

TECHNICAL SPECIFICATIONS

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**SECTION 31052
LAYOUT OF WORK AND SURVEYS**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Section includes general requirements for survey work to be performed by the CONTRACTOR and/or CONTRACTOR's Surveyor.
1. Set offset stakes, slope stakes, and grade stakes for field layout of features of the Work.
 2. Perform surveys for measurement of pay quantities.
 3. Perform surveys to record as-built conditions of the project.
 4. Perform surveys in a timely manner so that construction progress is not delayed.
 5. Submit information in a complete manner that allows for one-time review by OWNER or OWNER's representative. Partial submittals are allowed provided corrections and final submittal allow for 3 business days for review by OWNER or OWNER's representative.
 6. Submit all information required in Section 1.02 in a timely manner.

1.02 SUBMITTALS

- A. Field Notes and Records. Record surveys in field notebooks and provide copies of such records to OWNER or OWNER's representative at intervals as required by OWNER. Furnish each field notebook to OWNER when filled or completed. Electronic notes may be used if printouts are furnished to OWNER and if the format of the printed information is approved by OWNER.
- B. Surveyor shall submit certified as-built drawings within 2 days of completion of the specific item requiring surveying. These submittals must be approved by OWNER before installation of the subsequent component of the work begins. To avoid project delays, the Surveyor may provide submittals for portions of each completed surface for approval; however, a final consolidated drawing of each surface will be provided at the completion of each surface and at the end of the project for submittal in the Construction Quality Assurance report. Provide record (as-built) drawings to OWNER for the following items:
1. Pre-Construction Topographic Sheet(s)
 - Elevations and limits of ground surface within and adjacent to the excavation and consolidation areas
 - Elevations and limits of off-site stockpiles (Dredge Material Placement Sites on Roberts and Rough and Ready Islands)
 2. Bottom of Excavations As-Built Topographic Sheet
 - Elevations and limits of bottom of excavation areas

3. Top of Clean Backfill As-Built Topographic Sheet
 - Elevations and limits of top of clean backfill within excavation areas.
4. Top of Subgrade As-Built Topographic Sheet
 - Elevations and limits of top of subgrade in waste consolidation area (i.e., surface on which excavated material will be placed)
5. Top of Consolidated Waste Grade As-Built Topographic Sheet(s)
 - Elevations and limits of top of consolidated soil and waste
6. Top of Foundation Layer As-Built Topographic Sheet
 - Elevations and limits of top of the Foundation Layer
 - Point-over-point survey to verify Foundation Layer thickness
7. Top of Vegetative Layer As-Built Topographic Sheet
 - Elevations and limits of top of vegetative layer
 - Point-over-point survey to verify vegetative layer thickness
8. Geosynthetics As-Built Sheet
 - Limits of the geogrid, geocomposite (blanket and strips), geomembrane, and geotextile, including subdrain alignment.
9. Miscellaneous Items.
 CONTRACTOR's Surveyor shall include the following as-built information on one of the sheets identified above (as appropriate) or shall provide additional sheets, as needed.
 - Locations and elevations of settlement monuments;
 - Alignment and grades of constructed channels and drainage pipes (including beginning and end, outlets, inverts, changes in direction, etc.);
 - Location and alignment of buried utilities;
 - Locations and elevations of the LFG passive vents;
 - Alignments of storm water control features;
 - Subgrade, finished grade, and extent of new access roads;
 - Stockpile limits and grades (pre- and post-construction);
 - Final site as-builts showing contours and any other miscellaneous constructions including fence, wells, probes, electrical, etc. (if applicable); and
 - OWNER-provided reference points shall be shown on all as-built drawing sheets.

- C. Surveyor shall provide a Text/ASCII file containing all collected as-built locations. As-built drawings shall depict all collected locations with an associated point reference number such that points in the provided Text/ASCII file can be referenced on the drawings.
- D. Surveyor shall follow the general format of the attached exhibits when choosing layout of data for presentation of as-built information (see Part 3.07B for an example).
- E. Provide as-built survey drawings on the same datum and coordinate basis as the construction drawings. Provide as-built survey information and associated point data on the same datum and coordinate basis as design drawings. All point data must have clear, easy to understand descriptions. Provide all point data in Text/ASCII format electronically with list of

descriptor abbreviations. All information provided must be accompanied with a letter explaining what is being submitted and a list of what information is given in each electronic copy. Submit all survey information of any layer to OWNER before that layer is covered.

- F. Surveyor shall provide all drawings in electronic format: AutoCAD Civil 3D and Adobe pdf.
- G. The final as-built survey drawings (electronic and hard copies) are due within 10 business days after substantial completion date and at least 10 business days before de-mobilization from the site.

1.03 SURVEYING ACCURACY AND TOLERANCES IN SETTING OF SURVEY STAKES

- A. Perform control traverse field surveys and computations to an accuracy of at least 1:10,000.
- B. The tolerances applicable in setting survey stakes are set forth below. Such tolerances do not supersede stricter tolerances required by the Drawings or Specifications, and do not otherwise relieve the CONTRACTOR of responsibility for measurements in compliance therewith.

TABLE OF MARK	HORIZONTAL POSITION	ELEVATION
Permanent reference points and temporary settlement markers	1 in 10,000	± 0.01 ft
General excavation and earthwork	1 in 2,000	± 0.10 ft

- C. Tolerances for designed thicknesses shown on Drawings are +0 to +0.2 foot and for elevations shown on the Drawings are +/-0.10 foot unless otherwise specified.
- D. Excavation elevation tolerance: +0 to -0.5 ft.
- E. Tolerances for trench grading are:
 - a. Horizontal +/- 0.5 foot
 - b. Vertical +/- 0.1 foot
- F. Elevations for subsequent layers above the previous layer shall be adjusted for slope as needed to provide the required thickness for the subsequent layer above the approved AS-BUILT elevations.

1.04 COORDINATION WITH OWNER

- A. Keep OWNER informed on progress of survey work to allow OWNER sufficient time and ample opportunity to verify survey work without inconvenience or delay to OWNER, CONTRACTOR, or INSTALLER.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.01 EQUIPMENT AND PERSONNEL

- A. Provide instruments and other survey equipment that is accurate, suitable for the surveys required in accordance with recognized professional standards, and in proper condition and adjustment at all times. Provide OWNER with calibration certificates for all equipment utilized during construction. Submit certificates under provisions of Section 01340. Calibration certificates are not required for GPS-based survey equipment.
- B. **The CONTRACTOR's Surveyor must be a surveyor licensed in the State of California. All survey submittals described in Section 1.02 shall be conducted under the direct supervision of the CONTRACTOR's Surveyor. The licensed surveyor is required to sign and stamp each as-built (record) drawing and provide a Statement of Certification certifying that the work was performed within the tolerances listed in the specifications.**

3.02 REFERENCE POINTS

- A. Prior to construction, the CONTRACTOR's Surveyor shall verify with OWNER the locations of site reference points, benchmarks, and survey control points. Prior to construction, the CONTRACTOR'S Surveyor shall inspect each existing site reference point and assess its condition and reliability. Promptly notify OWNER if survey control points are damaged, mismarked, or otherwise unusable upon discovery. Also, notify OWNER of any damage caused by the CONTRACTOR, then repair or replace control points at no additional cost to OWNER.
- B. Prior to construction, the CONTRACTOR's Surveyor shall perform a survey of the reference points and prepare a control verification letter containing deltas between OWNER-provided reference points and CONTRACTOR-measured field locations for these points.

3.03 MONITORING DEVICE PROTECTION

- A. Prior to beginning any site work, locate all monitoring wells, piezometers, utility boxes, valve boxes, or other utilities located within and adjacent to the access, laydown, excavation, and consolidation areas associated with the initial remediation.
- B. Install markers identifying the location of these devices.
- C. The purpose of the work is to protect these items during construction.
- D. Any items damaged during construction by the CONTRACTOR will be replaced by the CONTRACTOR at no cost to OWNER.
- E. An example replacement cost for a monitoring well is approximately \$25,000.

3.04 VERIFICATION

- A. OWNER reserves the right to perform any desired checking of the CONTRACTOR's surveys. If OWNER's check of the CONTRACTOR's survey reveals a discrepancy, the CONTRACTOR's Surveyor shall work with OWNER to resolve and correct the discrepancy. If OWNER's check (by a licensed surveyor) indicates a discrepancy that OWNER's and Contractor's surveyors are unable to resolve, OWNER's interpretation shall prevail. OWNER's check does not relieve the CONTRACTOR of the responsibility for adequate performance of the Work.

3.05 USE BY THE OWNER

- A. OWNER may at any time use the line and grade points and markers established by the CONTRACTOR. The CONTRACTOR's surveys are a part of the Work and may be checked by OWNER or representatives of OWNER at any time. The CONTRACTOR is responsible for (1) any lines, grades, or measurements which do not comply with specified design criteria or proper tolerances, or which are otherwise defective, and (2) for any resultant defects in the Work. The CONTRACTOR will be required to conduct re-surveys or check surveys to correct errors indicated by review of the field notebooks or otherwise detected.

3.06 SURVEYS FOR LAYOUT AND PERFORMANCE OF WORK

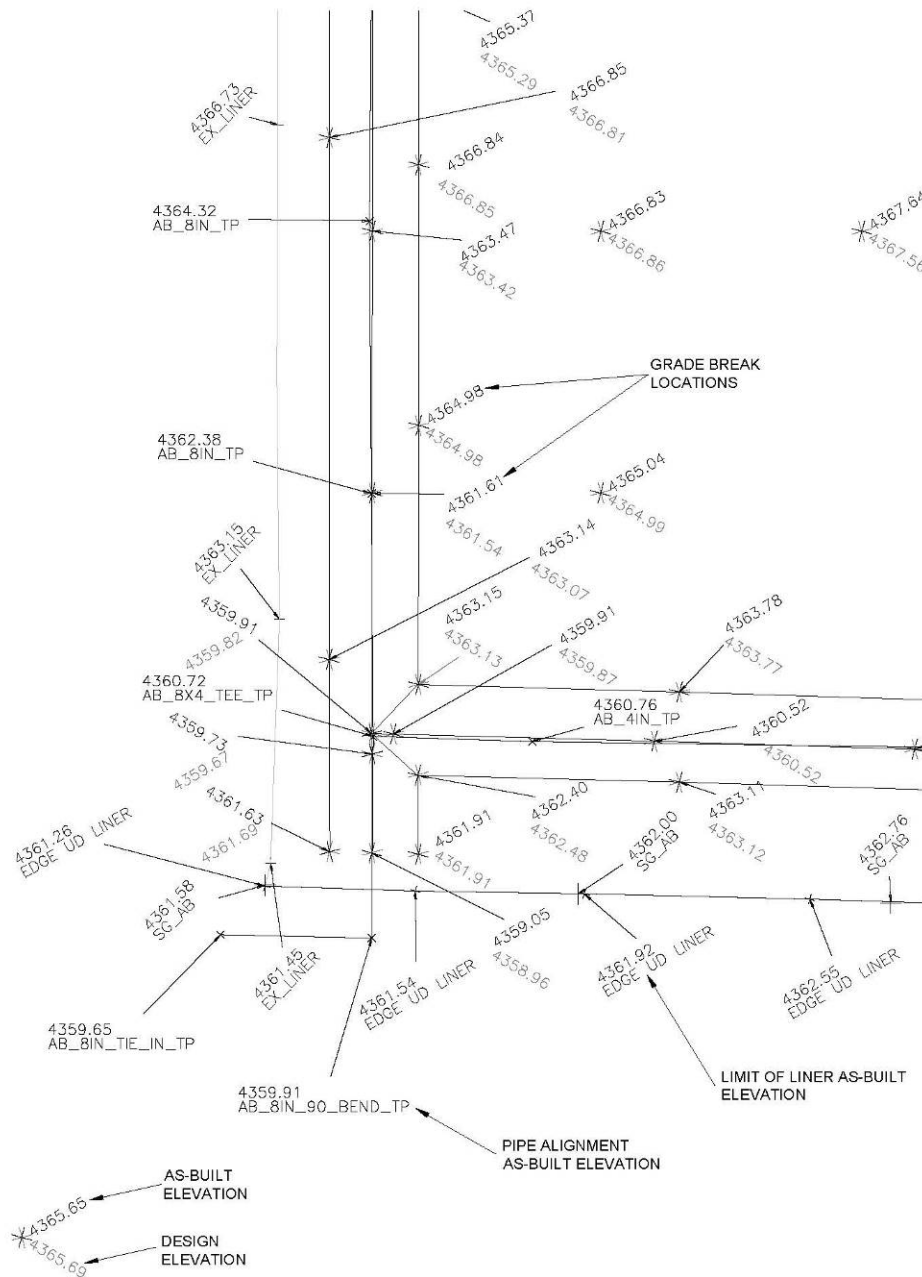
- A. Perform surveys for layout and performance of the Work, reduce the field notes, make necessary calculations, and prepare drawings necessary to carry out such work.

3.07 SURVEYS FOR RECORD DRAWINGS AND MEASUREMENT FOR PAYMENT

- A. When the Specifications require items of work to be measured by surveying methods, the CONTRACTOR's Surveyor will perform the surveys and perform necessary calculations to determine payment quantities. OWNER may perform independent checks. Items requiring surveys for determining pay quantities are given in Section 01200, Measurement and Payment.
- B. Design versus Constructed Point Drawings.
1. The Surveyor shall prepare drawings for each layer of the final cover system (top of consolidated waste, top of foundation layer [geosynthetic subgrades], top of low permeability layer, and top of vegetative layer) as well as the bottom of excavation and final grades in the excavation areas. Points shall be established on a 50-foot maximum grid, and shall provide a comparison of the design elevation against the actual elevation at each point. Additionally, points shall be established at major changes in grade (i.e., at gradebreaks), changes in alignment, along flow lines, and

at any specific points shown in the Drawings. The difference in design versus constructed elevation for each point shall not exceed the tolerance described in paragraph 1.03C of this section.

2. An example of a design versus constructed point drawing is included below:



END SECTION

**SECTION 31110
SITE PREPARATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and grubbing within the limits of earthwork for the excavation and consolidation areas.
- B. Clearing and grubbing within the limits of stockpiles and future surface water features.
- C. Clearing and grubbing in the Rail Line Excavation footprint.

1.02 RELATED SECTIONS

- A. Section 21052 - Survey
- B. Section 31210 – Stockpiling and Soil Management
- C. Section 31221 – Excavation
- D. Section 31222 – Earthfill
- E. Section 31310 – Erosion and Sediment Control

PART 2 PRODUCTS

2.01 STRIPPED MATERIALS

- A. Grass, roots, plants, organic soils, trees, stumps, etc.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that any plant life designated to remain is tagged or identified and protected.

3.02 PROTECTION

- A. Protect sensitive habitat areas and any features designated to remain.
- B. Protect survey benchmarks from damage or displacement.
- C. Protect existing structures and improvements (e.g., monitoring wells) designated to remain.

3.03 CLEARING AND GRUBBING

- A. CONTRACTOR shall clear by removing all vegetation such as trees, roots, stumps, shrubs, brush, limbs, and other vegetative growth.
- B. CONTRACTOR shall remove stumps and roots with diameters greater than 1 inch within the Rail Line Excavation footprint to a depth of 2 ft below the existing grade.
- C. CONTRACTOR shall grub by completely removing and disposing of wood, stumps, and root matter below the existing ground surface as needed, unless otherwise shown on the drawings.

- D. CONTRACTOR shall prepare subgrade following clearing and grubbing in areas for staging or stockpiling by smoothing and compacting the surface. If additional fill is required to smooth the surface, earthfill shall be used in accordance with Section 31222.

3.04 DISPOSAL

- A. CONTRACTOR shall dispose of trees, tree stumps, and tree root material off-site and stockpile other organic matter on-site. The off-site disposal location shall meet all local, state, and federal requirements.

END OF SECTION

**SECTION 31130
DECONTAMINATION**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section covers the decontamination requirements for the CONTRACTOR's equipment.
- B. The Work covered in this section includes, but is not necessarily limited to the following:
 - 1. Preparation of a Decontamination Plan.
 - 2. Establishment of decontamination facilities.
 - 3. Decontamination of all equipment and transport vehicles after exposure to waste and/or contaminated materials and prior to leaving the waste unit.
 - 4. Containment, sampling and analysis, treatment, consolidation and/or disposal of decontamination wastes in accordance with all applicable laws, including obtaining all permits for such disposal.
 - 5. Cleanup and removal of the decontamination facility.

1.02 RELATED SECTIONS

- A. Section 31140 - Dewatering
- B. Section 31221 – Excavation
- C. Section 31222 – Earthfill
- D. Section 31223 – Waste Consolidation and Placement
- E. Section 31310 –Erosion and Sediment Control

1.03 DEFINITION

- A. Decontamination: Process of using physical and/or chemical methods for the cleaning and complete removal of contaminated soils. For this project, decontamination will consist of removing solid waste, dust, debris, oily residues, and soil contaminated with metals, polychlorinated biphenyls (PCBs), pesticides, volatile organic compounds (VOCs), total petroleum hydrocarbons (TPHs), and dioxins/furans.

1.04 SUBMITTALS

- A. The CONTRACTOR shall prepare a Decontamination Plan and submit the plan to the OWNER within seven (7) calendar days of contract execution. A complete (i.e., approved, approved with comments, or information only) Decontamination Plan is required prior to the CONTRACTOR's mobilization to the site. The Decontamination Plan shall address the following elements.
 - 1. Location of the decontamination facility and/or area.
 - 2. Estimates of decontamination waste quantities.
 - 3. Methods for the analysis of decontamination wastes.

4. Methods for collection (i.e., storage tanks), treatment, and disposal of decontamination wastes.
 5. Equipment, methods, and reagents to be used for decontamination.
 6. Frequency of decontamination.
 7. Contingency plans for incident/emergency situations.
 8. Safety data sheets for chemicals used for decontamination.
- B. The CONTRACTOR shall submit copies of all permits to OWNER no later than three (3) working days prior to anticipated start of construction activities.
- C. The CONTRACTOR shall submit a register of the chemicals, GHS- (Globally Harmonized System of the Classification and Labeling of Chemicals) compliant safety data sheets, estimated maximum quantity of chemicals with container types, and storage locations to OWNER for approval no later than one (1) weeks prior to mobilization.

PART 2 PRODUCTS

2.01 GENERAL

- A. Decontamination solutions and equipment shall be suitable to remove solid waste, debris, oily residues and soils containing metals, PCBs, Pesticides, VOCs, TPH, and Dioxins/Furans.
- B. Provide high-pressure wash equipment and vacuums equipped with high-efficiency particulate air filters, or steam cleaning equipment.
- C. Equipment for vacuuming shall be suitable to vacuum paved surfaces and shall also be suitable to initially remove dust from materials and equipment that will be subsequently decontaminated.
- D. Soaps, degreasers, and other cleaning solutions shall be used as necessary and shall be non-hazardous.

2.02 DECONTAMINATION WASTES

- A. Provide facilities for the complete containment of decontamination wastes.
- B. Provide facilities for the separation of solid from liquid wastes such that all wastes must be disposed in compliance with the OWNER's requirements as well as applicable laws, regulations, and discharge requirements.
- C. CONTRACTOR shall receive approval from OWNER for the use of liquids for decontamination prior to such use.
- D. Decontamination wastes and wastewater will be temporarily stored in containers with secondary containment at the Site and shall be properly disposed of in accordance to the applicable local, state, and federal requirements.

PART 3 EXECUTION

3.01 ESTABLISHMENT OF DECONTAMINATION FACILITIES

- A. Prior to beginning work, establish and make ready for operation the decontamination facilities within a Decontamination Zone consistent with the approved Decontamination Plan.
- B. The decontamination facility shall include a containment area to collect waste generated from decontamination and to prevent waste from contacting and/or penetrating the ground outside the waste unit.
- C. The decontamination facility shall allow OWNER or OWNER's representative to efficiently observe the decontamination of equipment and vehicles prior to leaving the waste unit, including efficient observation of the undercarriage and tarped cover of the transport vehicles and the undercarriage of equipment and vehicles.

3.02 DECONTAMINATION

- A. The decontamination process shall include the removal of accumulated soil material, and other contamination from equipment and materials while said equipment and materials are physically located in the decontamination facility. CONTRACTOR shall decontaminate equipment and materials at the frequency stated in the Decontamination Plan.
- B. Methods shall conform to the Decontamination Plan and, at a minimum, shall consist of brushing, scrubbing, vacuuming, steam cleaning, or high-pressure washing, or combinations of these. Cleaning solutions shall be used as needed to thoroughly remove contamination.
- C. The CONTRACTOR shall decontaminate the following materials and equipment.
 - 1. Every item to be used by the CONTRACTOR at the site, prior to mobilization to the site.
 - 2. Equipment used during onsite activities prior to leaving the site.
 - 3. Every item of any sort mobilized by the CONTRACTOR to the site, prior to leaving the site or to demobilization from the site.
- D. The CONTRACTOR shall afford the ENGINEER the opportunity to observe each decontaminated transport vehicle prior to the vehicle's departure from the site.
- E. To the extent practicable, the CONTRACTOR shall minimize generation of decontamination wastewater and other decontamination-derived residuals.

3.03 DECONTAMINATION WASTES

- A. Wastes collected from decontamination of equipment and all other materials shall be collected and disposed of in accordance with the approved decontamination plan, OWNER's requirements, and all applicable laws.
- B. The CONTRACTOR shall minimize the use of water to be used for decontamination activities to the extent reasonable.

- C. Precautions shall be taken to prevent rainwater and surface runoff from entering the decontamination facility. In the event that rainwater and surface runoff enter the decontamination facility, it shall be handled by the CONTRACTOR in the same manner as decontamination wastewater.
- D. The CONTRACTOR shall be responsible for sampling and analysis, treatment, and disposal of all decontamination wastes in accordance with all applicable laws, including preparation of profiles and manifests in advance of transportation, if needed.

3.04 CONTAMINATION OF NON-CONTAMINATED AREAS

- A. If the CONTRACTOR contaminates areas presently not contaminated or re-contaminates areas that have been remediated, the CONTRACTOR shall be solely responsible for all costs incurred in removing such contamination. This includes, but is not limited to, contamination caused by fugitive dust, wheel tracking, accidental spills, water runoff, water run-on, and erosion.
- B. Care shall be taken in the delivery, spreading, and compacting of backfill. Equipment that is placing and compacting the fill, which comes in contact with contaminated materials, shall be decontaminated before performing any further Work.

END OF SECTION

**SECTION 31140
DEWATERING**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes furnishing all labor, materials, equipment, tools, and appurtenances required to complete and maintain the work of lowering and controlling the groundwater levels, hydrostatic pressures, and surface water to permit all excavations and construction to be performed as shown, specified, or required (e.g., to allow inspection of the bottom of the excavation to verify waste removal and depth, maintain excavation stability, minimize free water in excavated materials, etc.). The holding, sampling, testing, potential treatment, and discharge is considered as part of this work.
- B. The time period for dewatering starts when excavation begins, extends through backfilling and waste consolidation, and ends with final completion. Correct all damage resulting from inadequacy of the dewatering system or from flooding of the construction site from the dewatering system.

1.02 RELATED SECTIONS

- A. Section 31130 - Decontamination
- B. Section 31221 – Excavation
- C. Section 31222 – Earthfill
- D. Section 31223 – Waste Consolidation and Placement
- E. Section 31310 – Erosion and Sediment Control

1.03 SUBMITTALS

- A. The CONTRACTOR shall prepare a Dewatering Plan and submit the plan to the OWNER within seven (7) calendar days of contract execution. A complete (i.e., approved, approved with comments, or information only) Dewatering Plan is required prior to the CONTRACTOR's mobilization to the site. The Dewatering Plan shall address the following elements.
 - 1. Location of the water storage facility and/or area.
 - 2. Methods for the analysis of dewatering water.
 - 3. Methods for collection, treatment, and disposal of dewatering water.
 - 4. Methods for decontamination of pumps and equipment that come into contact with potentially contaminated water.
 - 5. Contingency plans for incident/emergency situations.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 REQUIREMENTS

- A. Comply with the following minimum requirements for dewatering:
1. Draw down the static water level in excavations, as required, to minimize free water in excavated soils and maintain stability of the excavation limits until backfill is placed and compacted to its required density.
 2. Provide pumping system with filters to prevent loss of fine materials. Pass pump water through a sediment control system and treatment system, if necessary, before temporary storage in a baker tank at a location to be approved by the OWNER. No discharge of water to approved areas outside the excavation will be allowed without filtering. Once the water has been tested and appropriately treated it will be discharged into an acceptable publicly owned treatment works point (e.g., sanitary sewer) to be identified by OWNER.
 3. Do not cause settlement damage to adjacent structures. Carry out work using methods which will not endanger adjacent structures. Correct as necessary, any adverse effects dewatering may have on existing structures, wells, utilities, and water courses, at no additional cost to the OWNER.
 4. Monitor the elevation of the groundwater and control the pumping as necessary.
 5. Provide sufficient standby equipment that is capable of immediately operating to maintain dewatering on a continuous basis in the event that all of, or part of, the system should become inadequate or fail.
 6. Control groundwater at a static level to limit disturbance of site soils, prevent disturbance of the backfill, and prevent flotation or movement of structures, if any.
 7. Obtain and maintain all city, county, state, and federal permits and approvals associated with construction dewatering and temporary surface water control.

END OF SECTION

**SECTION 31210
STOCKPILING AND SOIL MANAGEMENT**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes loading, hauling, placing, and constructing temporary or permanent stockpiles as needed for completion of the construction.
- B. CONTRACTOR shall locate stockpiles as shown in the drawings. Stockpiles cannot be located over protected habitat or facility operations areas without prior written approval by the OWNER.
- C. Soil management required to process in-place soils or stockpiled soils so they can be utilized for various fill materials (Earthfill, Operations Layer, borrow soil, Earthfill, etc.).
- D. Management of soils is the CONTRACTOR's responsibility. There will not be an extension of the contract time or additional compensation due to the moisture content of the in-place, imported or stockpiled soils.

1.02 RELATED SECTIONS

- A. Section 31110 – Site Preparation
- B. Section 31221 – Excavation
- C. Section 31222 – Earthfill
- D. Section 31223 – Waste Placement
- E. Section 31310 –Erosion and Sediment Control

PART 2 PRODUCTS

2.01 STRIPPED MATERIALS

- A. Grass, roots, plants, organic soils, trees, stumps, etc., as per Section 31110.

2.02 EARTHFILL SOILS

- A. Soil obtained from on-site stockpiles that meet the requirements of Section 31222 for various earthfill soil (borrow soil, Topsoil, and Earthfill). CONTRACTOR shall segregate earthfill that meets the requirements of Section 31222 soil during excavation.

2.03 WASTE MATERIAL

- A. Material excavated from within waste cell areas and areas of known contamination described in Section 31221.

PART 3 EXECUTION

3.01 STOCKPILING MATERIALS

- A. After excavation, CONTRACTOR shall load and haul surplus materials to onsite stockpiles as approved by OWNER.
- B. Locations of temporary stockpiles for soil to be used as fill shall be selected by the CONTRACTOR and approved by OWNER.
- C. Existing project staging areas shall be located as shown on the Construction Drawings.
- D. CONTRACTOR is responsible for maintaining stockpiles to a maximum slope of 4H:1V and a maximum height of 15 ft.
- E. Stockpiles expected to remain beyond the end of the initial remediation construction must be a minimum of 30 ft from the toe of the rail line embankment.
- F. Stockpiles that will remain beyond the end of the initial remediation that contain material excavated from areas of known contamination shall be covered with a minimum 12-inch thick layer of either material from the 6-inch Rail Line excavation or earthfill in accordance with Section 31222.
- G. Sheetflow runoff shall be directed to ditches/pipes and surfaces shall be graded to drain throughout construction of stockpiles. Details and locations shall be shown on the Construction Drawings.
- H. Provide quality control during operations to verify that materials go to appropriate stockpiles.
- I. Provide separation between stockpiles to allow equipment access.
- J. Place in layers not greater than 1 foot and compact by track walking with dozers.
- K. Shape each stockpile to uniform lines and grades.
- L. Apply/place interim cover material on stockpiles when not being actively managed (e.g., visqueen, etc.) to minimize dust and erosion. Spray foams and water can be utilized for temporary conditions.
- M. Construct access roads to top of stockpile no steeper than 6% in slope.
- N. Water or cover stockpiles as necessary to control dust, prevent erosion, and control sediment.
- O. Monitor organic stockpiles to detect and control fires.
- P. Stockpile slopes, erosion control, and drainage of slopes are CONTRACTOR'S responsibility. CONTRACTOR shall install best management practices (BMPs) for the stockpiles as required by the approved C-SWPPP.

3.02 QUALITY ASSURANCE

- A. Sampling and testing of materials to determine material type may be performed at the stockpile, at the material source, or at the place of use.
- B. Cooperate fully with OWNER, construction quality assurance (CQA) personnel, and/or ENGINEER in obtaining samples and performing tests. Include all costs for assistance in unit prices for work.

END OF SECTION

**SECTION 31221
EXCAVATION**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes:
1. Excavation in the excavation and consolidation areas to the elevations, grades, and lines shown in the Construction Drawings.
 2. Field quality control and surveying.
 3. Hauling and stockpiling all excavated materials, as required.

1.02 RELATED SECTIONS

- A. Section 31110 – Site Preparation
- B. Section 31130 – Decontamination
- C. Section 31140 – Dewatering
- D. Section 31210 – Stockpiling and Soil Management
- E. Section 31222 – Earthfill
- F. Section 31223 – Waste Placement
- G. Section 31310 – Erosion and Sediment Control

1.03 DEFINITIONS

- A. **Waste Material:** Consists of a mixture of solid waste (municipal solid waste and construction and demolition debris), impacted soil, and native and fill soils excavated from the waste cells. Materials that meet the requirements described in Part 2.02 may be used as Foundation Layer (see Section 31222 and Section 31223). All excavated waste material will be disposed within the limits of IAS-11.
- B. **Impacted Soil:** All materials excavated from the designated areas of known contamination are to be considered impacted soil. These materials consist of soil potentially contaminated with metals, polychlorinated biphenyls (PCBs), pesticides, volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), and dioxins/furans due to former onsite operations. All impacted soil will be disposed of within either IAS-11 or stockpiled within the limits of Cell M per Section 31210.
- C. **Native and Fill Soils:** Soil material within the project area, but outside of waste cell areas and areas of known or potential contamination, including material excavated from the Rail Line Excavation area. Excavated materials that meet the requirements of Section 31222 can be used as earthfill. Any material that does not meet the requirements of Section 31222 must be stockpiled in Stockpile #1A.
- D. **Earthfill:** Onsite or approved off-site soil that meets the requirements of Section 31222.

1.04 SUBMITTALS

- A. The CONTRACTOR shall submit to OWNER and the Construction Quality Assurance (CQA) consultant for review a Remedial Design Implementation Plan describing the proposed methods of construction, including dewatering, excavation, material transport, and consolidation and compaction for the removal of waste material and placement in the consolidation area or other temporary storage area. The review shall be for method only. The CONTRACTOR shall remain responsible for the adequacy and safety of the methods.
- B. Stormwater Pollution and Prevention Plan as per Section 31310.
- C. Decontamination Plan as per Section 31130.
- D. Dewatering Plan as per Section 31140.
- E. The CONTRACTOR shall notify OWNER and the CQA consultant in writing at least 7 days in advance of intent to perform the work of this Section.
- F. If work is interrupted for reasons other than inclement weather, the CONTRACTOR shall notify OWNER and the CQA consultant immediately and provide a plan and schedule for resuming the work.

1.05 FIELD MEASUREMENTS

- A. Verify that survey benchmarks are consistent with the design.

PART 2 PRODUCTS

2.01 MATERIALS OBTAINED FROM EXCAVATIONS

- A. Waste Material.
- B. Impacted Soils.
- C. Native and Fill Soil.

PART 3 EXECUTION

3.01 PREPARATION

- A. CONTRACTOR is responsible for all aspects of worker safety during excavation activities.
- B. Institute health and safety monitoring during excavation of waste.
- C. Identify required lines, levels, contours, and datum by survey.
- D. Locate, identify, and protect utilities from damage. Notify Utility Notification Center to locate utilities, if applicable.
- E. Prior to any excavation notify OWNER and evaluate utility locations.
- F. Provide for dust control.
- G. Provide for odor control.
- H. Provide for dewatering as necessary.
- I. Protect benchmarks and erosion control facilities from excavation equipment and vehicular traffic.
- J. Implement erosion and sediment control plan before beginning excavations.

- K. Notify OWNER of unexpected subsurface conditions and discontinue affected work until notified by OWNER to resume work.

3.02 EXCAVATION OF WASTE CELLS

- A. Material shall be excavated from waste cells (excluding Cell L) and transported to IAS-11 for consolidation and placement per Section 31223.
- B. Material shall be excavated from Cell L, spread in accordance with Attachment A in Section 31221, and, pending being cleared, transported to IAS-11 for consolidation and placement per Section 31223.
- C. CONTRACTOR is responsible for the stability of the excavation. Benching, sloping, shoring, and dewatering may be required.
- D. CONTRACTOR shall monitor the side slopes and excavation perimeter for cracking and signs of instability.
- E. CONTRACTOR shall be prepared to mitigate slope instability with approval by the OWNER's representative.
- F. CONTRACTOR shall comply with all local, state, and federal excavation safety regulations.
- G. CONTRACTOR shall excavate to the limits, elevations, and grades shown on the Construction Drawings.
- H. CONTRACTOR shall maintain the bottom of the excavation until the OWNER's representative can observe and document the excavation bottom. If additional waste is observed, CONTRACTOR shall continue excavation within the horizontal limits until the bottom of the excavation is observed to be native soil (i.e., soil free of debris) by OWNER's representative. If additional waste is observed on the sides of the excavation within the rail line footprint, CONTRACTOR shall continue excavation laterally until the excavation is observed to be free of debris by OWNER's representative.
- I. Groundwater levels may be above floor of the excavation grades. Provide dewatering as necessary per Section 31140 to allow excavation, grade verification, and placement of overlying materials.
- J. CONTRACTOR shall provide equipment and materials or establish procedures to prevent waste material from leaving the work area by wind or precipitation erosion. Surface water run-off from excavated areas shall be controlled so that impacted surface water does not flow onto non-waste areas.
- K. CONTRACTOR shall provide odor suppressants and dust control to mitigate odors and fugitive dust produced during excavation and shall comply with the approved Community Air Monitoring Plan.
- L. Air monitoring shall be conducted during waste excavation in accordance with the approved Community Air Monitoring Plan.
- M. Grade tolerance: Comply with Section 31052

3.03 EXCAVATION OF AREAS OF KNOWN CONTAMINATION

- A. Material shall be excavated from areas of known contamination and transported to IAS-11 for consolidation and placement per Section 31223 if capacity is available or temporarily stockpiled in Cell M per Section 31210.
- B. CONTRACTOR shall comply with all local, state, and federal excavation safety regulations.
- C. CONTRACTOR shall excavate to the limits, elevations, and grades shown on the Construction Drawings.
- D. Groundwater levels may be above excavation grades. Provide dewatering as necessary per Section 31140 to allow excavation, grade verification, and placement of overlying materials.
- E. CONTRACTOR shall provide equipment and materials or establish procedures to prevent material from leaving the work area by wind or precipitation erosion. Surface water run-off from excavated areas shall be controlled so that impacted surface water does not flow onto non-waste areas.
- F. CONTRACTOR shall provide odor suppressants and dust control to mitigate odors and fugitive dust produced during excavation and shall comply with the approved Community Air Monitoring Plan.
- G. Air monitoring shall be conducted during waste excavation in accordance with the approved Community Air Monitoring Plan.

3.04 EXCAVATION WITHIN RAIL LINE FOOTPRINT

- A. Material shall be excavated from within the rail line footprint, outside of the waste cells and areas of known contamination, to a depth of 6 inches below the original grade and transported to Stockpiles 1A and/or 1B for placement per Section 31210.
- B. All areas beneath embankments or structures shall be free of vegetation and roots with diameters greater than 1 inch to a depth of 2 ft below the original ground surface, as defined prior to earthwork activities.
- C. CONTRACTOR shall comply with all local, state, and federal excavation safety regulations.
- D. CONTRACTOR shall excavate to the limits, elevations, and grades shown on the Construction Drawings.
- E. CONTRACTOR shall provide equipment and materials or establish procedures to prevent material from leaving the work area by wind or precipitation erosion. Surface water run-off from excavated areas shall be controlled so that impacted surface water does not flow onto non-waste areas.
- F. CONTRACTOR shall provide odor suppressants and dust control to mitigate odors and fugitive dust produced during excavation and shall comply with the approved Community Air Monitoring Plan.
- G. Air monitoring shall be conducted during waste excavation in accordance with the approved Community Air Monitoring Plan.

3.05 FIELD QUALITY CONTROL

- A. Provide for visual inspection of excavated waste material and bottom and side-slopes of excavation.
- B. Perform as-built surveys as required to document excavation limits, elevations, and grades.

3.06 FIELD QUALITY ASSURANCE

- A. OWNER or OWNER's representative to review surveyed excavation grades to verify and document that design excavation depths are achieved prior to backfilling.
- B. OWNER or OWNER's representative to observe excavation bottoms and sides to verify and document that no visible debris remains within the rail line footprint prior to backfilling.
- C. CONTRACTOR shall cooperate fully with OWNER or OWNER's representative in scheduling and performing field quality assurance observations. Include costs for coordination and assistance in unit prices.
- D. CONTRACTOR shall accommodate collection of confirmation soil samples, where required, by OWNER representative.

ATTACHMENT A



14 April 2021

Port of Stockton, Radiological Support

PF-144273-REC-001: RADIOLOGICAL SUPPORT DURING EXCAVATION RECOMMENDATIONS

Subject: Perma-Fix Recommendations when Supporting Port of Stockton's Excavation Activities

Perma-Fix is expected to perform gamma scans of excavated material from IAS-03/04, which is estimated at a volume of less than 100 cubic yards, within Port of Stockton's Rough and Ready Island (RRI). In order to perform this task effectively, Perma-Fix recommends the following:

- a. Excavated waste material shall be laid out by others on a ~500 square meter Radiological Screening Yard (RSY) pad for gamma surface scan. Excavation will be performed by others.
 - i. Ideally, an RSY pad would be established on a concrete or asphalt area by others; this area will be pre-surveyed by Perma-Fix to confirm its adequacy. If concrete or asphalt is not available, a soil or gravel surface that has been pre-surveyed by Perma-Fix would also work.
 - ii. The pad can be located at a mutually-agreeable location (near the excavation site or IAS-11).
- b. Excavated waste material from IAS-03/04 shall be transported by others to the RSY pad by dump truck or other conventional means and spread approximately 6 to 9 inches thick by others. If solid waste contains items larger than 6 or 9 inches, they will be laid out in a single layer.
- c. Upon successfully laying the waste material within the RSY pad, Perma-Fix personnel will use a sodium iodide (NaI) detector coupled with a GPS unit and software that will simultaneously log radiation and position data to perform the gamma walkover surface scan. This effort is estimated to take ~ 4 hours.
- d. Following completion of the walkover survey, the data will be evaluated to determine if any material exhibits elevated radioactivity. In the event that gamma scan surveys indicate areas of potentially elevated activity, an investigation will be initiated by Perma-Fix personnel. The investigation will consist of, at a minimum, isolating soil volumes where the highest readings were recorded and determine whether the elevated radioactivity is localized or diffused among the soil volume.
 - i. Material with potentially elevated concentrations will remain segregated on the RSY pad, which may be covered with a poly cover by others.
 - ii. If the volume of material with elevated readings is large enough to warrant the need for yellow iron support, Perma-Fix will administer a Radiation Awareness Training to the excavation company worker(s) that may be needed to segregate the material.
 - iii. Other follow-up activities including soil sampling or spectroscopy measurements may be considered as part of investigatory efforts by Perma-Fix employees. These efforts are not anticipated to hinder planned fieldwork.
- e. Material not exhibiting elevated radioactivity can be transferred by others to its final location, anticipated to be at IAS-11.

END OF SECTION

SECTION 31222
EARTHFILL

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes:
1. Placing and compacting Earthfill to promote drainage around the perimeter of IAS-11.
 2. Placing and compacting Earthfill to construct the Foundation Layer.
 3. Placing and compacting Earthfill as backfill within the waste, known contamination, and rail line excavation areas.
 4. Placing and compacting the Vegetative Layer.

1.02 RELATED SECTIONS

- A. Section 31210 – Stockpiling and Soil Management
B. Section 31221 – Excavation
C. Section 31224 – Gravel
D. Section 31225 – Subgrade Preparation
E. Section 31310 – Erosion and Sediment Control
F. Section 31710 – Polyethylene Pipes
G. Section 31720 – Geotextile
H. Section 31730 – Geocomposite
I. Section 31750 – LLDPE Geomembrane

1.03 REFERENCES

- A. Anchor QEA, LLC [Anchor QEA], 2017. Port of Stockton 2017-2021 Maintenance Dredging Sediment Characterization. June.
- B. Geosyntec, 2020. Draft Site 47 Focus Feasibility Study, Appendix E. April 20.
- C. ASTM D422. Standard Test Method for Particle-Size Analysis of Soils.
- D. ASTM D1140. Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75-um) Sieve.
- E. ASTM D1556. Standard Test Method for determining soil density in-place by Sand Cone Method.
- F. ASTM D1557. Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- G. ASTM D2216. Standard Method for laboratory determination of water (moisture) content of soil and rock.
- H. ASTM D2217. Practice for wet preparation of soil samples for particle size analyses and determination of soil constants.

- I. ASTM D2487. Standard Classification of soils for engineering purposes (United Soil Classification System).
- J. ASTM D2488. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
- K. ASTM D2937. Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
- L. ASTM D4318. Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soil.
- M. ASTM D6938. Standard Test Method for determining density of soil and moisture in-place by Nuclear Methods.
- N. Construction Quality Assurance (CQA) Plan.

1.04 SUBMITTALS

- A. Submit 50-pound representative samples of the proposed earthfill materials to OWNER within 10 days after contract award.
- B. Submit mix design for CLSM and test data for mix design within 10 days after contract award.

PART 2 PRODUCTS

2.01 EARTHFILL

- A. Material from Roberts Island Dredge Material Placement Sites (DMPS) and the Rough and Ready Island DMPS as characterized June 2017 (Anchor QEA, 2017 and Geosyntec, 2020).
- B. Shall not contain organics, blocks, broken concrete, masonry rubble, debris, or any other deleterious material.
- C. Backfill below the water table shall be free-draining gravel underlain and covered with geotextile separator fabrics or controlled low strength material (CLSM).
- D. Earthfill within 1 ft of geomembrane shall be free of material larger than 1 inch.
- E. Free of excessive moisture.

2.02 VEGETATIVE LAYER

- F. Material from Roberts Island Dredge Material Placement Sites (DMPS) and the Rough and Ready Island DMPS.
- G. Shall not contain blocks, broken concrete, masonry rubble, debris, or any other deleterious material.
- H. Shall not be placed as backfill in excavations with free-standing water. Backfill below the water table should be free-draining gravel covered with a geotextile separator fabric or controlled low strength material (CLSM).
- I. Shall be free of material larger than 1 inch.
- J. Free of excessive moisture.

- K. Shall have a hydraulic conductivity (i.e., permeability) of less than 10^{-4} cm/sec when measured by ASTM D5084 or ASTM D2434. Permeability ASTM test shall be determined based on the characteristics of the vegetative layer material proposed (i.e., gradation and Atterberg limits).

2.03 CLSM (Controlled Low-Strength Material)

- A. Shall meet the requirements in Section 19-3.02G Controlled Low-Strength Material of the 2018 Caltrans Standard Specifications for cement and aggregate.
- B. Shall have a 28-day compressive strength of 100 psi but no more than 150 psi when tested under ASTM D4832.
- C. Shall have a minimum 4-inch slump and a maximum 8-inch slump.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete layout, surveys, and grade setting (or grade checking) prior to beginning this work.
- B. Verify soils meet requirements for proposed use (i.e., as Earthfill, Vegetative Soil Layer prior to placement).

3.02 PLACEMENT OF EARTHFILL

- A. Scarify and moisture condition surfaces that will receive Earthfill prior to placement.
- B. Bench or key Earthfill into existing subgrades and side slopes as needed.
- C. Compact any Earthfill inaccessible to large equipment by compacting with small compactors.
- D. Place Earthfill in loose lift thickness not exceeding 8 inches, except for the first lift above geosynthetics which must be 12 inches. Compact to a minimum of **90 percent** of maximum dry density at a moisture content within **3 percent** of optimum per ASTM D1557.
- E. Do not place Earthfill under water.
- F. Scarify the top of each compacted lift before placing subsequent lift. If a sheepfoot or padfoot roller is used scarifying is not required.
- G. Maintain the moisture content of prepared subgrade and each lift.
- H. Repair all eroded and desiccated soil areas before placing subsequent lifts.
- I. Place and compact Earthfill to the lines, grades, cross sectional requirements, and dimensions shown on the Construction Drawings.
- J. Grade final Earthfill surfaces to remove ruts and gouges.
- K. In areas where geosynthetics will be placed over the completed Earthfill, CONTRACTOR shall prepare the subgrade surface for the overlying geosynthetics per Section 31225.
- L. All Earthfill not overlain by geosynthetics shall be finished by track-walking perpendicular to slope contours so that track marks are parallel to the contours.
- M. Grade tolerance: Comply with Section 31052.

3.03 PLACEMENT OF EARTHFILL AS FOUNDATION LAYER

- A. Scarify and moisture condition surfaces that will receive Earthfill prior to placement.
- B. Compact any Earthfill inaccessible to large equipment by compacting with small compactors.
- C. Place Earthfill in loose lift thickness not exceeding 8 inches, except for the first lift above geosynthetics which must be 12 inches. Compact to a minimum of **90 percent** of maximum dry density at a moisture content within **3 percent** of optimum per ASTM D1557.
- D. Scarify the top of each compacted lift before placing subsequent lift. If a sheepsfoot or padfoot roller is used scarifying is not required.
- E. Maintain the moisture content of prepared subgrade and each lift.
- F. Repair all eroded and desiccated soil areas before placing subsequent lifts.
- G. Place and compact Earthfill to the lines, grades, cross sectional requirements, and dimensions shown on the Construction Drawings.
- H. In areas where geosynthetics will be placed over the completed Earthfill, CONTRACTOR shall prepare the subgrade surface for the overlying geosynthetics per Section 31225.
- I. All Earthfill not overlain by geosynthetics shall be finished by track-walking perpendicular to slope contours so that track marks are parallel to the contours.
- J. Grade tolerance: Comply with Section 31052.

3.04 PLACEMENT OF EARTHFILL AS BACKFILL

- A. Proof roll surfaces that will receive Earthfill prior to placement. If a firm and non-yielding surface cannot be achieved, a 16 oz/sy nonwoven geotextile, per Section 31720, shall be placed at the base of the excavation. Unless sewn, geotextile shall be overlapped a minimum of 24 inches. The geotextile shall be covered with a minimum of 12 inches of gravel per Section 31224.
- B. Transition from new fill to existing fill in excavations greater than 4 ft using 1H:1V slopes or 6-in. wide benches at each vertical foot.
- C. Compact any Earthfill inaccessible to large equipment with small compactors.
- D. Place Earthfill in loose lift thickness not exceeding 8 inches. Compact to a minimum of **90 percent** of maximum dry density at a moisture content between **0 and 3 percent** above optimum per ASTM D1557.
- E. Scarify the top of each compacted lift before placing subsequent lift. If a sheepsfoot or padfoot roller is used scarifying is not required.
- F. Do not place Earthfill below groundwater. If groundwater is encountered during excavation, drainage gravel shall be placed in accordance with Section 31224 from the base of the excavation to two feet above the elevation of the first water observed and covered with a 16 oz/sy nonwoven geotextile. Geotextile shall be overlapped a minimum of 18 inches.
- G. Place and compact Earthfill to the lines, grades, cross sectional requirements, and dimensions shown on the Construction Drawings.
- H. Grade final Earthfill surfaces to remove ruts and gouges.

- I. In areas where geosynthetics will be placed over the completed Earthfill, CONTRACTOR shall prepare the subgrade surface for the overlying geosynthetics per Section 31225.
- J. All Earthfill not overlain by geosynthetics shall be finished by track-walking perpendicular to slope contours so that track marks are parallel to the contours. Equipment loading in areas overlying geosynthetics shall be consistent with the requirements of Part 3.08 of this specification.
- K. Grade tolerance: Comply with Section 31052.

3.05 CONSTRUCTION OF EARTHFILL TEST PAD

- A. Any earthfill placed at elevations that are not accessible to CQA personnel for testing shall be compacted using a method acceptable to the OWNER's representative developed outside the excavation with a 12-inch test pad constructed by the CONTRACTOR and observed by the OWNER's representative.
- B. Two 8-inch-thick loose lifts shall be used to construct the test pad and the CQA personnel shall monitor and document the compaction effort and moisture (e.g., lift thickness, equipment used, passes with an excavator sheepsfoot roller attachment, tamps with the back of an excavator bucket or plate, spray duration from a water truck, etc.). Alternative lift thicknesses may be used if compaction criteria are met.
- C. Compaction effort and moisture conditioning shall be continued until the dry density and moisture requirements described in part 3.03 are met. The methods that allow the CONTRACTOR to meet the relative compaction requirements shall be replicated by the CONTRACTOR when backfilling areas and excavations inaccessible to CQA personnel.
- D. CQA personnel shall observe and document the construction activities (e.g., lift thickness, equipment used, passes with an excavator sheepsfoot roller attachment, tamps with the back of an excavator bucket or plate, spray duration from a water truck, etc.) to document that the minimum compaction requirements have been met.

3.06 PLACEMENT OF CLSM

- A. CLSM may be used as an alternative to earthfill with prior written approval by the OWNER's representative for mix design, placement method, location, elevation, and thickness.
- B. CLSM shall be batched by a ready-mix concrete plant and mixed and delivered to the jobsite by means of transit mixing trucks.
- C. If used around pipes or items that can float, the CONTRACTOR shall take the necessary precautions to prevent flotation or movement of such items.
- D. The CLSM shall be placed so that there is complete and intimate contact between the pipe(s), the item(s), and the materials on the walls and floor of the excavation.
- E. No equipment or traffic shall be allowed on the CLSM until the surface of the CLSM can withstand the weight of the equipment or traffic without displacement or damage.

3.07 PLACEMENT OF VEGETATIVE LAYER

- A. Place only when underlying geosynthetic installations are complete in accordance with the Specifications and accepted by OWNER.
- B. Place to the lines and grades shown on the Construction Drawings.
- C. Do not damage underlying geosynthetic materials.
- D. There are no minimum compaction, wheel rolling, or track-walking requirements for the vegetative layer.
- E. Dry density should be at or below 85% of the maximum dry density per ASTM D1557.
- F. Contractor shall maintain interim stability of the vegetative layer during construction. Place in a single lift using a CAT D4 LGP (or equivalent).
- G. Place material from the bottom of the slope toward the top.
- H. No sharp equipment turns or sudden braking shall be allowed during Vegetative Layer material placement. **Any application of braking force shall not result in sudden loading or stressing of the underlying geosynthetics.**
- I. Grade tolerance: Comply with Section 31052.

3.08 MATERIALS IN CONTACT WITH GEOSYNTHETICS

- A. Equipment used for placing soil shall not be driven directly over geosynthetics. A minimum thickness of 1 ft of material is required between a low ground pressure dozer (such as a wide pad bulldozer or equivalent) and underlying geosynthetics. A minimum thickness of 3 ft of material is required between rubber-tired vehicles and underlying geosynthetics. In areas of heavy vehicle traffic, such as construction access ramps, the material thickness should be at least 3 ft. In any case, the following table shall be complied with during construction:

Table 31222-2

MAXIMUM EQUIPMENT GROUND PRESSURE (psi)	INITIAL LIFT THICKNESS (ft)
5	1.0
10	1.5
20	2.0
>20	>3.0

3.09 FIELD QUALITY ASSURANCE

- A. OWNER or OWNER’s representative will perform conformance testing and inspections in accordance with the CQA Plan.
- B. OWNER or OWNER’s representative will determine maximum dry density and the optimum moisture content for all fill materials per ASTM D1557, except foundation layer material consisting of processed and consolidated waste placed per Section 31223.
- C. OWNER or OWNER’s representative will visually classify fill materials per ASTM D2488 and determine particle size distribution per ASTM D422.

- D. OWNER or OWNER's representative will measure in-place dry density and moisture content, using one or more of the following methods: ASTM D6938, ASTM D1556, and ASTM D2216.
- E. CONTRACTOR shall cooperate fully with OWNER or OWNER's representative in scheduling and performing field quality assurance tests. Include costs for coordination and assistance in unit prices.

END OF SECTION

**SECTION 31223
WASTE PLACEMENT**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes:
 - 1. Waste placement and compaction in a consolidation area to achieve the design grades as shown on the Construction Drawings and the properties described in Part 3.03.
 - 2. Rail Line excavation material placement and compaction in a consolidation area.

1.02 RELATED SECTIONS

- A. Section 31130 – Decontamination
- B. Section 31140 – Dewatering
- C. Section 31210 – Stockpiling and Soil Management
- D. Section 31221 – Excavation
- E. Section 31222 – Earthfill
- F. Section 31225 – Subgrade Preparation
- G. Section 31310 – Erosion and Sediment Control

1.03 REFERENCES

- A. ASTM D422. Standard Test Method for Particle-Size Analysis of Soils.
- B. ASTM D698. Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)) (Standard Proctor).
- C. ASTM D1556. Standard Test Method for Density of Soil in Place by Sand-Cone Method.
- D. ASTM D1557. Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- E. ASTM D2216. Standard Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- F. ASTM D2487. Standard Practice for Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- G. ASTM D2937. Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
- H. ASTM D4318. Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- I. ASTM D4767. Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils.
- J. ASTM D6913. Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

- K. ASTM D6938. Standard Test Method for determining density of soil and moisture in-place by Nuclear Methods.
- L. EPA SW-846 Test Method 9095B. Paint Filter Liquids Test.

1.04 HEALTH AND SAFETY

- A. Waste consolidation work shall be performed in accordance with the CONTRACTOR's approved Health and Safety Plan.
- B. It is the sole responsibility of the CONTRACTOR to follow all procedures set forth in the CONTRACTOR's approved Health and Safety Plan.
- C. Any deviations from the CONTRACTOR's Health and Safety Plan shall be submitted to the OWNER or OWNER's representative in writing for approval prior to being implemented.

1.05 DEFINITIONS

- A. Waste Material: Consists of a mixture of solid waste (municipal solid waste and construction and demolition debris), impacted soil, and native and fill soils excavated from the waste cells. Materials that meet the requirements described in Part 2.02 may be used as Foundation Layer. All excavated waste material will be disposed of within IAS-11.
- B. Impacted Soil: All materials excavated from the designated areas of known contamination are to be considered impacted soil. These consist of soil potentially contaminated with metals, polychlorinated biphenyls (PCBs), pesticides, volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), and dioxins/furans due to former onsite operations. All impacted soil will be disposed of within either IAS-11 or stockpiled within the limits of Cell M per Section 31210.
- C. Native and Fill Soils: Soil material within the project area, but outside of waste cell areas and areas of known or potential contamination, including material excavated from the Rail Line Excavation area. Excavated materials that meet the requirements of Section 31222 can be used as earthfill. Any material that does not meet the requirements of Section 31222 must be stockpiled in Stockpile #1A.
- D. Earthfill: Onsite or approved off-site soil that meets the requirements of Section 31222.

1.06 SUBMITTALS

- A. The CONTRACTOR shall submit to OWNER or OWNER's Representative and ENGINEER for review a Waste Handling Work Plan describing the proposed methods of construction, including dewatering, waste processing (if needed), excavation, consolidation, material transport, compaction, and backfilling for the consolidation of waste material in accordance with the specifications.. The review shall be for method only. The CONTRACTOR shall remain responsible for the adequacy and safety of the methods.
- B. For the foundation layer, OWNER or OWNER's representative shall establish the following a minimum of **14 days** prior to starting construction:
 - 1. At a minimum, for identification purposes of the borrow soil, the following information shall be provided: moisture content (ASTM D2216), grain size (ASTM

D422 or ASTM D6913), Atterberg Limits (ASTM D4318) if applicable, and soil classification by USCS (ASTM D2487).

- C. The CONTRACTOR shall notify OWNER or OWNER's representative in writing at least 7 days in advance of intent to perform the work of this Section.
- D. If work is interrupted for reasons other than inclement weather, the CONTRACTOR shall notify OWNER or OWNER's representative immediately and provide a plan and schedule for resumption of the work.

PART 2 PRODUCTS

2.01 WASTE MATERIAL

- A. Shall consist of material from designated excavation areas.
- B. Material used to construct the Foundation Layer shall meet requirements of Section 2.02.

2.02 FOUNDATION LAYER

- A. Shall consist of soil material excavated from areas of known contamination or generated during the base grading of IAS-11.
- B. Earthfill, as described in Section 31222 may be used for Foundation Layer if needed to meet final foundation layer grades and upon approval by OWNER or OWNER's representative.
- C. Shall not contain any particles larger than 6 inches, masonry rubble, or any other deleterious material.
- D. Foundation Layer within 6 inches of the overlying geosynthetics shall have a maximum particle diameter of 1 inch.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete layout, surveys, and grade setting (or grade checking) prior to beginning this work.

3.02 WASTE PLACEMENT

- A. All excavated waste material shall be hauled to and placed within IAS-11.
- B. All excavated impacted soil shall be hauled to and placed within IAS-11 or stockpiled in Cell M per Section 31210.
- C. All materials excavated from the rail line footprint, outside of the waste cell and impacted soil areas shall be hauled to and placed within Stockpile 1 in accordance with Section 31210.
- D. CONTRACTOR shall place material in lifts with a maximum loose lift thickness of 8 inches. The loose lifts shall be compacted with 2 passes of a 10-ton (static) smooth drum vibratory roller or equal approved by the OWNER's representative. For vibrating base plate compactors, the mini-mum number of passes shall be 2 and the vibration frequency shall not be less than 1,600 cycles per minute. Single pads or plates shall weigh at least 200 pounds. Other equipment can be considered with approval of the OWNER's representative.

- E. CONTRACTOR to place material relatively uniformly to gradually raise the waste fill to design grades and prevent instability from placing locally high waste piles over soft native soils. CONTRACTOR is responsible for monitoring interim stability of the waste and repairing any deformation that occurs during placement.
- F. Do not place material under water; CONTRACTOR shall be prepared to dewater.
- G. Scarify the top of each compacted lift before placing subsequent lifts. If a sheepsfoot or padfoot roller is utilized for compaction, scarifying is not required.
- H. Place and compact excavated material to the lines, grades, cross sectional requirements, and dimensions shown on the Construction Drawings.
- I. Grade final surfaces to remove ruts and gouges.
- J. CONTRACTOR is responsible for managing all liquids within the waste placement area, including surface water and groundwater, in accordance with the Dewatering Plan and Stormwater Pollution Prevention Plan.
- K. Grade tolerance: Comply with Section 31052.

3.03 PLACEMENT OF FOUNDATION LAYER

- A. Scarify, moisture condition, and compact surfaces that will receive Foundation Layer.
- B. Place Foundation Layer in compacted lift thickness not exceeding 6 inches. Compact to a minimum of **90 percent** of maximum dry density at a moisture content within **3 percent** of optimum per ASTM D1557.
- C. Compact any Foundation Layer inaccessible to large equipment with small mechanical or vibratory compactors.
- D. Do not place Foundation Layer under water.
- E. Scarify the top of each compacted lift before placing subsequent lift. If a sheepsfoot or padfoot roller is utilized for compaction, scarifying is not required.
- F. Maintain the moisture content of each lift.
- G. Repair all eroded and desiccated soil areas before placing subsequent lifts.
- H. Place and compact Foundation Layer to the lines, grades, cross sectional requirements, and dimensions shown on the Construction Drawings.
- I. Grade final Foundation Layer surfaces to remove ruts and gouges.
- J. Prepare the subgrade surface for the overlying geosynthetics per Section 31225.
- K. Grade tolerance: Comply with Section 31052.

3.04 FIELD QUALITY ASSURANCE

- A. OWNER or OWNER's representative will measure in-place dry density and moisture content, using one or more of the following methods: ASTM D6938, ASTM D1556, ASTM D2216, and ASTM D2937.
- B. OWNER or OWNER's representative will sample compacted waste material to measure in-place strength.
- C. Failure to meet required densities will require rework and reprocessing by CONTRACTOR at no additional cost to OWNER.

- D. CONTRACTOR shall cooperate fully with the OWNER or OWNER's representative in scheduling and performing field quality assurance tests. Include costs for coordination and assistance in unit prices.

END OF SECTION

SECTION 31224
GRAVEL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Placement of gravel for the stormwater control features (i.e., around pipes within vegetative layer and as gravel windows at the toe of slopes) as shown on the Construction Drawings.
- B. Placement of gravel as excavation backfill when free water is encountered.
- C. Placement and compaction of gravel as road base material.
- D. Work includes furnishing, loading, hauling, and placing the material.

1.02 RELATED SECTIONS

- A. Section 31140 – Dewatering
- B. Section 31210 – Stockpiling and Soil Management
- C. Section 31221 – Excavation
- D. Section 31222 – Earthfill
- E. Section 31225 – Subgrade Preparation
- F. Section 31310 – Erosion and Sediment Control
- G. Section 31710 – Polyethylene Pipe and Fittings
- H. Section 31720 – Geotextile
- I. Section 31730 – Geocomposite
- J. Section 31750 – LLDPE Geomembrane

1.03 REFERENCES

- A. ASTM D422 - Standard Method for Particle-Size Analysis of Soils.
- B. ASTM D 2419 - Sand Equivalent Value of Soils and Fine Aggregate
- C. ASTM D2434 - Standard Method for Permeability of Granular Soils (Constant Head).
- D. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

1.04 SUBMITTALS

- A. Submit 50-pound representative samples of the proposed gravel materials to OWNER within 10 days after contract award.
- B. Submit data sheet from the quarry stating that the material provided meets the requirements of Caltrans Class 2 Permeable Material.

PART 2 PRODUCTS

2.01 GRAVEL

- A. Durable and hard gravel obtained and imported from off-site borrow source.
- B. Free of organic or other deleterious material.
- C. Containing no limestone.
- D. Shall not be from recycled sources.
- E. Shall have a Sand Equivalent (ASTM D2419) greater than 75.
- F. Having a hydraulic conductivity (i.e., permeability) of 1 cm/sec when measured using ASTM D2434.
- G. Required gradation, consistent with Caltrans Class 2 Permeable Material:

<u>U.S. Sieve Size</u>	<u>Percent Passing</u>
1 inch	100
3/4 inch	90 - 100
3/8 inch	40-100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

PART 3 EXECUTION

3.01 PLACEMENT OF GRAVEL FOR STORMWATER CONTROL FEATURES

- A. Place materials only when underlying excavations, foundations, and geosynthetic installations are complete and accepted by OWNER or OWNER’s representative.
- B. Place to lines and grades shown on the Drawings.
- C. Place to the uniform thickness shown on the Drawings.
- D. Place without damaging underlying geosynthetics.
- E. Grade tolerance: Comply with Section 31052.
- F. Do not cause underlying geosynthetics to bridge across ditch alignments or pipe alignments. If bridging does occur, repair by installing additional compensating geosynthetic materials at no additional cost to the OWNER.

3.02 PLACEMENT OF GRAVEL AS BACKFILL

- A. Place materials only when underlying excavations are complete and accepted by OWNER or OWNER’s representative.
- B. Groundwater levels may be above excavation grades. Provide dewatering as necessary per Section 31140 to allow placement of backfill materials.
- C. Place 16 oz/sy nonwoven geotextile specified in Section 31720 prior to placement of gravel as backfill. Overlap adjacent geotextile panels a minimum of 18 inches.
- D. CONTRACTOR shall place material in lifts with a maximum loose lift thickness of 8 inches. The loose lifts shall be compacted with 4 passes of a 10-ton (static) smooth drum vibratory

GRAVEL

roller. For vibrating base plate compactors, the mini-mum number of passes shall be 4 and the vibration frequency shall not be less than 1,600 cycles per minute. Single pads or plates shall weigh at least 200 pounds. Other equipment can be considered with approval of the Engineer.

- E. Place gravel to two feet above the elevation where first water was observed and cover with 16 oz/sy. Overlap adjacent geotextile panels a minimum of 18 inches.
- F. Grade tolerance: Comply with Section 31052.

3.03 PLACEMENT OF GRAVEL AS ROAD BASE

- A. Place materials only when underlying excavations, foundations, and geosynthetic installations are complete and accepted by OWNER or OWNER's representative.
- B. Place to lines and grades shown on the Drawings.
- C. Place to the uniform thickness shown on the Drawings.
- D. Place without damaging underlying geosynthetics.
- E. CONTRACTOR shall place material in lifts with a maximum loose lift thickness of 8 inches. The loose lifts shall be compacted with 4 passes of a 10-ton (static) smooth drum vibratory roller. For vibrating base plate compactors, the mini-mum number of passes shall be 4 and the vibration frequency shall not be less than 1,600 cycles per minute. Single pads or plates shall weigh at least 200 pounds. Other equipment can be considered with approval of the Engineer.
- F. Grade tolerance: Comply with Section 31052.

3.02 FIELD QUALITY CONTROL

- A. Prior to beginning drainage gravel placement, demonstrate that placement techniques will not damage the underlying geosynthetic materials. Demonstrate this by constructing test fill over geosynthetics in an area not part of final construction.

3.03 FIELD QUALITY ASSURANCE

- A. The OWNER will perform gradation and hydraulic conductivity tests of materials before and during placement in accordance with ASTM D422.
- B. Assist the OWNER as necessary in collecting material samples and conducting tests.
- C. OWNER reserves the option of waiving gradation specifications if products submitted by CONTRACTOR meet the design intent.

END SECTION

**SECTION 31225
SUBGRADE PREPARATION**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes:
 - 1. Preparing any surface that will receive geosynthetics.

1.02 RELATED SECTIONS

- A. Section 31222 – Earthfill
- B. Section 31223 – Waste Placement
- C. Section 31720 – Geotextile
- D. Section 31730 – Geocomposite
- E. Section 31750 – LLDPE Geomembrane
- F. Section 31760 – Geogrid

1.03 REFERENCES

- A. ASTM D1556. Standard Test Method for Density of Soil in Place by Sand-Cone Method.
- B. ASTM D1557. Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- C. ASTM D2937. Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
- D. ASTM D6938. Standard Test Method for In-Place Density and Water Content of Soil and Soils-Aggregate Using Nuclear Methods.

PART 2 PRODUCTS

2.01 EARTHFILL

- A. Comply with Part 3.02 of Section 31222.

2.02 FOUNDATION LAYER

- A. Comply with Parts 2.02 and 3.03 regarding Foundation Layer of Section 31223.

PART 3 EXECUTION

3.01 SUBGRADE

- A. Areas of subgrade include all areas requiring placement of geosynthetics.
- B. CONTRACTOR shall smooth-drum roll smooth all surfaces and confirm compaction of a minimum of 90 percent of maximum dry density at a moisture content within 3 percent of optimum per ASTM D1557.

- C. Any areas not satisfying the compaction requirement shall receive additional compaction effort until the requirement is met or the areas is over-excavated 6 inches and backfilled in accordance with Section 31222, Parts 3.01 and 3.02, or Section 31223, Parts 3.01 and 3.03 to meet the compaction requirements prior to placement of geosynthetics.
- D. Remove any angular or sharp rocks and all debris from the completed surface.
- E. Remove all rocks or clods greater than 1-inch in largest diameter from the completed subgrade surface.
- F. Grade tolerance: Comply with Section 31052.
- G. Completed subgrade surface must have no vertical irregularities greater than 0.5 inch or abrupt grade transitions. The subgrade surface should provide for a continuous, intimate contact with the overlying geosynthetics.
- H. All grade breaks must have a minimum radius of 1 foot.
- I. Round corners and slope transitions. Minimum radius: 1 foot, maximum radius: 2 feet.
- J. CONTRACTOR to maintain prepared subgrade to minimize erosion until the subgrade is covered.
- K. CONTRACTOR to apply water for dust control, as needed, until prepared subgrade is covered.

3.02 FIELD QUALITY ASSURANCE

- A. OWNER or OWNER's representative will perform Construction Quality Assurance (CQA) testing during geosynthetics subgrade preparation consisting of:
 - 1. Verifying that surfaces are proof-rolled and any yielding areas are repaired.
 - 2. Conducting moisture-density relationship tests.
 - 3. Conducting field density and moisture tests.
 - 4. Verifying that angular or sharp rocks, and other debris that could damage the geosynthetics are removed from the surface of the subgrade.
 - 5. Verifying that the subgrade is free of irregularities and, excluding areas receiving geogrid, is steel drum rolled smooth prior to geosynthetic placement.
 - 6. Verify that the final subgrade surface provides continuous and intimate contact with the overlying geosynthetic.
 - 7. Performing any other inspections described in the CQA documents for the project.
- B. Nonconforming areas identified by OWNER or OWNER's representative will be promptly addressed by CONTRACTOR at no additional cost to OWNER.
- C. CONTRACTOR shall cooperate fully with the OWNER or OWNER's representative in scheduling and performing field quality assurance tests. Include costs for coordination and assistance in unit prices.

END OF SECTION

**SECTION 31310
EROSION AND SEDIMENT CONTROL**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes:
1. Implementation of erosion and sediment control measures at the project site during construction:
 - a. Measures shall be in accordance with the approved CONTRACTOR-prepared Construction Storm Water Pollution Prevention Plan (C-SWPPP), including the Erosion and Sediment Control Plan (ESCP), as needed.
 2. Installation of the following, as needed:
 - a. Fiber Rolls (Wattles).
 - b. Silt Fence.
 - c. Temporary Sediment Trap.
 - d. Straw Bale Barrier.
 - e. Erosion Control Mats.
 - f. Tarps.
 - g. Rip-Rap.
 - h. Hydroseed.
- B. CONTRACTOR is solely responsible for **developing and implementing** erosion and sediment control measures, as appropriate, to meet the OWNER's site-wide SWPPP, the construction SWPPP, and all applicable local, state and federal regulations. If the erosion control measures are inadequately maintained, or are found to be inadequate in the field, install additional measures at no cost to OWNER to prevent sediment laden runoff from leaving the site.
- C. The term erosion includes water and wind erosion, and dust control.

1.02 RELATED SECTIONS

- A. Section 31110 – Site Preparation
- B. Section 31130 – Decontamination
- C. Section 31210 – Stockpiling and Soil Management
- D. Section 31221 – Excavation
- E. Section 31222 – Earthfill
- F. Section 31223 – Waste Placement
- G. Section 31320 – Hydroseeding

1.03 SUBMITTALS

- A. Within **14 business days** of Notice of Award, submit a C-SWPPP that meets the OWNER's site-wide SWPPP as well as local, state and federal regulations.

- B. The C-SWPPP shall be prepared by a Qualified SWPPP Developer (QSD) experienced in developing SWPPP and/or ESCPs.
- C. The SWPPP/ESCP shall also incorporate, as appropriate, requirements listed in the *Stormwater Best Management Practice Handbook: Construction, January 2015* (www.cabmphandbooks.com) published by the California Stormwater Quality Association.
- D. CONTRACTOR shall provide to OWNER for approval product specifications required by the temporary ESCPs at least **7 calendar days** prior to their installation.

1.04 SEQUENCING AND SCHEDULING

- A. All erosion control features must be approved by OWNER before beginning site earthwork.
- B. Route runoff from cleared or disturbed areas. Route through temporary sediment traps, straw bale barriers, or silt fences. Place erosion control facilities prior to any earthwork, clearing, and grubbing. It is preferable for construction to progress in an upstream direction starting with downstream erosion control facilities as the first items of construction.
- C. Stabilize disturbed ground at the end of each work day. For slopes not receiving geosynthetics, perform surface roughening immediately upon reaching final grade by uniformly track-walking up and down the slope with a crawler tractor or sheepsfoot roller, leaving a pattern of clear imprints that parallel the slope contours. Implement soil stabilization and erosion/sedimentation controls upon reaching final grade.
- D. Notify OWNER or OWNER's representative of any soils showing signs of erosion.
- E. Ensure that all waters from dewatering operations reaching existing water courses meet or exceed the existing quality of the water course.

PART 2 PRODUCTS

2.01 GENERAL

- A. Erosion and sediment control elements – as required by the approved C-SWPPP.

PART 3 EXECUTION

3.01 GENERAL

- A. Erosion and sediment control facilities shall be installed as specified/required by the manufacturer, the C-SWPPP/ESCP, and these Specifications.

3.02 FIBER ROLLS

- A. Fiber Rolls shall be supplied and installed in accordance with manufacturer's recommendations.

3.03 SILT FENCE

- A. Silt fences shall be supplied and installed in accordance with manufacturer's recommendations.

3.04 TEMPORARY SEDIMENT TRAP

- A. Form by excavation or construction of a compacted earthfill.

3.05 STRAW BALE BARRIER

- A. Excavate a one-bale wide strip of soil 4 inches deep and perpendicular to the flow direction in the channel. Remove all grass and other materials that may allow underflow.
- B. Install straw bales end-to-end, with the bindings oriented horizontally around the sides of the bales. Anchor each bale into trench. Push bales together as firmly as possible.
- C. Chink the gaps between bales with straw to prevent water from escaping between bales. This must be done carefully to avoid separating the bales. Place and compact excavated soils against the upstream side of the straw bale barrier to a height of 4 inches to prevent piping under bales.

3.06 EROSION CONTROL MATS

- A. Erosion control mats shall be supplied and installed in accordance with manufacturer's recommendations.

3.07 TARPS

- A. Tarps shall be supplied and installed in accordance with manufacturer's recommendations.

3.08 RIP-RAP

- A. Rip-rap shall be supplied and installed in accordance with the Construction Drawings.

3.09 HYDROSEED

- A. Hydroseed shall be supplied and installed in accordance with Section 31320 of the Technical Specifications.

3.10 MAINTENANCE

- A. General Requirements – Observe the facilities during the first storm following construction to ensure that the facilities are properly located, constructed, and operating as designed. Maintain and repair facilities as needed to ensure that they continue to work as designed.
- B. Tarps – Maintain the tarps in accordance with manufacturer's recommendations.
- C. Silt Fence – Maintain the silt fence in accordance with manufacturer's recommendations.
- D. Temporary Sediment Traps – Remove sediment before it reaches the outlet. The trap bottom may be over-excavated to provide additional sediment storage.
- E. Straw Bale Barrier – Check for undercutting, damaged bales, evidence of erosion or sedimentation between bales, and "end run" erosion at the ends of the barrier. Make repairs, replace bales, and remove sediment before it reaches approximately one-half the height of the barrier.

- F. Erosion Control Matting – Maintain the erosion control matting in accordance with manufacturer’s recommendations.

3.11 REMOVAL OF TEMPORARY EROSION AND SEDIMENT CONTROL FACILITIES

- A. Remove all temporary control facilities **30 calendar days** after final completion of work or upon approval of OWNER, unless directed otherwise. Disposal of used control facilities shall be as designated by OWNER. Costs for removal of erosion control features are incidental and included in lump sum or unit cost. Final payment will not be released until this work is completed.
- B. Advise OWNER **5 calendar days** before removing temporary erosion control facilities.
- C. CONTRACTOR shall check with OWNER before removing the temporary erosion and sediment control measures as some temporary erosion and sediment control measures may remain in-place. OWNER will thereafter be responsible to remove those elements that are designated by OWNER to remain in-place.

END OF SECTION

SECTION 31320 HYDROSEEDING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes furnishing of all labor, materials, tools, supervision, transportation, and installation equipment necessary for applying hydroseed mixtures to areas shown on the Construction Drawings and in accordance with these Specifications.

1.02 RELATED SECTIONS

- A. Section 31210 – Stockpiling and Soil Management
- B. Section 31240 – Vegetative Layer
- C. Section 31310 – Erosion and Sediment Control

1.03 SUBMITTALS AND NOTIFICATIONS

- A. The CONTRACTOR shall submit all submittals/notifications to the OWNER at least 7 business days prior to material use or as otherwise indicated.
- B. A Certificate of Compliance for fiber shall be furnished to the OWNER at least 7 business days prior to installation.
- C. The CONTRACTOR shall furnish evidence to the OWNER that clearance has been obtained from the County Agricultural Commissioner, as required by law, before straw obtained from outside the County, in which it is to be used, is delivered to the site of the work.
- D. The test results from seed testing shall be delivered to the OWNER prior to applying the seed.
- E. Before seeding, the CONTRACTOR shall furnish written evidence (seed label or letter) to the OWNER that seed, not required to be labeled under the California Food and Agricultural Code, has been tested for purity and germination by a seed laboratory certified by the Association of Official Seed Analysts, or a seed technologist certified by the Society of Commercial Seed Technologists.
- F. All shipments of seed not accompanied by a valid California Nursery Stock Certificate shall be reported to the County Agricultural Commissioner at the point of destination for inspection and shall be held until released by the Commissioner.
- G. A Certificate of Compliance for stabilizing emulsion shall be furnished to the OWNER.

1.04 HYDROSEEDING WINDOW

- A. Complete hydroseeding between 1 January and 28 February 2022, unless otherwise authorized by OWNER.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Commercial Fertilizer
1. Lawn fertilizer shall be 16-6-8.
 2. Slow release fertilizer shall be 7-2-1 BioSol.
 3. Fertilizers shall conform to the requirements of the California Food and Agriculture Code.
- B. Bonded Fiber Matrix (BFM)
1. Shall be a hydraulically applied erosion system, consisting of long strand, virgin wood fibers, (95% by weight), bound together by a pre-blended, high strength polysaccharide polymer adhesive, (5% by weight).
 2. The virgin wood fibers shall be thermo-mechanically defibrated from clean whole wood chips, containing a minimum of 25% of the fibers averaging 10mm long, with a minimum of 50% or more retained on a #24 mesh screen.
 3. The matrix shall be of such character that it will disperse uniformly into a slurry when mixed with water.
 4. The slurry, when hydraulically applied to the ground, shall form an absorptive mat of mulch uniformly impregnated with seed and other ingredients.
 5. No materials which inhibit growth or germination shall be present in the mixture.
 6. BFM shall be ProMatrix Engineered Fiber Matrix or equal.
- C. Seed
1. Unless otherwise specified by OWNER, seed mix shall consist of:
 - Blando Brome (*Bromus hordeaceus*) - 30 lbs/acre;
 - Zorro Fescue (*Festuca myuros*) – 15 lbs/acre;
 - Rose Clover (*Trifolium hirtum*) – 10 lbs/acre;
 2. Seeds for the hydroseed mix (called Green to Gold) can be obtained from:
Pacific Coast Seed, Inc.
6144-A Industrial Way
Livermore, CA 94550-9749
Phone: 800-733-3462
Fax: 925-373-6855
 3. All seed shall be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. In addition, the container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. Prior to seeding at the request of the OWNER, the contractor shall provide a letter of certification, original Association of Official Seed Analysts (AOSA) seed test results, and calculations of PLS content.
 4. Seed treated with mercury compounds shall not be used.

- D. Water
1. Water shall be of potable quality.

PART 3 EXECUTION

3.01 FAMILIARIZATION

- A. Prior to implementing any of the work described in this Section, the CONTRACTOR shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section.
- B. Inspection:
1. Prior to implementing any of the work in this Section, the CONTRACTOR shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of this Section shall commence without adverse impact.
 2. If the CONTRACTOR has any concerns regarding the installed work of other Sections, immediately notify the OWNER in writing. Failure to notify the OWNER in writing or application of the hydroseeding mixture will be construed as CONTRACTOR's acceptance of the related work of all other Sections.

3.02 INSTALLATION

- A. Areas to receive hydroseed include the swale to the west of IAS-11, the IAS-11 CA vegetative soil cover, and stockpiles as shown on the site plan.
- B. Hydroseeding materials shall be applied in 3 separate applications in the following sequence:
1. The materials shall be uniformly applied using hydroseeding equipment at the below minimum rates:

Material	Quantity
Seed	55lbs/acre
Bonded Fiber Matrix	3,500 lbs/acre
Fertilizer	700 lbs/acre

2. Fertilizer shall be added by the CONTRACTOR and shall consist of 300 lbs/acre of 16-6-8 lawn fertilizer and 400 lbs/acre of 7-2-1 BioSol slow release fertilizer.
3. Water, fertilizer, and BFM shall be added to the tank simultaneously so that the finished load is a homogenous mix of the specified ingredients.
4. Seed shall be added last and be discharged within 2 hours. Loads held over 2 hours will be recharged with ½ the seed rate before application.
5. The slurry shall be continuously mixed and shall be mixed for at least 5 minutes after the last addition before application.
6. The slurry shall be applied in a sweeping motion to form a uniform application and form a mat. Spray from multiple direction to provide complete soil cover. Application shall be at a rate that is non-erosive and minimizes runoff.

- C. Mixing of materials for application with hydroseeding equipment shall be performed in a tank with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous mixture and a discharge system, which will apply the mixture at a continuous and uniform rate. The tank shall have a minimum capacity of 2,500 gal. The OWNER shall authorize use of equipment of smaller capacity if it is demonstrated that the equipment is capable of performing all operations satisfactorily.
- D. Any mixture containing stabilizing emulsion shall not be applied during rainy weather or when soil temperatures are below 5°C. Pedestrians or equipment shall not be permitted to enter areas where mixtures containing stabilizing emulsion have been applied.
- E. Seed shall be mixed on-site unless otherwise approved by the OWNER.
- F. Follow-up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.

3.03 FIELD QUALITY ASSURANCE

- A. OWNER or OWNER's representative shall verify that all areas to receive hydroseed are free of vegetation and debris.
- B. OWNER or OWNER's representative shall verify that all sloped areas are uniformly compacted and left in a roughed condition.
- C. OWNER or OWNER's representative shall verify the components and material ratios used to prepare the seed mixture in the field, prior to application.
- D. OWNER or OWNER's representative shall verify application rates used in the field.
- E. OWNER or OWNER's representative shall verify even application of the mixture along the surfaces to be hydroseeded and shall notify the CONTRACTOR of deficient areas. CONTRACTOR shall address deficient areas at no extra cost to the OWNER.
- F. All hydroseeded areas shall be inspected for failures and re-seeded, fertilized and mulched within the planting season, using not less than half the original applications rates.

3.04 PRODUCT PROTECTION

- A. The CONTRACTOR shall use all means necessary to protect all prior work, including all materials and completed work of other Sections. CONTRACTOR is responsible for washing or otherwise cleaning excess material off all areas not intended to receive treatment.
- B. In the event of damage, the CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the OWNER and at no additional cost to the OWNER.

END OF SECTION

**SECTION 31710
POLYETHYLENE PIPE AND FITTINGS**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes furnishing and installing High Density Polyethylene (HDPE) solid pipe and associated pipe fittings for the surface water drainage and subdrain features for the consolidation areas final cover.
- B. Pipe sizes and Standard Dimensional Ratio (SDR) shall be as listed on the Construction Drawings.

1.02 RELATED SECTIONS

- A. Section 31222 – Earthfill
- B. Section 31224 - Gravel
- C. Section 31720 – Geotextile
- D. Section 31730 – Geocomposite

1.03 REFERENCES

- A. ASTM D638. Standard Test Method for Tensile Properties of Plastics.
- B. ASTM D696. Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics.
- C. ASTM D746. Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- D. ASTM D790. Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- E. ASTM D1238. Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
- F. ASTM D1248. Specification for Polyethylene Plastics Molding and Extrusion Materials.
- G. ASTM D1505. Standard Test Method for Density of Plastics by the Density-Gradient Technique.
- H. ASTM D1525. Standard Test Method for Vicat Softening Temperature of Plastics.
- I. ASTM D1599. Standard Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.
- J. ASTM D1603. Standard Test Method for Carbon Black in Olefin Plastics.
- K. ASTM D1693. Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- L. ASTM D2122. Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
- M. ASTM D2240. Standard Test Method for Rubber Property – Durometer Hardness.
- N. ASTM D2657. Practice for Heat Joining of Polyolefin Pipe and Fittings.

- O. ASTM D2837. Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
- P. ASTM D3035. Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
- Q. ASTM D3261. Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- R. ASTM D3350. Specification for Polyethylene Plastics Pipe and Fittings Materials.
- S. ASTM D4218. Standard Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
- T. ASTM F714. Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- U. ASTM F1248. Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.
- V. National Sanitation Foundation (NSF) Standard Number 14. Plastics Piping Components and Related Materials.
- W. Plastic Pipe Institute (PPI).
- X. American National Standards Institute (ANSI).

1.04 SUBMITTALS

- A. Submit with each shipment of pipe to site, MANUFACTURER's certification of compliance with specified requirements of this Section. Submit catalog cut sheet of pipe and fittings to be supplied prior to commencing work.
- B. Provide written certification for qualified HDPE pipe fusion welders.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

- A. High density polyethylene (HDPE).
 - 1. Material Designation: PE 4710.
 - 2. Cell Classification: 445474 C, or higher.
- B. All pipe sizes shown on the Drawings and specified in this Section reference nominal diameter, unless otherwise indicated on the Drawings or in this Section. Pipe sizing and workmanship to be in accordance with ASTM F714 and ASTM D3035.
- C. Conforming to the following minimum requirements:

Table 31710-1

Property	ASTM Test Designation	Unit	Requirements
Density	D1505	gm/cm ³	0.947-0.955
Melt Index	D1238	gm/10 min	<0.15
Flexural Modulus	D790	Psi	110,000-180,000
Tensile Strength	D638	Psi	3,000-3,500
Slow Crack Growth Resistance (PENT)	F1473	Hrs.	500
Hydrostatic Strength	D2837	psi	>1,600
UV Stabilizer	D1603	% Carbon Black	2% minimum

- D. Containing no recycled compound except that generated in the MANUFACTURER's own plant and from resin of the same specification from the same raw material supplier.
- E. Resin for pipe and fittings to be listed by both N.S.F. and P.P.I. and manufactured in accordance with ASTM D3350 and ASTM F714.
- F. Homogeneous throughout and free of visible cracks, holes (except where specified or shown), foreign inclusions or other injurious defects. Being uniform in color, capacity, density, and other physical properties.
- G. Provide pipe with the following information continuously marked on the pipe or spaced at intervals not exceeding 5 feet.
 - 1. Name and/or trademark of the pipe MANUFACTURER.
 - 2. Nominal pipe size.
 - 3. Standard Dimensional Ratio (SDR).
 - 4. PE 4710.
 - 5. MANUFACTURER's Standard Reference.
 - 6. A production code from which the date and place of manufacture can be determined.

2.02 FITTINGS

- A. Provide fittings, manufactured from the same class of materials and fully compatible with the HDPE pipe.
- B. Provide fittings manufactured in accordance with ASTM D3350 and ASTM D3261. Provide fabricated fittings with pressure ratings matching or exceeding the HDPE pipe.
- C. If electrofusion fittings are required, provide fittings complying with ASTM F1055, with pressure ratings matching or exceeding the HDPE pipe.

2.03 PIPE BEDDING MATERIAL

- A. Pipe bedding material shall consist of gravel as described in Section 31224. Material shall be placed such as to prevent voids from occurring around the pipe.

PART 3 EXECUTION

3.01 PIPE INSTALLATION GENERAL REQUIREMENTS

- A. When shipping, delivering, and installing pipe, fittings, and accessories, do so in such a manner to ensure a sound, undamaged installation.
- B. Provide adequate storage for all materials and equipment delivered to the job site.
- C. Handle and store pipe and fittings in accordance with the MANUFACTURER's recommendations.

3.02 PLACING AND INSTALLING PIPE

- A. Provide required maintenance of all such materials and equipment used to handle, place, and lay pipe.
- B. Follow the MANUFACTURER's recommendations when hauling, unloading and stringing the pipe.
- C. Take precautions to prevent damage to the pipe.
- D. Do not push, pull, or drag pipe and fittings over sharp projections, or drop, or have objects dropped on the pipe and fittings.
- E. Inspect for defects before and during installation. Remove any piping showing kinks, buckles, cuts, gouges, or any other damage, which in the opinion of OWNER will affect performance of the pipe.
- F. Replace material found to be defective before or after laying with sound material without additional expense to OWNER.
- G. Field-cutting of pipes, where required, shall be made with a machine specifically design for cutting pipe. Flame cutting will not be allowed.
- H. Carefully lower pipe and accessories into the trench.
- I. Under no circumstances, drop or dump materials into the trench.
- J. Rest the full length of each section of pipe solidly upon the pipe bedding.
- K. Take up or relay pipe that has had the grade disturbed while joining or laying the pipe.

3.03 FUSION WELDING PIPE

- A. Join the HDPE pipe by the method of thermal butt or side wall fusion, as outlined in ASTM D2657. Perform fusion joining of pipe and fittings in accordance with the procedures established by the pipe MANUFACTURER. Of particular importance is the use of proper interface pressures and heater plate temperatures. Join the pipe outside of the trench.
- B. Use fusion pressures, temperatures, and cycle times according to pipe MANUFACTURER's recommendations. Only use personnel adequately trained and qualified in the welding technique involved.
- C. Clear and grade fusion welding sites, if necessary, to provide enough space for pipe storage and fusion equipment. Keep the site free of rocks, stumps, and debris which could cut, scar, or gouge the pipe.

- D. Polyethylene Fusion Qualification: All pipe fusion welding must be performed by the supplier, or a factory-supplied and/or certified fusion welding operator.
- E. Provide for instruction, testing, and installation training sessions as required to obtain training for welding personnel, including quality control personnel, in polyethylene fusion machine operation, instruction and familiarization with HDPE pipe and fitting fusion for the project. Only fully trained personnel will be allowed to perform the installation, supervision, or inspection of polyethylene-fusion joints. Submit to OWNER, prior to beginning fusion welding, a list of those personnel authorized, instructed, and certified for polyethylene fusion. Make all on-site training sessions conducted during this Contract available to quality assurance personnel at no charge to OWNER.
- F. Training: Provide assistance from the MANUFACTURER/supplier in instructing welding personnel in proper fusion welding procedures and techniques. Notifications will be required in writing, listing the names of those persons so familiarized. A MANUFACTURER's representative shall be certified in writing by the MANUFACTURER to be technically qualified and experienced in fusion welding of HDPE pipe.

3.04 INSTALLING FLANGED CONNECTIONS

- A. Bolt flanges using an evenly torqued crossing pattern. Retorque after 1 hour in the same crossing pattern.
- B. Polyethylene flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene materials. Wait at least 24-hours after initial flange bolt tightening, then re-tighten flange bolts again.

END OF SECTION

**SECTION 31720
GEOTEXTILE**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes furnishing all labor, materials and equipment necessary for installing non-woven geotextile used as cushion layer, separator, and as part of the blanket geocomposite.

1.02 RELATED SECTIONS

- A. Section 31221 – Excavation
- B. Section 31222 – Earthfill
- C. Section 31224 – Gravel
- D. Section 31730 – Geocomposite
- E. Section 31750 – LLDPE Geomembrane

1.03 REFERENCES

- A. ASTM D885. Methods for Testing Industrial Filament Yarns Made from Man-made Fibers.
- B. ASTM D1777. Method for Measuring Thickness of Textile Materials.
- C. ASTM D3786. Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method.
- D. ASTM D4355. Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water.
- E. ASTM D4491. Standard Test Method for Water Permeability of Geotextiles by Permittivity.
- F. ASTM D4533. Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- G. ASTM D4595. Standard Test Method for Tensile Properties by the Wide-width Strip Method.
- H. ASTM D4632. Standard Test Method for Breaking Load and Elongation of Geotextiles (grab method).
- I. ASTM D4751. Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- J. ASTM D5261. Standard Test Method for Determining the Mass per Unit Area of Geotextiles.
- K. ASTM D6241. Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.04 DEFINITIONS

- A. **MANUFACTURER:** Responsible for the production of geotextile rolls.

- B. CONTRACTOR: The party responsible for field handling, storing, deploying, repairing, anchoring, and any other aspects of installing the geotextile.
- C. Construction Quality Assurance Consultant (CQAC): The party, independent from the MANUFACTURER or CONTRACTOR, responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic components of the geotextile. Also responsible for issuing a CQA report with certification sealed by a Registered Professional ENGINEER.

1.05 SUBMITTALS

- A. Submit the following to OWNER, prior to confirmation of OWNER-CONTRACTOR Agreement, samples and complete description of geotextile fabric proposed for use that meets or exceeds requirements of this section. Include certified minimum property values and test methods used to obtain property values. Also include production capacity available and projected delivery dates.
- B. Submit, 10 days prior to installation, written instructions for storage, handling installation, and seaming of proposed geotextile.
- C. Submit, 10 days prior to installation, documentation attesting to in-ground durability of geotextiles.
- D. Submit, 10 days prior to installation, written instructions for repair of geotextile.
- E. Submit, 10 days prior to delivery, MANUFACTURER's certificates of compliance with specified product requirements. This submittal includes MANUFACTURER's Quality Control (MQC) testing certificates notarized by responsible party. Include lot, batch, and roll numbers, sampling procedures, test procedures, and test results.
- F. Warranty: Submit to OWNER, 10 days prior to installation, MANUFACTURER's and CONTRACTOR's written warranty against product and installation defects. Limits of liability must be accepted by OWNER.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect geotextile from ultraviolet light exposure, precipitation, inundation, mud, dirt, dust, puncture, cutting, and other damaging or deleterious condition.
- B. Ship geotextile in closed trailer.
- C. Immediately restore damaged protective covering.

PART 2 PRODUCTS

2.01 GENERAL

- A. Products shall be comprised of non-woven, needle punched polypropylene or polyester fabric; oriented into a staple network that maintains its structure during handling, placement, and long-term service.
- B. The geotextiles shall not be heat burnished.
- C. Resistant to soil chemicals.
- D. New product made from virgin materials.

2.02 6 OZ/YD² NONWOVEN GEOTEXTILE (AS A COMPONENT OF BLANKET GEOCOMPOSITE)

- A. The 6 oz/yd² geotextile component of the geocomposite shall conform to the following minimum average roll values (MARV), as defined by the Federal Highway Administration (FHWA), for the properties listed below.

Table 31720-1

TEST	ASTM TEST DESIGNATION	UNIT	REQUIREMENT
Polymer Composition (polyester or polypropylene)	N/A	%	> 95
Mass per unit area	D5261	oz/yd ²	> 6
Grab Tensile Strength	D4632	lbs	> 160 ⁽¹⁾
CBR Puncture Resistance	D6241	lbs	> 400
Trapezoidal Tear	D4533	lbs	> 65
Permittivity	D4491	1/sec	> 1.5
UV Resistance	D4355	% strength	> 70
Apparent Opening Size	D4751	mm	< 0.21
1. Average of machine and transverse direction values.			

2.03 16 OZ/YD² NONWOVEN CUSHION GEOTEXTILE

- A. The 16 oz/yd² geotextile shall conform to the following minimum average roll values (MARV), as defined by the Federal Highway Administration (FHWA), for the properties listed below.

Table 31720-2

TEST	ASTM TEST DESIGNATION	UNIT	MINIMUM REQUIREMENT
Polymer Composition (polyester or polypropylene)	N/A	%	95
Mass per unit area	D5261	oz/yd ²	16
Burst Strength	D3786	lbs/in ²	750
Grab Tensile Strength	D4632	lbs	390 ⁽¹⁾
CBR Puncture Resistance	D6241	lbs	1,000
Trapezoidal Tear	D4533	lbs	150
UV Resistance	D4355	% strength	70
1. Average of machine and transverse direction values.			

2.04 MANUFACTURER SOURCE QUALITY CONTROL

- A. The Geotextile MANUFACTURER shall sample and test the geotextiles at a minimum of once for every 100,000 sq. ft. (10,000 sq. m.). Test results shall demonstrate that the material conforms to all requirements in Part 2.02 of this Section, except for UV Resistance, which may be certified by the MANUFACTURER. Perform quality control tests on geotextile, at a sufficient frequency evaluate manufacturer's published material characteristics that meet generally accepted industry standards.
- B. OWNER will reject rolls for which quality control requirements are not met. The rejected rolls will be replaced at no cost to OWNER.
- C. Certify the quality of the rolls of geotextile.
- D. Provide quality control certificates for each lot and each shift's production. The quality control certificates must include:
 - 1. Roll numbers and identification.
 - 2. Sampling procedures.
 - 3. Results of quality control tests, including a description of test methods used.

2.05 LABELING

- A. Mark or tag geotextile rolls with the following information:
 - 1. Manufacturer's name.
 - 2. Product identification.
 - 3. Lot number or date.
 - 4. Roll number.
 - 5. Roll dimensions.
- B. Mark special handling requirements on rolls.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to installation of geotextile, examine underlying construction for conformance with specifications.

3.02 PROTECTION

- A. When placing soil materials over geotextile ensure the following:
 - 1. No damage to geotextile.
 - 2. No slippage of geotextile on underlying layers.
 - 3. No excessive tensile stresses in the geotextile.
- B. Ensure that geotextiles are covered within 15 days of deployment. Contractor needs to account for this in planning the work and construction sequencing.

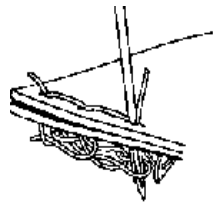
3.03 DEPLOYMENT

- A. Follow Manufacturer's recommendations, standards, and guidelines.

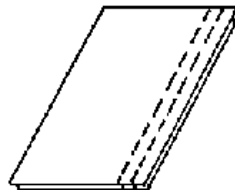
- B. Roll geotextile down slope keeping the geotextile sheet in sufficient tension to prevent folds and wrinkles.
- C. Weight geotextile with sandbags, or equivalent, to ballast during deployment. Leave ballast in place until geotextile is covered with succeeding construction layer.
- D. Cut geotextile using approved cutter only. Take care to protect other in-place geosynthetic materials when cutting geotextile.
- E. Do not trap excessive dust, stones, or moisture in geotextile that could damage or clog drains or filters, or hamper subsequent seaming.
- F. Examine installed geotextile over entire completed surface to ensure that no potentially harmful foreign objects, such as needles, are present. Remove any foreign objects.

3.04 SEAMS AND OVERLAPS

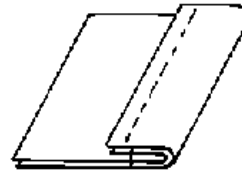
- A. Seams may be either overlapped, sewn, or fusion welded.
- B. Sew or fusion weld all geotextile seams installed as part of the IAS-11 CA construction, unless specifically excluded by OWNER or OWNER's representative.
 - 1. Overlap sewn geotextile seams 3 inches minimum prior to sewing. All sewn seams shall be either "single-prayer", "double prayer", or "single J" seams using a 401 two-thread chain stitch (see Figure 2771-1), or equivalent, and polymeric thread having chemical resistance and strength properties equal to or exceeding those of the geotextile.



401 chain stitch



Double prayer seam



Single "J" seam

- 2. Fusion welded seam shall be welded using a Mini-Wedge® welder or equivalent. Trial weld seam strength testing shall be performed under the supervision of the CQA Consultant on a representative sample of the materials. The samples for trial weld testing shall be seamed together following the procedures to be used in the field. Welded trial seams must have tensile strengths (tested in shear) greater than or equal to those of the parent materials.
- C. Geotextile placed as a separator fabric within excavation backfill may be overlapped a minimum of 24 inches, if not sewn.
- D. Ensure that no soil materials are inadvertently inserted beneath the seams of geotextiles.

3.05 REPAIRS

- A. Repair holes or tears in geotextiles with a patch from the same geotextile material, sewn in place with a minimum seam overlap of 12 inches in all directions. Sew the geotextile

within 1 inch of the outside edge of the patch materials. If tear exceeds 50 percent of the roll width, remove and replace the roll. No patches will be allowed within 1 inch of a panel edge.

- B. Remove any soil or other material which may have penetrated the torn geotextile.
- C. Notify OWNER of all repairs.

3.06 FIELD QUALITY ASSURANCE

- A. The CQAC will collect samples of geotextile delivered to the site for conformance testing at a minimum frequency of one (1) per hundred thousand (100,000) square feet of geotextile, and perform tests to determine product compliance with the values specified in Parts 2.02 and 2.03.
- B. Samples will be taken across the entire width excluding the first 3 feet of the roll unless otherwise approved. Sample size will be 3-foot long by the roll width.
- C. The CQAC will observe all repair operations.

3.07 ACCEPTANCE

- A. CONTRACTOR retains all ownership and responsibility for geotextiles until acceptance by OWNER.
- B. OWNER accepts geotextiles when all the following have been completed:
 - 1. The installation is complete.
 - 2. Conformance tests verify product requirements.
 - 3. Documentation of installation is complete including the CQAC's final report.
 - 4. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
 - 5. Written certification documents have been received by OWNER.

END OF SECTION

**SECTION 31730
GEOCOMPOSITE**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Installing the blanket double-sided geocomposites (geonet sandwiched between nonwoven geotextiles) for the landfill gas (LFG) collection system and vegetative layer for the final cover, as shown on the Construction Drawings. The 6 oz/yd² nonwoven geotextile component shall conform to Section 31720 of these specifications.
- B. Geotextiles heat-bonded to geonet prior to delivery.

1.02 RELATED SECTIONS

- A. Section 31222 – Earthfill
- B. Section 31223 – Waste Placement
- C. Section 31720 – Geotextile
- D. Section 31750 – LLDPE Geomembrane

1.03 REFERENCES

- A. ASTM D792. Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- B. ASTM D1505. Standard Test Method for Density of Plastics by the Density-Gradient Technique.
- C. ASTM D1603. Standard Test Method for Carbon Black in Olefin Plastics.
- D. ASTM D4218. Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
- E. ASTM D4716. Test Method for Constant Head Hydraulic Transmissivity of Geotextiles and Geotextile Related Products.
- F. ASTM D5035. Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method).
- G. ASTM D5199. Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
- H. ASTM D5321. Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
- I. ASTM D6241. Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
- J. ASTM D7005. Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

1.04 DEFINITIONS

- A. Batch: A quantity of resin, usually the capacity of one railcar, used in the fabrication of high density polyethylene (HDPE) geonet. The finished product will be identified by a roll number corresponding to the particular quantity of resin used.
- B. Construction Quality Assurance Consultant (CQAC): The party, independent from MANUFACTURER or INSTALLER, that is responsible for observing and documenting activities related to the quality assurance of production and installation of the geosynthetic components of the lining system.
- C. Construction Quality Assurance (CQA) Laboratory: The party, independent from the OWNER, MANUFACTURER, Fabricator, and INSTALLER, responsible for conducting tests on samples of geosynthetics obtained at the site.
- D. Construction Quality Assurance (CQA) Monitor: The site representative of the CQAC.
- E. Fabricator: The party responsible for the fabrication of geocomposite panels constructed from rolls received from the MANUFACTURER.
- F. MANUFACTURER: The party responsible for the production of the geocomposite rolls from resin and for the quality control of the resin.
- G. Geocomposite Subsurface: The geosynthetic surface on which the geocomposite lies.
- H. INSTALLER: The party responsible for field handling, transporting, storing, deploying, seaming, temporarily restraining (against wind), and installing the geocomposite.

1.05 SUBMITTALS

- A. Product Data: Submit the following to OWNER prior to confirmation of OWNER-CONTRACTOR Agreement.
 - 1. Resin Data.
 - a. Statement of production date or dates.
 - b. Certification stating that the resin meets the product requirements (see Paragraph 2.03).
 - c. Certification stating that all resin is of identical type.
 - d. Copy of quality control certificates issued by MANUFACTURER(s).
 - e. Test reports from MANUFACTURER.
 - 2. Geonet and Geotextile Rolls.
 - a. Statement of production date or dates, and MANUFACTURER's certificates for each day's production.
 - b. Laboratory test results and certification stating that the geonet component meets the product requirements of Part 2 and the geotextile component meet the product requirements of Section 31720.
 - c. Certification stating that all geonet rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.

- d. Certification stating that all geotextile rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.
 - e. Copy of quality control certificates issued by MANUFACTURER and including designation of test methods used. Also include roll numbers, batch numbers, lot numbers, and roll identification.
 - f. Test reports from the MANUFACTURER.
3. Geocomposite Rolls.
- a. Statement of production date or dates, and MANUFACTURER's certificates for each day's production.
 - b. Laboratory test results and certification stating that the geocomposite meets the product requirements of Part 2.
 - c. Certification stating that all geocomposite rolls are furnished by one supplier.
- B. Drawings (INSTALLER).
- 1. Submit installation layout drawing at least 14 days prior to installation of geocomposite. Upon acceptance, use these drawings for installation of geocomposite.

1.06 QUALIFICATIONS

- A. MANUFACTURER: Must have a minimum of 5 years of continuous experience in the manufacture of geocomposites. The MANUFACTURER must demonstrate a minimum of 15 million square feet of manufacturing experience.
- B. INSTALLER: Must have successfully installed a minimum of 1,000,000 square feet of geocomposite with documented references.

1.07 QUALITY ASSURANCE

- A. OWNER will engage and pay for the services of (1) Construction Quality Assurance Consultant (CQAC), and (2) Construction Quality Assurance (CQA) Laboratory for monitoring the quality of geocomposite.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. General: Conform to the MANUFACTURER's requirements.
- B. Delivery (MANUFACTURER):
 - 1. Transportation of the geocomposites shall be the responsibility of the MANUFACTURER. The MANUFACTURER shall be liable for all damage to the materials incurred prior to and during transportation to the site.
 - 2. Deliver materials to the site only after OWNER accepts required submittals.
 - 3. Separate damaged rolls from undamaged rolls and store at locations designated by OWNER until proper disposition of material is determined by OWNER.
 - 4. OWNER will determine damage.

5. Deliver in rolls, do not fold.
- C. Storage on Site (INSTALLER):
1. Store geocomposite rolls in the space allocated by OWNER.
 2. Store geocomposite rolls to protect from UV exposure, puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage.
 3. Store geocomposite rolls on prepared surface (not on wooden pallets).
 4. Stack geocomposite rolls no more than three rolls high.
- D. Handling on Site (INSTALLER):
1. Use appropriate handling equipment to load, move, and deploy geocomposite rolls. Appropriate handling equipment includes cloth chokers and spreader bars for loading, and spreader and roll bars for deployment. Dragging panels on ground surface will not be permitted.
 2. Do not fold geocomposite; folded material will be rejected.
 3. CONTRACTOR is responsible for off-loading, storage, and transporting material from storage area to installation site.

PART 2 PRODUCTS

2.01 GEOCOMPOSITE PROPERTIES

- A. The geocomposite MANUFACTURER shall furnish geocomposite having properties that comply with the required property values shown in Table 31730-1. The geocomposite MANUFACTURER shall provide results of tests performed using the procedures listed in Table 31730-1, as well as certification that the materials meet or exceed the specified values.
- B. In addition to the property values listed in Table 31730-1, the geocomposites shall:
1. Retain their structure during handling, placement, and long-term service.
 2. Be capable of withstanding outdoor exposure for a minimum of **15 calendar days** with no measurable deterioration. Longer exposures may be considered acceptable if MANUFACTURER's certifications are provided to, and reviewed and approved by ENGINEER.
- C. Geotextile will be thermally bonded to the geonet component of geocomposite material rather than chemically bonded.

**Table 31730-1
Geocomposite Property Values**

PROPERTIES	QUALIFIER	UNITS	SPECIFIED VALUES	TEST METHOD
Geonet Component:				
Polymer Composition	Minimum	%	95 polyethylene by weight	N/A
Polymer Specific Gravity	Minimum		0.935	ASTM D792 or D1505
Polymer Melt Index	Maximum	g/10 min.	1.0	ASTM D1238
Carbon Black Content	Range	%	2 – 3	ASTM D1603
Foaming Agents	Maximum	%	0.0	N/A
Nominal Thickness	Minimum	mil	300	ASTM D5199
Geotextile Filter Components:				
<i>2.01.1 As required in Section 31720 of these specifications</i>				
Geocomposite:				
Transmissivity ⁽¹⁾	Minimum	m ² /s	9x10 ⁻⁴	ASTM D4716
Peel Strength/Ply Adhesion	Minimum	lb/in	1	ASTM D413 or D7005

Note:

1. The transmissivity of the geocomposite shall be measured using water at 68°F ±3°F (20°C ±1.5°C) with a hydraulic gradient of 0.25, under a compressive stress of 250 psf. The purpose of the transmissivity test is to simulate the proposed cover system conditions shown on the Construction Drawings; therefore, the geocomposite shall be sandwiched between the material planned for use as foundation layer soil and a layer of LLDPE geomembrane for one test and between a layer of LLDPE geomembrane and the material planned for use as Vegetative Layer for a second test. The minimum test duration shall be 24 hours and the report for the test results shall include measurements at intervals over the entire test duration.

2.02 MANUFACTURING QUALITY CONTROL

- A. The geocomposite shall be manufactured with quality control procedures sufficient for certification requirements of this section and that meet generally accepted industry standards.
- B. The geocomposite MANUFACTURER shall sample and test the geocomposite to demonstrate that the material conforms to all requirements of this section.
- C. Any geocomposite sample that does not comply with this section will result in rejection of the roll from which the sample was obtained. The geocomposite MANUFACTURER shall replace any rejected rolls at no additional cost to OWNER.

- D. If a geocomposite sample fails to meet the quality control requirements of this section, OWNER will require that the geocomposite MANUFACTURER sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
- E. Additional sample testing may be performed, at the geocomposite MANUFACTURER's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required. The geocomposite MANUFACTURER shall sample and test the geocomposite, at a minimum, once every 100,000 sq. ft (10,000 sq. m) to demonstrate that its properties conform to the values specified in Table 31730-1. At a minimum, the following MQC tests shall be performed for the geocomposite:

Table 31730-2

	PROPERTY	PROCEDURE
Geonet Component	Specific gravity Thickness Carbon Black Melt Index Wide-Width Tensile Strength	ASTM D792 ASTM D5199 ASTM D1603 or D4218 ASTM D1238 ASTM D4595
Geotextile Components	As required by Part 2.02 of Section 31720 for Filter Geotextile	
Geocomposite	Peel Strength/Ply Adhesion Hydraulic Transmissivity	ASTM D7005 ASTM D4716

- F. The **hydraulic transmissivity** tests (ASTM D4716) need not be performed at a frequency of one per 100,000 sq. ft. However, the MANUFACTURER shall certify that these tests have been performed under conditions specified in Table 31730-1 on samples of geocomposite identical to the products that will be delivered to the site. The MANUFACTURER shall provide test results to OWNER demonstrating that the MANUFACTURER performed the tests and that acceptable results were obtained.
- G. The geocomposite MANUFACTURER shall certify that the geocomposite has a minimum compressive (roll-over) strength of 10,000 psf.
- H. The geocomposite MANUFACTURER shall additionally comply with the certification and submittal requirements of the CQA Plan.

2.03 PACKING AND LABELING

- A. Geocomposites shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.
- B. Geocomposite rolls shall be indelibly labeled with the following information.
1. MANUFACTURER's name;
 2. Product identification;

3. Lot number;
 4. Roll number;
 5. Roll dimensions, including weight; and
 6. Directions for unrolling.
- C. Geocomposite rolls which cannot be identified per 2.03.B above because of missing or damaged labels will be removed from the job site and replaced with properly labeled rolls at no additional expense to OWNER.
- D. If any special handling is required, it shall be so marked by the geocomposite MANUFACTURER on the rolls.

PART 3 EXECUTION (INSTALLER)

3.01 EXAMINATION OF GEOCOMPOSITE SUBSURFACE

- A. Verify in writing to OWNER that the surface on which the geocomposite will be installed is acceptable.
- B. Subgrade protrusions and grade changes must satisfy Section 31225.

3.02 PREPARATION

- A. The geocomposite shall be placed over the prepared foundation layer after approval by the CQA CONSULTANT and OWNER.
- B. Installation shall be in accordance with the MANUFACTURER's instructions and these Specifications. Where a conflict arises, these Specifications will prevail.

3.03 GEOCOMPOSITE INSTALLATION

- A. Deployment.
 1. Daily Panel Deployment: Deploy no more panels in one shift than can be secured during that same shift.
 2. Do not damage geocomposite by handling, by trafficking, leakage of hydrocarbons, or any other means.
 3. Unroll geocomposite panels using methods that will not damage, stretch or crimp geocomposite. Protect underlying surface from damage.
 4. Do not allow any vehicular traffic directly on geocomposite.
 5. Visually inspect geocomposite for imperfections. Mark faulty or suspect areas for repair.
 6. Geocomposite panels shall be cut using an approved cutter only.
 7. Limit geocomposite deployment to an amount that can be covered by the overlying layer within 15 days of deployment.
 8. During geocomposite panel placement, care should be taken not to entrap stones or moisture that could hamper subsequent seaming.
- B. Connections shall be overlapped a minimum of 6 inches along the length and minimum of one foot along the width (end to end connection of each roll).

1. The upper and lower geotextile portions of the geocomposite shall be overlapped.
 2. Connections of the geonet component shall be made using nylon ties secured at three-foot intervals along the length and one-foot intervals along the width.
- C. Defects.
1. Examine areas of the geocomposite for defects, holes, blister, un-dispersed raw materials, and any sign of contamination by soil and foreign matter. The surface of the geocomposite must be clean at the time of the installation and must be maintained free of soil and foreign material prior to the installation of the overlying LLDPE geomembrane.

3.04 REPAIR PROCEDURES

- A. Remove damaged geocomposite and replace with acceptable geocomposite materials if damage cannot be satisfactorily repaired.
- B. Repair, removal, and replacement are at CONTRACTOR's expense if the damage results from the CONTRACTOR's, INSTALLER's, or the CONTRACTOR's subcontractor activities.
- C. Repair any portion of the geocomposite exhibiting a flaw. Agreement upon the appropriate repair method will be determined between OWNER's Representative, the CQAC and the INSTALLER. Repair procedures available include:
 1. Patch to repair large holes and tears (over 2 inches long) by overlapping geocomposite 1 (one) foot in all directions.

3.05 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

- A. General.
 1. MANUFACTURER, Fabricator, and INSTALLER will participate in and conform with all terms and requirements of OWNER's CQA program. The CONTRACTOR is responsible for assuring this participation. CQC and CQA requirements are as specified in this paragraph and the CQA Plan.
- B. Conformance Testing (Performed by CQAC).
 1. Allow 3 days for conformance testing following the date material is available to the CQAC.
 2. CQAC will obtain samples as specified in Section 3.05.B.9. Conformance samples of the geonet and geotextile components shall be collected in addition to samples of the completed geocomposite. The CQAC shall coordinate with the manufacturer and installer to obtain component samples prior to heat bonding.
 3. Forward samples to Construction Quality Assurance Laboratory.
 4. Test samples for conformance with design specifications and guaranteed properties.
 5. Perform, as a minimum, the following tests to determine **geonet** characteristics.
 - a. Density: ASTM D792, Method A or ASTM D1505
 - b. Thickness: ASTM D5199
 - c. Carbon Black Content: ASTM D1603

6. Perform, as a minimum, the following tests to determine **geotextile** characteristics.
 - a. Grab strength (ASTM D4632)
 - b. Mass per unit area (ASTM D5261)
 - c. Puncture strength (ASTM D6241)
 - d. Trapezoidal tear strength (ASTM D4533)
 - e. Permittivity (ASTM D4491)
 - f. AOS (ASTM D4751)
7. Perform, as a minimum, the following tests to determine **geocomposite** characteristics.
 - a. Transmissivity: (ASTM D4716)
 - b. Peel strength: (ASTM D413 or ASTM D7005)
8. Additional tests may be performed at the discretion of the CQAC.
9. Sampling Procedures.
 - a. Sample across the entire width of the roll.
 - b. Cut sample 3-foot long by width of roll.
 - c. Mark machine direction on the samples with an arrow. CQA Monitor will be responsible for markings.
 - d. Sample at a rate of one per lot or 1 per 100,000 square feet of material supplied, whichever results in greatest number.
10. Conformance testing of the strip geocomposite is not required.

3.06 GEOCOMPOSITE ACCEPTANCE

- A. CONTRACTOR retains all ownership and responsibility for the geocomposite until acceptance by OWNER.
- B. OWNER will accept geocomposite installation when:
 1. All required documentation from the MANUFACTURER, fabricator, and INSTALLER has been received and accepted.
 2. The installation is finished.

END OF SECTION

**SECTION 31750
LLDPE GEOMEMBRANE**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes furnishing and installing the 40-mil thick Linear Low-Density Polyethylene (LLDPE) geomembrane for the consolidation cells final cover systems.

1.02 RELATED SECTIONS

- A. Section 31222 – Earthfill
- B. Section 31223 – Waste Placement
- C. Section 31720 – Geotextile
- D. Section 31730 – Geocomposite

1.03 REFERENCES

- A. Construction Quality Assurance (CQA) Plan.
- B. ASTM D638. Standard Test Method for Tensile Properties of Plastics.
- C. ASTM D746. Standard Test Method for Brittleness, Temperature of Plastics and Elastomers by Impact.
- D. ASTM D792. Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
- E. ASTM D1004. Standard Test Method of Initial Tear Resistance of Plastic Film and Sheeting.
- F. ASTM D1204. Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
- G. ASTM D1238. Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
- H. ASTM D1505. Standard Test Methods for Density of Plastics by Density-Gradient Technique.
- I. ASTM D1603. Standard Test Method for Carbon Black in Olefin Plastics.
- J. ASTM D1693. Standard Test Method for Environmental Stress Cracking of Ethylene Plastics.
- K. ASTM D3895. Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry.
- L. ASTM D4218. Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
- M. ASTM D4833. Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

- N. ASTM D5199. Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
- O. ASTM D5321. Standard Test Method for determining the coefficient of soil and geosynthetic or geosynthetic and geosynthetic friction by the direct shear method.
- P. ASTM D5397. Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
- Q. ASTM D5596. Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
- R. ASTM D5617. Standard Test Method for Multi-Axial Tension Test for Geosynthetics.
- S. ASTM D5641. Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
- T. ASTM D5885. Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.
- U. ASTM D5994. Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
- V. ASTM D6365. Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test.
- W. ASTM D6392. Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
- X. ASTM D6693. Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- Y. ASTM D7466. Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.
- Z. GRI Test Method GM17. Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.
- AA. GRI GM19 – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.04 DEFINITIONS

- A. Batch: A quantity of resin, usually the capacity of one railcar, used in the fabrication of LLDPE geomembrane sheet. The finished sheet will be identified by a roll number corresponding to the particular quantity of resin used.
- B. Bridging: The condition when geomembrane becomes suspended over its subgrade due to contraction of the material or poor installation.
- C. Construction Quality Assurance Consultant (CQAC): The party, independent from MANUFACTURER or INSTALLER, that is responsible for observing and documenting activities related to the quality assurance of production and installation of the geosynthetic components of the lining system.

- D. Construction Quality Assurance (CQA) Laboratory: The party, independent from OWNER, MANUFACTURER, Fabricator, and INSTALLER, responsible for conducting tests on samples of geosynthetics obtained at the site.
- E. Construction Quality Assurance (CQA) Monitor: The site representative of the CQAC.
- F. Extrudate: The molten polymer which is emitted from an extruder during seaming using either extrusion fillet or extrusion flat methods. The polymer is initially in the form of a ribbon rod, bead or pellets.
- G. Fabricator: The party responsible for the fabrication of geomembrane panels constructed from rolls received from the MANUFACTURER.
- H. MANUFACTURER: The party responsible for the production of the geomembrane rolls from resin and for the quality control of the resin.
- I. Geomembrane: An essentially impermeable membrane used as a solid or liquid barrier. Synonymous term for flexible membrane liner (FML).
- J. Geomembrane Subsurface: The soil or geosynthetic surface on which the geomembrane lies.
- K. INSTALLER: The party responsible for field handling, transporting, storing, deploying, seaming, temporarily restraining (against wind), and installing the geomembrane.
- L. Panel: The unit area of geomembrane that will be seamed in the field. If the geomembrane is not fabricated into panels in a factory, a panel is identified as a roll or portion of a roll without any seams.

1.05 SUBMITTALS

- A. Product Data: Submit the following to OWNER prior to confirmation of OWNER-CONTRACTOR Agreement.
 - 1. Resin Data.
 - a. Statement of production date or dates.
 - b. Certification stating that the resin meets the product requirements (see Paragraph 2.03).
 - c. Certification stating that all resin is from the same manufacturer, and that no reclaimed polymer is added to the resin.
 - d. Copy of quality control certificates issued by MANUFACTURER.
 - e. Test reports from MANUFACTURER.
 - 2. Geomembrane Rolls (MANUFACTURER).
 - a. Statement of production date or dates, and MANUFACTURER's certificates for each day's production.
 - b. Laboratory test results and certification stating that the geomembrane meets the product requirements of Part 2.
 - c. Certification stating that all geomembrane rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.

- d. Copy of quality control certificates issued by MANUFACTURER and including designation of test methods used. Also include roll numbers, batch numbers, lot numbers, and roll identification.
 - e. Test reports from the MANUFACTURER.
 - f. Typical results of complete notched constant tensile load test for specified resin and sheet thickness.
 - g. Statement certifying that no reclaimed polymer is added to the resin.
 - h. Statement listing percentages of processing aids, antioxidants, and other additives other than carbon black added to or in the resin.
 - i. Geomembrane delivery, storage, and handling instructions.
 - j. Geomembrane installation instructions.
 - k. Sample warranties for review.
- B. Extrudate Beads and/or Rod (MANUFACTURER).
1. Statement of production date or dates.
 2. Laboratory certification stating that the extrudate meets the product requirements of Part 2.
 3. Certification stating that all extrudate is manufactured by one manufacturer and resin is supplied from one supplier.
 4. Copy of quality control certificates issued by MANUFACTURER.
 5. Test reports from the MANUFACTURER.
 6. Certification stating that the extrudate bead or rod resin is the same type, from the same manufacturer and compatible with the resin used to manufacture the geomembrane supplied for this project.
- C. Schedules and Drawings (INSTALLER).
1. Submit installation schedule 2 weeks prior to installation. Include hours to be worked per day, week and shift. Indicate all weather delay built into schedule.
 2. Submit installation layout drawings 2 weeks prior to installation of geomembrane, submit drawings showing the panel layout indicating both fabricated (if applicable) and field seams, and details not conforming to the Contract Drawings. Upon acceptance, use these drawings for installation of geomembrane.
- D. Qualifications (INSTALLER).
1. Submit, 2 weeks prior to installation, name of INSTALLER, and resume of installation supervisor assigned to the project.
 2. Submit, 2 weeks prior to installation, resume of master seamer.
 3. Submit, 2 weeks prior to installation, resumes of installation seamers that will perform seaming operations.
- E. Field Quality Control Documents (INSTALLER).
1. Submit quality control documentation prepared during installation. Submit no later than 1 week following completion of work.

2. Submit daily prior to the start of installation, subgrade acceptance certificate signed by the installation supervisor for each area to be covered by the geomembrane. Allow OWNER or OWNER's representative time to inspect certified area.
- F. Equipment: Submit the following 2 weeks prior to installation: (INSTALLER).
1. Equipment list stating quantity, types, model numbers, calibration certificates, and maintenance requirements.
- G. Submit upon completion of the installation: (INSTALLER).
1. Certificate stating the liner has been installed in accordance with the plans and specifications.
 2. The warranty obtained from the MANUFACTURER/fabricator and the installation warranty.
 3. As-built drawings showing locations of panels, seams, repairs, patches, and destructive samples, including measurements.
 4. Copies of seam test results and statistical analysis of each welder's performance.
- H. During installation, the INSTALLER shall be responsible for the timely submission to the CQAC of:
1. Quality control documentation; and
 2. Subgrade acceptance certificates, signed by the INSTALLER, for each area to be covered by the geomembrane.

1.06 QUALIFICATIONS

- A. MANUFACTURER: Must have at least 5 years of continuous experience in the manufacture of LLDPE geomembrane rolls or similar products. The MANUFACTURER must demonstrate, by submitting a list of previous projects, a minimum of 15 million square feet of manufacture of LLDPE geomembrane or similar products.
- B. INSTALLER: Must have successfully installed a minimum of 10,000,000 square feet of welded polyethylene geomembrane with documented references.
- C. Master Welder Qualifications: Must have completed a minimum of 5,000,000 square feet of polyethylene geomembrane seaming work using the type of seaming apparatus proposed for use on this project.
- D. Other Seamers Qualifications: All seamers must have seamed a minimum of 1,000,000 square feet of LLDPE geomembrane.

1.07 QUALITY ASSURANCE

- A. OWNER will engage and pay for the services of (1) Construction Quality Assurance Consultant (CQAC), and (2) Construction Quality Assurance (CQA) Laboratory for monitoring the quality and installation of geomembrane material being installed as outlined in the Construction Quality Assurance (CQA) Plan.

- B. The Contractor shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the installation schedule.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. General: Conform to the MANUFACTURER's requirements.
- B. Delivery: (MANUFACTURER).
 - 1. Deliver materials to the site only after OWNER accepts required submittals.
 - 2. Separate damaged rolls from undamaged rolls and store at locations designated by OWNER until proper disposition of material is determined by OWNER.
 - 3. OWNER or OWNER's representative will determine damage.
 - 4. Deliver in rolls, do not fold.
- C. Storage on Site: (CONTRACTOR/INSTALLER).
 - 1. Store geomembrane rolls in the space allocated by OWNER.
 - 2. Store geomembrane rolls to protect from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage.
 - 3. Store geomembrane rolls on prepared surface (not on wooden pallets).
 - 4. Stack geomembrane rolls no more than three rolls high.
- D. Handling on Site: (CONTRACTOR/INSTALLER).
 - 1. Use appropriate handling equipment to load, move, and deploy geomembrane rolls. Appropriate handling equipment includes cloth chokers and spreader bars for loading, and spreader and roll bars for deployment. Dragging panels on ground surface will not be permitted.
 - 2. Do not fold geomembrane material; folded material will be rejected.
 - 3. CONTRACTOR is responsible for off-loading, storage, and transporting material from storage area to installation site.

1.09 WARRANTY (MANUFACTURER)

- A. Provide MANUFACTURER's warranty for geomembrane material in compliance with provisions of the Conditions of the Contract. Provide a minimum 20-year pro rata warranty for the material against deterioration due to exposure to the elements, either exposed or buried. The warranty for material must cover costs of material replacement and installation; assuming the area is rendered in a clean, dry, unencumbered condition. In the event the area cannot be rendered as such, compensation for defective material will be provided to OWNER on a pro rata basis for the estimated cost to OWNER at that time of supplying and installing material to a clean, dry, and unencumbered condition by a third-party installer.
- B. Installation: Provide an installation warranty for geomembrane material in compliance with the conditions of the Contract. Provide a minimum of 2-year non-pro rata warranty for the installation against defects.

PART 2 PRODUCTS

2.01 GEOMEMBRANE LABELING

- A. Provide the following information on geomembrane roll labels.
 - 1. Length, width, and weight.
 - 2. Name of MANUFACTURER and fabricator.
 - 3. Directions for unrolling.
 - 4. Product identification; lot number, batch number, and roll number.
- B. Geomembrane rolls which cannot be identified per 2.01.A above because of missing or damaged labels will be removed from the job site and replaced with properly labeled rolls at no additional expense to OWNER.

2.02 GEOMEMBRANE RESIN

- A. Resin shall be new, first quality, compounded, and manufactured specifically for producing LLDPE geomembrane.
- B. Do not mix resin types during manufacturing.
- C. Meeting the following requirements listed in Table 31750-1 unless otherwise approved:

**Table 31750-1
Properties for LLDPE Geomembrane Resin**

TEST	TEST DESIGNATION	REQUIREMENTS
Specific Gravity ¹	ASTM D792, Method B, or ASTM D1505	0.932 g/cm ³ minimum
Melt Flow Index	ASTM D 1238 Condition E, 190°C, 2.16 kg	1.0 g/10 min., maximum
¹ Measure on pure resin without additives.		

2.03 DOUBLE-SIDED TEXTURED GEOMEMBRANE

- A. Manufacturing:
 - 1. LLDPE geomembrane with two textured surfaces.
 - 2. Do not exceed a combined maximum total of 1 percent by weight of additives, fillers, or extenders other than carbon black or pigment. Identify percentage of processing aids, antioxidants, and other additives other than carbon black.
 - 3. Use materials produced in the United States or Canada.
 - 4. Provide finished product free from blemishes, holes, pin holes, bubbles, blisters, excessive gels, undispersed resins and/or carbon black, contamination by foreign matter and nicks or cuts on edges.
 - 5. Roll manufactured sheets or panel for shipment.
- B. The Geomembrane MANUFACTURER shall furnish geomembrane having properties that comply with the required property values shown in Table 31750-2. The Geomembrane MANUFACTURER shall provide results of tests performed using the procedures listed

in Table 31750-2, as well as certification that the materials meet or exceed the specified values.

- C. The LLDPE geomembrane shall be textured on one side, and the other side shall have studs so that along with an overlying geotextile the geomembrane will perform as drainage material.

**Table 31750-2
Properties for 40-mil Double-Sided Textured LLDPE Geomembrane**

TEST	TEST DESIGNATION	REQUIREMENTS
Sheet Thickness (does not include textured surface)	ASTM D5994	40 mil nominal -5%; lowest individual for 8 out of 10 values -10%; lowest individual for any of the 10 values, -15% (does not include textured surface)
Asperity	ASTM D7466	20 mil and examine for uniformity of texture visually.
Sheet Density	ASTM D792 or D1505	Maximum 0.939 g/cm
Oxidation Induction Time of Polyolefins	ASTM D8117, Standard or D5885, High Pressure	Minimum 100 minutes (ASTM D8117) or 400 minutes (ASTM D5885)
Tensile Strength at Break	ASTM D6693 Type IV	Min. 60 lbs/in (per unit width)
Elongation at Break	ASTM D6693 Type IV	Min. 250%
Tear Resistance	ASTM D1004, Die C	Min. 22 lb.
Puncture Resistance	ASTM D4833	Min. 44 lb.
Carbon Black Content	ASTM D4218	2 to 3%
Carbon Black Dispersion	ASTM D5596	9 in Categories 1 or 2 and 1 in Category 3
Oven Aging at 85°C	ASTM D5721 with D8117 or D5885	Standard OIT (minimum average) 35% or High Pressure OIT (minimum average) 60% retained after 90 days
UV Resistance	ASTM D7238 with D5885, 20 hr UV cycle at 75°C then 4 hr condensation at 60°C	35% retained after 1600 hours

2.04 EXTRUDATE ROD OR BEAD

- A. Meeting the MANUFACTURER's requirements.
- B. Made from same resin as the geomembrane.
- C. Thoroughly disperse additives throughout rod or bead.
- D. Containing 2 to 3 percent carbon black.
- E. Free of contamination by moisture or foreign matter.

2.05 WELDING EQUIPMENT

- A. Supply seam welding accessories meeting the following requirements:
1. Maintain sufficient operational seaming apparatus to continue work without delay.
 2. Use power source capable of providing constant voltage under combined line load.
 3. Provide protective lining and splash pad large enough to catch spilled fuel under electric generator, if located on liner.
 4. Tensiometers capable of measuring seam strength, calibrated and accurate within 2 pounds.
 5. Dies for cutting seam samples in first class condition.

2.06 MANUFACTURING QUALITY CONTROL

- A. Perform the following quality control tests at the manufacturing plant or other laboratories on geomembrane products:

**Table 31750-3
Manufacturer Quality Control Tests for All Geomembranes**

TEST	TEST DESIGNATION	FREQUENCY
Sheet Thickness	ASTM D5994	10 per roll
Asperity	ASTM D7466	(b)
Sheet Density	ASTM D792 (Method B) or D1505	(a)
Oxidation Time of Polyolefins	ASTM D8117 or D5885	(c)
Tensile Strength	ASTM D6693, Type IV	(b)
Elongation	ASTM D6693, Type IV	(b)
Tear Resistance	ASTM D1004, Die C	(b)
Puncture Resistance	ASTM D4833	(b)
Carbon Black Content	ASTM D4218	(b)
Carbon Black Dispersion	ASTM D5596	(b)
Oven Aging	ASTM D5721 with D8117 or D5885	(d)
UV Resistance	ASTM D7238 with D5885	(d)
<p>Note: Contact OWNER for test sample location.</p> <p>a. One per 100,000 square feet of sheet produced or one per resin batch, whichever results in the greatest number of tests.</p> <p>b. One per 50,000 square feet or one per resin batch, whichever results in the greater number of tests.</p> <p>c. One test per resin batch.</p> <p>d. One test per resin formulation.</p>		

- B. The MANUFACTURER shall permit OWNER's Representative to visit the manufacturing plant for project specific visits. If possible, such visits will be prior to or during the manufacturing of the geomembrane rolls for the specific project.

PART 3 EXECUTION

3.01 FAMILIARIZATION

- A. Verify in writing to OWNER that the surface on which the geomembrane will be installed is acceptable.
- B. No particles or debris on the geocomposite are allowed.

3.02 PREPARATION

- A. Repair damage caused to subgrade during deployment.
- B. Round edges of anchor trenches or cushion with geotextiles.
- C. Perform trial seam welds as follows:
 - 1. Perform trial welds on samples of geomembrane to verify the performance of welding equipment, seaming methods, and conditions.
 - 2. No seaming equipment or welder will be allowed to perform production welds until equipment and welders have successfully completed trial welds.
 - 3. Frequency of trial welds:
 - a. Minimum of two trial welds per day with one prior to the start of work and one at mid shift.
 - b. When directed by the CQA Monitor.
 - c. Every 2 hours when using a wedge weld to weld across seams.
 - d. Minimum one trial weld per person per shift.
 - e. When ambient temperature changes more than 10°F since previous trial weld.
 - 4. Make trial welds in the same surroundings and environmental conditions as the production welds, i.e., in contact with subgrade.
 - 5. Make trial weld sample at least 5 feet long and 12 inches wide with the seam centered lengthwise.
 - 6. Cut two, 1-inch wide test strips from opposite ends of the trial weld.
 - 7. Quantitatively test specimens, first for peel adhesion, and then for bonded seam strength (shear) (ASTM D6392).
 - 8. A single or double wedge weld specimen is considered passing when the following results are achieved. For double-wedge welding, both welds must pass in peel and shear.
 - a. The break is a film tearing bond (FTB).
 - b. The break is ductile.
 - c. The minimum peel and shear strengths are shown in the table below.

**Table 31750-4
Required 40-mil LLDPE Geomembrane Seam Strengths (Trial and Production Welds)**

TEST	Minimum Strength (lb/in)	Test Method
Hot Wedge Shear Strength ¹	60	ASTM D6392
Hot Wedge Peel Strength	50	ASTM D6392
Extrusion Shear Strength	60	ASTM D6392
Extrusion Peel Strength	44	ASTM D6392
1. Also called “bonded seam strength.”		

- d. For peel testing, there is no more than 10 percent separation of the weld. For wedge welds the width of the weld is equal to the width of the nip roller.
- e. For shear testing, set grips back 2 inches from the edge of the weld. Minimum elongation between the grips must be 2 inches.
- 9. A trial weld sample is considered passing when specimens pass peel and shear tests.
- 10. Repeat the trial weld in its entirety when any of the trial weld samples fail in either peel or shear.
- 11. When repeated trial weld fails, do not use welding apparatus and welder until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

3.03 INSTALLATION

A. Deployment.

- 1. Give careful consideration to the timing and temperature during deployment. The INSTALLER must verify that (a) there is no bridging or stresses in the geomembrane and (b) there are no wrinkles in the geomembrane that will fold over when covering with soil material. Ideally, deployment, welding, and covering should all occur at the same temperature. In a practical sense the INSTALLER should strive to perform these activities within as narrow a temperature range as practical, and avoid these activities during peak hot or cold conditions.
- 2. Panel Identification: Assign each panel an identifying code number of letter consistent with the INSTALLER’s submitted panel layout drawing. The coding is subject to approval by the CQA Monitor.
- 3. Daily Panel Deployment: Deploy no more panels in one shift than can be welded or secured during that same shift.

4. Do not deploy in the presence of excessive moisture, fog, dew, precipitation, ponded water, or high winds.
 5. Do not damage geomembrane by handling, by trafficking, or leakage of hydrocarbons or any other means.
 6. Do not wear damaging shoes or engage in activities that could damage the geomembrane.
 7. Unroll geomembrane panels using methods that will not damage, stretch or crimp geomembrane. Protect underlying surface from damage.
 8. Use methods that minimize wrinkles and differential wrinkles between adjacent panels.
 9. Remove wrinkled or folded material.
 10. Place ballast on geomembrane that prevents uplift from wind.
 11. Use ballast that will not damage geomembrane.
 12. Protect geomembrane in area of heavy traffic by placing protective cover which is compatible with and will not damage geomembrane.
 13. Repair damage to subgrade or other underlying materials prior to completing deployment of geomembrane.
 14. Do not allow any vehicular traffic directly on geomembrane.
 15. Visually inspect geomembrane for imperfections. Mark faulty or suspect areas for repair.
 16. Install material to account for shrinkage and contraction while avoiding wrinkles. Install material stress-free with no bridging before it is covered. Add material as needed to avoid bridging.
 17. Before wrinkles fold over, attempt to push them out. For wrinkles that cannot be pushed out, cut them out and repair cuts prior to burial or at the direction of the CQA Monitor.
 18. Use slip sheet when deploying textured geomembrane over geotextiles to avoid damaging geotextile fibers.
- B. Seam layout.
1. Orient seams parallel to line of a maximum slope, i.e., orient down not across slope.
 2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.
 3. Keep horizontal seams (seams running approximately parallel to slope contours) at least 6 feet away from toe or crest of slope, unless approved by OWNER.
 4. Use seam numbering system compatible with panel number system.
 5. Shingle panels on all slopes and grades as directed by OWNER.
- C. Seam welding personnel.

1. Provide at least one welder (master welder) who has experience welding over 5 million square feet of geomembrane using the same type of welding apparatus in use at site.
 2. Qualify personnel performing welding operations by experience and by successfully passing field welding tests performed on site.
 3. Master welder will provide direct supervision over other welders.
- D. Seam welding equipment.
1. Extrusion welder: equipped with gauges showing temperatures in extruder apparatus and at nozzle. Temperature at nozzle may be measured by external temperature gauges.
 2. Hot wedge welder: Automated variable speed vehicular mounted devices equipped with devices adjusting and giving temperatures at wedge. Pressure controlled by spring, pneumatic, or other system that allows for variation in sheet thickness. Rigid frame fixed position equipment is not acceptable.
 3. Maintain adequate quality of welding apparatus in order to avoid delaying the project.
 4. Use power source capable of providing constant voltage under combined line load.
- E. General welding procedures:
1. Do not commence welding until trial weld test sample, made with the equipment to be used passes trial weld test.
 2. Clean geomembrane surface of grease, moisture, dust, dirt, debris, and other foreign material.
 3. Overlap panels a minimum 3 inches for extrusion and 4 inches for hot wedge welding.
 4. Do not use solvents or adhesives unless product is approved in writing by OWNER.
 5. Provide adequate material on weld to allow peel testing of both sides of double wedge weld.
 6. Extend welding to the outside edge of all panels.
 7. If required, provide a firm substratum by using a flat board, a conveyor belt, or similar hard surface directly under the weld overlap to achieve firm support.
 8. Provide adequate illumination if welding operations are carried out at night, and night operations are approved by OWNER.
 9. Cut fishmouths or wrinkles along the ridge of the wrinkle in order to achieve a flap overlap. Extrusion weld the cut fishmouths or wrinkles where the overlap is more than 3 inches. When there is less than 3 inches overlap, patch with an oval or round patch extending a minimum of 6 inches beyond the cut in all directions.
 10. Log every 2 hours:
 - a. Temperature directly on the geomembrane surface being welded.

- b. Extrudate temperatures in barrel and at nozzle (extrusion welder).
 - c. Operating temperature of hot wedge (hot wedge welder) and any pressure adjustments made.
 - d. Preheat temperature.
 - e. Speed of hot wedge welder in feet per minute.
11. Weld only when ambient temperature, measured 6 inches above the geomembrane, is between 40°F (5°C) and 110°F (43°C).
 12. If the INSTALLER seams at ambient temperatures below 40°F (5°C) or above 110°F (43°C), then the INSTALLER must demonstrate and certify that such methods produce seams which are entirely equivalent to seams produced at ambient temperatures above 40°F (5°C) and below 110°F (43°C), and that the overall quality of the geomembrane is not adversely affected. In addition, a change order to the contract between the OWNER and the INSTALLER is required which specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane. Then, the temperatures in the above quality assurance procedure will be modified accordingly.
 13. Seaming below temperatures of 32°F must include preheating methods approved by OWNER.
- F. Defects and repairs.
1. Examine all welds and non-weld areas of the geomembrane for defects, holes, blister, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane must be clean at the time of the examination.
 2. Repair and non-destructively test each suspect location both in weld and non-weld areas. Do not cover geomembrane at locations which have been repaired until test results with passing values are available.
- G. Extrusion type of welding.
1. Use procedures to tack bond adjacent panels together that do not damage geomembrane and allow CQA tests to be performed.
 2. Purge welding apparatus of heat-degraded extrudate before welding.
 3. Bevel top edges of geomembrane a minimum of 45° and full thickness of geomembrane before extrusion welding.
 4. Clean seam welding surfaces of oxidation by disc grinder or equivalent not more than 30 minutes before extruding weld. Change grinding discs frequently. Do not use clogged discs.
 5. Do not remove more than 4 mils of material when grinding.
 6. Grind across, not parallel to, welds.
 7. Cover entire width of grind area with extrudate.

8. When restarting welding, grind ends of all welds that are more than 5 minutes old.
- H. Hot Wedge Welding.
1. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.
 2. Protect against moisture build-up between panels.
 3. If welding cross seams, conduct field test welds at least every 2 hours, otherwise, once prior to start of work and once at mid-day.
 4. Bevel edges of top and bottom panels on cross seams.
 5. Do not weld on geomembrane until equipment has passed trial weld test.
 6. Extrusion-weld a repair patch over all seam intersections as described in Paragraph 3.05.

3.04 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

- A. General.
1. MANUFACTURER, Fabricator, and INSTALLER will participate in and conform with all terms and requirements of OWNER's construction quality assurance program. The CONTRACTOR and INSTALLER are responsible for assuring this participation. Construction quality control and quality assurance requirements are as specified in this paragraph and the CQA manual.
- B. Conformance Testing (Performed by Construction Quality Assurance Laboratory).
1. Allow 5 days for conformance testing following the date material is available to the CQAC.
 2. Perform conformance testing on geomembrane rolls.
 3. Obtain samples as specified in Section 3.04.B.7. CQA Monitor will obtain samples.
 4. Forward samples to Construction Quality Assurance Laboratory.
 5. Test samples for conformance with design specifications and guaranteed properties.
 6. Perform, as a minimum, the following tests to determine geomembrane characteristics.
 - a. Density: ASTM D792, Method B or ASTM D1505.
 - b. Asperity: ASTM D7466
 - c. Thickness: Measured with appropriate micrometer where applicable. Take 10 measurements across the roll width.
 - d. Tensile Strength: ASTM D6693.
 - e. Carbon Black Content: ASTM D1603.
 - f. Carbon Black Dispersion: ASTM D5596.
 - g. Where optional procedures are noted in the test method, the requirements of the specifications prevail.
 - h. Additional tests may be performed at the discretion of the CQAC.

7. Sampling Procedures.
 - a. Sample across the entire width of the roll.
 - b. Cut sample 3 feet long by width of roll.
 - c. Mark machine direction on the samples with an arrow. CQA Monitor will be responsible for markings.
 - d. Sample at a rate of one per batch or one per 100,000 square feet of material supplied, whichever results in greatest number.

- C. Interface Direct Shear Strength: ASTM D5321. The CQAC will collect samples of geomembrane, geocomposite, and geotextile for interface direct shear strength testing at a minimum of one test per material type. Interface direct shear strength testing shall be conducted between the geocomposite and 40-mil double-sided textured LLDPE geomembrane using site-specific materials. The interfaces will be tested to post-peak conditions, defined as the point at which the applied shear force remains constant with increasing shear displacement. The minimum post-peak shear displacement shall be 3 inches. Submit, one each, 6"x6" coupons of geocomposite and geotextile and two 6"x6" coupons of geomembrane from the rolls of material that were used for each test to the CQA laboratory. Testing shall be performed such that orientation of the materials being tested (i.e. which side is up) is consistent with orientation of installation in the field. Testing shall be performed as described below:
 1. **Geocomposite (bottom) to Double-sided Textured LLDPE Geomembrane (top)**
 - a. Measure the asperity of both sides of the geomembrane [ASTM D7466] and report the value on the test data sheet.
 - b. Attach the site-specific LLDPE geomembrane to the upper box, with the lower asperity (as measured in D.1.a) side down.
 - c. Spray the surface of the LLDPE geomembrane with water.
 - d. Attach the site-specific geocomposite to the lower box and place the upper box over the geocomposite.
 - e. For each normal load, apply the normal test load, keep the sample ends open, and flood the system with water for at least 1 hour.
 - f. Use test normal stresses of 100, 200 and 400 psf.
 - g. Shear at 0.2 in./min per ASTM D5321 to a post-peak displacement of at least 3 in. (75 mm) or the point at which the applied shear force remains constant with increasing displacement, whichever is larger.
 2. **Geocomposite (top) to Double-sided Textured LLDPE Geomembrane (bottom)**
 - h. Measure the asperity of both sides of the geomembrane [ASTM D7466] and report the value on the test data sheet.
 - i. Attach the site-specific LLDPE geomembrane to the upper box, with the lower asperity (as measured in D.1.a) side down.

- j. Spray the surface of the LLDPE geomembrane with water.
 - k. Attach the site-specific geocomposite to the lower box and place the upper box over the geocomposite.
 - l. For each normal load, apply the normal test load, keep the sample ends open, and flood the system with water for at least 1 hour.
 - m. Use test normal stresses of 100, 200 and 400 psf.
 - n. Shear at 0.2 in./min per ASTM D5321 to a post-peak displacement of at least 3 in. (75 mm) or the point at which the applied shear force remains constant with increasing displacement, whichever is larger.
 - o.
 - 3. The testing laboratory should report the interface where deformations are observed, the height of the geomembrane asperities [ASTM D7466], and any other observation on the behavior of the materials (e.g., ripping of the geotextile or geotextile component of the geocomposite). The minimum required post-peak friction angle for all interfaces is **20 degrees**.
- D. Field Testing (Performed by INSTALLER).
- 1. General: Non-destructively test all field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), spark testing, or other approved methods. Perform testing as the seaming progresses and not at the completion of all the field seaming. Complete all required repairs in accordance with this specification. CQAC need to be informed when testing will be performed.
 - 2. Vacuum Testing.
 - a. Equipment:
 - 1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole, or valve assembly, and a vacuum gauge.
 - 2) A vacuum pump assembly equipped with a pressure control
 - 3) A rubber pressure/vacuum hose with fittings and connections.
 - 4) A soapy solution and an applicator.
 - b. Test Procedures.
 - 1) Place the box over the wetted seam area (soapy solution).
 - 2) Ensure that a leak-tight seal is created.
 - 3) Energize the vacuum pump and reduce the vacuum box pressure to approximately 10 inches of mercury, i.e., 5 psi gauge.
 - 4) Examine the geomembrane through the viewing window for the presence of soap bubbles for a period of not less than 10 seconds.
 - 5) Mark all areas where soap bubbles appear and repair in accordance with repair procedures described in this specification.

3. Air pressure testing for seaming processes producing a double seam with an enclosed channel.
 - a. Equipment, comprised of the following:
 - 1) An air pump (manual or motor driven) equipped with a pressure gauge capable of generating and sustaining a pressure over 40 psi and mounted on a cushion to protect the geomembrane.
 - 2) A rubber hose with fittings and connections.
 - 3) A sharp hollow needle, or other approved pressure feed device.
 - 4) A pressure gauge with an accuracy of plus or minus 1 psi.
 - b. Test Procedures.
 - 1) Seal both ends of the welded seam to be tested.
 - 2) Insert needle or other approved pressure feed device into the tunnel created by the weld.
 - 3) Energize the air pump to a minimum pressure of 20 psi or 0.5 psi per mil of liner thickness, whichever is greater, close valve and sustain pressure for at least 5 minutes.
 - 4) If loss of pressure exceeds 2 psi (10 mm mercury), or otherwise approved, or does not stabilize, locate faulty area and repair in accordance with repair procedures described in this specification.
 - 5) Puncture opposite end of seam to release air. If blockage is present, locate and test seam on both sides of blockage.
 - 6) Remove needle or other approved pressure feed device and seal the penetration holes.
4. Spark Testing for penetrations or other difficult areas not accessible for vacuum testing.
 - a. Equipment and Materials.
 - 1) 24-gauge copper wire.
 - 2) Low-amperage electric detector, 20,000 to 30,000 volts, with brush-type electrode capable of causing visible arc up to 3/4 inch from copper wire.
 - b. Procedures.
 - 1) Place copper wire within 1/4 inch of the edge of extrusion seam or clamp seal.
 - 2) Pass electrode over seam or clamp area and observe for spark. If a spark is detected perform a repair.
5. Destructive Testing (performed by CQAC and the INSTALLER).
 - a. Location and Frequency of Testing.
 - 1) Collect destructive test samples at a minimum frequency of one test location per 500 feet of seam length.

- 2) Determine test locations during welding. Locations may be prompted by suspicion or excess crystallinity, contamination, offset welds, or suspected defect. Monitor will be responsible for choosing the locations. Monitor will not notify INSTALLER in advance of selecting locations where weld samples will be taken.
 - 3) The Monitor may increase the test frequency based on marginal results or other reasons deemed appropriate by OWNER.
- b. Sampling Procedures.
- 1) Cut samples at locations designated by the CQA Monitor as the welding progresses. Verify that laboratory test results have been obtained before the geomembrane is covered by another material.
 - 2) CQA Monitor will number each sample and mark sample number and location in compliance with the CQA program.
 - 3) Immediately repair all holes in the geomembrane resulting from destructive test sampling. Repair in accordance with repair procedures described in this Section. Test the continuity of the repair in accordance with this Section.
 - 4) Size of Samples: minimum 12 inches wide by 44-inches-long with the seam centered lengthwise. Cut a 1-inch-wide strip from each end of the sample and test these for (shear and peel) in the field. Cut the remaining sample into three parts for distribution as follows:
 - One portion for the INSTALLER: 12 inches by 12 inches for quality control testing.
 - One portion for CQA Laboratory: 12 inches by 18 inches for quality assurance testing.
 - One portion to OWNER for archive storage: minimum 12 inches by 12 inches.
- c. Field Testing (Performed by INSTALLER).
- 1) Test the two, 1-inch-wide strips specified in Paragraph 4) above by tensiometer for peel and shear, respectively.
 - 2) Both test strips must meet peel and shear requirements for welded seams specified in Paragraph 3.02, C.8.
 - 3) If any field test sample fails, follow failed test procedures outlined in this Section.
- E. Laboratory Testing performed independently by CQA Laboratory and INSTALLER.
1. Test “seam strength” and “peel adhesion” (ASTM D6392). Test 1-inch wide samples at strain rate of 2 inches per minute.

2. Minimum acceptable values to be obtained for these tests are specified in Paragraph 3.02, C.8.
 3. Test at least five specimens for each test method. Four of five specimens must meet minimum requirements. None of the peel specimens may peel 100 percent, or the entire sample will be considered as failing.
 4. Select specimens alternately by test from the samples (i.e., peel, shear, peel, shear...).
 5. Provide test results no more than 24 hours after receiving samples.
 6. For double wedge welded samples, test both sides in peel.
- F. Failed Weld Procedures.
1. Follow these procedures when there is a destructive test failure. Procedures apply when test failure is determined by the Construction Quality Assurance Laboratory, INSTALLER, or by field tensiometer. Follow one of the following two options:
 - a. First Option.
 - 1) Reconstruct the seam between any two passing test locations. Cannot extrusion weld flap.
 - b. Second Option.
 - 1) Trace the weld at least 10 feet minimum in both directions from the location of the failed test, or to the end of the weld.
 - 2) Obtain a small sample at both locations for an additional field test.
 - 3) If these additional test samples pass field tests, then take laboratory samples.
 - 4) If the laboratory samples pass, then reconstruct the weld or cap between the two test sample locations that bracket the failed test location.
 - 5) If any sample fails, then repeat the process to establish the zone in which the weld must be reconstructed.
- G. Acceptable Welded Seams.
1. Bracketed by two locations from which samples have passed destructive tests.
 2. For reconstructed seams exceeding 50 feet, a sample taken from within the reconstructed weld passes destructive testing.
 3. Whenever a sample fails, provide additional testing for seams that were welded by the same welder and welding apparatus or welded during the same time shift.
- H. Seams That Cannot Be Non-Destructively Tested. Perform the following:
1. If the weld is accessible to testing equipment prior to final installation, non-destructively test the weld prior to final installation.

2. If the weld cannot be tested prior to final installation, cap strip the weld. The welding and cap-stripping operations must be observed by the CQA Monitor and INSTALLER for uniformity and completeness.

3.05 REPAIR PROCEDURES

- A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.
- B. Repair, removal, and replacement are at CONTRACTOR's expense if the damage results from the CONTRACTOR's, or the CONTRACTOR's subcontractor activities. Repair, removal, and replacement is at INSTALLER's expense if the damage results from the INSTALLER's, or the INSTALLER's subcontractor activities.
- C. Repair any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test. Agreement upon the appropriate repair method will be determined between OWNER's Representative, the CQAC and the INSTALLER. Do not commence welding on liner until trial weld test sample, made by that equipment and operator, passes trial test. Repair procedures available include:
 1. Patching: Used to repair large holes (over 0.375-inch diameter), tears (over 2-inches-long), undispersed raw materials, and contamination by foreign matter.
 2. Abrading and re-welding: Used to repair small sections of seams.
 3. Spot welding or seaming: Used to repair small tears (less than 2-inches-long), pin holes or other minor, localized flaws.
 4. Capping: Used to repair long lengths of failed seams.
 5. Removing the seam and replacing with a strip of new material.
- D. In addition, satisfy the following procedures:
 1. Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one (1) hour prior to the repair.
 2. Clean and dry all surfaces at the time of repair.
 3. The repair procedures, materials, and techniques must be accepted in advance of the specific repair by OWNER, CQAC and INSTALLER.
 4. Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches.
 5. Unless otherwise instructed by OWNER, cut geomembrane below large caps to avoid water or gas collection between the sheets.
- E. Verification of repair:
 1. Number and log each repair.
 2. Non-destructively test each repair using methods specified in Paragraph 3.04 of this Section.
 3. Destructive tests may be required at the discretion of OWNER.
 4. Reconstruct repairs until tests indicate passing results.

3.06 MATERIALS IN CONTACT WITH THE GEOMEMBRANE

- A. The Contractor shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or by other construction activities.
- B. Granular materials shall not be placed on the geomembrane at ambient temperatures above 104°F. Unless otherwise noted, the maximum allowable height for a wrinkle shall be 12 in. (300 mm).
- C. Equipment shall not be driven directly on the geomembrane. Unless otherwise specified by the ENGINEER, all equipment used to place overlying materials shall comply with the following requirement:

Table 31750-5

Maximum Allowable Equipment Ground Pressure (psi)	Initial Lift Thickness (ft)
5	1.0
10	1.5
20	2.0
>20	3.0

- D. In heavy traffic areas, such as access ramps, and in areas trafficked by rubber tire vehicles, the thickness of overlying compacted fill should be at least 3 ft. Roads shall be at least twice the width of the largest piece of equipment.
- E. Appurtenances:
 - 1. Installation of the geomembrane in appurtenant areas, and connection of the geomembrane to appurtenances shall be made according to the Specifications and Drawings. Extreme care shall be taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas. INSTALLER shall ensure that the geomembrane has not been visibly damaged while making connections to appurtenances.
 - 2. All clamps, slips, bolts, nuts, or other fasteners used to secure the geomembrane to each appurtenance shall be at least as durable as the geomembrane.

3.07 GEOMEMBRANE ACCEPTANCE

- A. INSTALLER retains all ownership and responsibility for the geomembrane until acceptance by OWNER.
- B. OWNER will accept geomembrane installation when:
 - 1. All required documentation from the MANUFACTURER, fabricator, and INSTALLER has been received and accepted.
 - 2. The installation is finished.

3. Test reports verifying completion of all field seams and repairs, including associated testing, are in accordance with the Section.
4. Written certification documents and drawings have been received by OWNER.

END OF SECTION