

Part 1 General

1.1 SECTION INCLUDES

- .1 Enviro Liner 6000^{HD} geomembrane

1.2 RELATED SECTIONS

- .1 Section 31 22 13 - Rough Grading
- .2 Section 31 23 23 – Backfilling
- .3 Section 33 42 13 – Pipe Culverts
- .4 Section 01 78 10: Warranties.

1.3 REFERENCES

- .1 ASTM D638 – Test Method for Tensile Properties of Plastics
- .2 ASTM D792 – Test Methods for Density and Specific Gravity of Plastics by Displacement
- .3 ASTM D814 - Standard Test Method for Rubber Property- Vapor Transmission of Volatile Liquids
- .4 ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting
- .5 ASTM D1434- Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting
- .6 ASTM D1505 – Test Method for Density of Plastics by the Density-Gradient Technique
- .7 ASTM D1603 – Test Method for Carbon Black in Olefin Plastics
- .8 ASTM D4329 – Practice for Fluorescent UV Exposure of Plastics
- .9 ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- .10 ASTM D4759 – Standard Practice for Determining the Specification Conformance of Geosynthetics
- .11 ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- .12 ASTM D5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tensile Load Test
- .13 ASTM D5596 – Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

- .14 ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
- .15 ASTM D5885 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
- .16 ASTM D6392 – Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- .17 ASTM D6497- Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
- .18 ASTM D6693 – Determining Tensile Properties of Non-reinforced Polyethylene and Non-reinforced flexible Polypropylene Geomembranes

1.4 PERFORMANCE REQUIREMENTS

- .1 Geomembrane:
 - .1 Contain the following chemical(s)
 - .1 []
 - .2 Remain flexible throughout service life
 - .3 Highly resistant to UV degradation

1.5 SUBMITTALS

- .1 Section 01 33 00; Submission Procedures
- .2 Product Data:
 - .1 Provide specification sheets for geomembrane
 - .2 Provide mill test reports for geomembrane roll stock used to make liner
 - .3 Provide shop test reports for each fabricated panel produced
 - .4 Provide field test reports for all welds completed in the field

1.6 QUALITY ASSURANCE

- .1 Geomembrane manufacturer to be ISO 9001 registered.
- .2 Fabricator to be ISO 9001 registered or follow ISO 9001 compliant procedures.
- .3 Installer to follow documented installation plan and work procedures.

1.7 WARRANTY

- .1 Section 01 78 10: Warranties.
- .2 Provide a manufacturer's pro-rated weathering warranty for
 - [Enviro Liner 6020^{HD} Ten (10) years]
 - [Enviro Liner 6030^{HD} Twenty five (25) years]
 - [Enviro Liner 6040^{HD} Twenty five (25) years]

Part 2 Products

2.1 MANUFACTURERS

- .1 Layfield Poly Films Ltd.

2.2 MATERIALS

- .1 Geomembrane:
 - .1 Geomembrane material
[Enviro Liner 6020^{HD}] [Enviro Liner 6030^{HD}] [Enviro Liner 6040^{HD}]
 - .2 Surface: Smooth, no striations, gels, pinholes or bubbles.
 - .3 Thickness (ASTM D 5199): Avg. thickness must exceed value with no individual reading lower than 10%.
<[0.50] [0.75] [1.00] mm> <<[0.020] [0.030] [0.040] inches>>.
 - .4 Maximum Membrane Density (ASTM D792 or ASTM D1505): 0.940 g/cc.
 - .5 Minimum Tensile Properties (ASTM D638 or ASTM D6693): Machine direction and perpendicular to machine direction average values on the basis of five (5) test specimens each direction:
 - .1 Break Strength: <[19] [25] [33.5] kN/m> <<[107] [141] [191] lb/in>>.
 - .2 Break Elongation: <[1500] [1200] [1200]%>.
 - .6 Minimum Tear Resistance (ASTM D1004):
<[49] [78] [137] N> <<[11] [17.5] [24] lb>>.
 - .7 Minimum Puncture Resistance (ASTM D4833):
<[196] [236] [311] N> <<[44] [53] [70] lb>>.
 - .8 Carbon Black Content: 2.0 - 3.0% to ASTM D1603.
 - .9 Carbon Black Dispersion (ASTM D5596):
 - .1 Carbon Black dispersion for 10 different views:
 - .2 Minimum nine views in categories 1 or 2 and 1 view in Category 3.
 - .10 High Pressure Oxidative Induction Time (ASTM D5885):
 - .1 Minimum 2000 minutes.
 - .11 Stress Crack Resistance Under Constant Load (ASTM D5397):
 - .1 Minimum 1000 hours.
 - .12 UV Resistance (ASTM D4329):
 - .1 Minimum 90% strength retained after 10,000 hours testing
 - .1 Testing performed on <0.75mm> <<30 mil>> specimen
 - .2 Irradiance of 0.90 w/m² at a wavelength of 310 nm
 - .3 Alternating 10 hour UV cycles at 60C followed by 2 hour condensation cycles at 50C
 - .13 Axi-Symmetric Break Resistance (ASTM D5617)
 - .1 Minimum: <[50]%>
 - .14 Flexibility (ASTM D6182)
 - .1 Minimum Flex Cycles before surface cracking: <[na] [4000] [4000] Cycles>
 - .15 Methane Permeability (ASTM D1434)

- .1 Transmission Rate: $<[2.11 \times 10^{-4}] \text{ m}^3/\text{m}^2 \cdot \text{day}$
- .16 Solvent Vapour Transmission (ASTM D814):
 - .1 ASTM Fuel C: $<[\leq 15] [\leq 10] [\leq 10] \text{ grams}/\text{m}^2 \cdot \text{hr}>$
 - .2 Ethanol: $<[\leq 15] [\leq 10] [\leq 10] \text{ grams}/\text{m}^2 \cdot \text{hr}>$
 - .3 Methanol: $<[\leq 15] [\leq 10] [\leq 10] \text{ grams}/\text{m}^2 \cdot \text{hr}>$
 - .4 ASTM IRM 902: $<[\leq 15] [\leq 10] [\leq 10] \text{ grams}/\text{m}^2 \cdot \text{hr}>$
- .17 Shop Seam Properties (ASTM D6693):
 - .1 Shear Strength: $<[6.5] [8.8] [12.2] \text{ kN}/\text{m}> <<[37] [50] [70] \text{ lb}/\text{in}>>$.
 - .2 Peel Strength: $<[5.3] [7.9] [10.5] \text{ kN}/\text{m}> <<[30] [45] [60] \text{ lb}/\text{in}>>$.
- .18 Field Seam Properties (ASTM D6693):
 - .1 Shear Strength: $<[5.3] [7.9] [10.5] \text{ kN}/\text{m}> <<[30] [45] [60] \text{ lb}/\text{in}>>$.
 - .2 Peel Strength: $<[4.6] [7.0] [9.3] \text{ kN}/\text{m}> <<[26] [40] [53] \text{ lb}/\text{in}>>$.

2.3 FABRICATOR

- .1 Layfield Geosynthetics and Industrial Fabrics Ltd., or;
Layfield Plastics Inc. or;
An approved fabricator of Layfield products.

2.4 FABRICATION

- .1 Set Up
 - .1 Carefully transfer rolls of geomembrane from storage to unwinding rack.
 - .2 The floor or table must be clean, dry, and free of foreign objects that could damage the liner.
 - .3 Pull panels to specified length, after double-checking dimensions on the work order.
 - .4 Ensure seaming equipment is in good repair and functioning properly. Ensure equipment is adjusted to the material.
 - .5 Follow documented welding procedures.
- .2 Qualification Seam
 - .1 A qualification seam will be run prior to any fabrication.
 - .2 The qualification seam must be run using the same material and equipment that will be used for fabrication.
 - .3 Machine conditions and operator used for fabrication must be the same as those used for the qualification weld.
 - .4 Qualification seam must be tested in shear and peel and meet the specified requirements for the material as stated in the materials section.
 - .5 A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, shift changed, or if the equipment is idle for more than 2 hours.
- .3 Fabrication Seams
 - .1 Fabrication seams must meet the specified requirements in peel and shear for the material.
 - .2 Fabrication seams will be destructively tested in shear and peel according to ASTM D6392.

- .1 Test one specimen each in peel and shear on the first and last welded panel, and,
- .2 Test one specimen each in peel and shear for every <300 lineal meters> <<1000 lineal feet>> of welding
- .3 A record of the seam test results is maintained on the Shop QC report.
- .4 The seaming process must be constantly supervised by the equipment operator. 100 % of the fabrication seams must be visually inspected during seaming.
- .4 Protection from Damage
 - .1 Protect completed panels from damage
 - .2 Handle carefully to avoid damaging the liner
- .5 Packaging
 - .1 Each panel will be accordion folded in one direction, and rolled or folded in the other direction.
 - .2 Wrap completed panels in a weather resistant, opaque cover material.
 - .3 Hold wrapper securely in place using UV resistant tape or other secure method.
 - .4 Label the packaged liner to clearly show:
 - .1 Material type
 - .2 Dimensions
 - .3 Stock code
 - .4 Sales order number
 - .5 QC number
 - .6 Panel number
 - .7 Unfolding and deployment directions

2.5 DELIVERY STORAGE AND PROTECTION

- .1 Shipping
 - .1 Completed panels will be placed on clean, serviceable pallets, free from exposed nails or other obstructions.
 - .2 A layer of geomembrane, geotextile, or wood will be placed on all pallets to protect the panel from damage.
 - .3 Secure panels to the pallet using metal or plastic bands. Use a layer of geomembrane between the packaged liner and the band to prevent damage to the liner as the band is tightened.
 - .4 The packaged liner must not extend beyond the outer edges of the pallet. Use larger pallets or a layer of plywood to extend the pallet edges to match the liner.
 - .5 Carefully handle and place on the truck to avoid damage to the liner.
 - .6 [Do not stack panels] [Panels may be stacked not more that two high].
- .2 Delivery
 - .1 All panels will be inspected for damage on delivery.
 - .2 Use suitable unloading equipment to handle panels. Do not drag, slide, or drop panels during unloading.

- .3 Place panels in a prepared area away from soft ground, standing water, or other deleterious surfaces.
- .4 Replace any pallets that may become damaged during shipping or handling.
- .5 Store liner panels in a secure area protected from extremes of heat or cold.
- .6 Protect panels from damage prior to use.

2.6 ACCESSORIES

- .1 Welding Rod will be manufactured from the same formulation as the geomembrane.
- .2 Preformed Pipe Boots will be vacuum formed from thicker sheet material manufactured from the same formulation as the geomembrane.

Part 3 Execution

3.1 INSTALLER

- .1 Layfield Environmental Systems or
An installer approved by Layfield.

3.2 PREPARATION

- .1 Ensure subgrade is compacted and surface finished to not impair installed membrane.
- .2 Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade. A smooth drum rolled surface is preferable.
- .3 Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.
- .4 If a suitable sub-grade is not available then a cushion layer of [<100mm> <<4 inches>> of clean sand] [LP8 non woven geotextile] shall be placed prior to liner placement.
- .5 Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.
- .6 Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
- .7 All concrete surfaces to which the liner will attach shall have "smooth trowel" finish. All the corners should have radius to a minimum 25mm (1 inch) as per the drawing.
- .8 Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.
- .9 A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

3.3 INSTALLATION

- .1 Installation of the geomembrane shall be performed in a logical sequence.
- .2 Place panels according to the drawings, the panel layout, and the label on each panel.
- .3 Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.
- .4 Weather Conditions at Time of Installation:
 - .1 Site welding may proceed at any temperature providing a suitable qualification weld can be prepared at site conditions using the operator, equipment, and materials intended for the project.
 - .2 Installation of membrane in winds above <20 km/h> <<12 mph>> can proceed only if the installer can demonstrate that the liner will not be at risk of damage.
 - .3 Do not install membrane during precipitation or in the presence of excessive moisture.
 - .4 Do not install in weather conditions that may be detrimental to the function of the membrane.
- .5 Ensure personnel working on geomembrane do not use damaging footwear.
- .6 Protect completed panels from damage; handle carefully to avoid damaging the liner.
- .7 Equipment and methods used to unroll liner panels should not damage the prepared subgrade.
- .8 Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.
- .9 Qualification Seams
 - .1 A qualification seam will be run prior to any field seams.
 - .2 A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.
 - .3 Machine conditions, and operator used for welding must be the same as those used for the qualification weld.
 - .4 Qualification seam must be tested in shear and peel, and meet the specified requirements for the material as stated in the materials section.
 - .5 A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.
- .10 Field Seams
 - .1 Field seams will be sampled for testing in a way that does not compromise the installed liner
 - .1 One sample to be tested for every <150m> <<500 ft>> of field seam
 - .2 Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner.
 - .3 Samples to be approximately <100 mm> <<4 inches>> long to permit testing of one shear and two peel specimens (ASTM D6392).

- .4 Test samples immediately after seaming
- .5 Record date, location and pass/fail description
- .2 Field seams must meet the specified requirements in peel and shear for the material.
- .3 A written record will be maintained for all field seam tests.
- .4 All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).

3.4 TOLERANCES

- .1 Seam Tests:
 - .1 Follow the procedure in ASTM D6392
 - .2 Test three specimens per sampling point, one in shear and two in peel.
 - .1 All specimens to meet seam strength requirements
 - .3 Procedures for Destructive Test Failure:
 - .1 Cut out seam and re-weld; or,
 - .2 Retrace welding path to <3 m> <<10 feet>> from location of failed test. Take sample for additional test. If passed - cap strip or extrusion weld between failed location and original failed location.

3.5 REPAIR

- .1 Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.
- .2 Identify any sign of foreign matter contamination.
- .3 Repair all through-thickness defects.
- .4 Defective Seams: Cap strip or replace.
- .5 Small Holes: Repair by extrusion welding using a bead of extruded material over hole. Patch if hole is larger than <6 mm> <<1/4 inch>>.
- .6 Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.
- .7 Repair blisters, large cuts and undispersed raw materials with patch.
- .8 Secure Patches by Extrusion Welding or Hot Air Welding:
 - .1 Extrusion welding.
 - .1 Clean area to be patched.
 - .2 Tack patch in place with hot air welding or with double sided tape.
 - .3 Prepare patch area by roughening with a wire brush.
 - .4 Extrude all the way around patch.
 - .5 More than one extrusion bead can be laid side-by-side on Enviro Liner 6000 materials. A maximum of three extrusion beads can be laid side-by side on Enviro Liner 6000.
 - .2 Hot Air Welding
 - .1 Hand hot air welding is permitted for patching Enviro Liner.

- .2 Clean area to be patched.
- .3 Hand weld the patch with a hot air gun and suitable roller.
- .9 Patches: Round or oval, of same geomembrane. Extend minimum <75 mm> <<3 inches>> beyond the edge of the defect.
- .10 Verification of Repairs: All repairs to be non-destructively tested using
 - .1 Air Lance Test, ASTM D4437 Method 7.2
 - .2 Vacuum Box Test ASTM D5641
- .11 Redo failed repairs and re-test.
- .12 Keep records of all repairs and the results of repair testing.

3.6 CLEANING

- .1 Section 01 74 00.
- .2 Cleaning solvents shall not be used unless product is approved by membrane manufacturer.
- .3 Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.

3.7 PROTECTION OF FINISHED WORK

- .1 Section 01 45 00: Protecting installed work.
- .2 Protect finished Work from damage. See instructions on backfilling if applicable.

END OF SECTION