e. B31.9, Building Services Piping.
    - f. B36.10M, Welded and Seamless Wrought Steel Pipe.
  5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

6. American Society for Testing and Materials (ASTM):
  - a. A47, Standard Specification for Ferritic Malleable Iron Castings.
  - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
  - d. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
  - e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - f. A135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
  - g. A139, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
  - h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
  - j. A182/A182M, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
  - k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
  - l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
  - m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both.
  - n. A197/A197M, Standard Specification for Cupola Malleable Iron.
  - o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
  - p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  - q. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
  - r. A276, Standard Specification for Stainless Steel Bars and Shapes.
  - s. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
  - t. A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength.
  - u. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

- v. A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
- w. A320/A320M, Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service.
- x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
- aa. A536, Standard Specification for Ductile Iron Castings.
- bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
- dd. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- ee. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- ff. B32, Standard Specification for Solder Metal.
- gg. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- hh. B61, Standard Specification for Steam or Valve Bronze Castings.
- ii. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- jj. B75, Standard Specification for Seamless Copper Tube.
- kk. B88, Standard Specification for Seamless Copper Water Tube.
- ll. B98/B98M, Standard Specification for Copper-Silicone Alloy Rod, Bar and Shapes.
- mm. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
- nn. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
- oo. D413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
- pp. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- qq. D1330, Standard Specification for Rubber Sheet Gaskets.
- rr. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- ss. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

- tt. D2000, Standard Classification System for Rubber Products in Automotive Applications.
  - uu. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
  - vv. D2464, Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  - ww. D2466, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  - xx. D2467, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  - yy. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
  - zz. ASTM D2657, Heat Joining of Thermoplastic Pipe and Fittings.
  - aaa. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
  - bbb. ASTM D3035, Polyethylene Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
  - ccc. D3222, Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
  - ddd. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
  - eee. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
  - fff. D4101, Standard Specification for Propylene Plastic Injection and Extrusion Materials.
  - ggg. F437, Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
  - hhh. F439, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
  - iii. F441, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
  - jjj. F491, Standard Specification for Poly (Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings.
  - kkk. F493, Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
  - lll. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
7. American Water Works Association (AWWA):
- a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  - b. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches for Water and Other Liquids.

- c. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- d. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
- e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
- f. C153/A21.53, Ductile-Iron Compact Fittings 3 Inches Through 24 Inches and 54 Inches Through 64 Inches, for Water Service.
- g. C200, Steel Water Pipe - 6 Inches and Larger.
- h. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches and Larger - Shop Applied.
- i. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 Inches Through 144 Inches.
- j. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
- k. C213, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
- l. C606, Grooved and Shouldered Type Joints.
- m. M11, Steel Pipe - A Guide for Design and Installation.
- 8. American Welding Society (AWS):
  - a. A5.8, Specification for Filler Metals for Brazing and Braze Welding.
  - b. QC 1, Standard for AWS Certification of Welding Inspectors.
- 9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP43, Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials.
- 10. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

- A. Submerged or Wetted: Zone below elevation of: Liquid surface or within 3 feet above top of liquid surface.

1.03 DESIGN REQUIREMENTS

- A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:
  - 1. Process Piping: ASME B31.3.
  - 2. Building Service Piping: ASME B31.9, as applicable.
  - 3. Sanitary Building Drainage and Vent Systems: Local plumbing code.
  - 4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO Standard Specifications for Highway Bridges, as applicable.
  - 5. Thrust Restraints:
    - a. Design for test pressure shown in Piping Schedule.
    - b. Allowable Soil Pressure: 1,000 pounds per square foot.

- c. Low Pressure Pipelines:
  - 1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
  - 2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

#### 1.04 SUBMITTALS

##### A. Shop Drawings:

- 1. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
- 2. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
- 3. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
- 4. The Contractor shall verify with pipe manufacturer all connection details.
- 5. Leachate Bypass Pumping Plan to maintain Cell 9-10 leachate flow during connection of new Cell 11 Leachate piping to existing system. The bypass pumping shall include an emergency response plan to be followed in the event of a failure bypass pumping system.

##### B. Quality Control Submittals:

- 1. Manufacturer's Certification of Compliance.
- 2. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.

##### C. Single Pipe Submittals:

- 1. Submit supplier's experience with these systems.
- 2. Pipe and Materials: Submit on cell class according to ASTM D3350 and applicable standards identified by the cell class.
- 3. Submit pipe sizes per ASTM F714 and ASTM D3035. Submit that any molded fittings in the system that shall meet ASTM D 3261. Submit details of typical fittings including ells, tees, end terminations, etc.
- 4. Submit data on system fusion welding procedure(s) and welding equipment required. Submit handling and storage data. Submit comprehensive system testing guidelines. Submit Fusion Technician certifications from pipe manufacture that technicians are qualified and have experience to fusion weld HDPE pipe 8-inch diameter or larger.



D. Dual Containment Piping System Submittals:

1. Submit supplier's experience with these systems.
2. Pipe and Materials: Submit on cell class according to ASTM D3350 and applicable standards identified by the cell class.
3. Submit carrier and containment pipe sizes per ASTM F714 or ASTM D3035. Submit that any molded fittings in the system that shall meet ASTM D 3261. Submit details of typical fittings including ells, tees, end terminations, etc.
4. Submit data on system fusion welding procedure(s) and welding equipment required. Submit handling and storage data. Submit comprehensive system testing guidelines.
5. Submit Fusion Technician certifications from pipe manufacture that technicians are qualified and have experience to fusion weld HDPE pipe 8-inch diameter or larger.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 60 00, Material and Equipment, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

1.06 HANDLING AND STORAGE OF HIGH-DENSITY POLYETHYLENE PIPE

- A. The Contractor shall exercise special care during the unloading, handling, and storage of all polyethylene pipe to ensure that the pipe is not cut, gouged, scored, or otherwise damaged. Any pipe segment, which has cuts in the pipe wall exceeding 10 percent of the wall thickness, shall be cut out and removed from the site at the Contractor's cost. The pipe shall be stored so that it is not deformed axially or circumferentially, which may hinder pipe installation. After the unloading of any pipe material ordered to the Project site and before installation of the pipe, the Contractor shall inspect all pipes to verify its condition prior to installation with the Engineer and/or the Project Inspector. A pipe condition inspection report shall be filed with and approved by the Engineer prior to installation.
- B. All polyethylene pipe without an ultraviolet inhibitor shall not be stored unprotected against the outside elements.

**PART 2 PRODUCTS**

2.01 PIPING

- A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement. This section also covers materials for polyethylene dual-contained system of pipe, structures and leak detection. Dual containment pipe is used at pipe penetrations in Bays 17-19 to the leachate collection and detection manholes.
- B. Diameters Shown: Standardized Products: Nominal size.

2.02 DUAL CONTAINMENT PIPING SYSTEM

- A. The dual containment piping system for gravity flow of leachate shall be ISCO Dual Contained Pipe from ISCO Industries, LLC, J-M Manufacturing Company, Inc. or approved equal.
- B. Pipe supplied for dual containment system shall have IPS (Iron Pipe Size) OD and shall meet ASTM D3035. Pipe sizes shall be as shown on the piping schedule and on the Drawings.
- C. Fittings shall be manufactured with the same OD as carrier and containment pipe and have minimum pressure rating for carrier equal to the carrier pipe.
- D. Pipe Joints and fittings shall be supplied to the job site ready for simultaneous butt-fusion. The fabricator shall show that the materials are capable of butt-fusion and shall provide a procedure to consistently produce sound welds.
- E. Carrier pipe support shall be with full round centralizers welded to the carrier pipe. Centralizer support spacing per Plastic Piping Institute standards.
- F. The centralizers will be either molded or machined from HDPE Pipe Grade resins or sheet. Manual or hand cut centralizers are not permitted since they have a low degree of dimensional accuracy. Centralizers should have at least two openings that will permit the flow of liquid between the carrier pipe and the containment pipe. The centralizer shall be thermally bonded to the primary carrier pipe and maintain position and alignment of the primary carrier in relation to the secondary containment piping. Each end of pipe will have a centralizer that is thermally bonded to both the OD of the primary carrier and the ID of the secondary containment piping and designed such that movement will be restrained between the two piping systems during the butt fusion process. The OD of the centralizer shall match the ID of the containment piping as closely as possible.

- G. End termination fittings shall be used to seal the system at both ends. The fitting shall be simultaneously butt fused to the carrier and containment pipe to seal the annular space. Terminations that are not butt fused in the system will not be allowed. This fitting will also provide the transition to single wall piping.

## 2.03 JOINTS

- A. Flanged Joints:
  - 1. Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.
  - 2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.
- B. Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.
- C. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.
- D. Mechanical Joint Anchor Gland Follower:
  - 1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
  - 2. Manufacturer and Product: EBAA Iron Inc.; Megalug.
  - 3. Or approved equal.
- E. Flexible Mechanical Compression Joint Coupling:
  - 1. Stainless steel, ASTM A276, Type 305 bands.
  - 2. Manufacturers:
    - a. Pipeline Products Corp.
    - b. Fernco Joint Sealer Co.
    - c. Or approved equal.
- F. Mechanical connections of high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:
  - 1. A polyethylene stub end thermally butt-fused to end of pipe.
  - 2. ASTM A240, Type 304 stainless steel backing flange, 125-pound, ANSI B16.1 standard. Insulating flanges shall be used where shown.
  - 3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
  - 4. Gaskets as specified on Data Sheet.

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### 2.04 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

### 2.05 VENT AND DRAIN VALVES

- A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
- B. Pipelines 2-1/2 Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

### 2.06 FINISHES

- A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.
- B. Galvanizing:
  - 1. Hot-dip applied, meeting requirements of ASTM A153.
  - 2. Electroplated zinc or cadmium plating is unacceptable.
  - 3. Stainless steel components may be substituted where galvanizing is specified.

## **PART 3 EXECUTION**

### 3.01 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

### 3.02 PREPARATION

- A. All Work shall be performed as specified herein and supervised by personnel experienced in the installation of the pipe.
- B. The Project Foreman assigned to the Project by the Contractor shall be onsite at all times from the time of inception to the time of completion. The Project Foreman shall not be replaced without prior consent of the Engineer.
- C. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

- D. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- E. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.03 PREPARATION FOR DUAL CONTAINED PIPING

- A. Pipe shall be prefabricated prior to shipment to the jobsite. No onsite fabrication to the pipe, fittings or system shall be allowed without express written consent of the Engineer and the piping supplier.
- B. Pipe shall be stored on clean, level, dry ground to prevent undue scratching or gouging of the pipe. The pipe ends shall be capped to prevent water and dirt from contaminating the annular space between the pipes. If the pipe must be stacked for storage, such stacking should be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe should be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.
- C. Segments of pipe having cuts or gouges in excess of 10 percent of the wall thickness of the pipe shall be cut out and removed. The undamaged portion of pipe can be rejoined after a new end piece has been welded to the pipe.

3.04 INSTALLATION-GENERAL

- A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
- B. Remove foreign objects prior to assembly and installation.
- C. Flanged Joints:
  - 1. Install perpendicular to pipe centerline.
  - 2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
  - 3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
  - 4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
  - 5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
- D. Threaded and Coupled Joints:
  - 1. Conform with ANSI B1.20.1.
  - 2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.

3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Couplings:

1. General:
  - a. Install in accordance with manufacturer's written instructions.
  - b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
2. Application:
  - a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
  - b. Nonmetallic Piping Systems: Teflon bellows connector.
  - c. Concrete Encased Couplings: Sleeve type coupling.

F. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

G. PVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

H. High Density Polyethylene Piping:

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.
2. Butt-fusion shall be performed in accordance with pipe manufacturer's recommendations as to equipment and technique. The Contractor shall perform trial fusion welds in the field and submit samples to the Engineer for review prior to installation of the pipe. Full penetration welds shall provide a homogeneous material across the cross section of the weld. The fusion machine employed for the trial welds shall be the same machine to be utilized for the complete Project installation Work.

3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.
4. Fusion equipment shall be operated only by technicians who have been certified by the pipe manufacturer or Supplier and who have a minimum of 2 years' experience of fusion welding 8 inches or larger diameter pipelines. The technician's experience, certification of successful fusion welds, and verifiable references shall be documented in the HDPE pipe submittal.
5. The certification shall include certified laboratory data confirming that said tests have been performed on the type of pipe to be provided under this Contract, and that satisfactory results were obtained prior to any installation of said pipe.
6. Only those tools designed for the aforementioned procedures and approved by the pipe manufacturer or Supplier and the Engineer, shall be used for assembly of pipe fittings to ensure proper installation. The heater plate shall be equipped with suitable means to measure the temperature of plate surfaces and to assure uniform heating such as thermometers or pyrometers.
7. Pipe Joining:
  - a. Sections of polyethylene pipe shall be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. Fusion equipment used in the joining procedure shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, fusion temperature, alignment, and fusion pressure. Electrofusion may be used for field closures as necessary when appropriate fusion equipment can be utilized in a trench type environment. For end sections or "tail" pipe, the use of electrofusion couplings as manufactured by GF Central Plastics can be utilized.
  - b. A fire-retardant bag or suitable enclosure shall be used with the heater plate to facilitate control of heating process and to protect the heater plate surfaces from dirt and other debris when not in use. The heater plate surfaces shall be cleaned regularly as needed to prevent accumulation of fusion welding residues or other substances that may result in faulty pipe joining.
  - c. Butt fusion shall conform to ASTM D2657 and pipe manufacturer's criteria for the type of joining. Joint strength shall be equal to that of the adjacent pipe.
  - d. The inside and outside of pipe ends shall be cleaned with a cotton or non-synthetic cloth to remove dirt, water, grease, and other foreign materials. The pipe ends shall be cut square and carefully aligned just prior to heating.

- e. After achieving the proper melt pattern, the pipe ends shall be brought together in a firm, rapid motion applying sufficient pressure to form a pipe bead (1/8 inch to 3/16 inch in height) around and inside the entire circumference of the pipe.
- f. Fused segments of pipe shall be moved as needed to avoid damage to the pipe. Handle dual contained pipe with care. Limit bending of the pipe. Nylon slings are preferred.
- g. A representative of the dual containment pipe fabricator shall be onsite to train the contractor's personnel. Only the system supplier or those personnel trained by the system supplier are approved to simultaneous weld dual containment pipe.
- h. Modification to the dual containment system will be done only by a representative of the dual containment pipe fabricator or trained installer. This includes changes in lengths of pipe and special tie in connections.

### 3.05 INSTALLATION-EXPOSED PIPING

#### A. Piping Runs:

- 1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
- 2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

#### B. Supports: As specified in Section 40 05 15, Piping Support Systems.

#### C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

#### D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

#### E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

#### F. Piping Clearance, Unless Otherwise Shown:

- 1. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inches, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.



2. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
4. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
5. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
6. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION-BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes: Provide flexible mechanical compression joints for pressure pipe.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's Work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
  - a. Shorter pipe lengths.
  - b. Special mitered joints.
  - c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.

11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line except PVC or HDPE: Maximum 2 inches.
2. Deflection from Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist due to hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.
2. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through the coupling sleeve.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer or thrust tie-rods and socket clamps.

- D. Thrust Blocking:
  1. Place between undisturbed ground and fitting to be anchored.
  2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
  3. Place blocking so that pipe and fitting joints will be accessible for repairs.
  4. Place concrete in accordance with Section 03 30 10, Structural Concrete.

3.08 BRANCH CONNECTIONS

- A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.
- B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.
- C. Threaded Pipe Tap Connections:
  1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
  2. Limitations: Threaded taps in pipe barrel are unacceptable.

3.09 SERVICE CONNECTIONS

- A. Connection of new service to existing wastewater/leachate force main shall be accomplished by butt fusion welds. If electrofusion fittings are used, they must be approved by Engineer during Shop Drawing review. Electrofusion connections shall be specifically designed for connection to the HDPE forcemain being installed, and shall be Central Electrofusion System, as manufactured by GF Central Plastics, Shawnee, Oklahoma or approved equal.

3.10 BYPASS PUMPING

- A. The Contractor shall provide bypass pumping for acceptable completion of the pipe installation. Bypass pumping shall consist of furnishing, installing, and maintaining all power, primary and standby pumps, appurtenances, and bypass piping required to maintain existing leachate flows from Bays 9-10 to the leachate storage tank. The Contractor shall submit a plan for bypass pumping diversion in accordance with paragraph 1.04.A Contractor Submittals of this Specification. The bypass pumping shall include an emergency response plan to be followed in the event of a failure of the bypass pumping system.

- B. Bypass pumping shall be done in such a manner as not to damage public property or create a nuisance or public menace. The pumped leachate shall be in an enclosed hose or pipe that is adequately protected from traffic and shall be redirected into leachate collection and conveyance system. Dumping or free flow of leachate into storm sewers or stormwater ponds is prohibited. The Contractor shall be liable for all cleanup, damages, and resultant fines in the event of a spill. After the Work is completed, flow shall be routed to the leachate collection/transmission system and all temporary equipment removed.
- C. The Contractor shall take all necessary precautions to ensure that no public properties are subjected to a leachate or condensate backup or spills are totally contained within the Project limits.
- D. The Contractor shall pump out or otherwise positively drain all locations of leachate or condensate, a minimum of once every 24 hours.
- E. The Contractor shall bypass or contain all leachate service connections from the time of disconnection to the time of reconnection by means of mechanical pumps and manifold system or by a bladder tank system, capable of holding adequate leachate or condensate from each service connection for a period of 24 hours. Each bladder shall be emptied or pumped each 24-hour period and properly disposed of in accordance to the Specification.
- F. When pumping is in operation, all engines shall be equipped in a manner to keep the pump noise to a minimum.

### 3.11 RECONNECTION OF LEACHATE/ CONDENSATE SERVICE CONNECTIONS

- A. The Contractor shall successfully test the installed pipe prior to reconnecting leachate collection and transmission services.

### 3.12 VENTS AND DRAINS

- A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown.

### 3.13 CLEANING

- A. Following assembly and testing, for final acceptance, flush leachate collection and leachate detection gravity pipes and force mains (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed. Leachate collection and leachate detection gravity systems must be cleaned, inspected and video camera verified with a certified report generated for submittal to FDEP as described in paragraph 3.14.

- B. If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush at lower velocity.
- C. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- D. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

### 3.14 PIPE TESTING – HDPE LANDFILL GAS PIPE

- A. Clean all piping of debris. Cleaning for tight lines shall consist of mechanically blowing air into one end of the section, discharging debris from the other end in a safe manner. Contractor shall provide mechanical blower for this cleaning. The cleaning operation shall demonstrate air velocities in the pipe of over 23 m/s (4,500 fpm) for 1 hour at all points along the centerline of the pipe. Alternatively, the pipe may be cleaned with a pig. Pipe may be cleaned in sections.
- B. Air Testing: All solid landfill gas piping (both above and below ground) shall be air tested for leakage. The line shall be tested with the ends of the piping temporarily closed. After all plugs are in place and securely blocked, introduce air slowly into the pipe section to be tested until the internal air pressure reaches 5.0 pounds per square inch greater than atmospheric pressure. Allow a minimum of 2 minutes for the air temperature to stabilize. Pipe and joints being air tested shall be considered acceptable when tested at an average pressure of 5.0 pounds per square inch greater than atmospheric pressure, when the section of line does not lose air at a rate greater than 0.0030 cubic foot per minute per square foot of internal pipe surface. Contractor shall provide calculations for maximum acceptable loss before testing and field data sheets with test results for Engineer approval.
- C. Piping shall be tested in its final configuration. Pipe sections shall be tested with all blind flanges and other connections in place in the same configuration that they will be under during operation of the system. Testing shall ensure that all pipe welds, blind flanges, and other connections are leak free according to the criteria listed above.
- D. Pipe test failures shall require the Contractor to find and fix the point(s) of leakage causing the failure. The section shall then be retested and the process repeated until all sections of pipe pass the air testing criteria.

3.15 DUAL CONTAINMENT PIPE TESTING

- A. Dual Containment pipe testing shall be air pressure tested for leakage. Inner pipe and outer containment pipe shall be adequately plugged and tested. Inner pipe should be tested first, followed by outside pipe at test pressure and duration as defined in paragraph 3.04 of Section 40 80 01, Piping Leakage Testing. Prior to testing, the pipes shall be cleaned using water for flushing, allowing the flush water to drain into manhole.

3.16 JET CLEANING AND VIDEO INSPECTION OF LEACHATE COLLECTION AND DETECTION PIPES.

- A. Prior to final acceptance and inspection by the Engineer and after the placement of drainage sand, Contractor shall completely flush and clean all parts of the newly installed Cell 11 primary and secondary leachate collection system. Remove all accumulated construction debris, rocks, sand, and other foreign material from the leachate collection system by jet cleaning. Contractor shall video camera survey the leachate collection system documenting that the entire system is clean and undamaged. Contractor to provide to the Owner an inspection report and video tape record of leachate collection pipelines performed by a qualified firm experienced in cleaning, inspecting, and video taping pipelines.

3.17 CLEANING AND VIDEO INSPECTION OF LFG COLLECTION AND TRANSMISSION PIPES

- A. Prior to final acceptance, Contractor shall completely clean all parts of the Cell 11 Landfill Gas Collection System (Headers, Header stubouts, condensate drains, Condensate force mains, and condensate sumps. Remove all accumulated sand and other foreign material from the LFG collection and transmission system.
- B. The initial phase of the Cell 11 LFG system consists of a 30-inch header pipe with stubouts for future connection of LFG minor headers and laterals within the perimeter berm. The temporary 24-inch LFG header at the south end of the initial construction phase (Bays 17 through 19 or at the south berm of Bay 25) that conveys LFG between east-west headers shall be flushed and cleaned, Contractor shall video camera survey the Cell 11 LFG transmission main system documenting the pipe condition and that the entire system is clean. Contractor to provide to the Owner an inspection report and video tape record of LFG pipelines performed by a qualified firm experienced in cleaning, inspecting, and video tap-in pipelines.

3.18 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.
- B. As specified in Section 09 90 00, Painting and Protective Coatings.

3.19 PIPE IDENTIFICATION

- A. See Piping Schedule.

3.20 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in Section 40 80 01, Piping Leakage Testing.

3.21 WARRANTY

- A. The Contractor shall provide to the Owner a warranty to be in force and effect for a period of 1 year from the date of final acceptance by the Owner. The warranty shall require the Contractor to repair or replace the pipe should leakage, separation, collapse, or other failure result from faulty materials or installation as determined by the Engineer.

3.22 SUPPLEMENTS

- A. The supplements listed below, following “END OF SECTION,” are part of this Specification.
  1. Piping Schedule Legend.
  2. Piping Schedule.
  3. Data Sheets.

<b>Number</b>	<b>Title</b>
-08	Stainless Steel Pipe and Fittings—General Service
-14	High Density Polyethylene (HDPE) Pipe

**END OF SECTION**





**PIPING SCHEDULE LEGEND**

**SERVICE**

AHP	Air, High Pressure
BYP	Bypass
LE	Leachate
LE/PRI	Primary Leachate Collection
LE/SEC	Secondary Leachate Detection
LFG	Landfill Gas
LFG/CO	Landfill Gas and Condensate
SD	Storm Drain
SD/LE	Storm Drain/Leachate from Storm Water Sump
SD/PRI	Storm Drain/Primary Leachate

**EXPOSURE**

BUR	Buried
EXP	Exposed
SUB	Submerged

**JOINT TYPE**

FW	Fusion Weld
FLG	Flanged

**MATERIAL**

HDPE	High Density Polyethylene
SST	Type 316 Stainless Steel

**PRESSURE TEST**

H	Hydrostatic
P	Pneumatic
I	In Service