

**Technical Specifications and
Construction Quality Assurance Plan for
Cell 2 of Horizontal Expansion of
Original Combustion Waste Storage Area**

**Orlando Utilities Commission
Stanton Energy Center
Orange County, Florida**



Prepared by:



Ardaman & Associates, Inc.

Geotechnical, Environmental, and
Materials Consultants

A Tetra Tech Company

Revision P0

November 2018

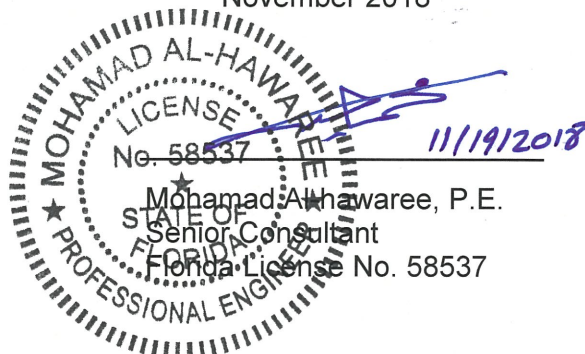


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SPECIFICATIONS

SECTION 1 LIST OF SPECIFICATION SECTIONS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

Section	Title
1	List of Specification Sections
2	Intent
3	List of Drawings
4	Contractor's Understanding, Description of Work, Definitions, and General Conditions
5	Site Preparation and Earthwork Construction
6	Construction of Soil Liner
7	HDPE Liner Materials for Bottom Liner System
8	HDPE Liner Installation for Bottom Liner System
9	Geocomposites, Geonets, and Geotextiles for Bottom Liner System
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11	Pressure-Rated HDPE Pipe and Fittings
12	Concrete and Reinforcing Steel
13	Concrete Uniform Section Mat
14	HDPE Liner Materials for Final Cover System
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16	Geocomposites for Final Cover System
17	Protective Soil Cover for Final Cover System
18	Sodding
19	Site Limitations
20	General Provisions
21	Final Inspection and Acceptance
22	Scheduling and Coordination

SPECIFICATIONS

SECTION 2 INTENT

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

These specifications present the minimum standards for providing the required materials and construction quality to ensure proper construction of Cell 2 of the lined horizontal expansion of the existing Combustion Waste Storage Area (CWSA) at the Orlando Utilities Commission (OUC) Stanton Energy Center (SEC) in Orange County, Florida. They also specify the construction, field inspection, sampling, quality control/quality assurance testing, and maintenance procedures associated with site preparation, earthen dike construction, excavation and grading, soil liner construction, geomembrane liners installation, geosynthetic drainage products placement, leachate collection and leak detection systems construction, and all other works associated with construction of the proposed lined landfill expansion.

Responsibilities of the parties involved and the minimum qualifications of each party to fulfill their responsibilities are included in these specifications. During the construction work, the following documents should be referred to: (i) technical specifications (Specifications), (ii) construction drawings (Drawings), (iii) applicable manufacturer's quality control/assurance manuals, (iv) Contractor's quality control plan, (v) applicable Florida Department of Environmental Protection (FDEP) regulations, (vi) applicable Occupational Safety and Health Administration (OSHA) safety regulations and OUC safety policy; and (vii) applicable ASTM International (ASTM) and Florida Department of Transportation (FDOT) standards.

The work covered by these specifications includes construction of one of three approximately 30-acre cells that comprise the 90-acre horizontal landfill expansion. The landfill cells will be used by OUC for disposal of: (i) fixated flue gas desulfurization (FGD) sludge, often referred to as ProMat; (ii) bottom ash; (iii) brine solids; (iv) miscellaneous wastes consisting of FGD recirculation tank sludge, scrubber sludge blowdown, cooling tower sludge, stack cleanout residue, scrubber residuals, waste coal, coal pulverizer rejects, lined pond cleanouts, soils that have contacted process water, and various power plant sump cleanouts.

Construction of the lined landfill expansion will require construction of earthen containment and perimeter dikes around the cell, and installation of a bottom liner system with a leachate collection/leak detection system on the inside slope of the containment dike, the bottom of the landfill, and the west slope of the existing landfill. The work consists of furnishing all labor, materials, plant, equipment, tools, supervisory personnel, and Contractor's facilities to undertake construction for one approximately 30-acre landfill cell and associated stormwater management facilities to the lines, grades and dimensions shown on the Drawings and in accordance with the Specifications. The work shall include the following major tasks:

- Clearing, grubbing, and stripping of the designated construction areas; excavating, dewatering, borrowing, moisture conditioning, hauling, placing, and compacting soil for grading the bottom of the landfill cell; and constructing earthen dikes and stormwater drainage ditches.
- Removing any incidental deleterious materials (e.g., topsoil, organic soil, debris) from the on-site soil stockpiles designated for construction by the Owner.
- Controlled burning of vegetation from the clearing, grubbing, and stripping operations.
- Removing any unsuitable soils (e.g., topsoil, organic soil, debris) within the designated construction area, and either dispose of them at on-site locations designated by the Owner or, if approved by the Engineer, stockpile them for later use in the upper 6 inches of the outer slope of the containment dike and the perimeter dike.
- Excavating any waste materials that exist at less than 6 inches below the liner design grades and transporting them to Cell 1 for disposal, at locations designated by the Owner, and backfilling any excavated areas with an approved fill material to achieve the liner design grade.
- Dewatering and demucking of the existing stormwater drainage ditch along the west side of the haul road that runs along the west side of the original CWSA and has been used as an access road for hauling of waste materials into Cell 1.
- Removing any standing water within the designated construction area and providing stormwater runoff and runoff control systems to allow construction to occur in-the-dry.
- Pumping all leachate (i.e., water has come into contact with any exposed waste materials during construction) to the CWSA Runoff Pond, which is located east of the CWSA, during the entire construction period.
- Relocating an existing soil stockpile within the Cell 2 footprint to another on-site location designated by the Owner.
- Supplying, hauling, conditioning, placing, and compacting clayey soil material to construct a minimum 12-inch thick compacted soil liner with a saturated hydraulic conductivity of no greater than 1×10^{-7} cm/sec as well as fine grading and maintenance of all surfaces until the overlying high density polyethylene (HDPE) liners and geocomposites are ready to be placed.
- Supplying all materials and installing approximately 30 acres of a minimum 60-mil thick textured HDPE geomembrane liner to the lines and grades shown on the Drawings, including all required ancillary items. This lower HDPE geomembrane liner serves as the secondary leakage barrier placed on the compacted soil liner.
- Supplying all materials and installing approximately 30 acres of HDPE geocomposite drainage layer that serves as the leak detection and secondary leachate collection layer.

- Supplying all materials and installing approximately 39 acres of a minimum 60-mil thick textured HDPE geomembrane liner. This upper HDPE geomembrane liner serves as the primary leakage barrier at the base of the horizontal landfill expansion and on the west slope of the existing landfill to a maximum elevation of +175 feet (NAVD88).
- Supplying all materials and installing approximately 39 acres of HDPE geocomposite drainage layer that serves as the primary leachate collection and removal system at the base of the horizontal landfill expansion and on the west slope of the existing landfill to a maximum elevation of +175 feet (NAVD88).
- Exposing the Cell 1 bottom liner system along the north side of Cell 1 and connecting it to the Cell 2 bottom liner system, as shown on the Drawings.
- Exposing the Cell 1 slope liner system along the north side of Cell 1 and connecting it to the Cell 2 slope liner system, as shown on the Drawings.
- Supplying all materials and installing 8-inch diameter slotted DR 17 HDPE leachate collection pipes wrapped with gravel and 12 oz/yd² needle-punched polypropylene geotextile. Leachate collection piping shall be installed to collect leachate from the geocomposite drainage products and convey it to a lined leachate collection sump. The liners, leak detection, and leachate collection systems shall be installed to the lines, grades, and locations shown on the Drawings.
- Hauling, placing, conditioning, and compacting a 2-foot thick drainage/protective sand layer on top of the upper geocomposite at the base of the horizontal landfill expansion and on the west slope of the existing landfill to a maximum elevation of +175 feet (NAVD88).
- Installing pumps and all miscellaneous facilities associated with removing leachate from the lined leachate collection and leak detection sumps.
- Extending an existing force main to convey leachate from the leachate collection and leak detection sumps to the existing CWSA Runoff Pond.
- Sodding of the lined area of Cell 2 on top of the west slope of the original landfill, the crest road of the perimeter dike, the inside and outside slopes of the containment dike and perimeter dike, the stormwater drainage ditches, and any other areas disturbed by the construction activities.
- Clearing, grubbing, and stripping; excavating, dewatering, borrowing, moisture conditioning, hauling, placing, and compacting soil to construct: (i) drainage ditches, (ii) flumes, (iii) pipes and box culverts, and (iv) other miscellaneous items associated with stormwater management.
- Constructing an access road into Cell 2.
- Maintaining and cleaning all roadways used by construction traffic at all times such that there is no buildup of dirt or debris on the road surfaces to cause dusting emission.

- Installing cleanouts for the existing force main that conveys leachate from Cell 1 to the CWSA Runoff Pond, as shown on the Drawings.

Other works covered by the Specifications also include, but are not limited, to: (i) surveying; (ii) site preparation and stripping of designated areas; (iii) demolition and removal of debris or foreign objects from within the limits of construction; (iv) access road construction and maintenance; (v) repair to any facilities, equipment or property damaged by the Contractor; (vi) hauling and spraying water to control dusting; (vii) dewatering and control of surface water runoff; (viii) maintenance of completed work items until final acceptance of the entire construction by the Owner; and (ix) site clean-up.

The work shall be executed in conformity with the Drawings and these Specifications and the best acceptable standard practices. The Contractor shall use only competent, skilled workmen in all phases of construction.

The proposed expansion will involve more than one contractor during the construction period. Each contractor shall coordinate his work activities with the Owner and all other contractors involved in the project.

SPECIFICATIONS

SECTION 3 LIST OF DRAWINGS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

The drawings listed below have been developed for construction of Cell 2 of the horizontal expansion of the CWSA. Materials shall not be ordered, or work shall not start before receiving the set of Drawings and Specifications labeled "Issued for Construction". The drawings may be revised later to change the location or arrangement of the work, provide additional details, or include additional information or changes in some features of the work. Such revisions shall not be deemed cause for a price change unless it can be shown that the Contractor's work has changed materially and substantially.

Drawing No.	Revision	Title
GENERAL DRAWINGS		
G-1	P0	COVER SHEET
G-2	P0	INDEX OF DRAWINGS AND PROJECT LOCATION MAPS
G-3	P0	GENERAL NOTES, ABBREVIATIONS AND SYMBOLS
G-4	P0	AERIAL PHOTOGRAPH OF STANTON ENERGY CENTER
G-5	P0	TOPOGRAPHIC MAP
G-6	P0	AERIAL PHOTOGRAPH OF HORIZONTAL EXPANSION - CELL 2
G-7	P0	TOPOGRAPHIC SURVEY OF HORIZONTAL EXPANSION - CELL 2
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SPECIFICATIONS

SECTION 4 CONTRACTOR'S UNDERSTANDING, DESCRIPTION OF WORK, DEFINITIONS, AND GENERAL CONDITIONS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

4.1 Description of Work

The work for this project involves construction of Cell 2 of the lined horizontal expansion north of existing Cell 1, and on top of the west slope of the closed original CWSA. The landfill will be used for disposal of the coal combustion residuals (CCR) and other miscellaneous wastes.

The Contractor shall furnish all materials, equipment, supplies, tools, labor, and supervision necessary to perform the work covered by these Specifications and as shown on the Drawings. All work is to be performed and construction completed in accordance with the alignments, lines, grades, and dimensions defined in these Specifications and as shown on the Drawings. The Owner and the Engineer reserve the right to modify the design grade as well as any design elements during construction to maintain cut and fill balance and to expedite construction activities.

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4.2 Definition of Parties Involved

Specific items and parties or individuals that are involved with construction of the proposed landfill expansion are as follows:

- “Owner” refers to Orlando Utilities Commission.
- “Engineer” refers to the Design Engineer and/or the Construction Quality Assurance Engineer who is retained by the “Owner” to design and/or oversee any or all aspects of construction and installation quality, inspection, and testing.
- “Contractor” refers to the organization that is retained by the “Owner” for performance of site preparation, earthwork, bottom liner system installation, and other tasks associated with construction of the proposed landfill expansion.
- “Liner Manufacturer” or “Manufacturer” refers to the organization that will manufacture and supply the geomembrane liners and/or geosynthetic drainage products.
- “Liner Installer” refers to the organization that will be retained by the “Contractor” for installation of the geomembrane liners and geosynthetic drainage products.
- “Regulatory Agency” or “Agency” refers to the Florida Department of Environmental Protection (FDEP), which has the regulatory authority to review this project.

4.3 Responsibility and Authority

The principal organizations involved in the design and construction works associated with the proposed landfill expansion, as defined in Section 4.2, will have the following responsibilities and authorities in construction quality assurance (CQA). Delineation of these responsibilities and authorities will establish the necessary lines of communication that will facilitate decision making during construction.

4.3.1 Owner

The Owner will oversee, manage, and approve execution of all works associated with construction of the proposed landfill expansion. To accomplish the above overall task, the Owner will hire/engage, as necessary, the parties defined in Section 4.2. The Owner has the responsibility to ensure that the approved dewatering plan and CQA Plan are adhered to during construction. The dewatering plan must be signed and sealed by a Florida-licensed professional engineer, and submitted by the Contractor to the Owner for review and written approval. The Owner has the authority to select and dismiss the Engineer, the Contractor, the Liner Installer and/or the Liner Manufacturer, and to demand replacements of incompetent personnel at any time, as determined solely by the Owner. The Owner also has the authority to accept or reject design plans and specifications, recommendations of the Engineer, the supplied materials, and workmanship of the Contractor and its subcontractors.

4.3.2 Engineer

The Engineer is responsible for the design and construction specifications and quality assurance activities as specified in this CQA Plan.

Specific responsibilities of the Engineer shall include:

- Reviewing design criteria, plans, specifications, and CQA Plan.
- Providing and educating the inspection personnel on the CQA requirements and procedures.
- Reviewing Contractor's quality control plan to ensure that it conforms to the CQA Plan.
- Scheduling, directing, and coordinating the CQA activities.
- Providing results of the CQA activities to the Owner on a regular basis and at the end of the project. Additional responsibilities delegated to the Engineer by the Owner may include periodic review of CQA documentation and specifying corrective measures for any non-conformance with the project specifications.

The inspection personnel provided by the Engineer shall have the following specific responsibilities:

- Performing independent inspection of the work in progress to verify compliance with the design and construction criteria, Drawings, and Specifications.
- Verifying that all testing equipment used meet the test requirements and that the tests are conducted in accordance with standard procedures specified in the CQA Plan.
- Reporting to the Engineer the results of all inspections including the work that is not of acceptable quality or fails to meet the specification requirements.

4.3.3 Contractor

The responsibility of the Contractor is to perform all the construction activities in accordance with the design and construction criteria, the Drawings, and Specifications. The Contractor shall submit all the shop drawings and other necessary documents for approval by the Engineer. The Contractor is also responsible for cooperating with the Engineer in conducting all CQA inspection and testing activities. Furthermore, the Contractor is responsible to manage its subcontractors and to make sure they understand and adhere to the Specifications and the contractual requirements between the Owner and the Contractor. All contractual requirements between the Owner and Contractor shall “flow down” to the contracts between the Contractor and its subcontractors. Furthermore, the Contractor shall include the full text of the Specifications and contractual requirements for each subcontract executed for this project.

4.3.4 Liner Installer

The responsibility of the Liner Installer, working as a subcontractor to the Contractor, is to install the geomembrane liners and geosynthetic drainage products in accordance with the Drawings and Specifications. The Liner Installer shall submit all the shop drawings and other necessary documents for approval by the Engineer. The Liner Installer is also responsible for cooperating with the Engineer in conducting all CQA inspection and testing activities.

4.3.5 Regulatory Agency

The Regulatory Agency has the responsibility and authority to review all permit conditions and requirements, the dewatering plan, and the CQA documentation during and after construction to confirm that the dewatering plan and CQA Plan are adhered to during construction and that construction procedures and quality conform to the Specifications.

4.4 **Qualifications**

4.4.1 Engineer

The CQA Engineer and testing laboratory shall have the following minimum qualifications:

- The Engineer and the testing laboratory must have at least five continuous years of experience in similar projects immediately prior to the date of this project.

- The Engineer must have inspected and tested a minimum of five liner projects consisting of at least 5,000,000 square feet of geomembrane liner.
- The Engineer shall be familiar with the ASTM International, GRI, and other applicable testing standards. The testing laboratory shall possess testing equipment capable of testing geomembrane liner seams for peel and shear in accordance with ASTM D6392. The laboratory shall have performed at least 5,000 sets of peel and shear tests on geomembrane liner seams.
- The Engineer shall be capable of providing qualified technicians to perform the required tests on geomembrane liner and able to provide test results within 48 hours of receipt of samples requiring laboratory testing. The Engineer shall also be capable of providing technicians to perform full-time inspection and testing during site preparation, earthwork construction, geomembrane liner, and drain installation.
- The Engineer must be a full-time registered Professional Engineer in the state of Florida and be able to sign, seal, and certify that the project was constructed in accordance with the requirements stipulated in the Specifications.

4.4.2 Contractor

To be considered qualified for this project, the Contractor and its subcontractors must be well experienced in earthwork construction, placement and compaction of the soil liner below the geomembrane liners, and pipe installation. The Contractor must also be well experienced in project management, dike construction, earthwork excavation and grading, drain and culvert installation, dewatering, earthwork restoration, slope dressing, and fine grading of the liner subgrade.

At a minimum, the Contractor shall demonstrate the successful completion of at least three projects over the past 5 years similar in size and scope to this project. For each project submitted to document the Contractor's experience, the following information on the completed facility must be provided: (i) the name and purpose of the facility; (ii) the location and date of construction; (iii) the name of the facility owner and design engineer; (iv) the name and telephone number of a contact person at the facility who can discuss the project; and (v) description of the project, scope of work, and construction methods used.

The Contractor shall provide adequate and competent superintendence of all demolition and construction activities in connection with the work at all times. The Contractor shall either personally superintend his work or shall hire a competent superintendent that is approved by the Owner, and such representative shall be authorized to receive instructions from the Owner. The Owner shall have the rights to have the Contractor replace any incompetent personnel or subcontractors working on this project. The superintendent shall have authority to make sure that the work is carried out in accordance with the CQA Plan, Drawings, and Specifications in a first-class, thorough, and competent manner in every respect.

4.4.3 Liner Manufacturer

The Liner Manufacturer for this project shall be AGRU America, Inc., or other qualified liner manufacturer approved by the Owner prior to bid submittal. In any event, sufficient documentation shall be provided to the Owner of previously demonstrated ability to produce the specified liner by having successfully manufactured a minimum of 15 million square feet of HDPE liner installed in similar applications. The Manufacturer shall also provide documentation that he has satisfactorily produced textured HDPE liners, and that such production has been on-line for at least 6 months. The Manufacturer shall submit to the Owner, the Manufacturer's Quality Assurance - Quality Control Plan for review by the Owner. **Continuous spark testing of all liners manufactured for this project at the production facility is required prior to delivery of the liner rolls to the project site.**

The Manufacturer must provide to the Owner a written commitment that sufficient commercial quantities of the textured HDPE liners will be available for this project at the time of construction. The Manufacturer shall also submit specification sheets detailing minimum physical and chemical properties of the proposed 60-mil textured HDPE liner (including testing methods), field seaming methods and properties, and a certificate confirming compliance with the Specifications for this project.

4.4.4 Liner Installer

To be considered qualified for this project, the Liner Installer and all subcontractors must be well experienced in the installation of HDPE liners. The Liner Installer shall be the Manufacturer of the HDPE liner or an approved Installer trained and/or licensed to install the HDPE liner supplied by one of the approved liner manufacturers. If the Liner Installer is not the Manufacturer, then the Liner Installer must submit a written certification, or license to install, provided by an approved Liner Manufacturer.

The Liner Installer shall have installed HDPE liner in similar applications, for a period of not less than two years. The Liner Installer shall submit to the Owner a list of at least ten completed facilities, totaling a minimum of 4 million square feet, for which the Liner Installer has installed an HDPE geomembrane liner of the same type as specified in these Specifications. For each installation, the following information shall be provided:

- Name and purpose of facility, location, and date of installation.
- Name of Owner and Engineer, liner Manufacturer, and name and telephone number of contact at the facility who can discuss the project.
- Type and thickness of HDPE liner installed, and surface area covered (textured and smooth).
- Type of field seaming performed, and names of the Installation Supervisor and Master Seamer representing the Liner Installer.
- Crew size and typical daily production per crew.

The Liner Installer shall also submit to the Owner, for approval by the Engineer, a copy of the Manufacturer's standard specifications for liner handling and installation, and Quality Assurance - Quality Control Plans for review by the Owner. Moreover, the Liner Installer must submit qualification resumes for the HDPE liner Installation Supervisor(s) and Master Seamer(s) that will actually be performing the work on-site, including documentation that each has similar experience on completed facilities totaling a minimum of 4 million square feet of HDPE liner installation, for review and approval by the Owner. The Owner reserves the right to have the Contractor dismiss and replace any incompetent liner Installation Supervisor(s) and Master Seamer(s).

All other seamers or welders and quality control/testing technicians representing the Liner Installer who will be involved in the installation shall have a minimum of 1.5 million square feet of related HDPE liner installation experience.

4.5 Reports and Documentation

4.5.1 Contractor

Throughout the construction period, the Contractor shall maintain a careful record of any changes on the Drawings during actual construction. Any changes, in addition to the Contractor's field construction notes, shall be neatly and legibly prepared. In addition, the Contractor shall take construction photographs to document all demolition and construction activities, and submit them to the Owner on a weekly basis. The Contractor shall submit three copies of the notes and marked Drawings to the Owner, on a monthly basis, or more frequently if requested by the Owner. Upon completion of the work, and prior to acceptance by the Owner, the Contractor shall file with the Owner two sets of complete Drawings with all changes and the Contractor's field construction notes neatly and legibly recorded thereon. Such information will be used by the Engineer to prepare record Drawings for the Owner. Drawings may not be materially changed, except with the written approval of the Engineer, and the work cannot be considered as having been completed until the Engineer has approved it in writing. The Contractor shall not seek approval from the CQA technicians for any deviations from the Drawings and Specifications. Any design modifications or deviations from Drawings and Specifications can only be approved in writing by the Engineer.

4.5.2 CQA Engineer and Technician

Documentation of the CQA activities during construction shall consist of the following: (i) daily field reports; (ii) inspection, test data sheets, and photographs; (iii) acceptance reports for completed components; and (iv) final report.

A daily field report shall be prepared by the lead CQA technician to document the CQA activities of the day. At a minimum, the daily field report shall include the following information: (i) date, project name, location and any other project identification; (ii) description of weather condition; (iii) description of work locations for the day; (iv) description of equipment and personnel used during the day; (v) description of work performed and CQA activities; (vi) description of materials received; (vii) any equipment calibrations; (viii) any approval of completed work and/or rejection of work that did not meet the project specifications; (ix) any supporting inspection data sheets; (x) reports of any meetings held and their results; (xi) description of any problems and suggested

corrective measures; and (xii) signature of the CQA personnel. The CQA technician shall work under the supervision of the Engineer and consult daily with the Engineer on CQA activities and any associated problems.

Inspection and test data sheets used to document various CQA inspection and testing activities shall include the following information: (i) date, project name, location and any other project identification, (ii) description of inspection activity or test, (iii) location of inspection activity or test sample, (iv) result of inspection/test and comparison with project specifications, (v) personnel involved in the inspection/testing activity, and (vi) signature of the CQA personnel.

Photographs shall be taken as necessary to keep pictorial records of completed work, work in progress, problems and/or corrective measures. These photographs shall be submitted to the Owner on a weekly basis. The photographic data sheets shall contain the following information: (i) date, project name, location and any other project identification, (ii) location and description of work, (iii) purpose of the photograph, and (iv) signature of the CQA personnel.

Upon acceptance of a completed component of work by the CQA inspector, appropriate acceptance forms shall be filled out and signed by the CQA inspector and the Contractor's or Installer's representatives. At a minimum, the acceptance report shall contain the following information: (i) date, project name, location and any other project identification, and (ii) location and description of the accepted component.

At the completion of the project, the Engineer shall submit a final report, which summarizes the results of the CQA inspection and testing activities for the project. This document shall be signed and sealed by the Engineer and will become a part of the CQA Plan documentation. The final CQA report shall be submitted within 60 days of completion of all construction associated with the project, as outlined within the scope of services and approved by the Owner.

4.6 Project Meetings

Weekly project meetings shall be conducted by the Owner who will arrange for the meetings, record minutes, and distribute copies to the participants and those affected by the decisions made at the meetings. The project meetings shall consist of pre-construction CQA meeting, progress meetings, and problems or work deficiency meetings.

The pre-construction CQA meeting shall be attended by the Owner, the Engineer, the Contractor and the Liner Installer. Each participating organization will be provided with all relevant CQA documents and the following items shall be discussed at the meeting: (i) the role and responsibility of each organization in carrying out the CQA Plan, (ii) the authority and lines of communication for each organization, (iii) procedures for inspection, sampling, and testing, (iv) procedures for handling construction deficiencies, repairs, and re-testing, (v) methods for documenting and reporting inspection data, (vi) methods for distributing documents and reports, (vii) work area safety and security protocol, and (viii) storage and protection of construction materials. Following the pre-construction meeting, a site tour shall be conducted for visual observation of the site conditions by various organizations in relation to the above CQA Plan items.

Progress meetings shall be conducted weekly at a time determined at the pre-construction meeting. The progress meeting shall be attended by the Owner, the Engineer, the Contractor, and/or the Liner Installer. The Contractor's Project Manager and Superintendent, as well as the project manager and superintendent of all subcontractors that have on-site activities, shall attend all weekly progress meetings. The following items shall be discussed in the progress meeting: (i) activities and accomplishments of the previous week; (ii) overall progress of the project in relation to the project schedule; (iii) activities and goals for the remainder of the construction activities; (iv) any construction problems/deficiencies; (v) CQA activities and concerns; (vi) safety activities and concerns; (vii) submittals and submittal responses; (viii) change order requests and claims notifications; and (viii) an updated construction schedule and any anticipated changes to the schedule.

The Owner will arrange special meetings when problems and/or deficiencies occur or are anticipated to occur. These meetings shall be attended by the parties involved, which may include the Owner, the Engineer, the Contractor, and the Liner Installer. In these meetings, the problems or deficiencies shall be defined, discussed, and resolved.

4.7 Scheduling and Coordination

All scheduling and coordination of the work outlined herein shall be undertaken through the Owner's Project Manager assigned to the project. The Contractor shall propose a construction schedule to the Owner during contract negotiation and a construction schedule shall be agreed to by the Owner prior to execution of the construction contract. The schedule shall be in the form of a Gantt chart depicting all construction activities, and shall be updated weekly and provided to the Owner as work progresses.

The Contractor, the Liner Installer, and other subcontractors shall closely coordinate all planned and ongoing construction activities on a weekly basis, more frequent if warranted, with the Owner to facilitate timely completion of all work.

4.8 Access, Inspection and Testing

All materials furnished by the Contractor shall be subject to the examination and approval of the Owner, or his representative, at all times during the progress of the work and until the completion of the same. At the discretion of the Owner, additional CQA testing will be conducted at Owner's expense. As soon as the materials are examined and tested, the Contractor shall immediately remove all rejected materials from the work to a point such distance there from as the Owner may require. No material shall be used before being examined and approved by the Owner or his representative, but the failure on the part of the Owner or his representative to condemn or reject inferior materials or work shall not be construed to imply an acceptance of the same should their inferiority become evident at any time prior to final acceptance of the work.

The Contractor shall make necessary arrangement so that the Engineer may secure samples of materials used in construction for testing to ascertain whether any material to be included in the work meets the requirements of these specifications.

The Owner and his representative shall have free access to the work at all times. The Contractor shall furnish them with equipment, as needed, for ascertaining whether the work being performed, or the work which has been completed, is in accordance with the requirements of these specifications, even to the extent of uncovering, testing, or removing portions of finished work, if deemed necessary by the Owner. The costs of uncovering work for inspection and testing, and any ensuing repairs, if necessary, shall be borne by the Contractor.

The Owner may order the Contractor to suspend any work that may be affected, damaged, or endangered by climatic conditions. Furthermore, the Owner may temporarily suspend any work at any time when acceptable results as defined by these Specifications cannot be achieved because of inclement weather or other unsatisfactory field conditions. All costs associated with these work suspensions shall be borne by the Contractor.

4.9 Survey Control

The Owner will establish reference points for horizontal and vertical control near the construction area. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to complete the work to the location, lines, and grades shown on the Drawings or as otherwise revised or approved by the Owner. It is the responsibility of the Contractor to verify all dimensions prior to fabrication, installation, and/or construction of any item of work. The Contractor shall maintain the survey control system, and shall provide all his alignment and grade control surveying of whatsoever nature. The Contractor shall submit the survey results, signed and sealed by a Florida-licensed surveyor, for Owner's approval prior to the commencement of any construction activities that are dependent upon these survey results.

4.10 Precedence and Discrepancies

Work indicated on the Drawings and not mentioned in the Specifications, or vice-versa, shall be performed as though fully set forth in both. Work not particularly detailed, marked, or specified, shall be performed in the same manner as similar work that is detailed, marked, or specified. In work drawings, the precedence shall be drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions, and noted material over graphic indications.

In the event of a discrepancy between the Drawings and the Specifications, or within either, the discrepancy shall immediately be brought to the attention of the Engineer and the Owner. The Engineer will specify the correct interpretation upon the Owner's approval.

4.11 Superintendence

The Contractor shall provide and maintain continually on the site of the work during its progress, adequate and competent superintendence of all operations for and in connection with the work under these Specifications. The Contractor shall either personally superintend his work or shall hire a competent person that is approved by the Owner. Such representative shall be able to read, write, and speak English fluently, and shall be authorized to receive instructions from the Owner. The Superintendent shall have the responsibility to make sure that the work is carried out in accordance with the Specifications and Drawings.

4.12 Contractor's Staging Area

The staging area(s) will be designated by the Owner. The Contractor shall submit a staging plan within the designated area(s) for review and approval by the Owner. The Contractor shall be responsible for electrical connections and other utilities, as needed and as approved by the Owner. The Owner will provide the water required for construction. However, it shall be the responsibility of the Contractor to transport or convey the water from the designated sources, and to meter the quantity of water used.

4.13 Contractor Safety

The Contractor, contractor employees, subcontractors, and subcontractor employees shall comply with the regulations of the Owner, the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), and/or other applicable agencies. The Contractor shall show evidence for each employee, including employees of subcontractors, of Owner-required site-specific safety training. The regular on-site safety meetings shall be documented, and the minutes of the meetings need to be submitted to the Owner. The Owner's safety requirements are provided in an attachment to the contract.

4.14 Environmental Protection

The Contractor shall comply with all applicable regulations set forth by the Owner and the following governmental agencies:

1. Florida Department of Environmental Protection (FDEP)
2. U.S. Environmental Protection Agency (EPA)
3. St. Johns River Water Management District (SJRWMD)
4. South Florida Water Management District (SFWMD)
5. Orange County, Florida
6. U.S. Army Corps of Engineers
7. Occupational Safety and Health Administration (OSHA)
8. Florida Fish and Wildlife Conservation Commission (FFWCC)

The Contractor shall provide and maintain, during the life of the contract, environmental protection as defined herein. The Contractor shall provide environmental protective measures as required to control pollution that develops during normal construction practice and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project, including dust emission caused by construction traffic. The Contractor shall comply with all federal, state, and local regulations pertaining to water, air, and noise pollution.

4.15 Protection of Natural Resources

Limits of Work: The natural resources outside the limits of permanent work performed under this contract shall be preserved in their existing condition or restored to an equivalent or improved condition upon completion of the work. The Contractor shall confine construction activities to areas defined by the scope of work, Drawings, and Specifications.

Land Resources: Except in those areas indicated on the construction plans to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy trees or shrubs without permission from the Owner.

Temporary Facilities: The Contractor shall eliminate all signs of temporary construction facilities such as work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and all other vestiges of construction except for access roads. All other areas shall be restored to their original conditions.

Water Resources: The Contractor shall perform all work in such a manner that any adverse environmental impacts on water resources are reduced to a level acceptable to FDEP, SJRWMD, Orange County, FDEP, and EPA. Work must be performed in accordance with the applicable permit requirements. If water quality is compromised, all construction activities will cease until the problem is remedied and the Contractor receives notification to proceed from the Owner.

Oily Substances: The Contractor shall take whatever measures necessary to prevent oily or other potentially hazardous substances from entering the ground, drainage areas, or local bodies of water. All temporary fuel oil, petroleum, or liquid chemical storage tanks shall be protected with a temporary high density polyethylene (HDPE) lined earthen berm and secondary containment area of sufficient size and strength to contain the contents of the tanks in the event of content leakage or spillage. At the request of the Contractor, other forms of containment with impervious liner will be considered. If any spill occurs, the Contractor shall notify the Owner immediately and shall be responsible for all cleanup expenses.

Fish and Wildlife Resources: The Contractor shall take all necessary steps, as required, to prevent interference or disturbance to fish and wildlife. The Contractor shall not alter water flows or otherwise significantly disturb native habitat, adjacent to the project area, which are critical to fish and wildlife, except as approved by the Owner. The Contractor shall note that harming or harassing of the indigo snake, gopher tortoise, or other protected species is prohibited.

Fines: Any fines levied against the Contractor, or against the Owner that arise because of the Contractor's work during the life of this contract will be borne by the Contractor.

Protection of Erodible Soils: All earthwork brought to a final grade shall be immediately finished as indicated or specified. The Contractor shall protect all slope areas upon completion of rough grading.

4.16 Protection of Existing Facilities

The Contractor shall employ a security guard from the firm that currently provides security services to the Owner at the Stanton Energy Center for the designated construction entrance to the job site whenever delivery activities are ongoing. The Contractor is responsible, at no additional cost to the Owner, for timely repair or replacement of structures, equipment, pipelines, power lines, power poles, solar panels, monitor wells, piezometers, pumps, or any facilities damaged by the Contractor's operations and/or personnel during construction. All repairs and/or replacements shall be performed in a manner approved by the Owner.

4.17 Daily and Final Cleanup

The Contractor shall clean up the job site and shall install all barricades, as needed, at the end of each workday to maintain the site in a clean and safe condition, as required by the Owner. The Contractor shall fully comply with the requirements set forth in this section and in Sections 4.15 and 4.16 pertaining to site maintenance. The Contractor shall maintain all roadways used during construction in a condition that is acceptable to the Owner. The Contractor shall keep all roadways used by construction traffic free of dirt, debris, and dusting emission at all times, as directed by the Owner. This may require the use of a dedicated on-site vacuum sweep truck. Maintenance of all roadways used by construction traffic shall be at the Contractor's expense.

Upon completion of the work, the Contractor shall remove and dispose of all trash, debris, unused materials, etc. Remaining unused clean soils shall be stockpiled in areas designated by the Owner. Soil surfaces disturbed because of construction activities shall be regraded to their original condition as directed by the Owner.

Waste oil, antifreeze, fuels, grease, or any other hazardous materials shall be disposed of off-site in accordance with applicable regulations, and shall not be dumped on the ground. The Contractor shall furnish proper records documenting the disposition of any such waste materials to the Owner. The Contractor must report any and all spills to the Owner immediately, and shall be solely responsible for all spill remediation.

4.18 Final Inspection and Acceptance

Upon completing all clean-up operations, the Contractor shall advise the Owner that he is ready for final inspection. The Owner will then set a specific date and time for final inspection. The Owner, Engineer, and Contractor shall jointly inspect the project area to verify that all work has been completed in accordance with the Drawings and Specifications. Any work found lacking in any way shall be corrected and re-inspected. The Contractor shall provide certified as-built drawings to the Owner. The as-built drawings shall include, but not limit to, earthwork, liners, leachate collection and leak detection systems, piping, and other items constructed by the Contractor. Upon final inspection and receipt of the as-built drawings, the Owner will issue a Letter of Acceptance to the Contractor, and the Contractor may then request final payment.

4.19 Applicable Specifications, Codes, and Standards

All work shall be performed in compliance with these Specifications unless otherwise approved in writing by the Engineer. In the event of a conflict between these Specifications and the referenced standards, these Specifications shall govern.

4.20 Engineering Data

The lined landfill cell will be constructed adjacent to and north of Cell 1, and adjacent to and on top of the west slope of the closed original CWSA. Subsurface information is provided in soil boring logs. The subsurface soil information and condition are provided to the Contractor without a guarantee or obligation of any kind whatsoever on the part of the Owner. The Owner does not guarantee the correctness of the designations of any materials shown on the Drawings, nor any interpretations, deductions, or conclusions shown on any drawings or other documents relative to

subsurface conditions. Conditions affecting the Contractor's performance and schedule may differ from those indicated or described. The Contractor shall assume all responsibility for deductions and conclusions as to the nature or condition of soil and other materials to be excavated, the difficulties of performing and maintaining the required excavations, filling, dewatering, and of doing other work affected by the existing conditions, geology, and geometry of the job site.

SPECIFICATIONS

SECTION 5 SITE PREPARATION AND EARTHWORK CONSTRUCTION

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

5.1 Description of Work

Site preparation and earthwork activities shall include and cover all work for and in connection with: i) clearing, grubbing, and stripping and stockpiling of all vegetation, organics, and unsuitable materials from the construction area; ii) proof-rolling and subgrade preparation; iii) site grading; and iv) construction and maintenance of access roads and ramps.

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5.2	Referenced Standards	1
5.3	Site Preparation and Maintenance	2
5.4	Earthwork for Site Grading	3
5.5	Earthen Dike Construction	5

5.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

- D698: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D1140: Standard Test Method for Amount of Material in Soils Finer than the No. 200 Sieve
- D2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D2937: Standard Test Method for Density of Soil in Place by the Drive Cylinder Method

5.3 Site Preparation and Maintenance

5.3.1 Site Access

The Contractor shall, by his own inspection and by careful examination, fully convince himself as to the accessibility of the site for performing the work. The Contractor shall be responsible for modifying or preparing any access roads. Any modifications to the existing topography of the site (i.e., cut and/or fill) required for access during construction shall be submitted to the Owner for approval prior to actual construction.

Any fill material required for site access shall be obtained from on-site stockpiles designated by the Owner. Fill for temporary access ramps and roads shall consist of fine sands, slightly silty, silty, and clayey sands free of deleterious materials (organic matter, roots, wood, trash, debris, particles greater than 6 inches in size, etc.), and classifying as SP, SP-SM, SM, and SC-type soils in accordance with ASTM D2487. Even though the fill material will be stockpiled and supplied by the Owner, the Contractor shall be required to remove any incidental objectionable materials (e.g., roots, organic materials, debris) to meet the fill material requirements, as directed by the Engineer.

All areas disturbed by the Contractor in constructing temporary access roads and ramps shall be re-graded and restored to pre-construction condition, or as otherwise approved by the Owner.

5.3.2 Site Dewatering

The Contractor shall be responsible for transferring any standing water within the designated construction area to permit construction in the dry. Clean stormwater that has not been in contact with waste materials shall be discharged to on-site locations designated by the Owner. Any stormwater that has been in contact with waste materials is considered leachate, and shall be pumped to the CWSA Runoff Pond or as otherwise directed by the Owner. No water shall be released off-site or into adjacent ditches or streams without the Owner's written permission and appropriate discharge permits.

5.3.3 Clearing, Grubbing, and Stripping

The work shall consist of furnishing all tools, labor, materials, and equipment required for all clearing, grubbing, and stripping operations within the limits of construction. The work shall generally be performed in all areas designated for borrow and dike and general earthen construction.

The Contractor shall remove any debris from within the designated construction area. If required for disposal, these items shall be disposed of on-site at locations designated by the Owner.

Clearing shall consist of cutting, removing, and disposing of all grass, trees, brush, debris, and other objectionable organic material resting on or protruding above ground within the limits of grading as indicated on the Drawings.

Grubbing shall consist of the removal and disposal of stumps, roots, and other objectionable organic material within the limits of grading, as indicated on the Drawings. Stumps shall be

removed entirely. Roots and matted roots shall be grubbed to at least 12 inches below the existing grade or proposed final subgrade surface, whichever is greater.

Stripping shall consist of the removal of organic top soils and muck from within the limits of grading. Overstripping shall be avoided.

The Contractor shall perform controlled burning of vegetation from the clearing, grubbing, and stripping operations, and shall dispose of all organic or otherwise objectionable materials removed by clearing, grubbing, and stripping in on-site areas designated by the Owner. All required permits for controlled burning shall be obtained by the Contractor.

5.3.4 Unsuitable Soils/Waste Removal

All organics, highly compressible, and other deleterious soils within the designated construction area, as determined by the Engineer, shall be excavated and removed from the construction area and disposed of on-site at locations designated by the Owner or, if approved by the Engineer, stockpiling of the materials for later use in the upper 6 inches of the outer slope of the containment dike and the perimeter dike.

All waste materials that have to be excavated to achieve the liner design grade shall be disposed of inside Cell 1, at locations designated by the Owner.

5.4 **Earthwork for Site Grading**

The subgrade on which the double composite liner system is to be installed and on which the earthen dikes are to be constructed shall be prepared through cut and fill to alter the existing contours of the site to the lines and grades indicated on the Drawings.

5.4.1 Existing and Excavated Base Surfaces

Existing surfaces and those exposed as a result of excavation shall be scarified, wetted, or dried as may be required, and compacted to a dry density of not less than 95 percent of the Standard Proctor maximum dry density (ASTM D698) to a depth of not less than 12 inches beneath the surface before placement of any fill materials.

5.4.2 Fill Placement for Site Grading

Earthen fill materials meeting the requirements of Section 5.4.4 and subject to approval by the Engineer shall be wetted or dried, as may be required, homogenized and placed in successive relatively horizontal layers not exceeding 12 inches in loose thickness. After a lift is placed and compacted per these Specifications, its surface shall be scarified just before placement and compaction of the next lift to permit proper bonding between lifts. The base shall be smoothly graded to the lines and grades shown on the Drawings, or as otherwise revised by the Owner.

The operation of site grading shall be suspended at any time when satisfactory results cannot be obtained because of rain, inclement weather, or other unsatisfactory conditions in the field.

5.4.3 Source of Fill Materials

Fill materials for site grading and backfill of areas that have been excavated to remove unsuitable materials shall be obtained from on-site stockpiles designated by the Owner. Even though the fill materials will be stockpiled and supplied by the Owner, the Contractor shall be required to remove any incidental objectionable materials (e.g., roots, organic materials, debris) prior to compaction to meet the fill material requirements stipulated in Section 5.4.4, as directed by the Engineer.

5.4.4 Fill Material Requirements

Fill materials used for construction shall consist of fine sands and slightly silty to silty and slightly clayey to clayey fine sands classifying as SP, SP-SM, SP-SC, SM, or SC-type soils in accordance with ASTM D2487 and free from rocks, stones, and gravel in excess of 6 inches in diameter, and other deleterious materials (organic matter, roots, wood, trash, debris, sharp objects, etc.). Fill materials within the upper 12 inches of the final finished subgrade (i.e., finished grade on which the compacted soil liner will be constructed) shall not contain particles larger than ¼-inch in diameter. Materials used for site grading shall have an organic content less than 3 percent when used in site grading up to 1 foot below the design grade of the bottom liner system. Excavated materials with an organic content up to 8 percent may be used for site grading at depths greater than 1 foot below the design grade of the bottom liner system.

5.4.5 Compaction Criteria

Existing surface and surfaces exposed by excavation shall be inspected by the Engineer and compacted to a dry density of not less than 95 percent of the Standard Proctor maximum dry density (ASTM D698) prior to the placement of any fill materials. Standard Proctor compaction tests (ASTM D698) should be performed on samples of the in situ and borrow soils, as needed, to determine the optimum moisture content, allowable range of placement moisture content, and the relationship between dry density and molding moisture content to be used for compaction control.

5.4.6 Dewatering

The project site has a high water table, especially during the wet season. Although the bottoms of the leachate collection sumps are designed at the estimated seasonal high water table elevation, removal of surface water and subsurface dewatering will still be necessary particularly during construction of the leachate collection/leak detection sumps, the western part of the proposed horizontal landfill expansion area, and other below-grade installations. The Contractor shall submit a dewatering plan to the Owner for review and approval at least four weeks prior to commencement of the dewatering operation. The water from the dewatering operation shall be discharged to on-site locations designated by the Owner. The dewatering operation shall not be terminated until the remaining construction can be conducted in-the-dry and there is sufficient load on top of the HDPE liner to resist hydrostatic uplift, as determined by the Engineer.

After the dewatering operation, the slopes of any temporary dewatering and runoff diversion ditches shall be cut back to a slope no steeper than 3H:1V, and the ditches shall be backfilled and compacted in lifts in accordance with Sections 5.5.2 through 5.5.5.

5.4.7 CQA Inspection and Testing

The Engineer, retained by the Owner, will test and inspect the prepared base for compliance with the material and compaction criteria specified herein. The Engineer will perform in situ moisture content and density determinations at a minimum frequency of once per 22,500 square feet for compacted existing and excavated base surfaces and a minimum of once per 850 cubic yards of compacted fill using the drive cylinder method (ASTM D2937), or another method approved by the Engineer and deemed equivalent by him at his sole discretion.

5.4.8 Base Maintenance

It shall be the Contractor's responsibility to maintain, re-grade, and restore, as needed, the condition of the prepared base to the lines, grades, and degree of compaction noted above, and to maintain the surface to be lined smooth and free from deleterious materials.

5.5 **Earthen Dike Construction**

The earthen containment and perimeter dikes shall be constructed at the locations and to the lines and grades shown on the Drawings. The west slope of the existing landfill that will become part of the proposed expansion of landfill shall be re-worked, cut, or filled to the lines, grades and dimensions shown on the drawings.

5.5.1 Source of Fill Materials

Fill materials for dike construction shall be obtained from on-site stockpiles designated by the Owner. Even though the fill materials will be stockpiled and supplied by the Owner, the Contractor shall be required to remove any incidental objectionable materials (e.g., roots, organic materials, debris) prior to compaction to meet the fill material requirements stipulated in Section 5.5.2, as directed by the Engineer.

5.5.2 Dike Fill Material Requirements

Fill materials used in dike construction shall be classified as clean granular fill, subject to approval by the Engineer. The fill materials shall be free from wood, roots, trash, rocks, debris, or other deleterious material.

The clean granular fill materials shall consist of clean, granular soils that classify as SW, SP, SW-SM, SW-SC, SP-SM, and SP-SC in accordance with ASTM D2487. The soil shall have not more than 12 percent by dry weight passing the U.S. Standard No. 200 sieve in accordance with ASTM D1140. With prior approval by the Engineer, SC-type soils with not more than 25 percent by dry weight passing the U.S. Standard No. 200 sieve size may also be utilized in dike construction.

The fill materials shall not contain any particles larger than 6 inches in diameter, with the exception of the upper 1 foot of the interior dike slope, which shall not contain particle sizes larger than ¾-inch in diameter. Materials used in dike construction shall have an organic content less than 8 percent, except in the upper 6 inches of the outside slope of the containment dike and the perimeter dike where an organic content up to 15 percent may be used.

5.5.3 Dike Construction

The earthen dikes shall be constructed upon a prepared subgrade meeting the requirements specified in Sections 5.4.1 and 5.4.5. Portions of the prepared base surface that no longer meet the specified compaction criteria shall be scarified, wetted or dried, as needed, and re-compacted prior to placement of dike fill materials. Just prior to placement of the initial lift of dike fill material; the prepared base shall be scarified to permit proper bonding between the two surfaces.

After a lift is placed and compacted per these specifications, its surface shall be scarified just before placement and compaction of the next lift to permit proper bonding between the two lifts. At no time shall a new lift of fill be placed over a non-scarified or dried surface. If a dried surface develops, it shall be rewetted and re-compacted or thoroughly and uniformly mixed with moist underlying soils prior to placement of a new lift of fill.

Dikes shall be constructed by placement and compaction of fill materials in successive horizontal layers of not more than 12 inches in loose, vertical thickness. The fill materials shall be wetted or dried, and homogenized prior to compaction to obtain uniform moisture content in each lift. Each lift shall be compacted by rolling with a tamping roller, heavy rubber tire roller, steel wheel (sheep-foot) power roller, or other suitable compaction equipment. The Contractor shall plan the traffic flow of equipment to provide a thorough and uniform compaction effort on each successive lift of fill.

5.5.4 Compaction Criteria

Earthen dike fill materials shall be compacted to a dry density of not less than 95 percent of the Standard Proctor maximum dry density (ASTM D698). The Engineer shall perform Standard Proctor compaction tests (ASTM D698) on samples of the borrow soils, as needed, to determine the optimum moisture content and maximum dry density to be used for compaction control.

5.5.5 CQA Inspection and Testing

The Engineer, retained by the Owner, will undertake observations and perform CQA tests to determine compliance of the dike construction with these specifications. Prior to placement, the Engineer shall observe that the base surface or surface of the previously compacted lift is satisfactorily prepared in accordance with Sections 5.5.3 and 5.5.4. The Engineer shall also verify that the borrow soils used for construction are free of deleterious materials and meet the requirements specified in Section 5.5.4 for the appropriate material classification required for dike construction. Fines content determinations (ASTM D1140) shall be performed, as needed, to verify conformance of the clean granular fill with the requirements specified in Section 5.5.2.

During placement, the dike fill materials will be inspected to verify that they have been thoroughly homogenized, uniformly placed and adequately compacted. The Engineer shall make the necessary penetration tests to quantify the uniformity of compaction and probe measurements to verify compliance with the maximum lift thickness specified herein.

After compaction of each lift is complete, the Engineer, retained by the Owner, will perform moisture content determinations and in situ density determinations at a minimum rate of once per 850 cubic yards of compacted fill using the drive cylinder method (ASTM D2937), or another

method approved by the Engineer and deemed equivalent by him at his sole discretion. The Engineer shall compare results of these tests to the results of Standard Proctor tests to determine compliance with the specified compaction criteria.

5.5.6 Dike Maintenance

The Contractor shall maintain and restore, as needed, the condition of the completed earthen dike such that it conforms to the lines and grades shown on the Drawings and to the compaction criteria specified herein.

5.5.7 Erosion Control Features

Erosion and sedimentation control practices shall be employed by the Contractor to minimize erosion and sedimentation during construction until all work has been accepted by the Owner. Methods, which may be used, include, but are not limited to, vegetation, berms, and silt fences. An erosion control plan outlining the proposed erosion and sedimentation control measures to be undertaken during construction shall be submitted by the Contractor to the Owner for approval prior to construction.

All devices for erosion and sedimentation control shall be installed prior to beginning construction in an area. If the Owner determines that erosion or sedimentation is occurring because of the Contractor's construction activities despite implementation and maintenance of protective measures, the Contractor shall take additional protective measures at the Contractor's expense and as directed by the Owner.

Upon completion of the work or upon instruction by the Owner, the Contractor shall dismantle and remove all erosion and sedimentation control measures at the Contractor's expense.

SPECIFICATIONS

SECTION 6 CONSTRUCTION OF SOIL LINER

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

6.1 Description of Work

This Specification stipulates the material and installation requirements, including associated quality control/quality assurance inspection and testing requirements, for the soil liner to be constructed as the bottom component of the double composite liner system. The work shall include constructing the soil liner to the lines and elevations shown on the Drawings, on a prepared soil subgrade that has been accepted by the Engineer. The soil liner shall consist of a minimum 12-inch thick layer of clayey soil having an in-place saturated hydraulic conductivity equal to or less than 1.0×10^{-7} cm/sec.

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6.2	Referenced Standards	1
6.3	Material Property Requirements	2
6.4	Pre-Construction Material Testing	3
6.5	Construction Procedures	3
6.6	Quality Assurance Inspection and Testing	4

6.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

- D421: Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
- D422: Standard Test Method for Particle-Size Analysis of Soils
- D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D1140: Standard Test Method for Amount of Material in Soils Finer than No. 200 (75µm) Sieve

- D2216: Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D2937: Standard Test Method for Density of Soil In Place by the Drive-Cylinder Method
- D2974: Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
- D4318: Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- D5084: Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter
- D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

6.3 Material Property Requirements

The soil liner shall be constructed using clayey material that has the following characteristics:

- The material shall be relatively uniform in character, and free from deleterious materials such as wood, roots, trash, debris, etc.
- The material shall not contain any sharp or irregular objects, rocks, gravel, or particles in excess of ¾-inch in size.
- The material shall have an organic content of no greater than 2 percent, as determined by ASTM D2974.
- The material shall have a minimum fines content (i.e., percent of material by dry weight passing the U.S. No. 200 standard sieve) of 25 percent, as determined by ASTM D1140.
- The material shall have a liquid limit between 30 and 60 percent, and a plasticity index between 20 and 40 percent, as determined by ASTM D4318.
- The material shall classify as a clayey sand or sandy clay with an SC, CL, or CH designation in accordance with ASTM D2487.
- The material shall be capable of achieving a moisture content within the range that is required for effective compaction.
- The material shall be capable of achieving an in-place saturated hydraulic conductivity equal to or less than 1.0×10^{-7} cm/sec, as determined by ASTM D5084.

6.4 Pre-Construction Material Testing

A minimum of three representative samples of the clayey material from each proposed borrow source shall be submitted by the Contractor to the Engineer for laboratory index, compaction, and permeability testing at least four weeks prior to delivery of material to the job site.

Atterberg limit determinations (ASTM D4318), sieve analyses (ASTM D421 and D422), fines content determinations (ASTM D1140), and moisture content determinations (ASTM D2216) shall be performed on each representative sample submitted by the Contractor. If appropriate, one Standard Proctor compaction test (ASTM D698) shall be performed on a combined homogenized sample of the three representative samples. At least three laboratory permeability tests (ASTM D5084) shall be performed on test specimens prepared at different molding conditions determined by the Engineer. No material shall be used for construction of the soil liner without meeting this Specification and the approval of the Engineer.

6.5 Construction Procedures

The following procedures shall be observed by the Contractor during construction of the soil liner:

- The soil liner shall be constructed by placing, spreading, wetting or drying (as needed), homogenizing, and then compacting the clayey material in one lift.
- The soil liner shall be compacted prior to placement of the secondary HDPE liner. For molding moisture contents within the range of 3 percent dry to 3 percent wet of the optimum Standard Proctor moisture content, the liner materials shall be compacted to a dry density equal to or greater than 95 percent of the Standard Proctor maximum dry density (ASTM D698). For molding moisture contents greater than 3 percent wet of the Standard Proctor optimum moisture content, the fill materials shall be compacted to a dry density equal to or greater than 98 percent of the Standard Proctor dry density corresponding to the molding moisture content.
- After compaction, the surface of the soil liner shall be smoothed with a steel drum roller.
- A grader may be used to remove any excess material from the constructed soil liner. Conversely, areas not meeting the thickness requirements shall be augmented with additional material. The added material shall be reworked into the constructed soil liner to ensure homogeneity and proper bonding. This may be accomplished by scarification of the surface prior to addition of new material.
- The finished surface of the soil liner shall be smooth, free from roller marks, holes, depressions more than 0.5 inches, or protrusions more than 1 inch. No object shall protrude above the finished soil liner surface.
- The completed soil liner shall be protected from traffic and erosion. Any damaged areas shall be repaired, and the grade shall be re-established.
- To prevent desiccation cracking, the Contractor shall maintain the moisture content of the completed soil liner section by regularly spraying the surface of the constructed soil liner with clean water until it is covered by the secondary HDPE geomembrane liner.

6.6 Quality Assurance Inspection and Testing

The Engineer shall inspect and test the constructed soil liner to determine compliance with this Specification. Samples for construction quality assurance testing shall be obtained by a field representative of the Engineer from random locations within the constructed soil liner. The construction quality assurance test frequencies are specified below.

6.6.1 Field Test

- A minimum of two moisture content and field density (ASTM D2937 or ASTM D6938) determinations shall be conducted per acre.
- A minimum of four thickness measurements shall be conducted per acre.

6.6.2 Laboratory Test

- Percent fines (ASTM D1140) shall be determined at a minimum frequency of two tests per acre.
- Atterberg limits determinations (ASTM D4318) shall be at a minimum frequency of one test per acre.
- Hydraulic conductivity tests (ASTM D5084) shall be conducted at a minimum frequency of one test per acre.

If there are indications of a change in material quality or construction procedures, or if the test results are not consistently meeting the specification requirements, the test frequencies may be increased, at the discretion of the Engineer. All field density test and sampling locations shall be recorded by the Engineer.

Holes in the constructed soil liner created because of field testing or sampling shall be backfilled and tamped uniformly in 2-inch thick lifts by the Contractor using a rod or other method approved by the Engineer. The backfill material shall be the same material used for construction of the soil liner. At the surface, the backfill material shall extend slightly beyond the edge of the hole to ensure a good tie-in with the soil liner.

The Contractor shall be aware that laboratory hydraulic conductivity testing on samples of the soil liner may take up to three weeks, but preliminary test results may be available within one to two weeks. If the hydraulic conductivity test result indicates that a sample does not meet the specification requirement, the Contractor shall remove, replace, re-work, and re-compact the area represented by the failing sample, as directed by the Engineer.

SPECIFICATIONS

SECTION 7 HDPE LINER MATERIALS FOR BOTTOM LINER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

7.1 Description of Work

This Specification covers the material requirements for high density polyethylene (HDPE) geomembrane liner specified for the bottom liner system, factory inspection and testing requirements, and quality control testing by the Engineer.

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7.5	Quality Control Testing by Engineer	8
7.6	Warranty	10
7.7	Submittals	10

7.2 Referenced Standards

The following ASTM International (ASTM) standards are referenced in this Specification.

- D570: Standard Test Method for Water Absorption of Plastics
- D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
- D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1004: Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
- D1203: Standard Test Method for Volatile Loss from Plastics Using Activated Carbon Methods

- D1204: Standard Test Method for Linear Dimensional Changes of Non-Rigid Thermoplastic Sheeting or Film at Elevated Temperature
- D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603: Standard Test Method for Carbon Black in Olefin Plastics
- D1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics
- D2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D3895: Standard Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
- D4833: Standard Test Method for Index Puncture Resistance of Geotextiles and Geomembranes
- D4976: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
- D5199: Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D5321: Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- D5397: Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Load Test; Appendix - Procedure to Perform a Single Point Notched Constant Load (Appendix (SP-NCTL) Test)
- D5596: Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D5994: Standard Test Method for Measuring Core Thickness of Textured Geomembranes
- D6693: Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Non-reinforced Flexible Polypropylene Geomembranes
- D7466: Standard Test Method for Measuring the Asperity Height of Textured Geomembrane
- E96: Standard Test Methods for Water Vapor Transmission of Materials

7.3 Material Requirements

Two-sided textured geomembrane liner shall consist of unreinforced high density polyethylene (HDPE), designed and manufactured specifically for the purpose of liquid containment.

Product data sheets listing the minimum and nominal liner physical properties shall be provided to the Engineer at least two weeks prior to material delivery to the job site. Product data sheets for each type of HDPE resin, listing density, melt index, low temperature brittleness and environmental stress crack resistance, shall also be provided to the Engineer at least two weeks prior to delivery of material to the job site.

7.3.1 Base Resin

The uncolored base resin used to manufacture the liner shall be polyethylene having a minimum density of 0.932 g/cm³ classifying as Group 2, Class 2, Grade 4 or Grade 5 (PE 224 or PE 225) in accordance with ASTM D4976.

The formulated colored resin shall classify as a Group 2, Class 3, Grade 4 or Grade 5 high density polyethylene (PE 234 or PE 235) with physical properties meeting A46009 in accordance with ASTM D4976 with environmental stress crack resistance (ASTM D1693) $F_{50} > 1500$ hours (Condition B; 50°C/100% Igepal) and $F_{20} > 192$ hours (Condition C; 100°C/100% Igepal). The formulated colored resin shall contain not less than 97 percent of the base polymer, not less than 2.0 percent carbon black, and not more than 3 percent carbon black, anti-oxidants and heat stabilizers combined with no other additives, fillers or extenders. Carbon black dispersion in the liner shall be rated as Category 1 or 2 in ≥ 9 of 10 views, and as Category 3 in ≤ 1 of 10 views classified using ASTM D5596. The variation in carbon black content within each resin batch shall be no greater than ± 10 percent from the average carbon black content, determined from factory tests performed on every fifth liner roll (see Section 7.4.4.2).

The liner shall be manufactured from virgin resin, with not more than 3 percent regrind material. Regrind material, if used, must be of the same formulation as the virgin resin. Post-consumer resin of any type may not be used.

Liner sheets shall be manufactured using one of the following base resins unless approved otherwise by the Engineer:

- Chevron Phillips Marlex K306 or K307
- BP Solvay Fortiflex G36-10-150 (G36-24x1767)
- Formosa Plastics Formolene HL3812

Use of any of the approved base resins shall not relieve the Liner Manufacturer from complying with all other Specification criteria.

HDPE welding rods shall be manufactured from the same resin used to manufacture the liner. The welding rod shall be smooth, uniform in appearance and diameter and shall be free from contamination by foreign matter, including entrapped moisture that could result in air pockets within extrusion welds.

7.3.2 Physical Appearance of Liner Sheets

All liner sheets shall have good appearance qualities. Texturing on the surface of textured sheets shall be uniform and homogeneously distributed.

All liner sheets shall be free of pinholes, holes, blisters, gels, undispersed ingredients, fish-eye blemishes, any signs of contamination by foreign matter, or any defect that may affect serviceability. The edges of the sheets shall be straight and free from nicks and cuts. Liner rolls that require more than one patch per 5,000 square feet for repair of holes, blisters, gels, undispersed ingredients blemishes, etc., shall be considered defective, and shall be rejected and replaced at the Contractor's expense.

7.3.3 Textured Liner Physical Properties

Textured liner shall be the MicroSpike® liner manufactured by AGRU America, Inc., or any other liner products approved by the Owner prior to bid submittal, and shall meet the following criteria.

Property	Test Method	Criteria
Minimum Thickness	ASTM D5994	≥ 54 mil
Average Thickness	ASTM D5994	≥ 60 mil
Average Asperity Height	ASTM D7466	≥ 16 mil*
Density	ASTM D792 or D1505	> 0.940 g/cm ³ †
Melt Index	ASTM D1238 (190°C/2.16 kg)	< 1.0 g/10 minutes
Carbon Black Content	ASTM D1603	≥ 2.0% & <3.0%
Carbon Black Dispersion	ASTM D5596 (10 views)	Category 1 or 2 (≥9 views) and Category 3 (≤1 view)
Tensile Strength at Yield	ASTM D6693**	> 126 lb/inch
Tensile Strength at Break	ASTM D6693**	> 120 lb/inch
Elongation at Yield	ASTM D6693**	> 12%
Elongation at Break	ASTM D6693**	> 200%
Tear Resistance	ASTM D1004**	> 42 lb
Puncture Resistance	ASTM D4833	> 120 lb
† The density of the uncolored base resin shall be greater than 0.932 g/cm ³ . * Asperity height shall be sufficient to provide specified interface frictional resistance. ** Tested in both machine and transverse directions.		

All individual test specimens shall meet the minimum or maximum criterion tabulated above, with the following exceptions.

- The average tensile strength and elongation at break in both the machine and transverse directions, determined as the average of five test specimens in each direction, shall meet the criteria tabulated above.
- All individual test specimen results shall display tensile strengths at break equaling or exceeding 36 lb/inch and elongations at break equaling or exceeding 60 percent.

Textured liner shall also meet the criteria specified below for water vapor transmission; dimensional stability; low temperature brittleness; volatile loss; water absorption; environmental stress crack resistance; constant tensile load stress crack resistance; and oxidative induction time.

Property	Test Method	Criteria
Modulus of Elasticity	ASTM D6693	> 80,000 lb/in ²
Water Vapor Transmission	ASTM E96, Procedure BW	< 0.03 g/m ² /24 hours
Dimensional Stability	ASTM D1204 (100° C for 1 hour)	± 2% (maximum)
Low Temperature Brittleness	ASTM D746, Procedure B	< -94°F (<-70°C)
Volatile Loss	ASTM D1203, Method A	< 0.1%
Water Absorption	ASTM D570	< 0.1%
Environmental Stress Crack Resistance Constant Tensile Load Stress Crack	ASTM D1693, F ₅₀ (Cond. B; 50°C/100% Igepal)	> 1,500 hours
Resistance (Single Point Test at 30% of Yield Stress)	ASTM D5397 (SP-NCTL)	> 500 hours
Oxidative Induction Time	ASTM D3895 (200°C and 14.7 lb/in ² O ₂)	> 140 minutes

Routine testing for modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission will not be required from the Liner Manufacturer. Certification in writing shall be provided by the Liner Manufacturer that the liner meets the Specification requirements. In support of the certification, the Liner Manufacturer shall submit at least one test result for each property performed within one year prior to the date of the certification on liner manufactured with each type resin supplied to the project.

7.3.4 Frictional Characteristics

The surface roughness of textured liner shall be such that the peak interface friction angle is equal to or greater than 21 degrees between the double-sided geocomposite and the HDPE liner used in the bottom liner systems, between the HDPE liner and the compacted soil liner, and between the HDPE liner and bedding materials on the west sideslope.

For determining compliance with the specified interface friction angles, direct shear tests will be performed by the Engineer in accordance with Standard ASTM D5321 using the geosynthetic products and the borrow clayey sand/sandy clay liner materials (SC, CL, or CH designation in accordance with ASTM D2487) selected by the Contractor, and the on-site fine sand with silt fill materials (Group Symbol SP-SM in accordance with ASTM D2487) meeting the following gradation.

U.S. Standard Sieve Size	Percent Passing (Dry Mass Basis)
No. 4	100
No. 10	97-100
No. 20	95-100
No. 40	90-100
No. 60	60-95
No. 100	20-80
No. 140	7-25
No. 200	5-12

The direct shear tests will be performed at normal stresses selected by the Engineer ranging from 5 to 65 lb/in² to duplicate field conditions. The soil shall be compacted to a dry density equal to

95 percent of the Standard Proctor maximum dry density (ASTM D698) within ± 2 percent of the Standard Proctor optimum water content. The interface and soil shall be tested submerged with water. The tests shall be performed using a horizontal displacement rate of 0.3 inches per hour.

7.4 Manufacturing and Factory Inspection and Testing

The Liner Manufacturer shall submit product data sheets and test data for each liner type to the Engineer presenting the liner minimum physical properties for each property listed in Section 7.3.3, and the resin type(s) and properties. Written certification shall be provided by the Liner Manufacturer confirming compliance of the resin and liner sheets with this Specification.

7.4.1 Minimum Sheet Dimensions

The HDPE liner shall be supplied in rolled sheets having a minimum width of 22 feet and minimum length of 400 feet. Shorter roll lengths shall require approval of the Engineer.

7.4.2 Marking and Packaging

The Liner Manufacturer shall label each roll with the roll number, thickness, length, width and date manufactured.

Each roll shall be individually packaged at the factory and protected to prevent damage during shipment. If the liner is not packaged and a roll is damaged during shipment, it shall be rejected. If only the outermost surface of the roll is affected, it shall be peeled back, cut, and wasted (i.e., it shall be treated as if it were the protective packaging for the remainder of the roll). Rolled out liner stock that requires more than one repair patch per 5,000 square feet prior to installation shall be considered defective, and shall be rejected and replaced at the Contractor's expense.

7.4.3 Factory Inspection and Spark Testing

The Liner Manufacturer shall inspect all liner sheets at the factory for compliance with the physical appearance requirements listed in Section 7.3.2. The Liner Manufacturer shall continuously spark test all liner sheets during manufacturing. The spark tester shall be capable of detecting defects or pinholes equal to or less than 10 mils (0.25 mm) in diameter. The Liner Manufacturer shall submit a complete description of the spark tester, operating protocols, factory QA/QC plan for operating the system and identifying defective liner, and methods for removing or patching liner with pinholes to the Engineer at least two weeks prior to delivery of material to the job site. All necessary repairs to the liner shall be made by the Liner Manufacturer at the factory before shipment.

The Liner Manufacturer shall provide written certification that all liner rolls delivered to the project were continuously spark tested and do not contain pinhole defects at least two weeks prior to delivery of material to the job site.

7.4.4 Factory Testing

The Liner Manufacturer shall submit the factory testing QA/QC plan, and factory laboratory quality manual for all liner and resin tests required in this Specification to the Engineer at least two weeks prior to material delivery to the job site.

7.4.4.1 HDPE Resin

Factory test reports for the HDPE resin shall include the proportions of HDPE resin, carbon black and other additives, and test results for melt index, specific gravity, environmental stress crack resistance, low temperature brittleness and oxidative induction time. The factory test reports shall be submitted to the Engineer for approval before installation of any liner material. The following tests and minimum frequency of testing shall be undertaken by the Liner Manufacturer.

Resin Property	Test Method	Minimum Frequency
Density	ASTM D792	Once per Batch of Resin
Melt Index	ASTM D1238 (190°C/2.16 kg)	Once per Batch of Resin
Oxidative Induction Time	ASTM D3895	Once per Batch of Resin

The resin density and melt index shall be reported for the unblended resin and the blended resin after adding carbon black and antioxidants. The oxidative induction time shall be reported for the blended resin. Routine testing for low temperature brittleness and environmental stress crack resistance is not required. Certification of these properties, in accordance with the requirements in Section 7.3.3, will be accepted.

The resin manufacturer's certificate of analyses for each batch of resin shall also be provided to the Engineer for approval at least two weeks prior to delivery of material to the job site.

7.4.4.2 Liner Rolls

Factory test reports for each roll of liner shall include test results for the following properties: tensile strength and elongation at yield and at break; tear resistance; puncture resistance; minimum and average thickness; density; carbon black content; and carbon black dispersion. The factory test reports shall be submitted to the Engineer for approval before installation and prior to acceptance of the liner. Failure of any of the tests shall result in rejection of the corresponding liner rolls.

At the request of the Owner, but not more than once per day during each production run, the Liner Manufacturer shall furnish production line samples to the Owner who reserves the right to have these samples tested by the Engineer, at the Owner's expense, to evaluate compliance with this Specification. Failure of any of the tests shall result in rejection of the corresponding batch or production run of liner material.

The following tests and minimum frequencies of testing shall be undertaken by the Liner Manufacturer on liner rolls.

Liner Property	Test Method	Minimum Frequency
Core Thickness	ASTM D5994	Every Roll
Asperity Height	ASTM D7466	Every Roll
Tensile Strength at Yield	ASTM D6693	Every Roll
Tensile Strength at Break	ASTM D6693	Every Roll
Elongation at Yield	ASTM D6693	Every Roll
Elongation at Break	ASTM D6693	Every Roll
Tear Resistance	ASTM D1004	Every Roll
Puncture Resistance	ASTM D4833	Every Roll
Density	ASTM D792 or D1505	Every 5 Rolls
Carbon Black Content	ASTM D1603	Every 5 Rolls
Carbon Black Dispersion	ASTM D5596	Every 5 Rolls
Notched Constant Load ESCR (Single Point at 30% of Yield Stress)	ASTM D5397 (SP-NCTL)	Every 20 Rolls

Tensile tests (ASTM D6693) and tear resistance tests (ASTM D1004) shall be performed in both the machine and transverse directions. Tensile properties (ASTM D6693), tear resistance (ASTM D1004) and puncture resistance (ASTM D4833) tests may be performed on only one test specimen from each roll of smooth liner (in each direction, where applicable) and the moving average as well as the minimum value from each five consecutive rolls reported to the Engineer. Five test specimens shall be tested in each direction for tensile properties (ASTM D6693) from each of the first 20 rolls of textured liner manufactured for this project. Provided all test results comply with Specifications, the number of test specimens may then be reduced, as allowed above for smooth liner, if approved by the Engineer. All factory testing shall be at the Liner Manufacturer's expense.

Certification of the liner modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission shall be provided in accordance with Section 7.3.3 of this Specification.

7.5 Quality Control Testing by Engineer

7.5.1 Sampling by Liner Manufacturer

The Liner Manufacturer shall obtain and secure samples of the liner for conformance testing by the Engineer. One 2-foot wide sample across the full width of each roll shall be cut during production. The samples shall be labeled, packaged, and shipped by the Liner Manufacturer for delivery along with the corresponding liner rolls to the project site.

The following sampling procedure shall be used to allow positive visual confirmation by the Engineer that samples supplied by the Liner Manufacturer represent the liner rolls indicated by the Liner Manufacturer.

- Apply three or more randomly and uniquely located, permanent paint-stick markings in the machine direction across the path of the knife on the liner sheet to be sampled prior to cutting the sample. The markings shall be generally located within 2 feet of the end of the roll bearing the Liner Manufacturer's roll label.

- Cut a minimum 24-inch wide sample across the entire roll width ensuring that the knife passes through the paint markings, leaving half of the marking on the liner roll and the other half on the sample.
- Roll the sample such that the end bearing the paint markings is on the outer end of the rolled sample. The outer end of each sample shall also be marked with the roll number.
- Ship liner samples on the same truck carrying the corresponding liner rolls.

Upon delivery of the liner rolls and the corresponding samples to the project site, the Engineer's representative will observe that the paint markings on each sample coincide with those on the corresponding liner roll.

Testing by the Engineer will be made for the following liner properties at the following sampling frequencies unless revised otherwise by the Engineer during construction.

Property	Test Method	Sampling Frequency
Thickness	ASTM D5994	2 per acre
Asperity Height	ASTM D7466	2 per acre
Density	ASTM D792 or D1505	1 per acre
Carbon Black Content	ASTM D1603	1 per acre
Tensile Strength at Yield	ASTM D6693*	2 per acre
Tensile Strength at Break	ASTM D6693*	2 per acre
Elongation at Yield	ASTM D6693*	2 per acre
Elongation at Break	ASTM D6693*	2 per acre
Tear Resistance	ASTM D1004*	2 per acre
Frictional Characteristics	ASTM D5321	1 per 10 acres
Other Properties	As requested by the Engineer	Up to 2 samples per acre
* Tested in both machine and transverse directions.		

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

7.5.2 Sampling by Liner Installer

If sampling of the liner for conformance testing is not undertaken by the Liner Manufacturer, or when otherwise requested by the Engineer, the Liner Installer shall obtain and secure samples of the liner for conformance testing by the Engineer from locations designated by the Engineer. The samples shall be properly labeled to identify the liner roll or panel from which the sample was obtained and the machine direction if the sample was not obtained across the full width of the roll.

Testing by the Engineer will be made for the liner properties at the sampling frequencies in Section 7.5.1 unless revised otherwise by the Engineer during construction.

7.6 Warranty

A written warranty shall be provided to the Owner from the Liner Manufacturer. This document shall warrant the quality of the liner material for a period of not less than 20 years.

7.7 Submittals

The following submittals are required as part of the requirements of this Specification.

- Product data sheets and test data listing the minimum liner physical properties, and product data sheets for each type resin listing the resin properties (Sections 7.3 and 7.4).
- A written certification from the Liner Manufacturer that the resin and liner sheets comply with this Specification (Section 7.4).
- Written certification from the Liner Manufacturer that the liner modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission meet the requirements of this Specification. In support of the certification, the Liner Manufacturer shall submit the results of at least one test for each certified property performed within one year prior to the date of the certification on liner manufactured with each type resin supplied to the project (Section 7.3.3).
- Written certification from the Liner Manufacturer that the HDPE resin low temperature brittleness and environmental stress crack resistance meet the requirements of this Specification. In support of the certification, the Liner Manufacturer shall submit the result of at least one test for each certified property performed within one year prior to the date of the certification for each type resin used to manufacture liner supplied to the project (Section 7.4.4.1).
- Description of the spark testing device, the factory QA/QC plan for operating the system, and written certification that all liner rolls have been continuously factory spark tested and do not contain pinhole defects (Section 7.4.3).
- Factory testing QA/QC plan and factory laboratory quality control manual for all liner and resin tests required in this Specification (Section 7.4.4)
- Factory test reports for each batch of HDPE resin used in the liner sheets including proportions of base polymer and additives, oxidative induction time, melt index and density. The resin manufacturer's certificate of analysis shall be provided for each batch of resin (Section 7.4.4.1).
- Factory quality control certificates for each liner roll including minimum and average thickness, tensile properties, tear resistance, puncture resistance, density, carbon black content and carbon black dispersion (Section 7.4.4.2).

- Written warranty from the Liner Manufacturer to warrant the quality of the liner material for a period of not less than 20 years (Section 7.6).

SPECIFICATIONS

SECTION 8 HDPE LINER INSTALLATION FOR BOTTOM LINER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

8.1 Description of Work

This Specification covers the installation of High Density Polyethylene (HDPE) geomembrane liner and associated ancillary work. The HDPE liner shall be installed in accordance with this Specification and as shown on the Drawings. Liner installation includes: (i) surface water control during liner installation; (ii) maintenance of the compacted soil liner; (iii) placement and seaming of 60-mil HDPE textured liner; (iv) excavation and backfilling liner anchor trenches; and (v) placement of temporary ballast loading.

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8.2 Referenced Standards

The following ASTM International (ASTM) standards are referenced in this Specification.

D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft³ (600 kN-m/m³))

D1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

D2216: Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock

D2937: Standard Test Method for Density of Soil in Place by the Drive Cylinder Method

D4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils

D4254: Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

D4437: Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes

D4944: Standard Test Method for Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method

D6392: Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

8.3 Surface Water Control and Base Maintenance

The base of the construction area shall be maintained well-drained prior to and during liner installation. Liner work areas shall be maintained well-drained and dry to prevent uplift of the liner after installation. The Contractor's proposed method(s) for dewatering, surface water control and routing water shall be submitted to the Owner for approval at least four weeks prior to implementation.

The Liner Installer shall maintain and restore, as needed, the condition of the prepared base prior to and during liner deployment and installation such that the prepared base is maintained in accordance with the Specifications in Section 6 at the time of liner deployment.

8.4 Liner Handling and Installation

Installation of the liner shall be in compliance with this Specification and with the Liner Manufacturer's standard guidelines and specifications for liner installation, subject to approval by the Engineer, including, but not limited to: handling and site storage requirements; unrolling and laying of liner sheets; field seaming; anchor trench installation; and temporary ballast loading. The Contractor shall submit a liner handling and installation plan to the Owner for review and approval at least two weeks prior to installation.

8.4.1 On-Site Storage

On-site storage shall be as needed to protect the liner rolls from excessive accumulations of soil on the liner surfaces, water, heat, mechanical abrasion, puncture, and vehicular traffic. Liner rolls shall be stored on a firm, dry, elevated surface in a protected storage area approved by the Owner. Liner rolls shall not be stacked more than three rolls high, or as otherwise recommended by the Liner Manufacturer.

8.4.2 Handling and Panel Placement

Appropriate handling equipment shall be used when loading or moving rolled liner sheets from one place to another. Appropriate equipment includes spreader and roll bars for deployment, and cloth chokers with a spreader bar for off-loading.

Liner deployment shall not be performed when precipitation is occurring, when excessive moisture (i.e., fog, dew) or wet conditions exist, when the ambient air temperature is below 40° F (5°C) or above 100°F (38°C), when high winds (>20 mph) are occurring, or when other adverse climatologic conditions exist that would, in the opinion of the Engineer and/or Owner, adversely affect liner installation. The Liner Installer may submit a procedure for welding in ambient air temperatures below 40° F and above 100°F for review and approval by the Engineer.

The liner sheets shall be unrolled and deployed in a manner which minimizes wrinkles and prevents the occurrence of folds and creases. Liner panels shall be installed from high to low elevation to prevent runoff from flowing below installed liner panels, and shingled at seams with the upslope panel overlaying the downslope panel. "Vise-grips" or other tools, if used to grip the liner during handling and deployment, shall have clean, smooth grip faces, and corners on the grip faces shall be rounded. The pressure applied by the grips shall not be so great as to indent or otherwise damage the liner. The Liner Installer shall demonstrate his methods for handling and deploying the liner at the start of the liner installation for approval by the Engineer, and shall include the details in the liner handling and installation plan submittal.

The liner shall be installed at the locations and to the lines, grades and dimensions shown on the Drawings, or as otherwise approved by the Engineer. Panel layout and deployment shall be such that the seams run down the slope of the dikes and are oriented perpendicular to the top of slope of the dikes. This seam orientation shall be maintained for a distance of at least 10 feet from the inside toe of the dikes or as otherwise shown on the Drawings or approved by the Engineer. The Liner Installer shall submit a panel layout plan indicating the proposed liner panel configuration, and identifying field seams, anchor trenches, vents, pipe penetrations, and other details needed to complete the work, for approval by the Engineer, at least two weeks prior to liner installation.

8.4.3 Field Seams

All liner shall be seamed the same day that the liner is deployed. All liner shall be ballasted immediately after deployment to prevent uplift by winds. Welding of field seams shall not take place unless suitable surface and weather conditions exist, and satisfactory welds can be achieved as confirmed by field trial test welds.

All liner sheets must be continuously and tightly bonded using continuous double-wedge fusion welds or extrusion fillet welds both made with automated welding equipment approved by the Engineer. The use of extrusion fillet welds shall be limited to patches at liner panel T-seams, patches at liner repairs, pipe penetrations or other detail work as approved by the Engineer. Field seaming shall be conducted in the dry, on relatively smooth surfaces, and in such a manner to prevent water, moisture, soil, dust, dirt or other foreign material from being included within the weld.

Adjoining liner sheets shall be overlapped a minimum of 4 inches, and in no case less than 3 inches at any location, by adequately lapping the edges of the sheets. The overlap shall not exceed 6 inches for double-wedge fusion welds. Seam overlaps on the bottom area shall be made such that the direction of flow over the lined surface is from the top sheet toward the bottom sheet to form a shingle effect.

Edges to be welded shall be wiped and cleaned thoroughly to remove any dirt, dust, soil, water, moisture or other foreign material. All field seams must be symmetric, uniform in appearance and width meeting the appearance criteria listed below, unless approved otherwise by the Engineer based on destructive test results. All field seams must be uniform in physical properties meeting the seam strength, shear elongation, peel separation and failure mode criteria in Section 8.4.3.1 of this Specification.

- (i) Extrusion Fillet Welds: The surface of extrusion fillet welds shall be smooth in appearance. The interior of the center extrudate bead shall be homogeneous and uniform in appearance. The weld shall be symmetric in width with the crown of the extrudate bead centered along the edge of the top liner sheet. The total width of the weld shall be between $1\frac{1}{4}$ and $1\frac{3}{4}$ inches with the center bead comprising approximately one-third of the total width. The total thickness of the center of the weld shall be 3 to 4 times the thickness of the liner sheets being welded. The squeeze-out lip along both edges of the weld shall be similar in shape and size.
- (ii) Double-Wedge Fusion Welds: The surface of double-wedge fusion welds shall be slightly embossed from the nip rollers along the top and bottom surfaces of both fusion weld areas. The fusion weld areas shall be symmetric and each shall have a width equal to or greater than $\frac{5}{8}$ inches and thickness reduction of 10 to 25 mils. The width of the air channel shall typically be $\frac{1}{2}$ to $\frac{5}{8}$ inches. Squeeze-out along the inside and outside edges of the fusion welded areas shall be similar in size and typically extend no more than about $\frac{1}{8}$ inch.

The surface of both HDPE liner sheets along extrusion fillet welds shall be ground prior to welding to remove any oxidized surface film in accordance with the following criteria unless approved otherwise by the Engineer: (i) grind with 80 grit sand paper holding the grinding wheel such that the grinding marks are oriented perpendicular to the seam and made from the bottom sheet toward the top sheet to prevent gouging of the lower sheet; (ii) the edge of the upper sheet shall be beveled approximately 45° by the grinding process; (iii) the depth of grinding shall be approximately 5 percent of the liner thickness and in no case more than 10 percent of the liner thickness; and (iv) the width of grinding shall be slightly less than the width of the extrusion weld such that grinding marks are not visible beyond the edges of the weld. Welding shall be completed within one hour of grinding the surface of the liner.

Heat-degraded resin in the barrel of the extrusion welder shall be purged prior to making extrusion welds.

Seams shall not exhibit heat distortion from overheating during welding (e.g., warping, excessive thermal puckering). The underside of field seams shall be inspected for heat distortion from welding at the end of all seams, wherever samples for destructive testing are cut from the field

seam, and at locations identified by the Engineer wherever the appearance of the weld is indicative of potential heat distortion.

8.4.3.1 Field Seam Strength

All welded field seams shall meet the following criteria when tested in accordance with ASTM D6392 except where noted otherwise:

- (i) Shear Strength: The specimen shall exhibit: a strength in shear equal to or greater than 120 lb/inch (ppi); a film-tear bond failure (FTB) mode; and a shear elongation at break equal to or greater than 50 percent. The test shall be performed at a rate of displacement of 2 inches/minute (ipm) for the first 2 inches of displacement, and the test then continued at a rate of displacement of 20 ipm until rupture.
- (ii) Peel Strength: The specimen shall exhibit: a peel strength equal to or greater than 91 ppi for double-wedge fusion welds and equal to or greater than 82 ppi for extrusion fillet welds; a film-tear bond failure (FTB) mode; and a peel separation (incursion area) less than or equal to 25 percent of the initial bonded area and less than 100 percent of the width of the initial bonded area (excluding the area and width of the squeeze-out from the initial bonded area and width). The peel strength criteria shall apply to both the top and bottom welds of double-wedge fusion welds.

Double-wedge fusion welds exhibiting AD, AD-BRK [with >25% peel separation of the bonded area] or AD-BRK [with separation across 100% of the bonded width regardless of separation area] locus-of-break behavior shall be considered non-FTB failure modes. Extrusion fillet welds exhibiting AD1, AD2, AD-BRK [with >25% peel separation of the bonded area], AD-BRK [with separation across 100% of the bonded width regardless of separation area] or AD-WLD [with shear strength <120 ppi or peel strength <82 ppi] locus-of break behavior shall be considered non-FTB failure modes.

8.4.3.2 Pass/Fail Criteria

The following pass/fail criteria shall be used to determine compliance of field seams with the above strength criteria:

- (i) All five specimens from a given sample tested in peel (both top and bottom for double-edge fusion welds) shall exhibit the specified strength, separation and FTB failure modes, and all five specimens tested in shear shall exhibit the specified strength, shear elongation at break ≥ 50 percent and FTB failure modes (i.e., 0 percent strength, shear elongation at break and peel separation failures and 0 percent non-FTB failures); or
- (ii) All five specimens from a given sample tested in peel and all five specimens tested in shear shall exhibit the specified strengths, all five specimens tested in shear shall exhibit elongation at break ≥ 50 percent, four of five specimens tested in peel shall exhibit acceptable peel separation, and four of five test specimens, for each type of test, shall exhibit FTB failure modes (i.e., 0 percent strength and shear elongation at break failures, and up to 20 percent non-FTB failures); or

- (iii) One specimen from a given sample tested in peel or shear may exhibit a non-FTB failure and a strength no less than 50 percent of the specified strength provided that all five field seam specimens tested from the duplicate (archive) sample exhibit the specified strength, all five specimens test in shear exhibit an elongation at break ≥ 50 percent, four of five specimens tested in peel exhibit acceptable peel separation, and no more than one test specimen of the five additional specimens exhibits a non-FTB failure (i.e., 0 percent shear elongation at break failures, 10 percent strength failures and up to 20 percent non-FTB failures).

If a field seam fails the criteria specified herein, and the Liner Installer wishes to establish to the Engineer that the failed sample represents a smaller section of the field seam than designated by the Engineer, additional sample may be obtained at progressively increasing distances from both sides of the failed sample, at locations approved by the Engineer, until two consecutive samples on each side of the original sample pass the field seam criteria. At that point, the extent of the original defect in both directions along the field seam will be considered isolated and the Liner Installer may then either: (i) cap, re-weld and re-test the seam up to and including the closest of the two passing samples, and patch and weld the hole of the furthest passing sample; or (ii) cap, re-weld and re-test the entire length of sampling. The costs of the additional tests shall be borne by the Contractor.

If approved by the Engineer, double-wedge fusion welds may be repaired by extrusion welding the flap of the top sheet to the bottom sheet if the seam non-compliance was due only to a non-FTB failure of the destructive test sample.

The duplicates of additional samples requested by the Liner Installer for identifying the extent of a defective seam will not be tested, i.e., the seam shall meet either pass/fail criteria (i) or (ii). The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

8.4.4 Anchor Trenches

The liner shall be anchored in anchor trenches at the locations shown on the Drawings. Field seams shall be welded continuously through the anchor trench.

Liner anchor trenches shall be no less than 18 inches in width and 24 inches in depth. The corners of the trenches shall be slightly rounded to minimize sharp bends in the liner. After placement of the liner along the side and across the bottom of the trench, the trench shall be backfilled with soil fill meeting the material requirements specified in Section 6. Anchor trench backfill shall be compacted to a dry density not less than 95 percent of the Standard Proctor maximum dry density (ASTM D698). The liner within the anchor trench shall not be damaged during placement and compaction of the soil.

8.4.5 Temporary Ballast Loading

Adequate temporary ballast loading that will not damage the liner shall be placed by the Liner Installer atop the liner during installation as needed to prevent uplift by wind and by rapid changes in barometric pressure. The temporary ballast loading shall be in addition to permanent anchor trenches. Sufficient temporary ballast loading shall be placed along panel edges, in particular, as

needed to minimize the risk of wind flow under the panels. Continuous loading shall be provided at all panel edges during days off, at night, and whenever inclement or stormy weather is anticipated.

Temporary ballast loading may consist of sand filled bags. Bags used for containing sand shall be resistant to degradation by ultraviolet radiation (sunlight), shall contain the sand without leakage, and shall be approved by the Engineer. Soil fill shall not be placed atop the liner for temporary ballast loading without being adequately and completely contained.

Temporary ballast loading shall be maintained as necessary or as otherwise directed by the Engineer. All temporary ballast loading shall be removed by the Liner Installer prior to demobilizing from the site unless otherwise approved by the Engineer.

The Liner Installer shall submit a complete description and details of proposed temporary ballast materials and placement procedures at least two weeks prior to liner installation. Approval by the Owner or Engineer shall not relieve the Liner Installer from responsibility to provide sufficient temporary ballast to prevent uplift during construction.

8.4.6 Pipe Penetrations

All pipe penetrations shall be made in accordance with the details shown on the Drawings and the Liner Manufacturer's recommendations, subject to approval by the Engineer. Pipe penetrations through the HDPE liner shall typically consist of a pipe boot, constructed with the same material as the liner penetrated by the pipe, continuously extrusion welded to the liner and the HDPE pipe. Other pipe penetrations, if used, are shown on the Drawings.

8.4.7 Repairs

All liner defects (scratches, blisters, rips, punctures, tears, holes, pinholes, creases, folds, strain-yielded areas, etc.) and holes created by removal of samples for destructive testing shall be marked and repaired by completely covering the defect or hole with a round or oval-shaped piece of the corresponding HDPE liner material extending at least 4 inches beyond the edges of the defect/hole and continuously welding the patch to the liner sheet using an extrusion weld. Scratches shall be considered a defect when the depth is in excess of 5 percent of the liner thickness or as otherwise determined by the Engineer. Holes created by removal of samples for destructive testing shall be marked, patched and repaired as specified above for liner defects. The panel number, repair location, type of defect, description of repair made, and date repaired shall be documented for each liner repair.

8.4.8 Liner Protection

No equipment, tools or personnel that can readily cause damage to the HDPE liner shall be allowed on the liner during and after installation. Personnel working on the HDPE liner shall not smoke, wear potentially damaging shoes, dispose of trash or other debris, or engage in any activity that could damage the liner.

The passage of construction equipment, other than light rubber-tired equipment approved by the Engineer, over any exposed HDPE liner surface is strictly prohibited. Light rubber-tired equipment

exerting a contact stress less than 6 lb/in² will be allowed provided proper care is taken when operating the vehicle to avoid pulling, displacing, or damaging the liner.

Any damage to the liner (e.g., tears, punctures, creases, folds, strain-yielded areas, etc.) occurring during construction shall be immediately brought to the attention of the Engineer and repaired as approved by the Engineer at the expense of the Liner Installer.

8.4.9 Fuel and Oil Spill Clean-Up

All spills or leaks of fuels or oils from equipment and vehicles on the surface of the liner shall be thoroughly cleaned with soap and water or, at the discretion of the Engineer, the affected liner shall be cut, removed and replaced with new liner material. Subgrade soils contaminated with fuel or oil shall be excavated and replaced to the extent designated by the Engineer. Contaminated soils shall be disposed of on site in an area designated by the Owner.

8.5 Inspection and Field Testing by Liner Installer

8.5.1 Initial Qualifying Welds

All master seamers/welders and seamers/welders shall demonstrate their ability to consistently make successful seams prior to installation of the liner. Each seamer or welder shall prepare test strips for each type of seam between different liner types and for both extrusion or double-wedge fusion welds. Each test strip shall have a minimum length of 20 feet. Qualifying welds shall be made using the same conditions that will exist during actual liner installation (i.e., same grinder operators) for extrusion welds and making the welds on similar ground conditions. Twelve test specimens shall be cut from the test strip at an approximately uniform spacing of 18 inches or at locations selected by the Engineer and tested by the Liner Installer in both shear and peel (6 test specimens each) for compliance with the Specification requirements in Section 8.4.3. No seamer/welder shall be allowed to make production welds in the liner without first successfully passing the initial qualifying welds.

8.5.2 Daily Qualifying Welds

At the beginning of each working day, after any interruption in power, after any prolonged idle period during the day, and at the request of the Engineer at any other time during the day, each seamer shall prepare a 3-foot (for extrusion welds) or 10-foot (for double-wedge fusion welds) long test strip using the welding apparatus assigned to him. Ten samples from the test strip shall be cut at locations selected by the Engineer and tested by the Liner Installer in both shear and peel for compliance with the specification requirements in Section 8.4.3. The sample weld shall successfully pass the test requirements before either the seamer or seaming apparatus are allowed to operate on production welds. A log of daily qualifying welds and test results shall be maintained by the Engineer.

8.5.3 Non-Destructive Testing of Welds

The Liner Installer shall continuously test every field weld (i.e., 100 percent of the length of all field seams), including field welds around patches, using non-destructive testing techniques. These tests shall be performed in the presence of the Engineer. Extrusion welds shall be tested

using a vacuum box and test procedures specified in ASTM D5641. Once a generous amount of soap solution is uniformly placed over the weld, a minimum vacuum of 4 to 8 lb/in² should be applied to the seam and held for a minimum of 10 seconds. Any bubble formation must be noted and the corresponding defective area identified, marked, and subsequently repaired.

Placement of the vacuum box shall continue at successive locations along the extrusion weld and overlap the prior test location by at least 10 percent of the minimum chamber length or at least 2 inches, whichever is greater.

Double-wedge fusion welds shall be non-destructively tested by pressurizing the air channel between the two welds to a pressure between 25 and 30 lb/in² and monitoring the pressure for any decline with time. After allowing 2 minutes for relaxation, the pressure shall be monitored over test periods of either 5 or 10 minutes based on the following criteria. A weld will be considered satisfactory if either of the following criteria are satisfied:

- (i) the loss in pressure is equal to or less than 2 lb/in² and the pressure stabilizes within the 5-minute test period; or
- (ii) if criteria (i) is not satisfied, the additional pressure drop is equal to or less than 1 lb/in² during an additional test period of 5 minutes (i.e., the total pressure drop is less than or equal to 3 lb/in² over a 10-minute test period), and the pressure stabilizes during the second test period.

The length of welded section tested by air pressure shall not exceed 550 feet, without prior approval by the Engineer. If a non-compliant pressure drop is noted, pressure testing may be repeated in a step fashion each time halving the length of weld being tested until the extent of the defective weld is determined. Vacuum box testing (ASTM D4437) may also be used to locate a defect in the top weld or in the top of the air channel.

Once the defect is found, it shall be clearly identified, marked and repaired. Any defective seam shall be repaired so that it meets or exceeds the minimum requirements specified herein.

Welds in inaccessible areas where the use of the other nondestructive test methods is not practical shall be tested using a high voltage spark tester and the procedures specified in ASTM D6365 and by the equipment manufacturer. The spark testing equipment and proposed field testing procedures shall be pre-approved by the Engineer prior to use.

8.5.4 Sampling and Destructive Testing

The Liner Installer shall obtain and secure samples of the liner and field seams for destructive testing by the Engineer at locations designated by the Engineer. Samples shall be obtained at the frequency specified in Section 8.6.3. The Liner Installer shall obtain seam samples, in triplicate, from the designated location for laboratory testing. One portion of the sample shall be retained by the Liner Installer for testing. If the results of field tests performed by the Liner Installer, in the presence of the Engineer, indicate compliance with the criteria in Section 8.4.3, then the Liner Installer shall provide the second portion of the sample to the Engineer for independent quality control testing. The third portion will be retained by the Owner for archive storage. If the results of peel and shear tests performed by the Liner Installer in the field do not

meet or exceed the requirements specified herein, then the provisions of Section 8.4.3 shall apply for temporarily determining the extent of repairs pending performance of independent quality control tests by the Engineer.

The portions of seam samples provided to the Engineer for laboratory destructive testing and the Owner for archive storage shall each be not less than 12 inches wide by 18 inches long in the direction of the seam. The seam shall be centered along the sample length. Each of the triplicate samples shall be properly marked and identified by the Liner Installer. The Liner Installer shall repair all holes created by sampling in accordance with Section 8.4.7.

8.5.5 Visual Inspection

The Liner Installer shall visually inspect the entire liner surface for any defects including, but not limited to, seam imperfections, badly scuffed areas, scratches, blisters, tears, rips, holes, pinholes and punctures. The Liner Installer shall identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs shall be made in accordance with Section 8.4.7.

8.5.6 Quality Assurance Forms

The Liner Installer shall adopt and use the quality assurance forms prepared by the Engineer, or other forms approved by the Engineer, during all applicable phases of liner installation, inspection and testing. The Liner Installer can request approval to use their standard forms in lieu of forms prepared by the Engineer. The Liner Installer's forms must be submitted to the Engineer at least two weeks prior to liner installation for review and approval.

8.5.7 Certification

The Liner Installer's installation supervisor shall observe and check all phases of liner installation. When the liner is accepted by the Owner, the Liner Installer shall submit written certification to the Owner that the installation conforms to the requirements of the Liner Manufacturer.

8.6 Quality Control Inspection and Testing by Engineer

8.6.1 Base Maintenance and Repair During Liner Installation

The Engineer will undertake observations and perform quality control tests to determine compliance with these Specifications. Quality control by the Engineer will include monitoring soil placement to determine the suitability of subgrade materials and adequacy of compaction. The Engineer will perform *in-situ* density tests: (i) after compaction of fill as needed to fine grade, maintain and restore the condition of the prepared soil base; (ii) after compaction of fill in excavations as needed to restore grade; and (iii) after compaction of backfill in anchor trenches. *In-situ* density tests will be performed by the drive cylinder method (ASTM D2937), sand cone method (ASTM D1556), or other methods approved by the Engineer and deemed equivalent by him at his sole discretion. Water content tests made in the field using a calcium carbide gas pressure tester (ASTM D4944) may be used to provide water content information for construction control, but final acceptance of all liner subgrade material will be based upon ASTM D2216 unless approved otherwise by the Engineer. Penetration test probes may also be performed as needed

to verify the uniformity of compaction. The Engineer will perform Standard Proctor compaction tests (ASTM D698) as needed to determine compliance with compaction requirements.

Testing of the compacted soil base will be performed by the Engineer following final grading and compaction by the Earthwork Contractor before the surfaces are turned over to the Liner Installer. Testing of the compacted soil base will be repeated, as needed, immediately prior to liner placement. Final documentation and results from these tests, however, will not be available prior to liner deployment. Such testing shall not relieve the Liner Installer from his responsibility for restoration or repair of unsuitable areas following liner placement, in the event that such is deemed necessary by the Engineer. The Contractor shall retain a Florida-licensed surveyor to survey, sign, and seal the final grade, and have the elevations approved by the Engineer before the surfaces are turned over to the Liner Installer.

8.6.2 Liner Installation

All aspects of the liner installation will be inspected on a full-time basis by the Engineer. The Engineer will conduct his own inspections and tests in addition to those performed by the Liner Installer. The Engineer will undertake observations and perform quality control tests to determine compliance of the liner installation with these Specifications. Quality control by the Engineer will include monitoring: (i) liner handling and panel deployment; (ii) field welding of liner sheets and non-destructive testing of field welds; (iii) installation of anchor trenches; (iv) placement and maintenance of temporary ballast loading; and (v) installation of pipe penetrations. The Engineer will also monitor liner repair work, and evaluate the adequacy and acceptability of all repair work.

8.6.3 Destructive Testing

The Liner Installer shall obtain and secure samples of the liner and field seams for destructive testing by the Engineer from locations designated by the Engineer, and shall properly mark all samples to identify the particular seam or liner panel from which the sample was obtained.

- (i) Testing and sampling of liner material will be performed as specified in Section 7.5.
- (ii) Seam samples will be taken for destructive peel and shear testing by the Engineer at a minimum frequency of 1 sample per 500 feet of field seam. Samples for destructive testing will be obtained by the Liner Installer at locations designated by the Engineer within 48 hours of the welding the field seam unless approved otherwise by the Engineer.

Duplicate samples of all HDPE liner material and all field seams tested destructively by the Liner Installer shall also be secured by the Liner Installer and submitted to the Engineer for independent testing. All samples shall be properly marked and identified.

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor

shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

8.7 Insurance

The Liner Installer, through the Contractor, shall provide the Owner insurance coverage against blowout or uplift of the liner during installation. The insurance coverage shall remain in effect until the Owner issues a Letter of Acceptance to the Contractor.

The Contractor shall agree to provide the Owner with a commitment to re-install or replace any liner that may blowout during the time when the insurance coverage is in effect, at the same rate as required during initial installation, without adversely affecting the rate of progress of work yet to be performed. Additional materials, manpower and equipment shall be mobilized to the site within two weeks of a blowout occurrence as needed to comply with this commitment.

8.8 Warranty

A written warranty shall be provided to the Owner by the Liner Installer. This document shall warrant the quality of the workmanship for a period of not less than 2 years beginning on the date of the Letter of Acceptance from the Owner.

8.9 As-Built Drawings

The Liner Installer shall submit to the Owner, within 30 days of completion of installation of the liner, an as-built plan showing the location and identification of all installed liner panels, anchor trenches, repairs and destructive test samples.

8.10 Submittals

The following submittals are required from the Liner Installer as part of the requirements of the Specifications.

- The proposed methods for dewatering, surface water control, and routing water shall be submitted at least four weeks prior to implementation (Section 8.3).
- The proposed liner panel layout and details of the liner installation, including anchor trenches, vents, and pipe penetrations shall be submitted at least two weeks prior to liner installation (Section 8.4.2).
- A complete description and details of the liner handling and installation procedures, including the proposed temporary ballast loading, shall be submitted at least two weeks prior to liner installation (Section 8.4.5).
- Quality assurance forms proposed for use by the Liner Installer for all phases of liner installation, inspection and testing shall be submitted at least two weeks prior to liner installation (Section 8.5.6).

- Certification by the Liner Installer, when the liner is accepted by the Owner, that the liner installation complies with the requirements of the Liner Manufacturer (Section 8.5.7).
- Workmanship warranty for a period of at least two years beginning on the date of the Letter of Acceptance from the Owner (Section 8.8).
- As-built plan of the installed HDPE liner within 30 days of completion of liner installation in AutoCAD format (Section 8.9).

SPECIFICATIONS

SECTION 9 GEOCOMPOSITES, GEONETS, AND GEOTEXTILES FOR BOTTOM LINER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

9.1 Description of Work

This Specification covers the material requirements and installations of the geocomposites, geonets, and geotextiles in the bottom liner and leachate collection systems shown on the Drawings.

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9.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

D1248: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique

D1603: Standard Test Method for Carbon Black in Olefin Plastics

D1683: Standard Test Method for Failure of Sewn Seams in Woven Fabrics

D3786: Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method

D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity

- D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4716: Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4833: Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
- D5199: Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5261: Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- D7005: Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
- D7179: Standard Test Method for Determining Geonet Breaking Force

9.3 Material Requirements

Four different types of geosynthetic drainage products shall be installed in the leachate collection system above the primary HDPE geomembrane liner and in the leak detection system between the primary and secondary HDPE geomembrane liners. Classifications of these geosynthetic drainage products are as follows:

- Type A Geocomposite – Double-sided geocomposite to be used in the leachate collection system on the inside slope of the containment dike, beneath the landfill slope area, and on the west slope of the closed original CWSA.
- Type B Geocomposite – Single-sided geocomposite to be used in the leachate collection system in the interior portion of the landfill away from the slope area.
- Type C Geocomposite – Double-sided geocomposite to be used in the leak collection system on the inside slope of the containment dike and beneath the landfill slope area.
- Type D Geonet – Geonet to be used in the leak detection system in the interior part of the landfill away from the slope area.

The Type A, B, and C geocomposites used in the leachate collection and leak detection systems shall consist of an HDPE geonet core with non-woven geotextiles heat bonded to one (single-sided geocomposite) or both (double-sided geocomposite) sides of the geonet core. The geonet cores in the Type A, B, and C geocomposites as well as the Type D geonet shall be manufactured from unreinforced HDPE, and shall be designed and manufactured specifically for use as a drainage product. The geotextile used in the geocomposites and to wrap around the gravel in the

leachate collection pipe trench and sump shall be manufactured from non-woven geotextile that is suitable for material separation.

A complete description of the geocomposites and geonet proposed for use with a minimum 1 square yard sample and the Manufacturer's product data sheets shall be submitted by the Contractor to the Engineer for approval at least two weeks prior to delivery of materials to the job site. Certifications from the Manufacturer that the geocomposites and geonet comply with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of materials to the job site.

9.3.1 Geonet

9.3.1.1 HDPE Resin

The uncolored base resin shall be polyethylene having a minimum density of 0.932 g/cm³ classifying as Group 2, Class 2, Grade 4 or Grade 5 (PE 224 or PE 225) medium density polyethylene in accordance with ASTM D4976. The formulated colored resin shall classify as a Group 2, Class 3, Grade 4 or Grade 5 high density polyethylene (PE 234 or PE 235) with physical properties meeting A46009 in accordance with ASTM D4976 with environmental stress crack resistance (ASTM D1693) $F_{50} > 1,500$ hours (Condition B; 50°C/100% Igepal) and $F_{20} > 192$ hours (Condition C; 100°C/100% Igepal). The formulated colored resin shall contain not less than 97 percent of the base polymer; not less than 2.0 percent carbon black and not more than 3.0 percent carbon black, anti-oxidants and heat stabilizers combined with no other additives, fillers or extenders. The geonet shall be manufactured from virgin resin; with no more than 3 percent regrind material. Regrind material, if used, shall be of the same formulation as the virgin resin. No post-consumer resin of any type shall be used.

9.3.1.2 Physical Appearance

The geonet shall be uniform in appearance and composition and shall be free of tears, cuts, gels, undispersed ingredients, any signs of contamination by foreign matter, or any defect that may affect serviceability.

9.3.1.3 Physical Properties

A complete description of the geonet proposed for use and the Manufacturer's product data sheets and 2-foot long by roll width sample shall be submitted to the Engineer for approval at least two weeks prior to delivery of material to the job site. Certification from the Manufacturer that the geonet complies with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of material to the job site.

The geonet cores of the Type A, B, and C geocomposites, and the Type D geonet shall meet the following criteria:

Property	Test Method	Criteria			
		Type A	Type B	Type C	Type D
Melt Index (gm/10 mins)	ASTM D 1238, Condition E	≤1.0	≤1.0	≤1.0	≤1.0
Carbon Black Content (%)	ASTM D1603	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Density (g/cm ³)	ASTM D1505	≥0.94	≥0.94	≥0.94	≥0.94
Thickness Retention (%)	100 psi for 10,000 hours at 20°C temperature	≥75%	≥75%	≥75%	≥75%
Thickness (inches)	ASTM D5199	≥0.30	≥0.275	≥0.25	≥0.20
Transmissivity* (m ² /sec)	ASTM D4716	≥8.0x10 ⁻³	≥6.0x10 ⁻³	≥3.0x10 ⁻³	≥5.0x10 ⁻⁴
Tensile Strength** (lb/in)	ASTM D7179	≥75	≥65	≥55	≥45
* For the Type A, B, and C geocomposites, the values represent the transmissivities of the geonet core in the primary flow direction under a compressive normal load of 10,000 lbs/ft ² and a gradient of 0.1, with water at 70°F between steel plates for 15 minutes. For the Type D geonet, the value represents the transmissivity of the geonet in the primary flow direction under a compressive normal load of 10,000 lb/ft ² , a gradient of 0.02, and a seating time of 100 hours. ** Machine direction.					

9.3.2 Geotextiles

Geotextiles for the geocomposite and where shown on the Drawings shall be a non-woven, needle-punched fabric manufactured from 100 percent polyester or 100 percent polypropylene. The geotextiles shall be uniform and homogeneous in appearance and composition, and free from tears, cuts, thin spots, or any defects that may affect serviceability. The geotextiles shall meet the following criteria.

Two types of geotextiles with different weights shall be used. Geotextile with a mass of 8 oz/yd² shall be used in the Type A, B, and C geocomposites. Geotextile with a mass of 12 oz/yd² shall be used for wrapping of the gravel in the leachate collection pipe trench and leachate collection sump. The properties of the geotextiles are as follows:

Property	Units	Test Method	Criteria	
			8 oz/yd ² Geotextile	12 oz/yd ² Geotextile
Mass per Unit Area	oz/yd ²	ASTM D5261	≥8	≥12
Apparent Opening Size	USSF [†]	ASTM D4751	≥80	≥100
Grab Tensile Strength*	lb	ASTM D4632	≥220	≥320
Grab Elongation*	%	ASTM D4632	≥50	≥50
Trapezoidal Tear Strength*	lb	ASTM D4533	≥90	≥120
Puncture Resistance	lb	ASTM D4833	≥120	≥190
CBR Puncture	lb	ASTM D6241	≥575	≥900
Permittivity	sec ⁻¹	ASTM D4491	≥1.3	≥0.85
UV Resistance [500 Hours]	%	ASTM D4355	≥70	≥70
* Machine and transverse directions.				
† United States Standard Sieve Size.				

A complete description of the geotextiles proposed for use and the Manufacturer's product data sheets shall be submitted to the Engineer for approval at least two weeks prior to delivery of material to the job site. Certification from the Manufacturers that the geotextiles comply with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of material to the job site.

9.3.2.1 Geocomposite

The geonet core and geotextile in the Type A, B, and C geocomposites shall meet the requirements of Sections 9.3.1 and 9.3.2.

Type A and B geocomposites that will be installed in the leachate collection system shall have a transmissivity (ASTM D4716) of equal to or greater than 2.0×10^{-3} m²/sec in the machine direction under a compressive normal load of 10,000 lb/ft², a gradient of 0.02, and a seating time of 100 hours.

Type C geocomposite that will be installed in the leak detection system shall have a transmissivity (ASTM D4716) of equal to or greater than 5.0×10^{-4} m²/sec in the machine direction under a compressive load of 10,000 lb/ft², a gradient of 0.02, and a seating time of 100 hours.

For Type A, B, and C geocomposites, the bond between the geotextile and the geonet shall have a ply adhesion (ASTM D7005) of equal to or greater than 1.0 lb/in.

9.3.3 Frictional Characteristics

The minimum peak interface friction angle between the drainage sand and the double-sided geocomposite shall be 21 and 28 degrees for the leachate collection systems at the base, and on the west slope of the existing Combustion Waste Storage Area, respectively.

For determining compliance with the specified interface friction angles, direct shear tests will be performed by the Engineer in accordance with Standard ASTM D5321 using a fine sand with silt fill materials (Group Symbol SP-SM in accordance with ASTM D2487) from the site meeting the following gradation.

U.S. Standard Sieve Size	Percent Passing (Dry Mass Basis)
No. 4	100
No. 10	97-100
No. 20	95-100
No. 40	90-100
No. 60	60-95
No. 100	20-80
No. 140	7-25
No. 200	5-12

The direct shear tests shall be performed at normal stresses selected by the Engineer ranging from 5 to 65 lb/in² to duplicate field conditions. The soil shall be compacted to a dry density equal to 95 percent of the Standard Proctor maximum dry density (ASTM D698) within ± 2 percent of

the Standard Proctor optimum water content. The interface and soil shall be tested submerged with water. The tests shall be performed using a horizontal displacement rate of 0.3 inches per hour.

9.4 Factory Testing and Inspection

9.4.1 Factory Testing

9.4.1.1 Geonet

Standard factory testing reports for raw materials including melt index and specific gravity or density for each batch of resin used to manufacture the geonet shall be submitted to the Engineer for approval at least two weeks prior to delivery of material to the job site. The resin Manufacturer's certificate of analysis for each batch of resin shall also be provided to the Engineer at least two weeks prior to delivery of material to the job site.

Factory quality control certificates for the geonet component of the geocomposite shall be provided to the Engineer by the Manufacturer at least two weeks prior to delivery of material to the job site. As a minimum, the quality control certificates shall contain the geonet roll identification number, date manufactured, roll width and length, and resin batch number. The following factory quality control tests shall be provided at the indicated frequencies:

Property	Test Method	Frequency
Mass per Unit Area	ASTM D5261	Every 50,000 square feet
Thickness	ASTM D5199	Every 50,000 square feet
Tensile Strength*	ASTM D7179	Every 50,000 square feet
Transmissivity**	ASTM D4716	Every 20 Rolls
Melt Index	ASTM D1238	Once per Batch of Resin or Every 10 Rolls
Carbon Black Content	ASTM D1603	Once per Batch of Resin or Every 10 Rolls
Density	ASTM D1505	Once per Batch of Resin or Every 10 Rolls
* Machine and transverse direction.		
** Machine direction.		

Failure of any of the tests shall result in rejection of the corresponding lot of geonet.

9.4.1.2 Non-Woven Geotextile

Factory quality control certificates for the non-woven geotextile, including the component of the geocomposite, shall be provided to the Engineer by the Manufacturer at least two weeks prior to delivery of materials to the job site. The quality control certificates shall contain the geotextile roll number, date manufactured, roll length, and width. The Manufacturer shall provide test results to the Engineer at least one sample per lot of geotextile for mass per unit area, thickness, apparent opening size, permeability to water, and grab tensile strength and elongation in accordance with the test procedures in Section 9.3.2. Failure of any of the tests shall result in rejection of the corresponding lot of geotextile.

9.4.2 Factory Inspection

The geotextiles and geocomposite shall be visually inspected at the factory prior to shipment for compliance with the physical appearance requirements in Sections 9.3.1.2 and 9.3.2. Any necessary repair shall be made by the Manufacturer at the factory prior to shipment.

9.4.3 Marking and Packaging

Each geotextile and geocomposite roll shall be individually packaged at the factory to prevent damage during shipping and handling, and shall be completely wrapped by a protective ultraviolet resistant thin plastic film having a minimum thickness of 2 mils. The Manufacturer shall provide each roll with a label indicating the roll number, product name, length, width and date manufactured.

9.5 **Handling and Installation**

9.5.1 Storage and Handling

The Contractor shall be responsible for unloading and storing the geotextile and geocomposite rolls. During unloading, the Contractor shall obtain samples from the ends of rolls for testing by the Engineer at locations selected by the Engineer.

The geotextiles and geocomposites shall remain wrapped in the protective cover and shall be stored, as recommended by the Manufacturer and approved by the Engineer, in an area of the site that protects the geotextiles from moisture, water, ash, dirt, ultraviolet light and mechanical damage until the time of installation. The rolls shall not be unwrapped more than 1 hour before use. Handling of the rolls shall be in accordance with the Manufacturer's recommendations, and shall be as needed to protect the geotextiles from damage.

9.5.2 Laying and Installation

The geocomposites and geotextiles shall be installed at the locations and to the lines and dimensions shown on the Drawings.

The geocomposite shall be deployed with the most transmissive direction oriented towards the leachate collection pipe trench. The geocomposites and geotextiles shall be installed in a smooth and unwrinkled condition in uniform contact with the underlying materials and held in place as needed and approved by the Engineer until covered.

The ends of the geonet at a joint shall be overlapped 4 inches and tied together with polyethylene or polypropylene ties recommended by the Manufacturer and approved by the Engineer. Metallic ties shall not be used. A minimum of three ties shall be used at each joint, and the ties shall be of a color to allow easy inspection (e.g., white or yellow) against the black geonet. The upper and lower geotextiles of the composite at the joint shall be overlapped a minimum of 4 inches, and the top geotextile overlap shall be sewn in accordance with Section 9.5.3.

After installation, the geocomposite shall not be left exposed for more than 48 hours prior to covering.

The exposed edge of the geonet on all cut sides and ends of the geocomposite shall be covered with a piece of the same geotextile as on the composite overlapped 12 inches minimum on the bottom and top of the composite. The edge of the top lap shall be held in-place until covered using spot thermal bonding or black PVC pipe wrapping tape as approved by the Engineer and, if needed, temporary sand bags. The upper and lower geotextiles along the uncut edge of the geocomposite shall be sewn in accordance with Section 9.5.3.

Geotextiles shall be installed where shown on the Drawings in a manner that minimizes seams. The geotextiles shall be cut to the dimensions shown on the Drawings, overlapped if needed, and installed in a smooth unwrinkled condition in contact with the underlying materials. The geotextiles shall be held in place as needed until covered, and shall always be covered within 48 hours of installation.

9.5.3 Geotextile Field Seams

Field seams in geotextiles shall be made using a minimum overlap of 4 inches. The geotextile panels shall be sewn together with a sewing machine using a flat sewn seam with one row of stitches with a minimum of four stitches per inch, or a seam and stitching pattern recommended by the Manufacturer and approved by the Engineer. The thread used to sew the seams shall be 2000 denier minimum, or as recommended by the Manufacturer and approved by the Engineer, and shall have the same composition as the geotextile. The strength of field seams shall not be less than 50 percent of that of the un-aged geotextile in any principal direction when tested in accordance with ASTM D1683 at a strain rate of 12 inches/minute. The Contractor shall submit details of the proposed sewing method (type of stitch, number of stitches per inch, number of stitching rows, distance from the edge of the geotextile to the stitches, weight and type of thread, etc.) and a minimum 10 feet long sample of the sewn seam for approval by the Engineer at least one week prior to installation.

9.5.4 Geotextile Repairs

All tears, punctures, thinly stretched sections, or any other defect that may, as determined by the Engineer, render the geotextile unsuitable, shall be repaired by the Contractor. Repairs shall be made by overlaying a patch of geotextile over the damaged area with a 12-inch minimum lap all around. The patch shall be sewn to the geotextile, as specified in Section 9.5.3, all around the patch perimeter. Patches on geotextiles on the geocomposite shall be held in place by thermal bonding or 2-inch wide black PVC pipe wrapping tape, and sewn in accordance with Section 9.5.3 of this Specification where directed by the Engineer. Geotextile and geocomposite that require more than one repair to the geotextile per roll shall be rejected and replaced.

9.6 **Sampling and Inspection by Contractor**

9.6.1 Sampling

The Contractor shall obtain and secure samples of the geotextile, geonet, and geocomposite for destructive testing by the Engineer when the rolls are delivered to the site or subsequently during installation as requested by the Engineer. The samples shall be obtained from locations designated by the Engineer. All samples shall be properly marked and identified by the Contractor. The Contractor shall repair all openings created by sampling in accordance with Section 9.5.4 or completely remove the full width of the roll at the sampling location.

9.6.2 Visual Inspection

The Contractor shall visually inspect the surfaces of the installed geotextiles and geocomposites for any defects including, but not limited to, rips, tears, punctures and defective seams. The Contractor shall identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs to geotextiles shall be made in accordance with Section 9.5.4. Geocomposite with damage to both geotextile surfaces at any location shall be removed and replaced.

The Contractor shall visually inspect the surfaces for soil, ash, dust or debris that could result in clogging of the geonet or geotextiles. If soil, ash, dust or debris is entrapped in the geonet, it shall be removed and replaced or the surfaces cleaned as approved by the Engineer.

9.7 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance of the materials and work with this Specification. Quality assurance by the Engineer will include monitoring and/or inspecting: (i) geotextile handling, installation, overlapping and field seaming; (ii) geocomposite handling, installation, overlapping and field joining; (iii) the geotextile and geonet for damage; and (iv) geotextile and geonet for excessive entrapped soil, ash, dust or debris that could reduce the transmissivity of the composite.

Laboratory quality assurance tests shall be performed by the Engineer on the geonet, geotextiles, and geocomposites at the following minimum frequencies.

Material	Property	Test Method	Minimum Testing Frequency
Geonet or Geonet Core of Geocomposite	Thickness	ASTM D5199	Once per 100,000 ft ²
	Mass per Unit Area	ASTM D5261	
	Density	ASTM D1505	
	Carbon Black Content	ASTM D1603	
	Tensile Strength	ASTM D7179	
	Transmissivity*	ASTM D4716	Once per 200,000 ft ²
Geotextile or Geotextile Component of Geocomposite	Thickness	ASTM D5199	Once per 100,000 ft ²
	Mass Per Unit Area	ASTM D5261	
	Grab Strength & Elongation	ASTM D4632	
	Apparent Opening Size	ASTM D4751	Once per 100,000 ft ²
	Permeability	ASTM D4491	
	Field Seam Strength	ASTM D1683	Once per 500 feet of field seam
Geocomposite	Transmissivity*	ASTM D4716	Once per 100,000 ft ²
	Ply Adhesion	ASTM D7005	Once per 100,000 ft ²
* Transmissivities of the geonet cores of the Type A, B, and C geocomposites shall be measured along the primary flow direction under a compressive normal load of 10,000 lb/ft² and a gradient of 0.1 with water at 70°F between steel plates for 15 minutes. Test cross section for the Type A and B geocomposites in the leachate collection system shall consist of, from top to bottom, drainage sand, geocomposite, and textured HDPE liner under a compressive normal load of 10,000 lb/ft², a gradient of 0.02, and a seating time of 100 hours. Test cross section for the Type C geocomposite and Type D geonet in the leak detection system shall consist of, from top to bottom, textured HDPE liner, geonet, and textured HDPE liner under a compressive normal load of 10,000 lb/ft², a gradient of 0.02, and a seating time of 100 hours.			

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

9.8 Submittals

The following submittals are required from the Contractor as part of the requirements of this Specification.

- A complete description of each non-woven geotextile, the Manufacturer's product data sheets for each, and the Manufacturer's certification that the geotextiles meet the requirements of this Specification (Section 9.3).
- A minimum 1 square yard sample of each proposed non-woven geotextile (Section 9.3).
- Factory quality control certificates for each roll of non-woven geotextile, HDPE geonet, and geocomposite (Section 9.4.1.2).
- Proposed sewing method for field seaming the non-woven geotextiles and a minimum 10 feet long sample of sewn seam. (Section 9.5.3)
- A complete description of the HDPE geocomposite, a minimum 1 square yard sample of the composite and 1 square yard sample of the non-woven geotextile used on the composite, the Manufacturer's product data sheets, and the Manufacturer's certification that the geocomposite meets the requirements of this Specification (Section 9.3).
- As-built layout plans for the leachate collection and leak detection layers in AutoCAD format.

SPECIFICATIONS

SECTION 10 LEACHATE COLLECTION AND LEAK DETECTION SYSTEMS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

10.1 Description of Work

The work covered by this specification involves installing a leachate collection and leak detection systems at the bottom of the lined landfill horizontal expansion area. The leachate collection and leak detection systems shall be placed directly above the primary HDPE geomembrane liner and the secondary HDPE geomembrane liner, respectively.

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10.8	Construction Quality Assurance Inspection and Testing	8
10.9	Submittals	9

10.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

D638: Standard Test Method for Tensile Properties of Plastics

D695: Standard Test Method for Compressive Properties of Rigid Plastics

D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics

D790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792: Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement

- D1140: Standard Test Method for Amount of Material in Soils Finer than the No. 200 Sieve
- D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603: Standard Test Method for Carbon Black in Olefin Plastics
- D1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics
- D2240: Standard Test Method for Rubber Property - Durometer Hardness
- D2412: Standard Test Method for External Loading Properties of Plastic Pipe by Parallel-Plate Loading
- D2513: Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings
- D2837: Standard Specification for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
- D2937: Standard Test Method for Density of Soil in Place by the Drive Cylinder Method
- D3261: Standard Specification for Butt Heat Fusion Polyethylene Plastic Pipe and Tubing
- D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
- D4976: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
- D5084: Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter
- F714: Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter

10.3 Layout of Work

The Owner will establish reference points for horizontal and vertical controls near the designated construction area for the landfill cell. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to install the leachate collection and leak detection systems to the lines and grades shown on the Construction Drawings. It is the responsibility of the Contractor to verify all locations and dimensions prior to performance of any work.

10.4 Material Requirements

10.4.1 Base Resin

The base resin shall be high density, high molecular weight polyethylene (HDPE) with properties equivalent to ASTM Standard D3350 cell classification 345444C or 345464C. The pipe and fittings shall be manufactured from virgin resin with no regrind material. The resin shall contain

not less than 97 percent of the base resin, and not less than 2.0 percent carbon black as defined in ASTM D4976, Class C, to impart maximum weather resistance. The pipe material shall contain no more than 3 percent carbon black, anti-oxidants and heat stabilizers combined, and no other additives, fillers or extenders.

10.4.2 Physical Appearance

All pipes and fittings shall have good appearance qualities. The pipe and fittings shall be homogeneous throughout, and the surfaces shall be smooth and uniform with no visible defects. The pipes shall be free of holes, cracks, nicks, cuts, gouges, scratches, blisters, gels, undispersed ingredients, any signs of contamination by foreign inclusions, or any defect that may affect serviceability.

10.4.3 Non-Perforated HDPE Pipe and Fittings

The pipes used for removal of leachate and leakage from the sumps shall consist of 24-inch diameter DR 17 HDPE pipes. Except for 5-foot sections of the pipes at the bottom of the sump shown on the Construction Drawings, the leachate collection and leak detection sump pipes shall be non-perforated. Where specified, the perforations for the leachate collection and leak detection sump pipes shall consist of ½-inch diameter holes cleanly cut and evenly spaced along two lines around the pipe circumference at a 3-inch spacing along the length of the pipe, as shown on the Construction Drawings. The non-perforated pipes used for the clean-outs of the leachate collection and leak detection pipes shall consist of 8-inch diameter DR 17 HDPE pipe.

The HDPE pipe materials shall have the following properties:

Property	Test Method	Criterion
Density [Natural]	ASTM D1505	≥0.945 g/cc
Density [Black]	ASTM D1505	≥0.955 g/cc
Melt Index	ASTM D1238	<0.15 g/10 min
Flow Rate	ASTM D1238	>4.0 and <20 g/10 minutes
Carbon Black Content	ASTM D1603	>2.0% & <3.0%
Flexural Modulus	ASTM D790	≥120,000 psi
Tensile Strength at Yield	ASTM D638, Type IV, 2 ipm	≥3,000 psi
Elongation at Break	ASTM D638, Type IV, 2 ipm	≥400%
Compressive Strength at Yield	ASTM D695	≥1,600 psi
Hydrostatic Design Basis	ASTM D2837	≥1,600 psi
Low Temperature Brittleness	ASTM D746	►-60°C
Thermal Expansion Coefficient	ASTM D696	►0.022%/°C

Dimensions, workmanship, dimension ratio (DR) and corresponding pressure rating of the pipe shall be in accordance with the requirements of ASTM F714.

The Contractor or Supplier shall submit a complete description of the HDPE pipe and fittings proposed for use including the Manufacturer's name or trademark, pipe series designation and dimensions. Packaging, handling and shipment of the pipe shall also be in accordance with the

pipe Manufacturer's standards, instructions and recommendations, subject to the approval of the Engineer. The Manufacturer's product data sheets and certification from the Manufacturer that the pipe and fittings are in compliance with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of the materials to the job site.

10.4.4 Fabricated Fittings

Molded HDPE fittings specified on the Construction Drawings or otherwise needed to make pipe connections (e.g., 45° ells) shall meet all base resin, physical appearance and physical property requirements specified above for the pipe. All fittings shall be fully pressure rated to match or exceed the highest pipe pressure rating (i.e., lowest DR) to which they are connected. Molded butt fittings shall be manufactured in compliance with ASTM D2513 and ASTM D3261. Molded socket fittings shall not be used.

Fabricated HDPE fittings made by butt fusing or sidewall fusing cut segments of pipe (e.g., lateral wyes and concentric reducers) shall be used where called for on the Construction Drawings. Fabricated fittings shall be made using pipe segments meeting all base resin, physical appearance and physical property requirements specified in above for the pipe. All pipe segments in a fabricated fitting shall be pressure rated to exceed by 20% the highest pipe DR pressure rating to which they are intended to be connected, i.e., they shall be fabricated using heavier wall and lower DR pipe segments (as needed to have the fabricated fitting fully pressure-rated to match or exceed the highest pipe pressure rating to which they are intended to be connected).

The Contractor shall submit shop drawings containing a complete description of the HDPE pipe and fittings proposed for use on this project to the Engineer for approval at least two weeks prior to installation.

10.4.5 Perforated HDPE Pipes and Fittings

The leachate collection and leak detection pipes shall consist of 8-inch diameter perforated DR 17 HDPE pipe.

Where slotted pipe is specified on the Drawings, the slots shall be cleanly cut, identical in geometry, and evenly spaced. The slot length shall be located perpendicular to the longitudinal axis of the pipe. Slots shall be located in two straight rows along the length of the pipe. The rows of slots shall be spaced 180° on centers around the circumference of the pipe, and shall not be staggered. The slots shall satisfy the following criteria:

Dimension or Area	Criteria
Slot Width (inches)	>0.10 and <0.15
Slot Length Measured Along Outer Pipe Circumference (inches)	>2.00 and <3.25
Slotted Area (in ² /foot of pipe)	>2.0 (outer wall) >1.0 (inner wall)
Spacing Between Slots Along Pipe Length (c/c, inches)	>1.0 and <3.0

The Contractor shall submit shop drawings containing a complete description of the HDPE pipe and fittings proposed for use on this project and a 3-foot long sample of slotted pipe to the

Engineer for approval at least two weeks prior to delivery of the material to the job site. Slotted pipe shall not be delivered to the site without first receiving approval for delivery from the Owner.

10.4.6 Joining and Joint Requirements

The HDPE pipe sections, and the pipe and fittings, shall be joined using the butt, heat fusion technique. All joints shall be made in strict compliance with the Manufacturer's recommended practice, subject to the approval by the Engineer, and the joining procedures shall be qualified under Part 192.283 of the Pipeline Safety Regulations, Federal Safety Standards. All joints shall be performed by trained fusion technicians qualified by the Manufacturer and using equipment and controlled procedures approved by the Manufacturer. Operators performing butt fusion shall also be qualified under Part 192.285 of the Federal Safety Standards.

All pipe joints shall be stronger than the pipe itself under both tension and hydrostatic loading conditions. The joint shall be leak-tight, homogeneous and uniform throughout.

10.4.7 Filter Fabric

The gravel and some sections of drainage sand at the clean-out and sump pipes, as shown on the Drawings, shall be completely wrapped on all faces with a non-woven, needle-punched polypropylene or polyester filter fabric to preclude the migration of the drainage sand into the gravel.

The filter fabric shall be uniform and homogeneous in appearance and composition, and free from tears, cuts, thin spots or any defects that may affect serviceability. The filter fabric shall be supplied in rolls having a minimum width of 15 feet and minimum length of 300 feet, and shall meet the following material requirements:

Property	Test Method	Criterion
Mass per Unit Area	ASTM D5261	≥ 12 oz/yd ²
Apparent Opening Size	ASTM D4751	≥ 100 U.S. Standard Sieve
Grab Tensile Strength*	ASTM D4632	≥ 320 lb
Grab Elongation*	ASTM D4632	$\geq 50\%$
Trapezoidal Tear*	ASTM D4533	≥ 120 lb
Puncture Resistance	ASTM D4833	≥ 190 lb
CBR Puncture	ASTM D6241	≥ 900 lb
Permittivity	ASTM D4491	≥ 0.85 sec ⁻¹
UV Resistance [500 Hours]	ASTM D4355	≥ 70 %
* In both machine and transverse directions.		

A complete description of the filter fabric proposed for use by the Contractor that meets or exceeds the specified requirements shall be submitted to the Engineer for approval at least one week prior to delivery of the material to the job site. Factory testing, submittals and quality assurance inspection and testing shall be conducted in accordance with Section 9 of this Specification Document.

10.4.8 Filter Gravel

The filter gravel used for construction of the leachate collection system shall consist of clean, washed, rounded, sub-rounded to sub-angular particle shape, silica classifying as a GP-type poorly graded fine gravel, or fine gravel with coarse sand, as determined in accordance with ASTM D2487. Gravel consisting of predominantly angular or otherwise sharp-edged particles shall not be used.

The gravel shall be free of any trash or debris, and shall meet the following gradation requirements, as determined using ASTM D421 and D422:

U.S. Standard Sieve Size	Percent Passing (Dry Weight Basis)
2-inch	100
1½-inch	90-100
1-inch	40-60
¾-inch	15-40
⅜-inch	0-5

A complete description of the proposed filter gravel, including its chemical composition and the gradation test results, shall be submitted by the Contractor to the Engineer for approval at least one week prior to delivery of the material to the job site to confirm compliance with these specifications.

10.4.9 Drainage Sand

The sand used for construction of the drainage sand layer shall be obtained from on-site stockpiles designated by the Owner, and shall meet the following requirements:

- The material shall have no particle retained on a U.S. ¼-inch standard sieve.
- The material shall have a plasticity index of 0 percent (ASTM D4318).
- The material shall have an organic content no greater than 3 percent (ASTM D2974).
- The material shall classify as a fine sand or slightly silty fine sand with a SP or SP-SM designation in accordance with ASTM D2487.
- The material shall have a fines content equal to or less than 12 percent, as determined by ASTM D1140.
- The material shall be relatively uniform in character and, after compaction, shall be able to achieve an in-place saturated hydraulic conductivity equal to or greater than 1.0×10^{-4} cm/sec.

10.5 Installation of Drain System

Proper tools and equipment shall be used by the Contractor for installation of the drain system at the base of the landfill cell. The HDPE pipes shall be installed at the locations and along the lines and grades shown on the Construction Drawings. The leachate collection and leak detection systems shall be installed prior to placement of the drainage sand layer.

Prior to installation of the drain system, the Contractor shall carefully examine all HDPE pipe and fittings for any damage and defects. All defective materials shall be rejected and replaced. The Contractor shall also carefully inspect the base of the landfill cell and make sure that it is free of foreign objects or obstacles that may affect installation of the drain system. If water is present in the pipe trench or sump area, it shall be dewatered prior to placement of the filter fabric, gravel and HDPE pipes.

The filter fabric used in the gravel trench drain shall remain wrapped and protected from moisture and ultraviolet light until the time of installation. Storage at the site shall be in a suitable area protected from sunlight and moisture. After installation, the filter fabric shall not be left exposed for more than 48 hours before being covered with drainage sand or the upper liner.

During installation, the filter fabric shall be loosely laid with the long direction of the filter fabric roll placed along the alignment of the trenches upon the liner or geocomposite surface, as shown on the Construction Drawings. The liner or geocomposite surface shall be free from debris or objects that could damage the filter fabric. The filter fabric shall be in contact with the liner or geocomposite without excessive wrinkles or gaps. Field joints, where necessary, shall be made using a minimum lap length of 6 inches and flat sewn seams in accordance with the Manufacturer's recommendations, subject to approval by the Engineer. The thread used to sew the seams shall be of the same material as the filter fabric.

At the pipe penetrations, the filter fabric shall be cut to fit tightly around the pipe's circumference.

Tears, punctures, thinly stretched sections, or any other damaged filter fabric resulting from construction activities or as received from the Manufacturer which could allow the migration of the drainage sand or fine filter gravel through the fabric shall be overlain by another section or patch of filter fabric with a 6-inch lap all around the damaged area. The patch shall be field sewn to the filter fabric all around the patch perimeter.

Care shall be exercised in handling and placing the HDPE pipes to avoid any damage. Under no circumstances shall the pipes be dropped or dumped into the trench. A 6-inch thick layer of coarse filter gravel at the perforated sump pipes shall be placed in the trenches prior to the placement of the pipes. As each section of the pipe is placed in the trenches, the joints shall be assembled, and the pipes shall be brought to the lines and grades shown on the Construction Drawings. After the pipes are in place, additional gravel shall be placed around and over the drainage pipes, as shown on the Construction Drawings. The filter fabric shall then be wrapped around the gravel with a minimum overlap of 6 inches at all seams. At times when pipe laying is not in progress, the open ends of the drainage pipes shall be closed using a watertight plug or other means approved by the Engineer.

To prevent crushing of the HDPE pipes, sufficient backfill shall be placed over the pipes according to the Manufacturer's specifications before construction equipment is allowed to pass over the drainage pipes. Any pipe that is broken, cracked or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor at the Contractor's expense.

10.6 Pre-Construction Testing of Drainage Sand

Fill materials for construction of the drainage sand layer shall meet the requirements listed in Section 10.4.9 and shall be obtained from on-site stockpiles designated by the Owner. Even though the fill materials will be stockpiled and supplied by the Owner, the Contractor shall be required to remove any incidental objectionable materials (e.g., roots, organic materials, debris) prior to compaction to meet the fill material requirements stipulated in Section 10.4.9, as directed by the Engineer.

For the purpose of determining the hydraulic conductivity for compliance with the specification requirement, laboratory hydraulic conductivity tests shall be performed by the Engineer on representative samples of the soil stockpiles using specimens compacted to 100 percent of the Standard Proctor maximum dry density (ASTM D698).

10.7 Placement and Compaction Criteria for Drainage Sand

The drainage sand shall be wetted or dried, as may be required, homogenized and placed in one single 24-inch thick lift above the geocomposite. Placement of the drainage sand on the side slopes shall begin at the base of the landfill cell and progress upslope to the crest of the containment dike. Placement of the drainage sand directly over the geocomposite shall be performed by light track-mounted equipment (e.g., low ground pressure Caterpillar D-4 or D-5 dozers or equivalent equipment) and traveling on a minimum of 18 inches of sand. Care shall be exercised during placement so as not to damage the liner with the blade or tracks of the placement equipment. The drainage sand shall be placed in such a manner to avoid pushing, pulling or otherwise stretching the geocomposite and the underlying HDPE liners.

The drainage sand shall be compacted to a dry density of at least 95 percent of the Standard Proctor maximum dry density. Standard Proctor compaction tests (ASTM D698) shall be performed on samples of the drainage sand, as needed, to determine the maximum dry density for compaction control.

10.8 Construction Quality Assurance Inspection and Testing

10.8.1 Field Construction Quality Assurance Testing

The Engineer, representing the Owner, will undertake observations and inspections at the site during installation of the leachate collection and leak detection systems to:

- Determine compliance of the materials and work with this Specification. Quality control by the Engineer will include monitoring and/or inspecting: (i) the HDPE pipe and fittings; (ii) damage during installation; and (iii) the installation, alignment and joining of all pipe, and fittings.

- Ascertain that the materials are free of deleterious materials and that construction materials and procedures are in conformance with these Specifications, particularly filter fabric seams, HDPE pipe joints and seams, and placement of the drainage sand layer without damage to the underlying HDPE liners and geosynthetic drainage products.
- Perform *in situ* density tests in the drainage sand layer after compaction and compare the results to the Standard Proctor compaction test (ASTM D698). Testing shall be performed by the dry density method (ASTM D2937) or any other methods approved by the Engineer. Field *in situ* density measurements shall be made at a minimum frequency of two tests per acre.
- A minimum of four thickness measurements shall be conducted per acre.
- Recover samples for laboratory fines content determinations (ASTM D1140) and hydraulic conductivity tests (ASTM D5084). These tests shall be conducted at a minimum frequency of one test per acre.

10.8.2 Laboratory Construction Quality Assurance Testing

Laboratory hydraulic conductivity tests (ASTM D5084) shall be conducted on specimens remolded to 98 percent of the Standard Proctor maximum dry density (ASTM D698). If the hydraulic conductivity documented from a sample within a drainage sand layer section does not meet the requirement of the specifications, that drainage layer section shall be re-worked or the materials replaced, as determined by the Engineer. If re-worked, extreme care shall be exercised to prevent damage to the underlying geosynthetic drainage layers and HDPE liners.

10.9 Submittals

The following submittals are required from the Contractor or Owner's pipe supplier as part of the requirements of the Specifications.

- A complete description of the HDPE pipe and fittings with the Manufacturer's product data sheets, description of the HDPE resin, Manufacturer's certificate of analysis for the HDPE resin, and Manufacturer's certification that the pipe and fittings satisfy the requirements of this Specification.
- A 3-foot long sample of the perforated HDPE pipe.

SPECIFICATIONS

SECTION 11 PRESSURE-RATED HDPE PIPE AND FITTINGS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

11.1 Description of Work

This Specification covers the material requirements and installation of pressure-rated HDPE pipe and fittings shown on the Drawings.

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11.5	Storage and Handling	5
11.6	Installation	6
11.7	Protection and Repairs	6
11.8	Quality Control Inspection and Testing	6
11.9	Submittals	7

11.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

D638: Standard Test Method for Tensile Properties of Plastics

D695: Standard Test Method for Compressive Properties of Rigid Plastics

D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics

D790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792: Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique

D1603: Standard Test Method for Carbon Black in Olefin Plastics

D1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics

D2240: Standard Test Method for Rubber Property - Durometer Hardness

D2412: Standard Test Method for External Loading Properties of Plastic Pipe by Parallel-Plate Loading

D2513: Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings

D2837: Standard Specification for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials

D3261: Standard Specification for Butt Heat Fusion Polyethylene Plastic Pipe and Tubing

D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

F714: Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter

11.3 Material Requirements

11.3.1 Base Resin for HDPE Pipes

The base resin shall be high density, high molecular weight polyethylene (HDPE) with properties meeting or exceeding ASTM D3350 cell classification 345464C (thermoplastic material designation code PE3608 or higher). The resin shall contain not less than 97 percent of the base resin, and not less than 2.0 percent carbon black. The pipe material shall contain no more than 3.0 percent carbon black, anti-oxidants and heat stabilizers combined, and no other additives, fillers or extenders. Rework material from the Manufacturer's pipe production may be used when blended with new resin of the same thermoplastic material designation code provided pipe containing rework material meets the requirements of ASTM F714. Rework material shall be limited to a maximum of 30 percent by weight.

11.3.2 Physical Appearance

All pipes and fittings shall have good appearance qualities. The pipe and fittings shall be homogeneous throughout, and the surfaces shall be smooth and uniform with no visible defects. The pipes shall be free of holes, cracks, nicks, cuts, gouges, scratches, blisters, gels, undispersed ingredients, any signs of contamination by foreign inclusions, or any defect that may affect serviceability.

11.3.3 Physical Properties

Pipe and fitting dimensions, workmanship, dimension ratio (DR) and corresponding pressure rating shall be in accordance with the requirements of ASTM F 714. Pipes shall be furnished in

Standard 40-foot lengths. The pipe material shall meet the following criteria:

Property	Test Method	Criterion
Density [Natural Resin]	ASTM D1505	>0.945 g/cc
Density [Black]	ASTM D1505	>0.955 g/cc
Melt Index	ASTM D1238	<0.15 g/10 minutes
Carbon Black Content	ASTM D1603	≥2.0% & <3.0%
Flexural Modulus	ASTM D790	>120,000 psi
Tensile Strength at Yield	ASTM D638, Type IV*	>3,000 psi
Compressive Strength at Yield	ASTM D695	>1,600 psi
Hydrostatic Design Basis	ASTM D2837	>1,600 psi
Low Temperature Brittleness	ASTM D746	<-60°C
Thermal Expansion Coefficient	ASTM D696	<0.022%/°C
*Type IV Specimen tested at a rate of strain of 2 inches/minute		

The Contractor or Supplier shall submit a complete description of the HDPE pipe and fittings proposed for use to the Engineer for approval at least two weeks prior to delivery of materials to the job site. The Manufacturer's product data sheets and certification from the Manufacturer that the pipe and fittings comply with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of materials to the job site.

11.3.4 Pipe Sizes

Both solid and slotted HDPE pipe shall have the nominal diameters and DR shown on the Drawings. Dimensions, workmanship, DR and corresponding pressure rating shall be in accordance with ASTM F714.

11.3.5 Slotted Pipe

Where slotted pipe is specified on the Drawings, the slots shall be cleanly cut, identical in geometry, and evenly spaced. The slot length shall be located perpendicular to the longitudinal axis of the pipe. Slots shall be located in two straight rows along the length of the pipe. The rows of slots shall be spaced 180° on centers around the circumference of the pipe, and shall not be staggered. The slots shall satisfy the following criteria:

Dimension or Area	Criteria
Slot Width (inches)	>0.10 and <0.15
Slot Length Measured Along Outer Pipe Circumference (inches)	>1.50 and <2.50
Slotted Area (in ² /foot of pipe)	>2.0 (outer wall) >1.0 (inner wall)
Spacing Between Slots Along Pipe Length (c/c, inches)	>1.0 and <3.0

The Contractor shall submit a 3-foot long sample of slotted pipe for each DR rating shown on the Drawings at least two weeks prior to delivery of material to the job site. Slotted pipe shall

not be delivered to the site without first receiving approval from the Owner.

11.3.6 Fabricated Fittings

Fabricated fittings made by butt fusing cut segments of pipe shall be used where shown on the Drawings. Fabricated fittings shall be made using pipe segments meeting the base resin, physical appearance and physical property requirements specified in Sections 11.3.1, 11.3.2 and 11.3.3 of this Specification. Shop drawings for fabricated fittings shall be submitted to the Engineer for approval at least two weeks prior to fabrication.

11.3.7 Approved Manufacturers

The following manufacturers and corresponding pipe series designations are approved for use:

- Performance Pipe DriscoPlex PE 3608/PE 4710 Pipe
- Poly Pipe EHMW PE 3608/PE 4710 Pipe

Other manufacturers producing equivalent pipes may be approved, at the sole discretion of the Engineer, provided product data sheets and resin certificates are submitted to the Engineer for review and approval.

The Manufacturer's product data sheets, resin certificates, and certification from the Manufacturer that the pipe and fittings shall comply with the Specifications shall be submitted to the Engineer for approval at least two weeks prior to delivery of materials to the job site

11.3.8 Marking and Packaging

The pipe Manufacturer shall mark each pipe length and each fitting with the Manufacturer's name or trademark, pipe series designation, size and DR.

Packaging, handling and shipment shall be in accordance with the pipe Manufacturer's standards, instructions and recommendations.

11.3.9 Molded Fittings

Molded fittings shall meet the requirements of Sections 9.3.1, 9.3.2 and 9.3.3 of this Specification, and the requirements of ASTM D 2513 and D 3261.

11.4 Joint Requirements and Pressure Testing

The HDPE pipe, and the pipe and fittings, shall be joined using butt, heat fusion wells. All joints shall be made in compliance with the Manufacturer's recommended practice for heater surface temperature, heating time, applied pressure and cooling time, subject to the Engineer's approval. All joints shall be made by trained technicians qualified by the Manufacturer and using equipment and controlled procedures approved by the Manufacturer.

All pipe joints shall be stronger than the pipe itself under both tension and hydrostatic loading conditions. The joints shall be leak-tight, homogeneous and uniform throughout. The Contractor

shall submit written documentation certifying compliance with the Manufacturer's standard specifications and Quality Assurance/Quality Control plan for the butt, heat fusion technique.

Bend back tests shall be performed at least once per day for each pipe diameter and DR to demonstrate the integrity of the fusion welds.

All pipe joints shall be hydrostatically pressure tested prior to burial in accordance with the Manufacturer's recommendations. At a minimum, the pipes shall be filled with water, trapped air bled from the pipe, and the pipe then pressurized to 90 psi. The initial pressure shall be applied and allowed to stand for 3 hours. During this time water should be added at hourly increments to maintain the pressure. After the initial testing period, the pipe shall be filled with water, the pressure returned to 90 psi, and the pressure held for at least 2 hours. The pipeline and joints will be considered to have passed the pressure test if there are no visual leaks, and not more than the following allowance for expansion under test pressure is met:

Diameter (Inches)	Maximum Allowance for Expansion (U.S. Gallons/100 Feet of Pipe)	
	2-Hour Test	3-Hour Test
12	2.3	3.4
16	3.3	5.0
18	4.3	6.5
24	8.9	13.3
30	12.7	19.2
36	18.0	27.0
42	23.3	35.5

These testing criteria will not be waived unless the hydraulic pressure tests of the welded pipe are performed in accordance with Section 11.4 of the Specifications.

Bolted flange connections, where specified on the Drawings, shall be made in accordance with the Manufacturer's recommendations and the details shown on the Drawings. The flange outside diameter and drilling configuration shall conform to ANSI standards. The bolts, nuts and washers shall be AISI type 316 stainless steel. The HDPE flanges shall have AISI type 316 stainless steel back-up rings. Bolts shall be torqued in accordance with the Manufacturer's recommendations, and as approved by the Engineer. The torque of each bolt shall be checked when the bolts are cool. Flanged connections will not be allowed to be buried unless the bolts are cool and the torque of each bolt checked just prior to burial.

11.5 Storage and Handling

The Contractor shall comply with the pipe Manufacturer's recommendations for handling and storing pipe and fittings. The pipe shall be stored on clean, level ground to prevent undue scratching or gouging and as needed to protect the pipe from being covered with excessive dirt, from water and moisture, and from mechanical abrasion. Care shall be taken to minimize the amount of soil collected inside the pipe while handling and installing. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp objects, and care shall be exercised during installation not to damage the pipes and fittings.

Any pipe section, fitting or joint, which becomes broken, cracked, crushed, cut, scratched, gouged or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor at the Contractor's expense. Scratches greater than 6 inches in length and gouges exhibiting a depth in excess of 8 percent of the wall thickness of the pipe shall be cause for rejection of pipe or fittings to the extent designated by the Engineer.

11.6 Installation

11.6.1 HDPE Pipe and Fittings

The installation of the pipes and fittings shall be made by the Pipe Contractor coordinating his work with the Owner's pipe supplier for delivery of materials and field welding, and with the Liner Installer for installation of the pipe boots, where applicable. The installation methods and handling shall be in accordance with the Manufacturer's recommendations as approved by the Engineer.

Pipe sections shall be joined adjacent to the trench, prior to placing the pipe on the pipe bedding. Care shall be taken not to drop the pipe while moving it, and to avoid excess stress or strain during installation. When pulling the pipe, either a pulling head or a suitable wraparound sleeve with rubber protective cover shall be used to prevent the pulling cables from damaging the pipe. The maximum pulling length shall be limited to 500 feet.

Pipe installation and placement of backfill around pipes shall be performed when the pipe is in a contracted state, i.e., during the cool of morning, at night, or during periods of over-cast skies.

Immediately after placement, the pipe shall be thoroughly and completely embedded, supported, and covered, and the backfill compacted, in accordance with Sections 5.4.4 and 5.4.5 of the Specifications, and the details shown on the Drawings.

11.6.2 Pipe Vents

Pipe vents shall be installed at locations and to lines and dimensions shown on the Drawings.

11.7 Protection and Repairs

Care shall be exercised during construction not to damage the pipes and fittings. Construction equipment shall not be allowed to pass over any pipe culvert until a minimum of 2 feet of compacted cover is placed above the crown of the pipe.

Any pipe section, fitting or joint, which becomes broken, cracked, crushed, cut, scratched, gouged or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor at the Contractor's expense. Scratches greater than 6 inches in length and gouges exhibiting a depth in excess of 8 percent of the wall thickness of the pipe or fitting shall be cause for rejection of a pipe section or fitting to the extent designated by the Engineer.

11.8 Quality Control Inspection and Testing

The Engineer, representing the Owner, will undertake observations and inspections to determine compliance of the materials and work with this Specification. Quality control by the Engineer will

include monitoring and/or inspecting: (i) the HDPE pipe and fittings for correct size, DR rating workmanship, and fabrication; (ii) damage during installation; and (iii) the installation, alignment and welding of all pipe, fittings and seep shields.

11.9 Submittals

The following submittals are required from the Contractor as part of the requirements of Section 11 of the Specifications.

- A complete description of the HDPE pipe and fittings with the Manufacturer's product data sheets, description of the HDPE resin, Manufacturer's certificate of analysis for the HDPE resin, and Manufacturer's certification that the pipe and fittings satisfy the requirements of this Specification.
- Shop drawings for HDPE pipe fittings.

SPECIFICATIONS

SECTION 12 CONCRETE AND REINFORCING STEEL

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

12.1 Description of Work

This Specification covers the requirements for reinforced cast-in place concrete.

Section	Item	Page
12.2	Referenced Standards	1
12.3	General Requirements	2
12.4	Reinforcing Steel	3
12.5	Cast-in-Place Concrete	5
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12.7	Submittals	8

12.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

- A82: Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement
- A185: Specifications for Welded Steel Wire Fabric for Concrete Reinforcement
- A615: Specifications for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
- C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
- C33: Standard Specification for Concrete Aggregates
- C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C94: Standard Specification for Ready-Mixed Concrete
- C143: Standard Test Method for Slump of Hydraulic Cement Concrete
- C150: Standard Specification for Portland Cement

- C171 Standard Specification for Sheet Materials for Curing Concrete
- C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

The following American Concrete Institute (ACI) standards are referenced in this Specification.

- ACI 301: Specifications for Structural Concrete
- ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
- ACI 305R: Recommended Practice for Hot Weather Concreting
- ACI 306R: Recommended Practice for Cold Weather Concreting
- ACI 347: Recommended Practice for Concrete Formwork
- ACI SP-66: Recommended Practice for Placing Reinforcing Bars

12.3 General Requirements

12.3.1 Product Handling

The Contractor shall use all means necessary to protect materials before, during and after installation and to protect any other completed work. In the event of damage, the Contractor shall immediately make all repairs and replacements specified by the Engineer at no additional cost.

Concrete reinforcement shall be stored in a manner to prevent excessive rusting and fouling with dirt, grease and other bond-breaking coatings. Precautions shall be taken to maintain reinforcing steel identification after the bundles are broken.

12.3.2 Formwork

Formwork, where required, shall comply with all pertinent codes and regulations, and all pertinent recommendations contained in ACI 347. Where provisions of pertinent codes and standards conflict with the requirements of this section of this Specification, the more stringent provisions shall govern.

All form lumber in contact with exposed concrete shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic, or other acceptable material capable of producing the desired finish. No selected form facing materials shall be specified for rough form finish surfaces. Form sealers shall be first quality of their respective kinds and subject to approval by the Engineer.

Form ties shall be a type which do not leave an open hole through the concrete and which permit neat and solid patching at every hole. Wire ties and wood spreaders shall not be used. When forms are removed, no metal shall be less than 2-inches from the surface. Alternate forming systems may be used subject to approval by the Engineer.

All other materials not specifically described but required for proper completion of concrete formwork, shall be as selected by the Contractor subject to approval by the Engineer.

12.3.3 Design and Construction of Forms

Design and construction of all forms, where required, shall be sufficiently tight to prevent leakage of mortar, and able to prevent excessive deflection when filled with wet concrete. Design loads and pressures shall conform to those stipulated in ACI 347.

All required cast-in-place concrete shall be formed, where needed, to the shapes, sizes, lines, and dimensions indicated on the Drawings. The Contractor shall exercise care in the layout of forms to avoid the necessity for cutting of concrete after it is in place. Proper provisions shall be made for all openings, offsets, recesses, anchorage, blockings, and other features of the work as shown on the Drawings or as required. Reinforcement and other such items required to be anchored in the concrete shall be set before the concrete is placed. Reinforcement shall not be used to support forms or keyways.

The forms shall be braced and tied together to maintain position and shape and to ensure safety to personnel. Bracing and supporting members of ample size and strength shall be constructed to carry safely, without excessive deflection, all dead and live loads to which they may be subjected. The Contractor shall provide metal spreader ties that give positive tying and accurate spreading. Forms shall be constructed straight, true, plumb, and square within a tolerance horizontally of 1 in 400 and a tolerance vertically of 1 in 500. Forms shall be sufficiently wetted to prevent joints from opening up before concrete is placed.

12.3.4 Removal of Forms

Side forms of footings and foundations may be removed, with Engineer's approval, 72 hours after placement of concrete, but the time may be extended by the Engineer, if deemed necessary. The Contractor shall use all means necessary to protect workers, the installed work and materials, and ensure the complete safety of the work. Nails and tie wires or form ties shall be cut off flush, and all surfaces left smooth and clean. Metal spreader ties on exposed concrete shall be removed by snapping off inside the wall surface, and pointing up and rubbing the resulting pockets to match the surrounding areas. Holes resulting from the use of the spreader rods and sleeve nuts shall be flushed using water and then solidly packed throughout the wall thickness with cement grout applied under pressure by means of a grouting gun. Grout shall be one (1) part Portland cement to two and one-half (2-1/2) parts sand. Grout shall be applied immediately after removing forms.

12.4 Reinforcing Steel

The Contractor shall comply with all pertinent codes and regulations, the pertinent recommendations contained in ACI SP-66 and "Recommended Practice for Placing Reinforcing

Bars" of the Concrete Reinforcing Steel Institute. When provisions of pertinent codes and standards conflict with the requirements of this section of the Specification, the more stringent provisions shall govern.

The Contractor shall submit shop drawings he has reviewed and approved for each cast-in-place concrete structure to the Engineer for approval. Submittals shall include bending diagrams, assembly diagrams, splicing and laps of rebar, and shapes, dimensions and details of bar reinforcing and accessories.

All concrete reinforcement materials shall be new, free from rust, and comply with the following standards:

- Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (ASTM A615, Grade 60).
- Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement (ASTM A82).
- Specifications for Welded Steel Wire Fabric for Concrete Reinforcement (ASTM A185).

All materials shall be stored in a manner to prevent excessive rusting and fouling with dirt, ash, grease, and other bond-weakening coatings. All other materials not specifically described but required for a complete and proper installation of concrete reinforcement, shall be as selected by the Contractor subject to approval by the Engineer.

Reinforcement shall be fabricated in strict accordance with the approved shop drawings. The Contractor shall not use bars with kinks or bends not shown on the Drawings or on the accepted shop drawings. Bending or straightening steel, which has been partially embedded in hardened concrete or in any other manner that will injure the material will not be permitted. Any bending shall be done cold. Bends for stirrups and ties shall be made around a pin having a diameter not less than four times the minimum thickness of the bar. Bends for other bars, including hooks, shall be made around a pin having a diameter not less than six times the minimum thickness of the bar for bars up to 1 inch in diameter and eight times the minimum thickness of the bar for bars over 1 inch in diameter.

All concrete reinforcement shall be accurately placed, secured and supported with metal chairs, spacers or hangers before the start of concrete placement. The clear space between bars shall not be less than the nominal diameter of round bars. In no case shall the clear distance be less than 1 inch nor less than one and one-third times the maximum size of aggregate. The Contractor shall provide the following minimum concrete covering of reinforcement:

- Concrete placed against soil or ash: 3 inches.
- Concrete cover over all reinforcing steel: 3 inches

12.5 Cast-in-Place Concrete

12.5.1 General

The Contractor shall comply with all pertinent codes and regulations, and all pertinent recommendations of ACI 301 and ACI 304. Where provisions of pertinent codes and standards conflict with this Specification, the more stringent provisions shall govern.

12.5.2 Documentation

Before any concrete is delivered, the Contractor shall furnish to the Engineer for approval, a concrete mix design for each class of concrete to be used. The design mixes shall be proven by compression test cylinders, tested by a recognized testing laboratory or by certification and test results of a standard mix of the transit-mix concrete supplier in accordance with ACI 301. All material used in the design mixes shall be that proposed for this project. Tests shall be in accordance with ASTM C39. The slump of the concrete used in these test cylinders shall not be less than the maximum slump specified.

The Contractor shall keep a record at the job-site showing time and location of each placement of concrete, together with transit-mix delivery slips certifying contents of the pour per ASTM C94. The record shall be made available to the Engineer for his use upon request. Upon completion of this portion of the work, the Contractor shall deliver the record and the delivery slips to the Engineer.

12.5.3 Concrete

All concrete, unless otherwise specifically permitted by the Engineer, shall be transit-mixed in accordance with ASTM C94. The control of concrete production and all tests of cement, aggregates, and water shall be by a recognized testing laboratory, approved by the Engineer.

Concrete shall be air entrained and shall conform to the following requirements:

Property	Criterion
Compressive Strength at 28 days	≥3000 psi
Cement Content	≥5.5 sacks per cubic yard
Water to Cement Ratio	≤0.45
Percent Air by Volume	4 to 6
Slump	4 to 5 inches

Cement shall be Portland cement conforming to ASTM C150, modified Type II, Low C₃A (5 percent max.), or equivalent approved by the Engineer.

Aggregates shall be non-reactive aggregates consisting of at least 95 percent silica (dry weight basis) and containing less than 1.0 percent total carbonates (dry weight basis) determined in accordance with ASTM D 4373 on specimens ground to pass the U.S. Standard No. 60 sieve.

12.5.4 Preparation

The Contractor shall remove all debris from the areas in which concrete will be placed. To ensure proper placement and bonding of concrete, the area shall be thoroughly cleaned. Forms, if required, shall be thoroughly wet (except in freezing weather) or sprayed or brushed with a releasing agent and all standing water removed. All transporting and handling equipment shall be thoroughly cleaned. The Engineer shall be notified at least 48 hours before concrete is placed. Concrete shall not be placed until all forms, reinforcing steel and other items to be embedded within the concrete have been inspected and approved by the Engineer.

12.5.5 Placing Concrete

Concrete shall be placed in conformance with ACI 304. Concrete shall be conveyed from mixer to place of final deposit by methods that will prevent separation and loss of materials. For chuting, pumping, and pneumatically conveying concrete, only equipment of such size and design as to ensure a practically continuous flow of concrete at the delivery end without loss or separation of materials shall be used. Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to re-handling and flowing. Concrete shall be placed as dry as possible consistent with good workmanship, never exceeding the maximum specified slump. Concrete shall be placed in a manner that will avoid splashing forms or reinforcing bars and shall not be dropped freely more than 4 feet. Aluminum pump lines or tools shall not be allowed for concrete pumping and placement.

Concrete shall be placed at such a rate that it is at all times plastic and flows readily between bare bars. Once concrete placement is started, it shall be a continuous operation until placement is complete. When stoppage of concrete operations occurs for any reason, construction joints shall be placed as required. Construction joints shall be provided with shear key, and/or dowels, to resist shear and moment as specified by the Engineer.

All Concrete shall be thoroughly consolidated by mechanical vibration or other suitable means during placement, working it around all embedded fixtures and into corners of forms. A vibrator shall be inserted at many locations, from 5 to 15 seconds, until vibration is sufficient to bring a continuous film or mortar to the surface. Vibration shall stop before any segregation of the concrete occurs.

Concrete batches delivered to the job-site shall be kept as uniform as possible in consistency and strength. The following shall be considered a basis for the rejection of the concrete delivered to the site.

- Evidence that the concrete has been re-tempered.
- Concrete that has been contaminated with foreign material.
- Slump exceeding maximum specified.
- Percent of entrained air not within specified limits.

- Discharge from truck not within the 1.5-hour limitation of ASTM C94.

12.5.6 Finishing

After concrete has been screeded to grade, it shall be floated with a metal or wooden float followed by a steel trowel finish. Unless otherwise indicated on the Drawings, the Contractor shall finish all concrete to an even and uniform appearance and, where no slope is required, level within plus or minus 1/8 inch in 10 feet.

12.5.7 Curing

All concrete shall be cured regardless of temperature, weather, or season, to protect it from premature drying, excessively hot or cold temperatures, and mechanical injury. Immediately upon finishing the concrete or removing formwork, curing procedures shall be initiated. Curing shall be continued for at least seven days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the specified strength. The curing procedure is used initially, may be replaced by any other procedures at any time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.

Optional curing methods include:

1. Continuous sprinkling with fresh water.
2. Waterproof sheet materials conforming to ASTM C171:
 - A. Immediately upon finishing an area, an acceptable curing membrane shall be applied.
 - B. Lap and securely join all joints.
 - C. Weight membrane down to prevent wind damage.
3. Curing Compound conforming to ASTM C309:
 - A. Immediately upon finishing an area, an acceptable curing compound shall be applied to the entire area.
 - B. The compound shall be applied in strict conformance to the recommendations of the Manufacturer.

Moisture loss from surfaces placed against wooden or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the time prescribed by one of the methods noted above. No traffic shall be allowed on concrete until it has been sufficiently cured.

12.5.8 Hot Weather Requirements

Concrete placement in hot weather shall be in accordance with ACI 305. Concrete with a placement temperature that will cause loss of slump, flash set or cold joints shall not be used. A concrete temperature during placement of less than 90°F shall be maintained. All means necessary to avoid drying the concrete prior to finishing operations shall be used. All required windbreaks, sunshades, fog sprays, evaporation retardants and other devices to protect the concrete shall be provided and used by the Contractor.

12.5.9 Cold Weather Requirements

Concrete placement in cold weather shall be in accordance with ACI 306. Concrete shall be placed with the mix temperature between 50°F and 70°F. When the mean daily outdoor temperature is at or below 40°F, the concrete shall be maintained between 50°F and 70°F for the required curing period of Section 14.5.7 of this Specification. Concrete shall not be placed against or on frozen material.

The Contractor shall provide and use all required framework, cover, heating apparatus, and other devices to protect the concrete. Concrete and/or aggregates shall be protected during batching, transit and mixing, and before and after placing.

12.5.10 Defective Work

The Contractor shall inspect all concrete surfaces and patch all pour joints, voids, rock pockets, form tie holes, and other imperfections before the concrete is thoroughly dry. Defective areas shall not be patched until the concrete has been observed by the Engineer. If the defects are serious or affect the strength of the structure, or if patching does not satisfactorily restore the quality and appearance of the surface, the Engineer may require the concrete be completely removed and replaced in accordance with the provisions of this section, all at no additional cost to the Owner. This determination will be made solely by the Engineer.

12.6 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance of the materials and work with this Specification. Quality assurance by the Engineer will include monitoring and/or inspecting: (i) reinforcing steel placement; (ii) concrete placement, finishing and curing; and (iii) sampling and testing of the concrete for compliance with this Specification including samples for testing in accordance with ASTM C31, ASTM C39 and ASTM C143.

12.7 Submittals

The following submittals are required from the Contractor as part of the requirements of this Specification: (i) shop drawings for reinforcing steel; (ii) concrete mix design; and (iii) transit-mix delivery slips.

SPECIFICATIONS

SECTION 13 CONCRETE UNIFORM SECTION MAT

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

13.1 Description of Work

This Section covers the material requirements and installation of concrete uniform section mat at the locations shown on the Drawings.

Section	Item	Page
13.2	Referenced Standards	1
13.3	Material Requirements	1
13.4	Installation Procedures	2
13.5	Quality Assurance Inspection and Testing	3
13.6	Submittals	3

13.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field

C33: Standard Specification for Concrete Aggregates

C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

C150: Standard Specification for Portland Cement

C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

13.3 Material Requirements

The concrete uniform section mats (with thicknesses as shown on the Drawings) shall consist of concrete-filled Fabriform-type facing, with weep holes, underlain by non-woven geotextile filter fabric.

13.3.1 Fabric

The fabric forms shall consist of 100 percent woven polyester or polypropylene with a mass per unit area of no less than 6 oz/yd² and with a double-layer mass per unit area of no less than 12 oz/yd². The fabric forms shall consist of multiple panels of double-layer fabric joined in such a manner as to provide an average thickness as shown on the Drawings. Individual width panels shall be cut to suitable lengths and the two layers of fabric separately joined edge to edge by means of a heavy thread, double-stitched. The tensile strength of stitch joints shall be not less than 100 pounds per inch.

13.3.2 Grout

Grout shall consist of a mixture of Portland cement, fine aggregate and water so proportioned and mixed as to provide a pumpable slurry. Pozzolan and grout fluidizers conforming to the Specifications may be used at the option of the Contractor. The mix shall obtain a minimum compressive strength of 2000 psi at 28 days when tested in accordance with ASTM C31 and ASTM C39. The grout mix design shall be submitted to the Engineer for approval at least two weeks prior to construction of the mats.

Portland cement shall conform to ASTM C150. Pozzolan, if used, shall conform to ASTM C618. Only clean fresh water shall be used. Aggregate shall meet the requirements of ASTM C33, except as to grading. Aggregate grading shall be reasonably consistent and shall be well graded from the maximum size, which can be handled with available pumping equipment.

13.3.3 Weep Holes

The mat shall contain weep holes at the specific locations shown on the Drawings. The weep holes, where specified, shall consist of 7/8-inch inside diameter polyethylene tubes through the mat on a 60-inch center-to-center spacing. The weep holes shall not protrude past the bottom surface of the mat to avoid damaging the HDPE liner.

13.4 **Installation Procedures**

Prior to placement of the fabric form panels, a layer of 12 oz/yd² non-woven geotextile, meeting the requirements of Section 10 of the Specifications, shall be placed on the prepared subgrade to the lines and dimensions shown on the Drawings.

Prior to grout injection, the fabric form panels shall be positioned to the locations, lines and grades shown on the Drawings. Panels of fabric may be factory assembled in predetermined sizes and joined side-by side at the site by field sewing or by means of zipper closures attached to the upper and lower layers of fabric. Simple butt joints shall not be permitted.

Expansion joints shall be used at the locations shown on the Drawings.

Only approved grout mixing, pumping and agitating equipment shall be used in preparation and handling of the grout. All oil and other rust inhibitors shall be removed from the pumps and mixers. All materials shall be accurately measured by volume or weight as they are fed into the mixer or delivered to the pump. The quantity of water shall be such as to produce a grout having a pumpable consistency. Time of mixing shall be not less than 1 minute. If agitated continuously,

the grout may be held in the mixer or agitator for a period not exceeding 2.5 hours in temperatures below 70° F and for a period not exceeding two hours at higher temperatures. If there is a lapse in a pumping operation, the grout shall be re-circulated through the pump or through the mixer drum (or agitator) and pump.

Grout shall be introduced into the space between the layers of fabric and shall be injected in such a way that excessive pressure on the fabric envelope is avoided. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap and the burlap pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of grout.

The thickness of the mat shall be measured by survey or other appropriate methods, approved by the Engineer. Measurement of thickness shall not be made by inserting anything through the mat that could damage the HDPE liner. Any mat measuring less than 90 percent of the average of all thickness measurements shall be re-injected with grout until the average thickness has been attained.

Foot traffic shall not be permitted on the freshly pumped mat. Walk boards shall be used where necessary.

13.5 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance with this Specification. Quality assurance by the Engineer will include checking layout and measuring dimensions of the fabric forms, placement and spacing of weep holes, placement of expansion joints, measuring the thickness of the mat, and taking field samples of the grout in accordance with ASTM C31 for compressive strength tests in accordance with ASTM C39.

13.6 Submittals

The Contractor shall submit a complete description of the concrete uniform section mat, weep holes and proposed grout mixture to the Engineer for approval at least two weeks prior to installation of the mat.

SPECIFICATIONS

SECTION 14 HDPE LINER MATERIALS FOR FINAL COVER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

14.1 Description of Work

This Specification covers the material requirements for high density polyethylene (HDPE) geomembrane liner specified for the final cover system, factory inspection and testing requirements, and quality control testing by the Engineer.

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14.2 Referenced Standards

The following ASTM International (ASTM) standards are referenced in this Specification.

D570: Standard Test Method for Water Absorption of Plastics

D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))

D746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1004: Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

D1203: Standard Test Method for Volatile Loss from Plastics Using Activated Carbon Methods

D1204: Standard Test Method for Linear Dimensional Changes of Non-Rigid Thermoplastic Sheeting or Film at Elevated Temperature

- D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603: Standard Test Method for Carbon Black in Olefin Plastics
- D1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics
- D2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D3895: Standard Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
- D4833: Standard Test Method for Index Puncture Resistance of Geotextiles and Geomembranes
- D4976: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
- D5199: Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D5321: Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- D5397: Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Load Test; Appendix - Procedure to Perform a Single Point Notched Constant Load (Appendix (SP-NCTL) Test)
- D5596: Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D5994: Standard Test Method for Measuring Core Thickness of Textured Geomembranes
- D6693: Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Non-reinforced Flexible Polypropylene Geomembranes
- D7466: Standard Test Method for Measuring the Asperity Height of Textured Geomembrane
- E96: Standard Test Methods for Water Vapor Transmission of Materials

14.3 Material Requirements

Two-sided textured geomembrane liner shall consist of unreinforced high density polyethylene (HDPE), designed and manufactured specifically for the purpose of liquid containment.

Product data sheets listing the minimum and nominal liner physical properties shall be provided to the Engineer at least two weeks prior to material delivery to the job site. Product data sheets for each type of HDPE resin, listing density, melt index, low temperature brittleness and

environmental stress crack resistance, shall also be provided to the Engineer at least two weeks prior to delivery of material to the job site.

14.3.1 Base Resin

The uncolored base resin used to manufacture the liner shall be polyethylene having a minimum density of 0.932 g/cm³ classifying as Group 2, Class 2, Grade 4 or Grade 5 (PE 224 or PE 225) in accordance with ASTM D4976.

The formulated colored resin shall classify as a Group 2, Class 3, Grade 4 or Grade 5 high density polyethylene (PE 234 or PE 235) with physical properties meeting A46009 in accordance with ASTM D4976 with environmental stress crack resistance (ASTM D1693) F₅₀ >1500 hours (Condition B; 50°C/100% Igepal) and F₂₀ >192 hours (Condition C; 100°C/100% Igepal). The formulated colored resin shall contain not less than 97 percent of the base polymer, not less than 2.0 percent carbon black, and not more than 3 percent carbon black, anti-oxidants and heat stabilizers combined with no other additives, fillers or extenders. Carbon black dispersion in the liner shall be rated as Category 1 or 2 in ≥9 of 10 views, and as Category 3 in ≤1 of 10 views classified using ASTM D5596. The variation in carbon black content within each resin batch shall be no greater than ±10 percent from the average carbon black content, determined from factory tests performed on every fifth liner roll (see Section 14.4.4.2).

The liner shall be manufactured from virgin resin, with not more than 3 percent regrind material. Regrind material, if used, must be of the same formulation as the virgin resin. Post-consumer resin of any type may not be used.

Liner sheets shall be manufactured using one of the following base resins unless approved otherwise by the Engineer:

- Chevron Phillips Marlex K306 or K307
- BP Solvay Fortiflex G36-10-150 (G36-24x1767)
- Formosa Plastics Formolene HL3812

Use of any of the approved base resins shall not relieve the Liner Manufacturer from complying with all other Specification criteria.

HDPE welding rods shall be manufactured from the same resin used to manufacture the liner. The welding rod shall be smooth, uniform in appearance and diameter and shall be free from contamination by foreign matter including entrapped moisture that could result in air pockets within extrusion welds

14.3.2 Physical Appearance of Liner Sheets

All liner sheets shall have good appearance qualities. Texturing on the surface of textured sheets shall be uniform and homogeneously distributed.

All liner sheets shall be free of pinholes, holes, blisters, gels, undispersed ingredients, fish-eye blemishes, any signs of contamination by foreign matter, or any defect that may affect serviceability. The edges of the sheets shall be straight and free from nicks and cuts. Liner rolls that require more than one patch per 5,000 square feet for repair of holes, blisters, gels,

undispersed ingredients blemishes, etc., shall be considered defective, and shall be rejected and replaced at the Contractor's expense.

14.3.3 Textured Liner Physical Properties

Textured liner shall be the MicroSpike® liner manufactured by AGRU America, Inc., or any other liner products approved by the Owner prior to bid submittal, and shall meet the following criteria.

Property	Test Method	Criteria
Minimum Thickness	ASTM D5994	≥ 36 mil
Average Thickness	ASTM D5994	≥ 40 mil
Average Asperity Height	ASTM D7466	≥ 10 mil*
Density	ASTM D792 or D1505	> 0.940 g/cm ³ †
Melt Index	ASTM D1238 (190°C/2.16 kg)	< 1.0 g/10 minutes
Carbon Black Content	ASTM D1603	≥ 2.0% & <3.0%
Carbon Black Dispersion	ASTM D5596 (10 views)	Category 1 or 2 (≥9 views) and Category 3 (≤1 view)
Tensile Strength at Yield	ASTM D6693**	> 84 lb/inch
Tensile Strength at Break	ASTM D6693**	> 80 lb/inch
Elongation at Yield	ASTM D6693**	> 12%
Elongation at Break	ASTM D6693**	> 200%
Tear Resistance	ASTM D1004**	> 28 lb
Puncture Resistance	FTM 101 (Method 2065); or ASTM D4833	> 50 lb; or > 79 lb
† The density of the uncolored base resin shall be greater than 0.932 g/cm ³ . * Eight of ten values not less than 7 mils. Lowest individual value not less than 5 mils. ** Tested in both machine and transverse directions.		

All individual test specimens shall meet the minimum or maximum criterion tabulated above, with the following exceptions.

- The average tensile strength and elongation at break in both the machine and transverse directions, determined as the average of five test specimens in each direction, shall meet the criteria tabulated above.
- All individual test specimen results shall display tensile strengths at break equaling or exceeding 24 lb/inch and elongations at break equaling or exceeding 60 percent.

Textured liner shall also meet the criteria specified below for water vapor transmission; dimensional stability; low temperature brittleness; volatile loss; water absorption; environmental stress crack resistance; constant tensile load stress crack resistance; and oxidative induction time.

Property	Test Method	Criteria
Modulus of Elasticity	ASTM D6693	> 80,000 lb/in ²
Water Vapor Transmission	ASTM E96, Procedure BW	< 0.03 g/m ² /24 hours
Dimensional Stability	ASTM D1204 (100° C for 1 hour)	± 2% (maximum)
Low Temperature Brittleness	ASTM D746, Procedure B	< -94°F (<-70°C)
Volatile Loss	ASTM D1203, Method A	< 0.1%
Water Absorption	ASTM D570	< 0.1%
Environmental Stress Crack Resistance Constant Tensile Load Stress Crack	ASTM D1693, F ₅₀ (Cond. B; 50°C/100% Igepal)	> 1,500 hours
Resistance (Single Point Test at 30% of Yield Stress)	ASTM D5397 (SP-NCTL)	> 500 hours
Oxidative Induction Time	ASTM D3895 (200°C and 14.7 lb/in ² O ₂)	> 140 minutes

Routine testing for modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission will not be required from the Liner Manufacturer. Certification in writing shall be provided by the Liner Manufacturer that the liner meets the Specification requirements. In support of the certification, the Liner Manufacturer shall submit at least one test result for each property performed within one year prior to the date of the certification on liner manufactured with each type resin supplied to the project.

14.3.4 Frictional Characteristics

The surface roughness of textured liner shall be such that the peak interface friction angle is equal to or greater than 28 degrees between the double-sided geocomposite and the HDPE liner, and between the HDPE liner and the bedding materials.

For determining compliance with the specified interface friction angles, direct shear tests will be performed by the Engineer in accordance with Standard ASTM D5321 using the geosynthetic products and the on-site fine sand with silt fill materials (Group Symbol SP-SM in accordance with ASTM D2487) meeting the following gradation.

U.S. Standard Sieve Size	Percent Passing (Dry Mass Basis)
No. 4	100
No. 10	97-100
No. 20	95-100
No. 40	90-100
No. 60	60-95
No. 100	20-80
No. 140	7-25
No. 200	5-12

The direct shear tests shall be performed at normal stresses of approximately 5 lb/in² to duplicate field conditions. The soil shall be compacted to a dry density equal to 95 percent of the Standard Proctor maximum dry density (ASTM D698) within ±2 percent of the Standard Proctor optimum

water content. The interface and soil shall be tested submerged with water. The tests shall be performed using a horizontal displacement rate of 0.3 inches per hour.

14.4 Manufacturing and Factory Inspection and Testing

The Liner Manufacturer shall submit product data sheets and test data for each liner type to the Engineer presenting the liner minimum physical properties for each property listed in Section 14.3.3, and the resin type(s) and properties. Written certification shall be provided by the Liner Manufacturer confirming compliance of the resin and liner sheets with this Specification.

14.4.1 Minimum Sheet Dimensions

The HDPE liner shall be supplied in rolled sheets having a minimum width of 22 feet and minimum length of 400 feet. Shorter roll lengths shall require approval of the Engineer.

14.4.2 Marking and Packaging

The Liner Manufacturer shall label each roll with the roll number, thickness, length, width and date manufactured.

Each roll shall be individually packaged at the factory and protected to prevent damage during shipment. If the liner is not packaged and a roll is damaged during shipment, it shall be rejected. If only the outermost surface of the roll is affected, it shall be peeled back, cut, and wasted (i.e., it shall be treated as if it were the protective packaging for the remainder of the roll). Rolled out liner stock that requires more than one repair patch per 5,000 square feet prior to installation shall be considered defective, and shall be rejected and replaced at the Contractor's expense.

14.4.3 Factory Inspection and Spark Testing

The Liner Manufacturer shall inspect all liner sheets at the factory for compliance with the physical appearance requirements listed in Section 14.3.2. The Liner Manufacturer shall continuously spark test all liner sheets during manufacturing. The spark tester shall be capable of detecting defects or pinholes equal to or less than 10 mils (0.25 mm) in diameter. The Liner Manufacturer shall submit a complete description of the spark tester, operating protocols, factory QA/QC plan for operating the system and identifying defective liner, and methods for removing or patching liner with pinholes to the Engineer at least two weeks prior to delivery of material to the job site. All necessary repairs to the liner shall be made by the Liner Manufacturer at the factory before shipment.

The Liner Manufacturer shall provide written certification that all liner rolls delivered to the project were continuously spark tested and do not contain pinhole defects at least two weeks prior to delivery of material to the job site.

14.4.4 Factory Testing

The Liner Manufacturer shall submit the factory testing QA/QC plan, and factory laboratory quality manual for all liner and resin tests required in this Specification to the Engineer at least two weeks prior to delivery of material to the job site.

14.4.4.1 HDPE Resin

Factory test reports for the HDPE resin shall include the proportions of HDPE resin, carbon black and other additives, and test results for melt index, specific gravity, environmental stress crack resistance, low temperature brittleness and oxidative induction time. The factory test reports shall be submitted to the Engineer for approval before installation of any liner material. The following tests and minimum frequency of testing shall be undertaken by the Liner Manufacturer.

Resin Property	Test Method	Minimum Frequency
Density	ASTM D792	Once per Batch of Resin
Melt Index	ASTM D1238 (190°C/2.16 kg)	Once per Batch of Resin
Oxidative Induction Time	ASTM D3895	Once per Batch of Resin

The resin density and melt index shall be reported for the unblended resin and the blended resin after adding carbon black and antioxidants. The oxidative induction time shall be reported for the blended resin. Routine testing for low temperature brittleness and environmental stress crack resistance is not required. Certification of these properties, in accordance with the requirements in Section 14.3.3, will be accepted.

The resin manufacturer's certificate of analyses for each batch of resin shall also be provided to the Engineer for approval at least two weeks prior to delivery of material to the job site.

14.4.4.2 Liner Rolls

Factory test reports for each roll of liner shall include test results for the following properties: tensile strength and elongation at yield and at break; tear resistance; puncture resistance; minimum and average thickness; density; carbon black content; and carbon black dispersion. The factory test reports shall be submitted to the Engineer for approval before installation and prior to acceptance of the liner. Failure of any of the tests shall result in rejection of the corresponding liner rolls.

At the request of the Owner, but not more than once per day during each production run, the Liner Manufacturer shall furnish production line samples to the Owner who reserves the right to have these samples tested by the Engineer, at the Owner's expense, to evaluate compliance with this Specification. Failure of any of the tests shall result in rejection of the corresponding batch or production run of liner material.

The following tests and minimum frequencies of testing shall be undertaken by the Liner Manufacturer on liner rolls.

Liner Property	Test Method	Minimum Frequency
Core Thickness	ASTM D5994	Every Roll
Asperity Height	ASTM D7466	Every Roll
Tensile Strength at Yield	ASTM D6693	Every Roll
Tensile Strength at Break	ASTM D6693	Every Roll
Elongation at Yield	ASTM D6693	Every Roll
Elongation at Break	ASTM D6693	Every Roll
Tear Resistance	ASTM D1004	Every Roll
Puncture Resistance	FTM 101 (Method 2065); or ASTM D4833	Every Roll
Density	ASTM D792 or D1505	Every 5 Rolls
Carbon Black Content	ASTM D1603	Every 5 Rolls
Carbon Black Dispersion	ASTM D5596	Every 5 Rolls
Notched Constant Load ESCR (Single Point at 30% of Yield Stress)	ASTM D5397 (SP-NCTL)	Every 20 Rolls

Tensile tests (ASTM D6693) and tear resistance tests (ASTM D1004) shall be performed in both the machine and transverse directions. Tensile properties (ASTM D6693), tear resistance (ASTM D1004) and puncture resistance (FTM 101 or ASTM D4833) tests may be performed on only one test specimen from each roll of smooth liner (in each direction, where applicable) and the moving average as well as the minimum value from each five consecutive rolls reported to the Engineer. Five test specimens shall be tested in each direction for tensile properties (ASTM D6693) from each of the first 20 rolls of textured liner manufactured for this project. Provided all test results comply with Specifications, the number of test specimens may then be reduced, as allowed above for smooth liner, if approved by the Engineer. All factory testing shall be at the Liner Manufacturer's expense.

Certification of the liner modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission shall be provided in accordance with Section 14.3.3 of this Specification.

14.5 Quality Control Testing by Engineer

14.5.1 Sampling by Liner Manufacturer

The Liner Manufacturer shall obtain and secure samples of the liner for conformance testing by the Engineer. One 2-foot wide sample across the full width of each roll shall be cut during production. The samples shall be labeled, packaged, and shipped by the Liner Manufacturer for delivery along with the corresponding liner rolls to the project site.

The following sampling procedure shall be used to allow positive visual confirmation by the Engineer that samples supplied by the Liner Manufacturer represent the liner rolls indicated by the Liner Manufacturer.

- Apply three or more randomly and uniquely located, permanent paint-stick markings in the machine direction across the path of the knife on the liner sheet to be sampled prior to

cutting the sample. The markings shall be generally located within 2 feet of the end of the roll bearing the Liner Manufacturer's roll label.

- Cut a minimum 24-inch wide sample across the entire roll width ensuring that the knife passes through the paint markings, leaving half of the marking on the liner roll and the other half on the sample.
- Roll the sample such that the end bearing the paint markings is on the outer end of the rolled sample. The outer end of each sample shall also be marked with the roll number.
- Ship liner samples on the same truck carrying the corresponding liner rolls.

Upon delivery of the liner rolls and the corresponding samples to the project site, the Engineer's representative will observe that the paint markings on each sample coincide with those on the corresponding liner roll.

Testing by the Engineer will be made for the following liner properties at the following sampling frequencies unless revised otherwise by the Engineer during construction.

Property	Test Method	Sampling Frequency
Thickness	ASTM D5994	2 per acre
Asperity Height	ASTM D7466	2 per acre
Density	ASTM D792 or D1505	1 per acre
Carbon Black Content	ASTM D1603	1 per acre
Tensile Strength at Yield	ASTM D6693*	2 per acre
Tensile Strength at Break	ASTM D6693*	2 per acre
Elongation at Yield	ASTM D6693*	2 per acre
Elongation at Break	ASTM D6693*	2 per acre
Tear Resistance	ASTM D1004*	2 per acre
Frictional Characteristics	ASTM D5321	1 per 10 acres
Other Properties	As requested by the Engineer	Up to 2 samples per acre
* Tested in both machine and transverse directions.		

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

14.5.2 Sampling by Liner Installer

If sampling of the liner for conformance testing is not undertaken by the Liner Manufacturer, or when otherwise requested by the Engineer, the Liner Installer shall obtain and secure samples of the liner for conformance testing by the Engineer from locations designated by the Engineer. The

samples shall be properly labeled to identify the liner roll or panel from which the sample was obtained and the machine direction if the sample was not obtained across the full width of the roll. Testing by the Engineer will be made for the liner properties at the sampling frequencies in Section 14.5.1 unless revised otherwise by the Engineer during construction.

14.6 Warranty

A written warranty shall be provided to the Owner from the Liner Manufacturer. This document shall warrant the quality of the liner material for a period of not less than 20 years.

14.7 Submittals

The following submittals are required as part of the requirements of this Specification.

- Product data sheets and test data listing the minimum liner physical properties, and product data sheets for each type resin listing the resin properties (Sections 14.3 and 14.4).
- A written certification from the Liner Manufacturer that the resin and liner sheets comply with this Specification (Section 14.4).
- Written certification from the Liner Manufacturer that the liner modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission meet the requirements of this Specification. In support of the certification, the Liner Manufacturer shall submit the results of at least one test for each certified property performed within one year prior to the date of the certification on liner manufactured with each type resin supplied to the project (Section 14.3.3).
- Written certification from the Liner Manufacturer that the HDPE resin low temperature brittleness and environmental stress crack resistance meet the requirements of this Specification. In support of the certification, the Liner Manufacturer shall submit the result of at least one test for each certified property performed within one year prior to the date of the certification for each type resin used to manufacture liner supplied to the project (Section 14.4.4.1).
- Description of the spark testing device, the factory QA/QC plan for operating the system, and written certification that all liner rolls have been continuously factory spark tested and do not contain pinhole defects (Section 14.4.3).
- Factory testing QA/QC plan and factory laboratory quality control manual for all liner and resin tests required in this Specification (Section 14.4.4)
- Factory test reports for each batch of HDPE resin used in the liner sheets including proportions of base polymer and additives, oxidative induction time, melt index and density. The resin manufacturer's certificate of analysis shall be provided for each batch of resin (Section 14.4.4.1).
- Factory quality control certificates for each liner roll including minimum and average thickness, tensile properties, tear resistance, puncture resistance, density, carbon black content and carbon black dispersion (Section 14.4.4.2).

- Written warranty from the Liner Manufacturer to warrant the quality of the liner material for a period of not less than 20 years (Section 14.6).

SPECIFICATIONS

SECTION 15 HDPE LINER INSTALLATION FOR FINAL COVER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

15.1 Description of Work

This Specification covers the installation of High Density Polyethylene (HDPE) geomembrane liner for the final cover and associated ancillary work. The HDPE liner shall be installed in accordance with this Specification and as shown on the Drawings. Liner installation includes: (i) maintenance of the prepared 6-inch thick compacted bedding materials for HDPE liner; (ii) placement and seaming of 40-mil HDPE textured liner; (iii) excavation and backfilling liner anchor trenches; and (iv) placement of temporary ballast loading.

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15.2 Referenced Standards

The following ASTM International (ASTM) standards are referenced in this Specification.

D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))

D1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

D2216: Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock

D2937: Standard Test Method for Density of Soil in Place by the Drive Cylinder Method

- D4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils
- D4254: Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- D4437: Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- D4944: Standard Test Method for Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method
- D6392: Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

15.3 Placement of Bedding Materials

The HDPE liner shall be underlain by a minimum of 6 inches of bedding materials at the locations and to the lines and grades shown on the Drawings. Before placement of the HDPE liner bedding materials, the sideslope of the CWSA at the final build-out conditions shall be re-worked, cut, or filled to the lines, grades and dimensions shown on the drawings.

15.3.1 Source of Fill Materials

Fill materials shall be obtained from on-site stockpiles designated by the Owner. Even though the fill materials will be stockpiled and supplied by the Owner, the Contractor shall be required to remove any incidental objectionable materials (e.g., roots, organic materials, debris) prior to compaction to meet the fill material requirements stipulated in Section 15.3.2, as directed by the Engineer.

15.3.2 Fill Material Requirements

Fill materials used as a 6-inch thick HDPE liner bedding material shall classify as clean granular fill, subject to approval by the Engineer. The fill materials shall be free from wood, roots, trash, rocks, debris, or other deleterious material.

The clean granular fill materials shall consist of clean, granular soils that classify as SW, SP, SW-SM, SW-SC, SP-SM, and SP-SC in accordance with ASTM D2487. The soil shall have not more than 25 percent by dry weight passing the U.S. Standard No. 200 sieve in accordance with ASTM D1140. With prior approval by the Engineer, SC type soils with not more than 25 percent by dry weight passing the U.S. Standard No. 200 sieve size may also be utilized as bedding materials. The fill materials shall not contain particle sizes larger than 1/4-inch in diameter. The materials shall have an organic content of less than 3 percent.

15.3.3 Fill Materials Placement

The 6-inch thick bedding layer shall be wetted or dried, and homogenized prior to compaction to obtain uniform moisture content. Materials shall be compacted by rolling with a tamping roller,

heavy rubber tire roller, steel wheel (sheep-foot) power roller, or other suitable compaction equipment. The Contractor shall plan the traffic flow of equipment to provide a thorough and uniform compaction effort on each successive lift of fill.

15.3.4 Compaction Criteria

Fill materials for the bedding layer shall be compacted to a dry density of not less than 95 percent of the Standard Proctor maximum dry density (ASTM D698). The Engineer shall perform Standard Proctor compaction tests (ASTM D698) on samples of the bedding materials, as needed, to determine the optimum moisture content and maximum dry density to be used for compaction control.

15.3.5 CQA Inspection and Testing

The Engineer, retained by the Owner, will undertake observations and perform CQA tests to determine compliance of the bedding layer construction with these specifications. Prior to placement, the Engineer shall observe that the sideslope of the CWSA at the final build-out condition is satisfactorily prepared. The Engineer shall also verify that the borrow soils used for construction are free of deleterious materials and meet the requirements specified in Section 15.3.2 for the appropriate material classification required for bedding materials. Fines content determinations (ASTM D1140) shall be performed, as needed, to verify conformance of the clean granular fill with the requirements specified in Section 15.3.2.

During placement, the fill materials will be inspected to verify that they have been thoroughly homogenized, uniformly placed and adequately compacted. The Engineer shall make the necessary penetration tests to quantify the uniformity of compaction and probe measurements to verify compliance with the maximum lift thickness specified herein.

The Engineer, retained by the Owner, will perform moisture content determinations and *in situ* density determinations at a minimum rate of two tests per acre of compacted bedding materials using the drive cylinder method (ASTM D2937), or another method approved by the Engineer and deemed equivalent by him at his sole discretion. The thickness of the bedding layer shall be measured at a frequency of four per acre. The Engineer shall compare results of these tests to the results of Standard Proctor tests to determine compliance with the specified compaction criteria.

15.3.6 Maintenance

The Contractor shall maintain and, if needed, restore the condition of the completed bedding layer such that it conforms to the lines and grades shown on the Drawings and to the compaction criteria specified herein until the entire construction has been completed and accepted by the Owner.

15.3.7 Erosion Control Features

Erosion and sedimentation control practices shall be employed by the Contractor to minimize erosion and sedimentation during construction until all work has been accepted by the Owner. Methods, which may be used, include, but are not limited to, vegetation, berms, and silt fences.

An erosion control plan outlining the proposed erosion and sedimentation control measures to be undertaken during construction shall be submitted by the Contractor to the Owner for approval prior to construction.

All devices for erosion and sedimentation control shall be installed prior to beginning construction in an area. If the Owner determines that erosion or sedimentation is occurring because of the Contractor's construction activity despite implementation and maintenance of protective measures, the Contractor shall take additional protective measures, as directed by the Owner and at the Contractor's expense.

Upon completion of the work or upon instruction by the Owner, the Contractor shall dismantle and remove erosion and sedimentation control measure implemented during construction.

15.4 Liner Handling and Installation

Installation of the liner shall be in compliance with this Specification and with the Liner Manufacturer's standard guidelines and specifications for liner installation, subject to approval by the Engineer, including, but not limited to: handling and site storage requirements; unrolling and laying of liner sheets; field seaming; anchor trench installation; and temporary ballast loading. The Contractor shall submit a liner handling and installation plan to the Owner for review and approval at least two weeks prior to installation.

15.4.1 On-Site Storage

On-site storage shall be as needed to protect the liner rolls from excessive accumulations of soil on the liner surfaces, water, heat, mechanical abrasion, puncture and vehicular traffic. Liner rolls shall be stored on a firm, dry, elevated surface in a protected storage area approved by the Owner. Liner rolls shall not be stacked more than three rolls high, or as otherwise recommended by the Liner Manufacturer.

15.4.2 Handling and Panel Placement

Appropriate handling equipment shall be used when loading or moving rolled liner sheets from one place to another. Appropriate equipment includes spreader and roll bars for deployment, and cloth chokers with a spreader bar for off-loading.

Liner deployment shall not be performed when precipitation is occurring, when excessive moisture (i.e., fog, dew) or wet conditions exist, when the ambient air temperature is below 40° F (5°C) or above 100°F (38°C), when high winds (>20 mph) are occurring, or when other adverse climatologic conditions exist that would, in the opinion of the Engineer and/or Owner, adversely affect liner installation. The Liner Installer may submit a procedure for welding in ambient air temperatures below 40° F and above 100°F for review and approval by the Engineer.

The liner sheets shall be unrolled and deployed in a manner which minimizes wrinkles and prevents the occurrence of folds and creases. Liner panels shall be installed from high to low elevation to prevent runoff from flowing below installed liner panels, and shingled at seams with the upslope panel overlaying the downslope panel. "Vise-grips" or other tools, if used to grip the liner during handling and deployment, shall have clean, smooth grip faces, and corners on the

grip faces shall be rounded. The pressure applied by the grips shall not be so great as to indent or otherwise damage the liner. The Liner Installer shall demonstrate his methods for handling and deploying the liner at the start of the liner installation for approval by the Engineer, and shall include the details in the liner handling and installation plan submittal.

The liner shall be installed at the locations and to the lines, grades and dimensions shown on the Drawings, or as otherwise approved by the Engineer. Panel layout and deployment shall be such that the seams run down the sideslope of the CWSA and are oriented perpendicular to the top of sideslope of the CWSA. The Liner Installer shall submit a panel layout plan indicating the proposed liner panel configuration, and identifying field seams, anchor trenches, pipe penetrations, and other details needed to complete the work, for approval by the Engineer, at least two weeks prior to liner installation.

15.4.3 Field Seams

All liner shall be seamed the same day that the liner is deployed. All liner shall be ballasted immediately after deployment to prevent uplift by winds. Welding of field seams shall not take place unless suitable surface and weather conditions exist, and satisfactory welds can be achieved as confirmed by field trial test welds.

All liner sheets must be continuously and tightly bonded using continuous double-wedge fusion welds or extrusion fillet welds both made with automated welding equipment approved by the Engineer. The use of extrusion fillet welds shall be limited to patches at liner panel T-seams, patches at liner repairs, pipe penetrations or other detail work as approved by the Engineer. Field seaming shall be conducted in the dry, on relatively smooth surfaces, and in such a manner to prevent water, moisture, soil, dust, dirt or other foreign material from being included within the weld.

Adjoining liner sheets shall be overlapped a minimum of 4 inches, and in no case less than 3 inches at any location, by adequately lapping the edges of the sheets. The overlap shall not exceed 6 inches for double-wedge fusion welds. Seam overlaps on the bottom area shall be made such that the direction of flow over the lined surface is from the top sheet toward the bottom sheet to form a shingle effect.

Edges to be welded shall be wiped and cleaned thoroughly to remove any dirt, dust, soil, water, moisture or other foreign material. All field seams must be symmetric, uniform in appearance and width meeting the appearance criteria listed below, unless approved otherwise by the Engineer based on destructive test results. All field seams must be uniform in physical properties meeting the seam strength, shear elongation, peel separation and failure mode criteria in Section 15.4.3.1 of this Specification.

- (i) Extrusion Fillet Welds: The surface of extrusion fillet welds shall be smooth in appearance. The interior of the center extrudate bead shall be homogeneous and uniform in appearance. The weld shall be symmetric in width with the crown of the extrudate bead centered along the edge of the top liner sheet. The total width of the weld shall be between $1 \frac{1}{4}$ and $1 \frac{3}{4}$ inches with the center bead comprising approximately one-third of the total width. The total thickness of the center of the weld shall be 3 to 4 times the thickness of the liner sheets

being welded. The squeeze-out lip along both edges of the weld shall be similar in shape and size.

- (ii) Double-Wedge Fusion Welds: The surface of double-wedge fusion welds shall be slightly embossed from the nip rollers along the top and bottom surfaces of both fusion weld areas. The fusion weld areas shall be symmetric and each shall have a width equal to or greater than 5/8 inches and thickness reduction of 10 to 25 mils. The width of the air channel shall typically be 1/2 to 5/8 inches. Squeeze-out along the inside and outside edges of the fusion welded areas shall be similar in size and typically extend no more than about 1/8 inch.

The surface of both HDPE liner sheets along extrusion fillet welds shall be ground prior to welding to remove any oxidized surface film in accordance with the following criteria unless approved otherwise by the Engineer: (i) grind with 80 grit sand paper holding the grinding wheel such that the grinding marks are oriented perpendicular to the seam and made from the bottom sheet toward the top sheet to prevent gouging of the lower sheet; (ii) the edge of the upper sheet shall be beveled approximately 45° by the grinding process; (iii) the depth of grinding shall be approximately 5 percent of the liner thickness and in no case more than 10 percent of the liner thickness; and (iv) the width of grinding shall be slightly less than the width of the extrusion weld such that grinding marks are not visible beyond the edges of the weld. Welding shall be completed within one hour of grinding the surface of the liner.

Heat-degraded resin in the barrel of the extrusion welder shall be purged prior to making extrusion welds.

Seams shall not exhibit heat distortion from overheating during welding (e.g., warping, excessive thermal puckering). The underside of field seams shall be inspected for heat distortion from welding at the end of all seams, wherever samples for destructive testing are cut from the field seam, and at locations identified by the Engineer wherever the appearance of the weld is indicative of potential heat distortion.

15.4.3.1 Field Seam Strength

All welded field seams shall meet the following criteria:

- (i) Shear Strength: The specimen shall exhibit: a strength in shear equal to or greater than 80 lb/inch (ppi); a film-tear bond failure (FTB) mode; and a shear elongation at break equal to or greater than 50 percent. The test shall be performed at a rate of displacement of 2 inches/minute (ipm) for the first 2 inches of displacement, and the test then continued at a rate of displacement of 20 ipm until rupture.
- (ii) Peel Strength: The specimen shall exhibit: a peel strength equal to or greater than 60 ppi for double-wedge fusion welds and equal to or greater than 55 ppi for extrusion fillet welds; a film-tear bond failure (FTB) mode; and a peel separation (incursion area) less than or equal to 25 percent of the initial bonded area and less than 100 percent of the width of the initial bonded area (excluding the area and width of the squeeze-out from the initial bonded area and width). The peel strength criteria shall apply to both the top and bottom welds of double-wedge fusion welds.

Double-wedge fusion welds exhibiting AD, AD-BRK [with >25% peel separation of the bonded area] or AD-BRK [with separation across 100% of the bonded width regardless of separation area] locus-of-break behavior shall be considered non-FTB failure modes. Extrusion fillet welds exhibiting AD1, AD2, AD-BRK [with >25% peel separation of the bonded area], AD-BRK [with separation across 100% of the bonded width regardless of separation area] or AD-WLD [with shear strength <80 ppi or peel strength <55 ppi] locus-of break behavior shall be considered non-FTB failure modes.

15.4.3.2 Pass/Fail Criteria

The following pass/fail criteria shall be used to determine compliance of field seams with the above strength criteria:

- (i) All five specimens from a given sample tested in peel (both top and bottom for double-edge fusion welds) shall exhibit the specified strength, separation and FTB failure modes, and all five specimens tested in shear shall exhibit the specified strength, shear elongation at break ≥ 50 percent and FTB failure modes (i.e., 0 percent strength, shear elongation at break and peel separation failures and 0 percent non-FTB failures); or
- (ii) All five specimens from a given sample tested in peel and all five specimens tested in shear shall exhibit the specified strengths, all five specimens tested in shear shall exhibit elongation at break ≥ 50 percent, four of five specimens tested in peel shall exhibit acceptable peel separation, and four of five test specimens, for each type of test, shall exhibit FTB failure modes (i.e., 0 percent strength and shear elongation at break failures, and up to 20 percent non-FTB failures); or
- (iii) One specimen from a given sample tested in peel or shear may exhibit a non-FTB failure and a strength no less than 50 percent of the specified strength provided that all five field seam specimens tested from the duplicate (archive) sample exhibit the specified strength, all five specimens test in shear exhibit an elongation at break ≥ 50 percent, four of five specimens tested in peel exhibit acceptable peel separation, and no more than one test specimen of the five additional specimens exhibits a non-FTB failure (i.e., 0 percent shear elongation at break failures, 10 percent strength failures and up to 20 percent non-FTB failures).

If a field seam fails the criteria specified herein, and the Liner Installer wishes to establish to the Engineer that the failed sample represents a smaller section of the field seam than designated by the Engineer, additional coupons may be obtained at progressively increasing distances from both sides of the failed sample, at locations approved by the Engineer, until two consecutive samples on each side of the original sample pass the field seam criteria. The costs of the additional testing shall be borne by the Contractor. At that point, the extent of the original defect in both directions along the field seam will be considered isolated and the Liner Installer may then: (i) either cap, re-weld and re-test the seam up to and including the closest of the two passing samples, and patch and weld the hole of the furthest passing sample; or (ii) cap, re-weld and re-test the entire length of sampling. The costs of the additional tests shall be borne by the Contractor.

If approved by the Engineer, double-wedge fusion welds may be repaired by extrusion welding the flap of the top sheet to the bottom sheet if the seam non-compliance is due only to a non-FTB failure of the destructive test sample.

The duplicates of additional samples requested by the Liner Installer for identifying the extent of a defective seam will not be tested, i.e., the seam shall meet either pass/fail criteria (i) or (ii). The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

15.4.4 Anchor Trenches

The liner shall be anchored in anchor trenches at the locations shown on the Drawings. Field seams shall be welded continuously through the anchor trench.

Liner anchor trenches shall be no less than 18 inches in width and 24 inches in depth. The corners of the trenches shall be slightly rounded to minimize sharp bends in the liner. After placement of the liner along the side and across the bottom of the trench, the trench shall be backfilled with soil fill meeting the material requirements specified in Section 3. Anchor trench backfill shall be compacted to a dry density not less than 95 percent of the Standard Proctor maximum dry density (ASTM D698). The liner within the anchor trench shall not be damaged during placement and compaction of the soil.

15.4.5 Temporary Ballast Loading

Adequate temporary ballast loading that will not damage the liner shall be placed by the Liner Installer atop the liner during installation as needed to prevent uplift by wind and by rapid changes in barometric pressure. The temporary ballast loading shall be in addition to permanent anchor trenches. Sufficient temporary ballast loading shall be placed along panel edges, in particular, as needed to minimize the risk of wind flow under the panels. Continuous loading shall be provided at all panel edges during days off, at night, and whenever inclement or stormy weather is anticipated.

Temporary ballast loading may consist of sand filled bags. Bags used for containing sand shall be resistant to degradation by ultraviolet radiation (sunlight), shall contain the sand without leakage, and shall be approved by the Engineer. Soil fill shall not be placed atop the liner for temporary ballast loading without being adequately and completely contained.

Temporary ballast loading shall be maintained as necessary or as otherwise directed by the Engineer. All temporary ballast loading shall be removed by the Liner Installer prior to demobilizing from the site unless otherwise approved by the Engineer.

The Liner Installer shall submit a complete description and details of proposed temporary ballast materials and placement procedures at least two weeks prior to liner installation. Approval by the Owner or Engineer shall not relieve the Liner Installer from responsibility to provide all temporary ballast loading as needed to prevent uplift during construction.

15.4.6 Pipe Penetrations

All pipe penetrations shall be made in accordance with the details shown on the Drawings and the Liner Manufacturer's recommendations, subject to approval by the Engineer. Pipe penetrations through the HDPE liner shall typically consist of a pipe boot, constructed with the same material as the liner penetrated by the pipe, continuously extrusion welded to the liner and the HDPE pipe. Other pipe penetrations, if used, are shown on the Drawings.

15.4.7 Repairs

All liner defects (scratches, blisters, rips, punctures, tears, holes, pinholes, creases, folds, strain-yielded areas, etc.) and holes created by removal of samples for destructive testing shall be marked and repaired by completely covering the defect or hole with a round or oval-shaped piece of the corresponding HDPE liner material extending at least 4 inches beyond the edges of the defect/hole and continuously welding the patch to the liner sheet using an extrusion weld. Scratches shall be considered a defect when the depth is in excess of 5 percent of the liner thickness or as otherwise determined by the Engineer. Holes created by removal of samples for destructive testing shall be marked, patched and repaired as specified above for liner defects. The panel number, repair location, type of defect, description of repair made, and date repaired shall be documented for each liner repair.

15.4.8 Liner Protection

No equipment, tools or personnel that can readily cause damage to the HDPE liner shall be allowed on the liner during and after installation. Personnel working on the HDPE liner shall not smoke, wear potentially damaging shoes, dispose of trash or other debris, or engage in any activity that could damage the liner.

The passage of construction equipment, other than light rubber-tired equipment approved by the Engineer, over any exposed HDPE liner surface is strictly prohibited. Light rubber-tired equipment exerting a contact stress less than 6 lb/in² will be allowed provided proper care is taken when operating the vehicle to avoid pulling, displacing, or damaging the liner.

Any damage to the liner (e.g., tears, punctures, creases, folds, strain-yielded areas, etc.) occurring during construction shall be immediately brought to the attention of the Engineer and repaired as approved by the Engineer at the expense of the Liner Installer.

15.4.9 Fuel and Oil Spill Clean-Up

All spills or leaks of fuels or oils from equipment and vehicles on the surface of the liner shall be thoroughly cleaned with soap and water or, at the discretion of the Engineer, the affected liner shall be cut, removed and replaced with new liner material. Bedding materials contaminated with fuel or oil shall be excavated and replaced to the extent designated by the Engineer. Contaminated soils shall be disposed of on site in an area designated by the Owner.

15.5 Inspection and Field Testing by Liner Installer

15.5.1 Initial Qualifying Welds

All master seamers/welders and seamers/welders shall demonstrate their ability to consistently make successful seams prior to installation of the liner. Each seamer or welder shall prepare test strips for each type of seam between different liner types and for both extrusion or double-wedge fusion welds. Each test strip shall have a minimum length of 20 feet. Qualifying welds shall be made using the same conditions that will exist during actual liner installation (i.e., same grinder operators) for extrusion welds and making the welds on similar ground conditions. Twelve test specimens shall be cut from the test strip at an approximately uniform spacing of 18 inches or at locations selected by the Engineer and tested by the Liner Installer in both shear and peel (6 test specimens each) for compliance with the Specification requirements in Section 15.4.3. No seamer/welder shall be allowed to make production welds in the liner without first successfully passing the initial qualifying welds.

15.5.2 Daily Qualifying Welds

At the beginning of each working day, after any interruption in power, after any prolonged idle period during the day, and at the request of the Engineer at any other time during the day, each seamer shall prepare a 3-foot (for extrusion welds) or 10-foot (for double-wedge fusion welds) long test strip using the welding apparatus assigned to him. Ten samples from the test strip shall be cut at locations selected by the Engineer and tested by the Liner Installer in both shear and peel for compliance with the specification requirements in Section 15.4.3. The sample weld shall successfully pass the test requirements before either the seamer or seaming apparatus are allowed to operate on production welds.

15.5.3 Non-Destructive Testing of Welds

The Liner Installer shall continuously test every field weld (i.e., 100 percent of the length of all field seams), including field welds around patches, using non-destructive testing techniques. These tests shall be performed in the presence of the Engineer. Extrusion welds shall be tested using a vacuum box and test procedures specified in ASTM D4437. Once a generous amount of soap solution is uniformly placed over the weld, a minimum vacuum of 4 to 8 lb/in² should be applied to the seam and held for a minimum of 10 seconds. Any bubble formation must be noted and the corresponding defective area identified, marked, and subsequently repaired.

Double-wedge fusion welds shall be non-destructively tested by pressurizing the air channel between the two welds to a pressure between 25 and 30 lb/in² and monitoring the pressure for any decline with time. After allowing 2 minutes for relaxation, the pressure shall be monitored over a test period of not less than 5 minutes. A weld will be considered satisfactory if either of the following criteria are satisfied:

- (i) the loss in pressure is equal to or less than 2 lb/in² and the pressure stabilizes within the 5-minute test period; or
- (ii) if criteria (i) is not satisfied, the additional pressure drop is equal to or less than 1 lb/in² during an additional test period of 5 minutes (i.e., the total pressure drop is less than or

equal to 3 lb/in² over a 10-minute test period), and the pressure stabilizes during the second test period.

The length of welded section tested by air pressure shall not exceed 550 feet, without prior approval by the Engineer. If a non-compliant pressure drop is noted, pressure testing may be repeated in a step fashion each time halving the length of weld being tested until the extent of the defective weld is determined. Vacuum box testing (ASTM D4437) may also be used to locate a defect in the top weld or in the top of the air channel.

Once the defect is found, it shall be clearly identified, marked and repaired. Any defective seam shall be repaired so that it meets or exceeds the minimum requirements specified herein.

Welds in inaccessible areas where the use of the other nondestructive test methods is not practical shall be tested using a high voltage spark tester and the procedures specified in ASTM D6365 and by the equipment manufacturer. The spark testing equipment and proposed field testing procedures shall be pre-approved by the Engineer prior to use.

15.5.4 Sampling and Destructive Testing

The Liner Installer shall obtain and secure samples of the liner and field seams for destructive testing by the Engineer at locations designated by the Engineer. Samples shall be obtained at the frequency specified in Section 15.6.3. The Liner Installer shall obtain seam samples, in triplicate, from the designated location for laboratory testing. One portion of the sample shall be retained by the Liner Installer for testing. If the results of field tests performed by the Liner Installer, in the presence of the Engineer, indicate compliance with the criteria in Section 15.4.3, then the Liner Installer shall provide the second portion of the sample to the Engineer for independent quality control testing. The third portion will be retained by the Owner for archive storage. If the results of peel and shear tests performed by the Liner Installer in the field do not meet or exceed the requirements specified herein, then the provisions of Section 15.4.3 shall apply for temporarily determining the extent of repairs pending performance of independent quality control tests by the Engineer.

The seam samples provided to the Engineer for laboratory destructive testing and the Owner for archive storage shall each be not less than 12 inches wide by 18 inches long in the direction of the seam. The seam shall be centered along the sample length. Each of the triplicate samples shall be properly marked and identified by the Liner Installer. The Liner Installer shall repair all holes created by sampling in accordance with Section 15.4.7.

15.5.5 Visual Inspection

The Liner Installer shall visually inspect the entire liner surface for any defects including, but not limited to, seam imperfections, badly scuffed areas, scratches, blisters, tears, rips, holes, pinholes and punctures. The Liner Installer shall identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs shall be made in accordance with Section 15.4.7.

15.5.6 Quality Assurance Forms

The Liner Installer shall adopt and use the quality assurance forms prepared by the Engineer, or other forms approved by the Engineer, during all applicable phases of liner installation, inspection and testing. The Liner Installer can request approval to use their standard forms in lieu of forms prepared by the Engineer. The Liner Installer's forms must be submitted to the Engineer at least two weeks prior to liner installation for review and approval.

15.5.7 Certification

The Liner Installer's installation supervisor shall observe and check all phases of liner installation. When the liner is accepted by the Owner, the Liner Installer shall submit written certification to the Owner that the installation conforms to the requirements of the Liner Manufacturer.

15.6 Quality Control Inspection and Testing by Engineer

15.6.1 Base Maintenance and Repair During Liner Installation

The Engineer will undertake observations and perform quality control tests to determine compliance with these Specifications. Quality control by the Engineer will include monitoring soil placement to determine the suitability of bedding materials and adequacy of compaction. The Engineer will perform *in-situ* density tests: (i) after compaction of fill as needed to fine grade, maintain and restore the condition of the prepared soil base; (ii) after compaction of fill in excavations as needed to restore grade; and (iii) after compaction of backfill in anchor trenches. *In-situ* density tests will be performed by the drive cylinder method (ASTM D2937), sand cone method (ASTM D1556), or other methods approved by the Engineer and deemed equivalent by him at his sole discretion. Water content tests made in the field using a calcium carbide gas pressure tester (ASTM D4944) may be used to provide water content information for construction control, but final acceptance of all liner bedding materials will be based upon ASTM D2216 unless approved otherwise by the Engineer. Penetration test probes may also be performed as needed to verify the uniformity of compaction. The Engineer will perform Standard Proctor compaction tests (ASTM D698) as needed to determine compliance with compaction requirements.

Testing of the compacted soil base will be performed by the Engineer following final grading and compaction by the Earthwork Contractor before the surfaces are turned over to the Liner Installer. Testing of the compacted soil base will be repeated, as needed, immediately prior to liner placement. Final documentation and results from these tests, however, will not be available prior to liner deployment. Such testing shall not relieve the Liner Installer from his responsibility for restoration or repair of unsuitable areas following liner placement, in the event that such is deemed necessary by the Engineer. The Contractor shall retain a Florida-licensed surveyor to survey, sign, and seal the final grade and have the elevations approved by the Engineer before the surfaces are turned over to the Liner Installer.

15.6.2 Liner Installation

All aspects of the liner installation will be inspected on a full-time basis by the Engineer. The Engineer will conduct his own inspections and tests in addition to those performed by the Liner Installer. The Engineer will undertake observations and perform quality control tests to determine compliance of the liner installation with these Specifications. Quality control by the Engineer will include monitoring: (i) liner handling and panel deployment; (ii) field welding of liner sheets and non-destructive testing of field welds; (iii) installation of anchor trenches; (iv) placement and maintenance of temporary ballast loading; and (v) installation of pipe penetrations. The Engineer will also monitor liner repair work, and evaluate the adequacy and acceptability of all repair work.

15.6.3 Destructive Testing

The Liner Installer shall obtain and secure samples of the liner and field seams for destructive testing by the Engineer from locations designated by the Engineer, and shall properly mark all samples to identify the particular seam or liner panel from which the sample was obtained.

- (i) Testing and sampling of liner material will be performed as specified in Section 7.5.
- (ii) Seam samples will be taken for destructive peel and shear testing by the Engineer at a minimum frequency of 1 sample per 500 feet of field seam. Samples for destructive testing will be obtained by the Liner Installer at locations designated by the Engineer within 48 hours of the welding the field seam unless approved otherwise by the Engineer.

Duplicate samples of all HDPE liner material and all field seams tested destructively by the Liner Installer shall also be secured by the Liner Installer and submitted to the Engineer for independent testing. All samples shall be properly marked and identified.

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

15.7 Insurance

The Liner Installer, through the Contractor, shall provide the Owner insurance coverage against blowout or uplift of the liner during installation. The insurance coverage shall remain in effect until the Owner issues a Letter of Acceptance to the Contractor.

The Contractor shall agree to provide the Owner with a commitment to re-install or replace any liner that may blowout during the time when the insurance coverage is in effect, at the same rate as required during initial installation, without adversely affecting the rate of progress of work yet to be performed. Additional materials, manpower and equipment shall be mobilized to the site within two weeks of a blowout occurrence as needed to comply with this commitment.

15.8 Warranty

A written warranty shall be provided to the Owner by the Liner Installer. This document shall warrant the quality of the workmanship for a period of not less than 2 years beginning on the date of the Letter of Acceptance from the Owner.

15.9 As-Built Drawings

The Liner Installer shall submit to the Owner, within 30 days of completion of installation of the liner, an as-built plan showing the location and identification of all installed liner panels, anchor trenches, repairs and destructive test samples.

15.10 Submittals

The following submittals are required from the Liner Installer as part of the requirements of the Specifications.

- Erosion control plan (Section 15.3.7).
- Shop drawings showing the proposed liner panel layout and details of the liner installation, including anchor trenches, vents, and pipe penetrations shall be submitted at least two weeks prior to liner installation (Section 15.4.2).
- A complete description and details of the proposed temporary ballast loading shall be submitted at least two weeks prior to liner installation (Section 15.4.5).
- Quality assurance forms proposed for use by the Liner Installer for all phases of liner installation, inspection and testing shall be submitted at least two weeks prior to liner installation (Section 15.5.6).
- Certification by the Liner Installer, when the liner is accepted by the Owner, that the liner installation complies with the requirements of the Liner Manufacturer (Section 15.5.7).
- Workmanship warranty for a period of at least two years beginning on the date of the Letter of Acceptance from the Owner (Section 15.8).
- As-built plan of the installed HDPE liner within 30 days of completion of liner installation (Section 15.9).

SPECIFICATIONS

SECTION 16 GEOCOMPOSITES FOR FINAL COVER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

16.1 Description of Work

This Specification covers the material requirements and installations of the double-sided geocomposites specified for the final cover system as shown on the Drawings.

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16.2 Referenced Standards

The following ASTM standards are referenced in this Specification.

D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

D1248: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique

D1603: Standard Test Method for Carbon Black in Olefin Plastics

D1683: Standard Test Method for Failure of Sewn Seams in Woven Fabrics

D3786: Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method

D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity

D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles

D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

D4716: Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile

D4833: Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

D5199: Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

D5261: Standard Test Method for Measuring Mass per Unit Area of Geotextiles

D7005: Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites

D7179: Standard Test Method for Determining Geonet Breaking Force

16.3 Material Requirements

A double-sided geocomposite shall be installed in the final cover system as a drainage layer to prevent the saturation of the soil cover materials that will be placed on top of the HDPE liner and the geocomposite. The double-sided geocomposite shall consist of an HDPE geonet core with non-woven geotextiles heat bonded to one (single-sided geocomposite) or both (double-sided geocomposite) sides of the geonet core. The geonet cores in the geocomposite shall be manufactured from unreinforced HDPE, and shall be designed and manufactured specifically for use as a drainage product. The geotextile used in the geocomposite shall be manufactured from non-woven geotextile that is suitable for material separation.

A complete description of the geocomposite proposed for use with a minimum 1 square yard sample and the Manufacturer's product data sheets shall be submitted by the Contractor to the Engineer for approval at least two weeks prior to delivery of material to the job site. Certifications from the Manufacturer that the geocomposites comply with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of material to the job site.

16.3.1 Geonet

16.3.1.1 HDPE Resin

The uncolored base resin for manufacturing of the geonet shall have a density of at least 0.932 g/cm³. The formulated colored resin shall have properties equivalent to ASTM D1248, Type III, Category 4 or 5, and Grade P34. The resin shall contain not less than 97 percent of the base polymer and not less than 2.0 percent carbon black as defined in ASTM D1248 for Class C high-density polyethylene. The geonet shall contain no more than 3 percent carbon black, anti-oxidants and heat stabilizers combined, and no other additives, fillers or extenders. The geonet shall be manufactured from virgin resin, with no more than 3 percent regrind material. No post-

consumer resin of any type shall be used.

16.3.1.2 Physical Appearance

The geonet shall be uniform in appearance and composition and shall be free of tears, cuts, gels, undispersed ingredients, any signs of contamination by foreign matter, or any defect that may affect serviceability.

16.3.1.3 Physical Properties

The geonet cores of the geocomposite shall meet the following criteria:

Property	Test Method	Criteria
Melt Index (gm/10 mins)	ASTM D 1238, Condition E	≤1.0
Carbon Black Content (%)	ASTM D1603	2.0-3.0
Density (g/cm ³)	ASTM D1505	≥0.94
Thickness Retention (%)	100 psi for 10,000 hours at 20°C temperature	≥75%
Thickness (inches)	ASTM D5199	≥0.30
Transmissivity* (m ² /sec)	ASTM D4716	≥8.0x10 ⁻³
Tensile Strength** (lb/in)	ASTM D7179	≥75
* The values represent the transmissivities of the geonet core in the primary flow direction under a compressive normal load of 10,000 lbs/ft ² and a gradient of 0.1, with water at 70°F between steel plates for 15 minutes. ** Machine direction.		

A complete description of the geonet proposed for use and the Manufacturer's product data sheets and 2-foot long by roll width sample shall be submitted to the Engineer for approval at least two weeks prior to delivery of material to the job site. Certification from the Manufacturer that the geonet complies with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of material to the job site.

16.3.2 Geotextiles

Geotextiles for the geocomposite shall be a non-woven, needle-punched fabric manufactured from 100 percent polyester or 100 percent polypropylene. The geotextiles shall be uniform and homogeneous in appearance and composition, and free from tears, cuts, thin spots, or any defects that may affect serviceability. Geotextile with a mass of 8 oz/yd² shall be used in the geocomposite. The properties of the geotextiles are as follows:

Property	Units	Test Method	Criteria
Mass per Unit Area	oz/yd ²	ASTM D5261	≥8
Apparent Opening Size	USSS [†]	ASTM D4751	≥80
Grab Tensile Strength*	lb	ASTM D4632	≥220
Grab Elongation*	%	ASTM D4632	≥50
Trapezoidal Tear Strength*	lb	ASTM D4533	≥50
Puncture Resistance	lb	ASTM D4833	≥120
Mullen Burst Strength	psi	ASTM D3786	≥360
Permeability to Water	cm/sec	ASTM D4491	≥0.2
* Machine and transverse directions.			
† United States Standard Sieve Size.			

A complete description of the geotextiles proposed for use and the Manufacturer's product data sheets shall be submitted to the Engineer for approval at least two weeks prior to delivery of material to the job site. Certification from the Manufacturers that the geotextiles comply with this Specification shall also be supplied to the Engineer at least two weeks prior to delivery of material to the job site.

16.3.2.1 Geocomposite

The geonet core and geotextile in the geocomposite shall meet the requirements of Sections 16.3.1 and 16.3.2.

Geocomposites shall have a transmissivity (ASTM D4716) of equal to or greater than 2.0×10^{-3} m²/sec in the machine direction under a compressive normal load of 250 lb/ft², a gradient of 0.33, and a seating time of 100 hours.

The bond between the geotextile and the geonet shall have a ply adhesion (ASTM D7005) of equal to or greater than 1.0 lb/in.

16.3.3 Frictional Characteristics

The minimum peak interface friction angle between cover soil and double-sided geocomposite for the final cover liner system shall be 34 degrees.

For determining compliance with the specified interface friction angles, direct shear tests will be performed by the Engineer in accordance with Standard ASTM D5321 using a fine sand with silt fill materials (Group Symbol SP-SM in accordance with ASTM D2487) from the site meeting the following gradation.

U.S. Standard Sieve Size	Percent Passing (Dry Mass Basis)
No. 4	100
No. 10	97-100
No. 20	95-100
No. 40	90-100
No. 60	60-95
No. 100	20-80
No. 140	7-25
No. 200	5-12

The direct shear tests shall be performed at normal stresses of approximately 5 lb/in² to duplicate field conditions. The soil shall be compacted to a dry density equal to 95 percent of the Standard Proctor maximum dry density (ASTM D698) within ± 2 percent of the Standard Proctor optimum water content. The interface and soil shall be tested submerged with water. The tests shall be performed using a horizontal displacement rate of 0.3 inches per hour.

16.4 Factory Testing and Inspection

16.4.1 Factory Testing

16.4.1.1 Geonet

Standard factory testing reports for raw materials including melt index and specific gravity or density for each batch of resin used to manufacture the geonet shall be submitted to the Engineer for approval at least two weeks prior to delivery of material to the job site. The resin Manufacturer's certificate of analysis for each batch of resin shall also be provided to the Engineer at least two weeks prior to delivery of material to the job site.

Factory quality control certificates for the geonet component of the geocomposite shall be provided to the Engineer by the Manufacturer at least two weeks prior to construction. As a minimum, the quality control certificates shall contain the geonet roll identification number, date manufactured, roll width and length, and resin batch number. The following factory quality control tests shall be provided at the indicated frequencies:

Property	Test Method	Frequency
Mass per Unit Area	ASTM D5261	Every 50,000 square feet
Thickness	ASTM D5199	Every 50,000 square feet
Tensile Strength*	ASTM D7179	Every 50,000 square feet
Transmissivity**	ASTM D4716	Every 20 Rolls
Melt Index	ASTM D1238	Once per Batch of Resin or Every 10 Rolls
Carbon Black Content	ASTM D1603	Once per Batch of Resin or Every 10 Rolls
Density	ASTM D1505	Once per Batch of Resin or Every 10 Rolls
* Machine and transverse direction.		
** Machine direction.		

Failure of any of the tests shall result in rejection of the corresponding lot of geonet.

16.4.1.2 Non-Woven Geotextile

Factory quality control certificates for the non-woven geotextile component of the geocomposite, shall be provided to the Engineer by the Manufacturer at least two weeks prior to construction. The quality control certificates shall contain the geotextile roll number, date manufactured, roll length, and width. The Manufacturer shall provide test results to the Engineer at least one sample per lot of geotextile for mass per unit area, thickness, apparent opening size, permeability to water, and grab tensile strength and elongation in accordance with the test procedures in Section 16.3.2. Failure of any of the tests shall result in rejection of the corresponding lot of geotextile.

16.4.2 Factory Inspection

The geotextiles and geocomposite shall be visually inspected at the factory prior to shipment for compliance with the physical appearance requirements in Sections 16.3.1.2 and 16.3.2. Any necessary repair shall be made by the Manufacturer at the factory prior to shipment.

16.4.3 Marking and Packaging

Each geocomposite roll shall be individually packaged at the factory to prevent damage during shipping and handling, and shall be completely wrapped by a protective ultraviolet resistant thin plastic film having a minimum thickness of 2 mils. The Manufacturer shall provide each roll with a label indicating the roll number, product name, length, width and date manufactured.

16.5 Handling and Installation

16.5.1 Storage and Handling

The Contractor shall be responsible for unloading and storing the geotextile and geocomposite rolls. During unloading, the Contractor shall obtain samples from the ends of rolls for testing by the Engineer at locations selected by the Engineer.

The geocomposite shall remain wrapped in the protective cover and shall be stored, as recommended by the Manufacturer and approved by the Engineer, in an area of the site that protects the geocomposite from moisture, water, ash, dirt, ultraviolet light and mechanical damage until the time of installation. The rolls shall not be unwrapped more than 1 hour before use. Handling of the rolls shall be in accordance with the Manufacturer's recommendations and shall be as needed to protect the geocomposite from damage.

16.5.2 Laying and Installation

The geocomposite shall be installed at the locations and to the lines and dimensions shown on the Drawings.

The geocomposite shall be deployed with the most transmissive direction oriented towards the leachate collection pipe trench. The geocomposites shall be installed in a smooth and unwrinkled condition in uniform contact with the underlying materials, and held in place as needed and approved by the Engineer until covered.

The ends of the geonet at a joint shall be overlapped 4 inches, and tied together with polyethylene or polypropylene ties recommended by the Manufacturer and approved by the Engineer. Metallic ties shall not be used. A minimum of three ties shall be used at each joint, and the ties shall be of a color to allow easy inspection (e.g., white or yellow) against the black geonet. The upper and lower geotextiles of the composite at the joint shall be overlapped a minimum of 4 inches, and the top geotextile overlap shall be sewn in accordance with Section 16.5.3.

After installation, the geocomposite shall not be left exposed for more than 48 hours prior to covering.

The exposed edge of the geonet on all cut sides and ends of the geocomposite shall be covered with a piece of the same geotextile as on the composite overlapped 12 inches minimum on the bottom and top of the composite. The edge of the top lap shall be held in-place until covered using spot thermal bonding or black PVC pipe wrapping tape as approved by the Engineer and, if needed, temporary sand bags. The upper and lower geotextiles along the uncut edge of the geocomposite shall be sewn in accordance with Section 16.5.3.

16.5.3 Geotextile Field Seams

Field seams in geotextiles shall be made using a minimum overlap of 4 inches. The geotextile panels shall be sewn together with a sewing machine using a flat sewn seam with one row of stitches with a minimum of four stitches per inch, or a seam and stitching pattern recommended by the Manufacturer and approved by the Engineer. The thread used to sew the seams shall be 2000 denier minimum, or as recommended by the Manufacturer and approved by the Engineer, and shall have the same composition as the geotextile. The strength of field seams shall not be less than 50 percent of that of the un-aged geotextile in any principal direction when tested in accordance with ASTM D1683 at a strain rate of 12 inches/minute. The Contractor shall submit details of the proposed sewing method (type of stitch, number of stitches per inch, number of stitching rows, distance from the edge of the geotextile to the stitches, weight and type of thread, etc.) and a minimum 3 feet long sample of the sewn seam for approval by the Engineer at least one week prior to installation.

16.5.4 Geotextile Repairs

Patches on geotextiles on the geocomposite shall be held in place by thermal bonding or 2-inch wide black PVC pipe wrapping tape, and sewn in accordance with Section 16.5.3 of this Specification where directed by the Engineer. Geotextile and geocomposite that require more than one repair to the geotextile per roll shall be rejected and replaced.

16.6 Sampling and Inspection by Contractor

16.6.1 Sampling

The Contractor shall obtain and secure samples of the geocomposite for destructive testing by the Engineer when the rolls are delivered to the site or subsequently during installation as requested by the Engineer. The samples shall be obtained from locations designated by the Engineer. All samples shall be properly marked and identified by the Contractor. The Contractor

shall repair all openings created by sampling in accordance with Section 16.5.4 or completely remove the full width of the roll at the sampling location.

16.6.2 Visual Inspection

The Contractor shall visually inspect the surfaces of the installed geocomposites for any defects including, but not limited to, rips, tears, punctures and defective seams. The Contractor shall identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs to geotextiles shall be made in accordance with Section 16.5.4. Geocomposite with damage to both geotextile surfaces at any location shall be removed and replaced.

The Contractor shall visually inspect the surfaces for soil, ash, dust or debris that could result in clogging of the geonet or geotextiles. If soil, ash, dust or debris is entrapped in the geonet, it shall be removed and replaced or the surfaces cleaned as approved by the Engineer.

16.7 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance of the materials and work with this Specification. Quality assurance by the Engineer will include monitoring and/or inspecting: (i) geocomposite handling, installation, overlapping and field joining; (ii) the geotextile and geonet for damage; and (iii) geotextile and geonet for excessive entrapped soil, ash, dust or debris that could reduce the transmissivity of the composite.

Laboratory quality assurance tests shall be performed by the Engineer on the geocomposites at the following minimum frequencies.

Material	Property	Test Method	Minimum Testing Frequency
Geonet Core of Geocomposite	Thickness	ASTM D5199	Once per 100,000 ft ²
	Mass per Unit Area	ASTM D5261	
	Density	ASTM D1505	
	Carbon Black Content	ASTM D1603	
	Tensile Strength	ASTM D7179	
	Transmissivity*	ASTM D4716	Once per 200,000 ft ²
Geotextile Component of Geocomposite	Thickness	ASTM D5199	Once per 100,000 ft ²
	Mass Per Unit Area	ASTM D5261	
	Grab Strength & Elongation	ASTM D4632	
	Apparent Opening Size	ASTM D4751	Once per 100,000 ft ²
	Permeability	ASTM D4491	
	Field Seam Strength	ASTM D1683	Once per 500 feet of field seam
Geocomposite	Transmissivity*	ASTM D4716	Once per 100,000 ft ²
	Ply Adhesion	ASTM D7005	Once per 100,000 ft ²
* Transmissivities of the geonet cores of the geocomposites shall be measured along the primary flow direction under a compressive normal load of 10,000 lb/ft ² and a gradient of 0.1 with water at 70°F between steel plates for 15 minutes. Test cross section for the Type A and B geocomposites in the final cover liner system shall consist of, from top to bottom, cover soil, geocomposite, and textured HDPE liner under a compressive normal load of 10,000 lb/ft ² , a gradient of 0.02, and a seating time of 100 hours.			

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor shall reimburse the Owner for the cost of these additional tests, including tests that fail to meet the requirements of the Specifications.

16.8 Submittals

The following submittals are required from the Contractor as part of the requirements of this Specification.

- A complete description of each geocomposite, the Manufacturer's product data sheets for each, and the Manufacturer's certification that the geocomposites meet the requirements of this Specification.
- A minimum 1 square yard sample of the composite and 1 square yard sample of the non-woven geotextile used on the geocomposite.
- Factory quality control certificates for each roll of geocomposite.
- Proposed sewing method for field seaming the non-woven geotextiles and a minimum 3 feet long sample of sewn seam.

SPECIFICATIONS

SECTION 17 PROTECTIVE SOIL COVER FOR FINAL COVER SYSTEM

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

17.1 General

This Specification covers the material requirements and installations of the soil cover that will be placed as part of the final cover system. The work shall include, placing a 24-inch thick layer of soil above the top geomembrane liner to the lines and elevations shown on the Drawings or as other directed by the Engineer. The top cover shall be placed above the double-sided geocomposite drainage layer and the HDPE liner installed in accordance with Sections 15 and 16 of the Technical Specifications.

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17.3	Material Requirements	1
17.4	Pre-Construction Testing of Protective Cover Soil	2
17.5	Placement and Compaction Criteria for Protective Cover	2
17.6	Construction Quality Assurance Inspection and Testing	3

17.2 Layout of Work

The Owner will establish reference points for horizontal and vertical controls near the designated construction area of the CWSA. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to construct the final cover to the lines and grades shown on the Drawings. It is the responsibility of the Contractor to verify all locations and dimensions prior to performance of any work.

17.3 Material Requirements

The soil used for construction of the protective cover layer shall meet the following requirements:

- The material shall have no particle retained on a U.S. ¼-inch standard sieve.
- The material shall have a plasticity index of 0 percent (ASTM D4318).

- The material shall have an organic content no greater than 8 percent (ASTM D2974) except for the upper 6 inches of the outside slope of the protective soil cover where an organic content up to 15 percent may be used to support vegetative growth.
- The material shall classify as a fine sand, sand with silt or silty fine sand with an SP, SP-SM, SM designation in accordance with ASTM D2487.
- The material shall have a fines content equal to or less than 25 percent, as determined by ASTM D1130.
- The material shall be relatively uniform in character and, after compaction, shall have an in-place saturated hydraulic conductivity no greater than 5.0×10^{-3} cm/sec.

17.4 Pre-Construction Testing of Protective Cover Soil

Fill materials for construction of the protective cover shall meet the requirements listed in Section 17.3 and shall be obtained from on-site stockpiles designated by the Owner. Even though the fill materials will be stockpiled and supplied by the Owner, the Contractor shall be required to remove any incidental objectionable materials (e.g., roots, organic materials, debris) prior to compaction to meet the fill material requirements stipulated in Section 17.3, as directed by the Engineer.

For the purpose of determining the hydraulic conductivity for compliance with the specification requirement, laboratory hydraulic conductivity tests shall be performed on representative samples of the soil stockpiles using specimens compacted to 100 percent of the Standard Proctor maximum dry density (ASTM D698).

17.5 Placement and Compaction Criteria for Protective Cover

Placement of the protective layer for the final cover system shall begin after the installation of the double-sided geocomposite and HDPE geomembrane. The protective soil cover shall be wetted or dried, as may be required, homogenized and placed in one single 24-inch thick lift above the geocomposite. Placement of the protective soil cover on the side slopes shall begin at the toe of the sideslope of the CWSA and progress upslope to the crest of the sideslope of the CWSA. Placement of the protective soil cover directly over the geocomposite shall be performed by light track-mounted equipment (e.g., low ground pressure Caterpillar D-4 or D-5 dozers or equivalent equipment) and traveling on a minimum of 18 inches of sand. Care shall be exercised during placement so as not to damage the liner with the blade or tracks of the placement equipment. The protective soil cover shall be placed in such a manner to avoid pushing, pulling or otherwise stretching the geocomposite and the underlying HDPE liners.

The protective soil cover shall be compacted to a dry density of at least 95 percent of the Standard Proctor maximum dry density. Standard Proctor compaction tests (ASTM D698) shall be performed on samples of the selected protective soil cover materials, as needed, to determine the maximum dry density for compaction control.

17.6 Construction Quality Assurance Inspection and Testing

A field representative of the Engineer will be present at the site during installation of the top cover to:

- Ascertain that the materials are free of deleterious materials and that construction materials and procedures are in conformance with these specifications, particularly placement of the protective cover layer without damage to the HDPE liner.
- Perform *in situ* density tests in the protective cover after compaction and compare the results to the Standard Proctor compaction test (ASTM D698). Testing shall be performed by the dry density method (ASTM D2937) or any other methods approved by the Engineer. Field *in situ* density measurements shall be made at a minimum frequency of two tests per acre.
- A minimum of four thickness measurements shall be conducted per acre.
- Recover samples for laboratory fines content determinations (ASTM D1140) and hydraulic conductivity tests (ASTM D5084). These tests shall be conducted at a minimum frequency of one test per acre.

Laboratory hydraulic conductivity tests (ASTM D5084) shall be conducted on specimens remolded to 95 percent of the Standard Proctor maximum dry density (ASTM D698). If the hydraulic conductivity documented from a sample within a drainage sand layer section does not meet the requirement of the specifications, that drainage layer section shall be re-worked or the materials replaced, as determined by the Engineer. If re-worked, extreme care shall be exercised to prevent damage to the underlying geosynthetic drainage layers and HDPE liners.

SPECIFICATIONS

SECTION 18 SODDING

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

18.1 Description of Work

Sodding of the lined area of Cell 2 on top of the west slope of the original landfill, the crest road of the perimeter dike, the inside and outside slopes of the containment dike and perimeter dike, the stormwater drainage ditches, and any other areas disturbed by the construction activities. Sodding shall be performed in accordance with these Specifications.

The Contractor shall be responsible for furnishing all labor, material, and equipment required to perform sodding activities, including soil/ground preparation, commercial fertilizer and limestone placement, and placement of sod.

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18.2 Material Requirements

All sod shall be in accordance with Section 981-3 of the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction and shall meet the following requirements:

- Sod shall be common Pensacola Bahia grass.
- Sod shall be at least 18 months old and shall be well matted with roots.
- Sod shall be supplied in commercial size rolls (25 square yards) or in rectangles (preferably 12-inch by 24-inch or larger) as approved by the Owner.

- The sod shall be sufficiently thick to secure a dense stand of live grass. The sod shall be live, fresh and uninjured, at the time of planting. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. It shall be reasonably free of weeds. Prior to harvesting, the area from which the sod is to be taken up shall be closely mowed and raked as necessary to remove excessive top growth and debris.
- Approved devices, such as sod cutters, shall be used for cutting the sod and due care shall be exercised to retain the native root soil intact.
- Sod shall be planted as soon as possible after being cut for use in the work. No sod that has been cut more than 72 hours prior to installation may be used. A letter of certification from the supplier as to when the sod was cut and what type shall be provided to the Owner, upon delivery of the sod to the job site.

Dolomitic limestone shall be a finely ground product, designated for agricultural use, with a carbonate equivalence exceeding 90 percent and approved by the Owner.

A commercial fertilizer satisfying the requirements of Section 982 of the FDOT Standard Specifications for Road and Bridge Construction, Florida Department of Transportation, latest revision, or as specified by the Owner shall be used. Commercial fertilizers shall comply with the State fertilizer laws. The numerical designation for fertilizer indicates the minimum percentages, respectively, of total nitrogen, available phosphoric acid, and water-soluble potash contained in the fertilizer. The chemical designation of the fertilizer for this work shall be 16-8-8 or as recommended by the Orange County Extension Service based on soil testing.

The Contractor shall provide necessary documents/certifications to the Owner confirming that all materials supplied meet the requirements of these specifications. (e.g., sod quality, sod age, etc.)

18.3 Ground Preparation and Fertilizer Application

The upper 6 inches of the soil surface shall be prepared to be favorable to turf growth in all areas to be sodded. The finished grade of the area to receive sod shall be a smooth and even surface, free of stones, gravel, and all other vegetation. Prior to placement of the prepared soil layer, the Contractor shall inspect and remove from the sites any large clods, stones, rocks, or other materials that may interfere with the sodding operation or the placement of the amended soil. All weeds or other objectionable vegetation shall also be removed by the Contractor. If necessary, the Contractor shall apply a systematic herbicide to all weeds or other objectionable vegetation. All herbicides shall be an EPA-approved product and applied according to the Manufacturer's recommendations, subject to the approval of the Owner.

The ground over which the sod is to be placed shall be prepared by disking to a depth of 6 inches. The prepared surface shall be loose and reasonably smooth.

The prepared soil layer shall meet the requirements of Section 987-1 of the FDOT Standard Specifications for Road and Bridge Construction. If necessary to meet the pH requirements, dolomitic limestone shall be spread uniformly over the area to be sodded. Once the pH has been properly adjusted, a commercial fertilizer satisfying the requirements of Section 982 of the FDOT

Standard Specifications for Road and Bridge Construction shall be applied at a rate of 700 lbs per acre or as recommended by the Orange County Extension Service based on soil testing. The device for spreading fertilizer and dolomitic limestone shall be capable of uniformly distributing the materials at the specified rates. Both fertilizer and dolomitic limestone shall be uniformly mixed into the soil, to a depth of 6 inches.

Grades on areas to be sodded shall be maintained in a true and even condition, preventing the formation of depressions where water will stand.

18.4 Sod Installation

Any sod that is not planted within 24 hours after cutting shall be stacked in an approved manner and maintained properly moistened. Sodding shall not be performed when weather and surface conditions are, in the Owner's opinion, unsuitable for proper results.

Sod shall be installed only when the soil is moist and in proper condition to induce growth. No sodding shall be done when the ground is unduly wet or otherwise not in a suitable condition.

The sod shall be placed on the prepared surface, with no visible open joints and no overlapping joints. The setting of the pieces shall be staggered to prevent a continuous seam along the line of flow. After placement, all sod shall be rolled to provide good contact between soil and sod. End joints shall be staggered 12 inches minimum. The sod shall be placed on prepared surfaces in close contact with one another. The edges of the grass sod shall be staggered to avoid continuous seams. The sod shall be carefully placed by hand, edge-to-edge with no gaps, commencing at the base of the area to be sodded and working upward. If necessary, the sod may be staked with wood lath. The stakes shall not interfere with the mowing operation. A true and even sod surface shall be provided which does not vary more than 1 inch from a 10-foot straight edge.

In order to prevent erosion caused by vertical edges at the outer limits, the outer two rows of sod shall be tamped in-place and the soil graded up to the sod edge and tamped in place to produce a feather edge effect.

In areas where the sod may slide, due to height and slope, the Owner may direct that the downslope edge of the sod be bermed or buried in soil to reduce the potential for sliding.

Any pieces of sod which, after placement, show an appearance of extreme dryness shall be removed from the work and replaced.

18.5 Watering and Maintenance

The Contractor shall water and otherwise maintain sodded areas as required to prevent the grass from drying out and to maintain the necessary soil moisture until the sod is firmly rooted into the underlying soil and cannot be easily pulled up. The moistened condition shall extend to the full depth of the rooting zone. Overwatering shall be avoided. The irrigation water shall be obtained from locations designated by the Owner.

Areas in which the grass dies, fails to root, or becomes eroded within 3 months of installation, shall be repaired as necessary and re-sodded by the Contractor. At no time shall the height of the grass be allowed to exceed 6 inches.

SPECIFICATIONS

SECTION 19 SITE LIMITATIONS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

19.1 Owner's Activities and Other Construction

Landfilling of waste materials and other operation activities by the Owner are expected to occur around the area of the proposed landfill expansion throughout the period of construction. The Owner will designate an access road to the construction area. All activities of the Contractor must be coordinated with the Owner to avoid conflicts with the Owner's activities.

Construction activities by other Contractor may be ongoing throughout the period of construction as part of other projects. The activities of the Contractor must be coordinated with the Owner to avoid conflicts with other contractors.

19.2 Contact with Stormwater Runoff and Leachate from Existing Landfill

Rain water that comes in contact with waste materials in the existing landfill is considered leachate. Appropriate personal protective equipment (PPE) must be used by all personnel in contact with waste materials or leachate during construction activities. Safety Data Sheets (SDS) for the waste materials and leachate may be requested from the Owner.

19.3 Existing Facilities

Any damage to existing facilities by the Contractor shall be repaired by the Contractor at his expense and as directed by the Owner.

SPECIFICATIONS

SECTION 20 GENERAL PROVISIONS

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

This Specification presents general provisions covering work performed for construction of Cell 2 at the Stanton Energy Center.

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20.3	Engineering Data	3
20.4	Right to Change Location and Drawings	3
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20.1 General

20.1.1 Scheduling and Coordination

The Contractor shall keep the Owner informed, at least one week in advance, of the times and places at which he intends to do work. All work shall be scheduled and coordinated with the Owner as outlined in Section 19 of these Specifications.

20.1.2 Submittal of Worked Man-Hours

The Contractor shall keep records of the worked man-hours weekly. A report summarizing all work hours must be submitted to the Owner at the weekly project meeting.

20.1.3 Inspection and Sampling of Materials

All materials furnished by the Contractor shall be subject to the examination and approval of the Owner or the Engineer at all times during the progress of the work until completion of the project. As soon as the materials are examined and/or tested and approved, the Contractor shall immediately remove all rejected materials from the work to a point such distance there from as the Owner may require. No material shall be used before being examined and/ or tested and approved by the Owner or the Engineer. Failure on the part of the Owner, or the Engineer, to condemn or reject inferior materials or work shall not be construed to imply an acceptance of the

same should their inferiority become evident at any time prior to final acceptance of the work.

The Contractor shall make timely necessary arrangements so that the Engineer may secure sample specimens of materials on the job for testing to ascertain whether materials included, or to be included, in the work meet the requirements of the Specifications.

20.1.4 Access to Work

The Owner and Engineer shall have free, unrestricted access to the work at all times. The Contractor shall furnish the owner and the engineer with tools, equipment, labor and samples, as needed, for ascertaining whether the work being performed, or the work which has been completed, is in accordance with the requirements of the Specifications, even to the extent of uncovering, testing, or removing portions of finished work, if deemed necessary by the Owner or the Engineer. Any repair costs associated with these inspections and any required repairs shall be borne by the Contractor.

20.1.5 Suspension of Work

The Owner may order the Contractor to suspend any or all work that may be affected, damaged, or endangered by climatic conditions. Further, the Owner may suspend any work at any time when acceptable results as defined in the Specifications cannot be obtained due to inclement weather or other unsatisfactory field conditions. During emergency conditions, the Contractor shall shut down all operations and muster all personnel to pre-designated areas.

20.1.6 Utilities and Contractors Facilities

Utilities may not be available at the job site. Utilities, electricity and fuel as may be required for construction and other purposes shall be secured and purchased by the Contractor. The Owner will make space available for Contractor's facilities for storage and for trailers. Fresh water for non-potable use shall be provided at a location selected by the Owner.

20.2 Drawings and Specifications

The Drawings and Specifications are intended to be coordinated. Anything shown on the Drawings but not mentioned in the Specifications, or vice-versa, or anything not expressly set forth in either, but which is reasonably implied, shall be furnished as though specifically shown and mentioned in both without any extra charge. Should anything be omitted from the Drawings, which is the subject of the Contract between the Owner and the Contractor, it shall be the duty of the Contractor so to notify the Owner before signing the Contract. The Contractor shall furnish such detailed plans and drawings as may be required for the execution of the work and which are not included in the Drawings furnished by the Engineer on behalf of the Owner; these shall include shop details.

Shop drawings for the compacted soil liner, the HDPE geomembrane liner, and the geocomposite drainage products shall be prepared and submitted to the Engineer for approval at least two weeks prior to installation. Shop drawings prepared by a subcontractor or supplier shall first be checked by the Contractor for compliance with the Specifications, and shall be initialed by the Contractor, prior to submittal to the Engineer for review and approval.

The Contractor shall submit all drawings and schedules with the supporting information sufficiently in advance of construction activities to allow ample time for engineer's review, recommendations and changes if any; applying the recommendations and changes of the engineer and resubmitting them before final approval. No claim by the Contractor for delays, arising from his failure in this respect, shall be allowed.

All drawings submitted by the Contractor must bear the stamp of approval by the Contractor as evidence that the drawings have been checked by the Contractor. The approval by the Engineer of drawings submitted by the Contractor shall be only for conformance with the design of the project and shall not relieve the Contractor from the responsibility for adherence to the Contract, nor shall it relieve him of the responsibility for any error, which may exist.

20.3 Engineering Data

The background information provided on the Drawings is for informational purposes only, and the data should be reviewed in conjunction with the notes on the Drawings. The Contractor shall be responsible for locating all underground utilities and infrastructure within the designated construction area.

The Contractor must form his own opinion of the character of the work and of the waste materials, and must satisfy himself with his own investigations, explorations, tests or studies, of the conditions affecting the work to be done. The Contractor must assume all responsibility for deductions and conclusions as to the nature or condition of the in-place ash, soil, borrow materials, subsurface water conditions, the difficulties of making and maintaining the work area dewatered, and doing any work affected by the job site condition.

20.4 Right to Change Location and Drawings

When additional information regarding the topography, subsurface, or other conditions becomes available from excavation, testing, data, or other work, the Engineer may find it desirable to change alignment, dimensions, or design of a portion of the work to conform to the newly disclosed conditions. Toward this end, the Owner reserves the right to make any such reasonable changes and the Contractor's operations shall be conducted to accommodate reasonable changes without additional expense.

20.5 As-Built Drawings

The Contractor shall maintain one set of prints of drawings issued for construction on the job site at all times for the preparation of As-Built Drawings. This set will be in addition to any sets needed and used in the actual construction operation. The As-Built Drawings shall be kept up-to-date by the Contractor, as approved by the Owner, on a daily basis, and will be reviewed by the Owner at the weekly progress meetings. The plans shall show the actual as-built condition. As-built Drawings shall be submitted to the Owner upon final acceptance of the work.

SPECIFICATIONS

SECTION 21 FINAL INSPECTION AND ACCEPTANCE

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

21.1 Final Inspection

Upon completing all clean-up operations, the Contractor shall advise the Owner he is ready for final inspection. The Owner will then set a specific date and time for the final inspection. The Owner, Engineer and Contractor will jointly inspect the project area to verify that all work has been completed in accordance with the Drawings and Specifications. Any work found lacking in any way should be corrected by the Contractor and re-inspected.

21.2 Letter of Acceptance

The Owner will issue a Letter of Acceptance for the work to the Contractor once all work has been satisfactorily completed and inspected. Final payment can be requested by the Contractor after receipt of the Letter of Acceptance.

21.3 Material and Workmanship Warranties

Warranties for HDPE liner, geosynthetic drainage products, and soil liner material and workmanship shall take effect from the date of the Letter of Acceptance for the liner from the Owner.

SPECIFICATIONS

SECTION 22 SCHEDULING AND COORDINATION

CELL 2 OF HORIZONTAL EXPANSION OF COMBUSTION WASTE STORAGE AREA

ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER ORANGE COUNTY, FLORIDA

All scheduling and coordination of the work shall be undertaken through the Owner.

22.1 Pre-Construction Coordination Meeting

There will be at least one coordination meeting with the Contractor and subcontractors, the Engineer, and the Owner before construction begins.

Each contractor shall submit a construction schedule to the Owner at the first coordination meeting. The schedule shall be in the form of a bar chart showing all construction activities, and shall be updated weekly and provided to the Owner as the work progresses. Each contractor shall also designate a project manager at the first coordination meeting. Each contractor's designated site supervisor shall also attend the coordination meeting.

22.2 Correspondence with Owner

All correspondence with the Owner shall be directed to the following address:

Mailing Address: Orlando Utilities Commission
Stanton Energy Center
5100 South Alafaya Trail
Orlando, FL 32831-2005

Attention: Mr. Charlie Doud, P.E.
Telephone: 407-719-6055
E-mail: cdoud@ouc.com

22.3 Correspondence with Engineer

All questions and correspondence regarding the Drawings and Specifications shall be directed to the Engineer, Ardaman & Associates, Inc., at the following address:

Mailing Address: Ardaman & Associates, Inc.
 8008 South Orange Avenue
 Orlando, Florida 32809

Attention: Mr. Mohamad Al-hawaree, P.E.
Telephone: 407-855-3860 (office)
Fax: 407-859-8121
E-mail: mal-hawaree@ardaman.com

22.4 Coordination with Other Contractors and Suppliers

Construction by other contractors may be ongoing throughout the period of construction. The schedule and activities of each contractor shall be approved by and coordinated with the Owner to avoid conflicts with other contractors. No contractor will be allowed additional payments for any delays in his work not coordinated through and approved by the Owner.