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SECTION 1
MANUFACTURING CAPABILITIES

Layfield is a leading supplier of extruded, fabricated and installed polymer based products. Layfield was originally established in the mid-1950s as a fabricated plastics business. In 1978, the current owners purchased Layfield and diversified the product line. Layfield has pursued an aggressive course of expansion through acquisitions, in-house developments and diversification.

Layfield Environmental Containment is a vertically integrated business involved in the manufacturing, fabrication, construction and maintenance of high performance geomembranes, floating covers and specialty geosynthetics. The company is active in multiple sectors including Oil & Gas, Water Management, Mining, Agriculture, Food and Construction & Infrastructure. Layfield does business throughout North America with a growing international business focused in Australia, South America and Asia.

We provide industry owners with single source accountability through our integration capabilities which combine geomembrane manufacturing, fabrication, construction and maintenance services.

The manufacture of geomembranes at Layfield is governed and controlled by our registered quality management system which meets the requirements of the ISO 9001:2008 standard. Each product is certified to meet published Minimum Average Roll Value (MARV) specifications. Layfield can provide signed mill certificates for each lot of geomembrane produced, showing actual results for specified properties.

Layfield manufactures and supplies a full range of standard grade and specialty fortified geomembranes. Fortified geomembranes are defined as a product heavily treated with special stabilizers providing enhanced heat, UV stability and chemical resistance. Our Research and Technology Group is constantly developing innovative ways to enhance the quality of our existing products and develop new and more specialized products.

Layfield manufactures some of the industry’s most popular brands of geomembranes including our Enviro Liner® and HAZGARD® geomembranes. Layfield is able to produce a variety of wide geomembrane widths and thicknesses designed both for prefabricated liners and field installed liners. Our co-extrusion process provides texturing capabilities and a variety of specialty skin colors.
Enviro Liner® 7000FLEXHD is a specialized coextruded geomembrane with fortified skin layers and a specialized blended polyolefin alloy core layer. Fortified is defined as a geomembrane heavily treated with special stabilizers providing enhanced heat, UV stability and chemical resistance. With Enviro Liner® 7000FLEXHD, both the skin layers and the core layer come with a very advanced and heavily stabilized UV antioxidant package. This results in a material that has excellent chemical resistance while providing important flexibility properties. Using fortified geomembrane technology gives the material excellent endurance and longevity properties. The Enviro Liner® 7000FLEXHD series has undergone extensive performance testing. The results of this testing have been documented in this technical specification booklet.

Enviro Liner® 7000FLEXHD builds on the strength of the original EL 6000 formulation. EL 6000 remains one of the leading flexible polyolefin geomembranes in North America. Enviro Liner® 7000FLEXHD is an ideal choice of geomembrane for long term exposed applications requiring excellent material chemical resistance.

Recommended applications include floating covers for municipal water, biogas covers, landfill caps, brine ponds, tailings dams and waste water treatment applications.

Enviro Liner® 7000FLEXHD is available in 30, 40, 50, 60 and 80 mil (0.75, 1.0, 1.25, 1.5, 2.0 mm). In addition to providing excellent chemical resistance, Enviro Liner® 7000FLEXHD can be factory prefabricated.

The advantage of large prefabricated factory panels includes a major reduction in the quantity of field welds required and reduced installation costs. All factory welds are completed in a controlled indoor environment ensuring excellent seam quality and seam integrity.
Definitions for Material Properties

Index Properties

Index properties characterize a geomembrane in its manufactured state. These properties are tested to ensure quality control during manufacturing of a geomembrane. Index properties define a geomembrane’s characteristics and physical properties. Examples of index properties include:

- Thickness
- Density
- Tensile Strength at break
- Tear Resistance
- Puncture resistance

Performance Properties

These are the properties that are tested to simulate important field conditions. They provide a more accurate indication of how a geomembrane will perform in the field. Examples of performance properties include:

- Solvent Vapor Permeability
- Water Vapor Permeability
- Methane Permeability
- Geomembrane Flexibility
- Large Scale Puncture Test
- Multi-Axial Stress Strain Test
- Low Temperature Behaviour

Endurance Properties

These are the properties that are tested to establish the long-term aging performance of a geomembrane. These properties provide an indication of longevity. Examples of endurance properties include:

- UV / Weathering Resistance
- Brine Resistance Testing
- LSI Testing
- Effects of Solar Irradiance
### EL 7000<sup>FLEXHD</sup> PRODUCT SPECIFICATIONS

<table>
<thead>
<tr>
<th>Performance Properties</th>
<th>ASTM</th>
<th>EL 7030</th>
<th>EL 7040</th>
<th>EL 7050</th>
<th>EL 7060</th>
<th>EL 7080</th>
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<tr>
<td>Thickness</td>
<td>D 5199</td>
<td>30 mils</td>
<td>40 mils</td>
<td>50 mils</td>
<td>60 mils</td>
<td>80 mils</td>
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<tr>
<td></td>
<td></td>
<td>0.75 mm</td>
<td>1.0 mm</td>
<td>1.25 mm</td>
<td>1.5 mm</td>
<td>2.0 mm</td>
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<tr>
<td>Tensile Strength at Break&lt;sup&gt;2&lt;/sup&gt; (MARV)</td>
<td>D 638</td>
<td>126 ppi</td>
<td>164 ppi</td>
<td>200 ppi</td>
<td>240 ppi</td>
<td>304 ppi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22 N/mm</td>
<td>28.7 N/mm</td>
<td>35 N/mm</td>
<td>42 N/mm</td>
<td>53 N/mm</td>
</tr>
<tr>
<td>Elongation at Break&lt;sup&gt;1&lt;/sup&gt; (50mm gauge)</td>
<td>D 638</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>700%</td>
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<tr>
<td>Tear Resistance</td>
<td>D 1004</td>
<td>16 lbs</td>
<td>22 lbs</td>
<td>27 lbs</td>
<td>33 lbs</td>
<td>44 lbs</td>
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<tr>
<td></td>
<td></td>
<td>70 N</td>
<td>100 N</td>
<td>120 N</td>
<td>150 N</td>
<td>200 N</td>
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<tr>
<td>Puncture Resistance (MARV)</td>
<td>D 4833</td>
<td>42 lbs</td>
<td>56 lbs</td>
<td>70 lbs</td>
<td>84 lbs</td>
<td>112 lbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>190 N</td>
<td>250 N</td>
<td>310 N</td>
<td>370 N</td>
<td>500 N</td>
</tr>
</tbody>
</table>

**Performance**

- Low Temperature Impact Resistance: D 746
  - -69° F
  - -56° C
- Axi-Symmetric Strain<sup>4</sup>: D 5617
  - 50%
- Stress Cracking: D 5397
  - > 1000 hrs
- Methane Permeability<sup>5</sup>: D 1434
  - 1.78x10<sup>-4</sup> m<sup>3</sup>/m<sup>2</sup>.day
- Water Vapor Permeability<sup>5</sup>: F 1249
  - 3 x 10<sup>-11</sup> cm/sec

**Endurance**

- High Temp Immersion 70°C Water pH of 7 for 2000 hrs: D 1693 D 5885
  - HPOIT Retained > 2000 min
- High Pressure Oxidative Induction Time (HPOIT): D 5885
  - Skin > 2500 mins
  - Core > 2000 mins
- UV Resistance Strength after 1600 h: D 4329
  - 90%
- Oven Aging at 85°C Strength after 90 days: D 7238
  - 80%
- Brine Testing, 90°C 4800 hours: D 1693
  - HPOIT Retained > 2000 mins
- Chlorine Immersion 50°C in 1% chlorine for 1000 hrs: D 696
  - HPOIT Retained > 2000 min

**Assembly**

- Fabrication options for Enviro Liner<sup>®</sup> 7000<sup>FLEXHD</sup>:
  - Factory Fabricated Only
  - Factory Fabricated Only
  - Factory or Field Fabrication
  - Field Fabrication Only
  - Field Fabrication Only

**Notes:**
1. This product meets or exceeds GRI-GM 17 specifications.
2. Tested at 20 inches/min.
3. Measured with a gage length of 1.5 inches.
4. This test measures out of plane response of a material to a force that is applied perpendicular to the initial plane of geomembrane sample.
5. Measured on 30 mil thickness.
6. Layfield recommends testing EL 7000<sup>FLEXHD</sup> series before use to ensure its compatibility with the specific aquatic species.
General Chemical Notes:

Solvent Vapor Permeability

Enviro Liner® 7000FLEXHD series is resistant to a wide range of chemicals. Enviro Liner® 7000FLEXHD has chemical resistance that is similar to HDPE without the issue of Environmental Stress Cracking. Enviro Liner® 7000FLEXHD is resistant to most inorganic chemicals and a large number of organic chemicals. The hydrocarbon resistance of Enviro Liner® 7000FLEXHD is very good. Enviro Liner® 7000FLEXHD is suitable for a large number of primary and secondary containment applications where chemical resistance is important. Enviro Liner® 7000FLEXHD is resistant to most combustible liquids (diesel fuel and heating oils) and is suitable for most secondary containment applications of flammable and combustible liquids. Enviro Liner® 7000FLEXHD is not affected by the presence of heavy metals. Where chemical resistance data is not available, Layfield recommends that the customer perform their own chemical test. Layfield will provide our customers with samples of Enviro Liner® 7000FLEXHD free of charge for chemical testing.

Water and Gas Transmission Properties

Water vapor permeability with geomembranes operates in a completely different manner than water permeability in clay liners. The movement of water in clay is actually as a liquid between the particles of clay while the movement of water vapor in a geomembrane is actually molecule-by-molecule between the molecules of the plastic. Comparison between the two systems is therefore difficult. Our Enviro Liner® 7000FLEXHD material was tested using ASTM F1249, which is a standard test method for “Water Vapor Transmission Rate through Plastic Film and Sheeting”. This test determines the rate of water vapor transmission through flexible barrier materials. Our Enviro Liner® 7000FLEXHD yielded a permeation rate of less that 1x10⁻¹³ cm/sec.

Methane Permeability

Layfield tested methane permeability in accordance with ASTM D1434. The permeability of polymers to gases is mainly a function of sheet density and the molecular structure of the polymer. Our Enviro Liner® 7000FLEXHD shows excellent resistance against methane and shows lower values when compared to geomembrane products like High Density Polyethylene (HDPE) 40 mil (1.0 mm), Poly Vinyl Chloride (PVC) 30 mil (0.75 mm), and Linear Low Density Polyethylene (LLDPE) 40 mil (1.0 mm). Values for HDPE 40 mil (1.0 mm), PVC 30 mil (0.75 mm), and LLDPE 40 mil (1.0 mm) were extracted from a research paper on methane gas migration through geomembranes (Stark et al, 2005).

<table>
<thead>
<tr>
<th>Chemical Value</th>
<th>Test Value</th>
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<tbody>
<tr>
<td>Fuel C1</td>
<td>3.58 g/(h•m²)</td>
</tr>
<tr>
<td>Fuel H2</td>
<td>2.42 g/(h•m²)</td>
</tr>
<tr>
<td>Ethanol</td>
<td>&lt;0.1 g/(h•m²)</td>
</tr>
<tr>
<td>Methanol</td>
<td>&lt;0.1 g/(h•m²)</td>
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<tr>
<td>IRM 9033</td>
<td>&lt;0.1 g/(h•m²)</td>
</tr>
<tr>
<td>Diesel 100%</td>
<td>0.13 g/(h•m²)</td>
</tr>
<tr>
<td>Biodiesel (Canola Source)</td>
<td>&lt;0.1 g/(h•m²)</td>
</tr>
<tr>
<td>Biodiesel (Tallow Source)</td>
<td>&lt;0.1 g/(h•m²)</td>
</tr>
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Table 1. Solvent Vapor Permeability Test Values

Graph 1.MethanePermeabilityRatesforVariousgeomembranes

Graph 1. Methane Permeability Rates for Various Geomembranes

<table>
<thead>
<tr>
<th></th>
<th>PVC (30mil)</th>
<th>LLDPE (40mil)</th>
<th>HDPE (40mil)</th>
<th>EL 703D (30mil)</th>
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<tr>
<td>Value</td>
<td>900 (0.75mm)</td>
<td>600 (1mm)</td>
<td>300 (1mm)</td>
<td>178 (0.75mm)</td>
</tr>
</tbody>
</table>
Geomembrane Flexibility

Compression Testing

Enviro Liner® 7000FLEXHD has significant HDPE components added to its structure as discussed previously in this booklet. Our challenge was to fabricate this new material in our fabrication facilities around North America. HDPE liners are traditionally assembled and welded in the field because folding and winding operations in the factory can cause the material to permanently deform at the folds.

Several material trials were conducted to determine the optimum thickness of the outside HDPE layers for attaining the desired flexibility required to perform folding and winding operations during factory fabrication. Initial bending tests gave good indication of the structure of EL 7000FLEXHD material, and a full scale trial was conducted on our geomembrane extrusion line.

The folding tests were designed to determine any stress induced failures. The compression testing unit comprised of an 8-ton hydraulic press; we estimated that this was enough compressive stress to determine if the material had adequate flexibility to withstand the folding and winding operations in a factory environment.

The material was double folded; the first fold was perpendicular to and the second fold was parallel to the machine direction. To determine any strength or elongation loss in the material, a dog bone specimen was cut from the folded sample with the double fold aligned in the center of the dog bone specimen.

Figure 7. Compression Testing used to determine optimum thickness

Figure 8. Dog bone samples tested to determine strength or elongation loss in EL 7000FLEXHD after compression

Puncture Resistance

Large Scale Puncture Test

The Truncated Cone Puncture (ASTM D5514) test simulates the relative puncture resistance of a geomembrane when subjected to gradually increasing loads over a relatively large area of the specimen. The test equipment is a pressure vessel that is designed to deliver a hydrostatic pressure of up to 100 psi (690 kPa). The truncated cones are designed to simulate rocks in the field and are tapered to a 45 degree angle on top to give a sharp edge. The hydrostatic pressure is increased in the vessel until geomembrane rupture is observed.
SECTION 3B

PERFORMANCE PROPERTIES

A modification of this test is to determine the Critical Cone Height (CCH) of a geomembrane. The CCH is a height of cone above the subgrade where an increase in pressure will not puncture the geomembrane. Typically a geomembrane would be able to resist puncture from a rock of a similar size up to 100 psi (690 kPa, about 230 ft, or 70 m of water volume). In our recent tests the CCH was found to be low for stiffer material like HDPE, with values around 35 mm/1.37”.

Previous studies on geomembranes using large scale testing have suggested that stiffer materials tend to fail at smaller cone heights. In previous studies HDPE demonstrated cone heights as low as 10 mm/0.4”. A technical report on the truncated cone testing is now available. Please contact Layfield for a copy.

Low Temperature Behavior

Enviro Liner® 7000FLEXHD retains its flexibility at low temperatures and does not become stiff even at temperatures as low as -40°C/-40°F. This feature is particularly important as it enables the geomembrane to be installed during extreme weather conditions. The practical handling temperature for our Enviro Liner® 7000FLEXHD is -25°C/-13°F which means we can install Enviro Liner® 7000FLEXHD in extreme environments. For more information on low temperature behavior, please refer to our cold temperature handling guide which is available on our website.
SECTION 3 C

ENDURANCE PROPERTIES

Ultra Violet Resistance and the significance of Antioxidants

Enviro Liner® 7000FLEXHD is designed to be a long term UV resistant material with a complete UV stabilization package included in the formulation. Weathering warranties are available for exposed use of Enviro Liner® 7000FLEXHD in a variety of applications.

The rate of loss of antioxidants increases with increasing temperatures and will result in antioxidant depletion in a geomembrane. The geomembrane degradation occurs primarily in three stages:
1. Antioxidant depletion from the geomembrane
2. Onset of degradation, and
3. The half-life (50% property degradation) where a geomembrane has deemed to fail. The third stage will accelerate in presence of elevated temperatures.

The EL 7000FLEXHD is a co-extruded, three layer geomembrane manufactured using prime grade resins, antioxidants and a UV package blended together to provide excellent chemical resistance and a high (HPOIT) High Pressure Oxidative Induction Time (HPOIT) value. HPOIT is an indicator of the performance of antioxidants in the material. EL 7000FLEXHD contains high loading of antioxidants and significantly exceeds the industry standard of 400 mins as per GRI GM13. The HPOIT values for EL 7000FLEXHD fortified geomembrane start at 2500 minutes, which may potentially extend the “antioxidant depletion” phase as shown on the geomembrane degradation curve above.

Resistance to Brine

Recent testing has shown that hot saline water can be detrimental to certain formulations of geomembrane. High salt content can react with antioxidants in standard geomembranes leading to loss of antioxidant protection and possible premature failure. Layfield investigated how EL 7000FLEXHD geomembrane would behave when exposed to hot salty water in long term brine storage ponds. In the ASTM D1693 test the polymer is moulded into a specimen that is 3mm (about 1/8”) thick.

The specimen is cut into a strip and scored with a razor blade to make a stress concentration point. The strip is then bent 180 degrees and held in a test frame. The test frame is placed in a test tube full of the immersion liquid and then heated to a test temperature.
ENDURANCE PROPERTIES

For our salt solution testing we changed the test liquid and the test temperature from that specified in the ASTM D1693. This allows us to model accelerated degradation using a hot salt water solution. In our test we used a 90˚C (194˚F) test temperature and a salt solution with the following ingredients:

- 100 g/L NaCl Sodium Chloride
- 62 g/L NaHCO3 Sodium Bicarbonate
- 50 g/L NaCO3 Sodium Carbonate

The results of the hot salt water testing showed a steady reduction in the HPOIT values at the 150 hour and 300 hour immersion points. At the 600 hour mark the HPOIT values began to level off. The two tests run in the stressed condition in 2011 and 2014 as well as the data from an un-stressed immersion test run in Australia in 2011. In this test the samples were immersed at 105°C (221˚F) but were not bent or stressed. EL 7000FLEXHD performed well after exposure to the hot brine solution for 4800 hours, the material retained most of the original HPOIT specification.

Effects of Solar Irradiance

Exposure to solar radiation has been shown to increase the surface temperature of black colored geomembranes resulting in thermal expansion of the material. Liner materials that show higher coefficient of liner thermal expansion are prone to dimensional change during service. Geomembranes with light colors have lower surface temperatures when they are exposed to sunlight. Previous research shows how the geomembrane surface temperatures between white and black can vary significantly over a period of time.

Layfield carried out a study to simulate the effect of solar irradiance were specimens where exposed to UV light in a climatic chamber. Layfield used ASTM D4355 as a procedural guide to set up the test. Both black and white geomembrane specimens were exposed to Xenon arc lamps emitting an irradiance of 0.19 W/m²nm, 340 nm while the chamber temperature was set to 40 oC (104 oF). By comparison an irradiance of 0.11 W/m²nm is equivalent to a UV index of 7 which would be typical of a sunny day in Southern Ontario, Canada in July.

It was concluded that the white surface resulted in 46% reduction in surface temperature compared to the black surface. Enviro Liner® 7000FLEXHD is manufactured with our state-of-the-art multi layer co-extrusion technology.

Layfield offers our geomembranes in black, white and tan skin colors. Light skin colors ensure lower geomembrane surface temperature and have the following benefits:

1. Lower expansion/contraction
2. Greater Resistance to long term degradation
3. Increased protection of soil subgrade from desiccation
4. Prevent heat build up under floating covers

Graph 3. Effect of Solar Irradiance on Surface Temperature

Figure 12. White Surfaced Floating Cover - Enviro Liner® Evaporation control cover for a winery in Australia
Prefabricated geomembrane liners are usually made of flexible liner materials that are thermally welded together to form large geomembrane panels that can be deployed very quickly in the field. On prefabricated panels all of the seams are manufactured in a controlled environment. Installation of prefabricated panels reduces the number of field seams and significantly improves overall efficiency and economics.

Field assembled geomembranes are typically stiffer and are not designed to be prefabricated in a factory environment and are subject to the variability of the weather.

Our Enviro Liner® 7000FLEXHD series has been formulated to overcome flexibility issues related with field fabricated geomembranes such as HDPE. HDPE’s crystalline structure makes it stiffer and produces lower elongation at yield compared to Enviro Liner® 7000FLEXHD, which is flexible with exceptional elongation behavior. For this reason, we do not fabricate HDPE into large panels as it is too stiff to fold and roll. Even in the field, HDPE liners have to be laid smooth on the ground with no creases. Backfilling over the creases may cause permanent deformation in those areas with significant loss in strength leading to geomembrane failure. Prefabricated panels also minimize field welding increasing quality control and reducing dependance on weather elements.

Prefabricated panels are welded in a controlled environment ensuring high seam integrity.

Key considerations of prefabricated panels:
- Prefabricated panels are manufactured in a controlled environment
- Less dependency on weather elements during construction
- Shorter on-site time
- Panels can be prefabricated between 20,000 ft² /1,860m² to 100,000 ft²/9,290m²
- Smaller jobs can be supplied in one prefabricated panel
SECTION 5

GEOMEMBRANE THICKNESS

At Layfield, we strongly believe that the thickness of materials should be a function of the containment design taking into consideration site specific conditions. There are a number of thickness standards that are often quoted. One of the most quoted standards is the USEPA RCRA Subtitle D for landfills*.

This standard requires a minimum material thickness of 30 mil (0.75mm) for the base liners of landfills. The Natural Resources Conservation Service (NRCS) has Conservation Practice Standard 521A that requires a minimum thickness of 40 mil (1.00 mm) for waste water and 30 mil (0.75 mm) for clear water ponds (unsupported materials).

In the 6th edition of the “Designing with Geosynthetics” book (Table 5.13) Robert Koerner ties thickness to survivability in the designations: Low 25 mil (0.63mm), Medium 30 mil (0.75mm), High 35 mil (0.88mm), and Very High 40 mil (1.0 mm). Therefore, the actual standard for the thickness of geomembranes is clearly between 30 mil (0.75mm) and 40 mil (1.0 mm).

One important aspect to consider is that thickness is not a key property of a geomembrane. The performance properties of a geomembrane need to be examined against the requirements of the project. For example Enviro Liner® 7000FLEXHD has better UV resistance than other materials that have twice its thickness. Selecting the thinner material in this case can help you retain UV resistance while adding other benefits such as improved flexibility. Thinner materials can be prefabricated (welded in the factory), reducing installation time & costs.

With a number of commodity grade liner materials, 60 mil (1.50 mm) and 80 mil (2.00 mm) thick products actually have worse yield, elongation and critical cone height puncture properties compared to more flexible 30 mil (0.75 mil) and 40 mil (1.00 mm) Enviro Liner® 7000FLEXHD products.

SECTION 6
WARRANTY

Ultra Violet Weathering Warranty

Enviro Liner® 7000FLEXHD geomembranes have been specially formulated for outstanding UV resistance. Layfield has developed a proprietary UV stabilization package for the Enviro Liner® 7000FLEXHD series which allows a 30 mil (0.75 mm) Enviro Liner® 7030FLEXHD to resist degradation as well as a 60 mil (1.5 mm) geomembrane stabilized with carbon black alone. This is a major advancement in flexible membrane liner technology as it allows the more flexible and durable Enviro Liner® formulation to be considered in exposed applications where a thicker material, such as HDPE 60 or 80 mil (1.5 & 2.0 mm), may have needed to be specified in the past. An extended exposed service life weathering warranty of up to 25 years is currently available for the Enviro Liner® 7000FLEXHD series in a 30 mil (0.75 mm), 40 mil (1.0 mm), 60 mil (1.5 mm) and 80 mil (2.0 mm) thickness. Our warranty is backed by natural and accelerated weathering tests. For further details please ask your Layfield representative for the technical paper “Long Term Weathering Stability and Warranty Implications for Thin Film Geomembranes”.

Warranty Terms*

1. Enviro Liner® 7000FLEXHD will be free from manufacturing defects and, if properly installed and maintained, shall withstand normal weathering for the term of the warranty.

2. The warranty does not cover any damage to the liner, or defects in the liner, resulting from conditions beyond the reasonable control of Layfield, including misuse, abuse, fire, acts of God, abnormal weather conditions of all types, improper installation or maintenance, excessive stress from any source, improper handling during transportation, unloading, storage or installation, floating debris, damage due to machinery, damage from exposure to chemicals harmful to the liner, foreign objects or animals. In addition, the maximum temperature of the effluent is not to exceed 40° C and the pH of the effluent is to be maintained between 5 and 9. In water treatment applications including reverse osmosis the Langelier Saturation Index must not be negative (below 0.0).

3. It is considered that a geomembrane fails when it is breached (holes or blistering) or if the tensile strength falls below a level of 50% of the original specification.

4. HPOIT testing needs to be performed on fabricated skin layers.

5. As a condition of the warranty, the liner will be installed following Layfield recommended procedures.

6. A claim for breach of warranty needs to be presented to Layfield in writing within 30 days of the discovery of the possible defect. Layfield will need to inspect and determine the cause of the possible defect and take appropriate steps to repair or replace the Liner if a defect exists.

*For the complete warranty terms and conditions please contact your nearest Layfield representative.

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Table 2. Enviro Liner® 7000FLEXHD Weathering Warranties

<table>
<thead>
<tr>
<th>Materials</th>
<th>Extended Weathering Warranty on White Side</th>
<th>Extended Weathering Warranty on Black Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enviro Liner® 7030</td>
<td>15 years</td>
<td>Up to 25 years</td>
</tr>
<tr>
<td>Enviro Liner® 7040</td>
<td>15 years</td>
<td>Up to 25 years</td>
</tr>
<tr>
<td>Enviro Liner® 7050</td>
<td>15 years</td>
<td>Up to 25 years</td>
</tr>
<tr>
<td>Enviro Liner® 7060</td>
<td>15 years</td>
<td>Up to 25 years</td>
</tr>
<tr>
<td>Enviro Liner® 7080</td>
<td>15 years</td>
<td>Up to 25 years</td>
</tr>
</tbody>
</table>
SECTION 7
APPLICATIONS

Major Applications

Exposed Applications: 25 year weathering warranty available on approved applications

Floating Covers
- Biogas covers
- Evaporation control
- Prevent waterfowl from landing
- Insulated covers
- Odor control
- Algae control

Water and Wastewater
- Municipal utilities
- Waste water treatment ponds
- Sewage lagoons
- Manure lagoons
- Industrial waste water
- Stormwater management ponds
- Aquaculture
- Decorative ponds
- Irrigation canal liners

Vapor Barriers
- Commercial
- Underslab building liners
- Vertical cut-off curtains

Oil and Gas
- Frac/flowback water
- Brine/produced water
- Tank liners
- Secondary containment of hydrocarbons and chemicals
- Evaporation floating covers

Mining
- Tailings ponds
- Raincoat covers
- Dam face waterproofing
- Remediation liners and covers
Floating Cover Applications

Floating covers are an economical way to protect water resources in ponds and reservoirs. Floating covers have many uses such as the storage of water, the collection of biogas, algae & odor control and evaporation control. Layfield's REVOC brand covers are designed for floating cover applications.

Layfield is a world leader in floating cover technology with a particular specialty in the protection of water reservoirs. We are currently seeing exceptional interest in biogas collection covers and have a number of key projects available for reference. We have also pioneered the development of algae control covers and have a specialized insulated cover that helps to control temperatures in treatment lagoons.

Enviro Liner® 7000FLEXHD will also be an excellent floating cover material where its flexibility will allow it to adapt to water level changes in ponds. Enviro Liner® 7000FLEXHD is suitable for water. All of Layfield's floating covers will help prevent the buildup of algae. Our REVOC Evaporation/Algae control cover is designed to be the least expensive option for algae control while our REVOC Insulated cover helps you control your process water temperatures while keeping algae in check.

Layfield provides a number of cover styles for biogas collection and use. Our REVOC Biogas covers are designed to cover waste water or manure ponds and collect the biogas for further use. The biogas can be used to generate heat, electricity, or flared for odor control or carbon credits. Layfield provided the cover for the first biogas to utility project in California where biogas is cleaned and sold as natural gas to the local utility.

There are two main designs for our REVOC Biogas covers. For large ponds we use defined cover construction that incorporates separate weights to maintain tension on the cover. For smaller ponds we have a prefabricated design that uses liquid filled weights for tension. These two designs allow us to cover any pond type and effectively collect biogas. We also offer tank covers and can integrate our REVOC Insulated cover into a biogas system to control the temperatures of an anaerobic system.

Floating covers control odors from waste water and manure ponds by preventing the evaporation of volatile ingredients into the atmosphere. By keeping ammonia, hydrogen sulfide and other odor causing chemicals trapped in the water, the floating cover prevents odors from leaving the property. All of Layfield's floating covers can be used for odor control. The presence of the cover on top of the liquid will help keep odors in the liquid.
SECTION 7

APPLICATIONS

Water and Waste Water Applications

In wastewater applications, Enviro Liner® 7000FLEXHD can contain many variants of waste water from municipal sewage to agricultural manure and commercial waste water. Enviro Liner® 7000FLEXHD is heavily fortified with advanced stabilizers and a proprietary UV inhibitor / antioxidant additive package that makes it very suitable for exposed long-term floating cover applications. In drinking water applications, Enviro Liner® 7000FLEXHD can help protect the water from contamination from external sources.

Enviro Liner® 7000FLEXHD can also be used to fabricate evaporation control covers in a number of agricultural and industrial applications. In wastewater applications, Enviro Liner® 7000FLEXHD floating covers help prevent odors, collect biogas, and prevent the build-up of algae.

Enviro Liner® 7000FLEXHD has a High Pressure Oxidative Induction Time (HPOIT) level of more than 2,000 minutes, this allows us to offer longer term extended UV weathering warranties on approved applications. Enviro Liner® 7000FLEXHD can also be placed with the white side exposed to help reduce the surface temperature of the geomembrane, which results in lower expansion/contraction cycles and prevents heat build-up under floating covers.

Enviro Liner® 7000FLEXHD has good multi axial stress strain values. This property is desirable for biogas collection covers or other applications where large concentrations of gases can develop against the liner and push it upwards. Another important property of Enviro Liner® 7000FLEXHD is its flexibility. Enviro Liner® 7000FLEXHD can be thermally welded together to fabricate very large panels, thus reducing the number of field seams in large municipal water and wastewater projects.

Figure 20. Floating cover Upper Chiquita reservoir
SECTION 8

PROJECT PROFILES

Biogas EL 7060 FLEXHD Floating Cover Project Profile

Location: Baltimore, Ohio, USA

Timeframe: 2014

Scope of Work: Design and build a biogas collection floating cover system utilizing Enviro Liner® 7060 FLEXHD material.

Background Information and Challenges:

A high profile client in Ohio was directed by the Ohio Environmental Protection Agency (EPA) to cover their existing lagoon digesters to control odor and biogas emissions from entering the atmosphere. Layfield Environmental Containment was selected by the owner to provide turn-key design/build services for a biogas collection floating cover system. The site was full of challenging conditions such as limited access and laydown staging area, uneven grade elevations around the digester and many existing utilities that could not be interrupted during construction.

Solution:

To fabricate the biogas collection cover, Layfield recommended the Enviro Liner® 7060 FLEXHD (EL 7060 FLEXHD) geomembrane in a 60 mil (1.5mm) thickness because of its flexibility and superior barrier properties including very low permeability to methane. Flexibility was very important since the cover needed to adapt to water level changes in the ponds. EL 7060 FLEXHD is manufactured with two heavily fortified HDPE skin layers on a flexible core. All layers are manufactured with special prime grade resins and an advanced antioxidant package. Other advantages of the EL 7060 FLEXHD geomembrane include excellent endurance and mechanical properties, such as HPOIT (High Pressure Oxidative Induction Time) and tensile strength.

The cover is designed to operate under slight pressure and is equipped with emergency relief valves that will trigger when the cover exceeds designed lift beneath the floating cover system.

Results:

The cover was fabricated outside the digester and pulled into place while the existing digesters were full and fully functional. Recently, the client witnessed wind speeds of over 65 MPH / 104 KMH and the floating biogas cover functioned extremely well. Our client is very satisfied with the end product.
Enviro Liner® 7040 FLEXHD Liquid Fertilizer Floating Cover

Location: North Battleford, SK, Canada

Timeframe: 2014

Scope of Work: Design and build a liquid fertilizer floating cover using Enviro Liner® 7040 FLEXHD material.

Project Owner: City of North Battleford

Background Information and Challenges:

The City of North Battleford built a facility to convert wastewater into marketable liquid fertilizer. The finished product (liquid fertilizer) requires protection from contamination and dilution by rainwater and thus a floating cover was needed. Layfield was the successful contractor and the floating cover portion of the work was essentially a design/build project. The client desired a product that had superior cold weather performance, would provide some measure of odor control, and also have a minimum 20 year lifespan (and warranty).

Solution:

The specified product did not meet this criteria, so Layfield proposed some alternatives, include Enviro Liner® 7040 FLEXHD. Layfield Environmental Containment selected the 7000 series (EL 7040 FLEXHD) because of its coextruded, fortified polyolefin geomembrane properties for this demanding containment application. We needed the flexibility for floating cover constructability and chemical resistance for odor control. Other differentiators for the EL 7000 series selection include UV resistance, high HPOIT, tensile strength, and stress crack physical properties. It was necessary to conduct ASTM cold weather comparison testing between the specified product and the EL 7040 FLEXHD, which the EL 7040 FLEXHD passed easily.

Results:

It is expected (from previous experience with this product/application) that air and/or gas will be generated in the process, so the cover was designed with underside transmission floats as well as a perimeter gas collection pipe and relief valves. The cover is designed to operate slightly under or above atmospheric pressure.
Enviro Liner® 7000 FLEXHD Defined Sump Floating Cover Sample Specification

PERFORMANCE REQUIREMENTS

Cover Material:
Ultraviolet (UV) resistance to meet requirements of the warranty
Resistant to chemicals or bacteria associated with pond contents

Cover System:
Designed to allow changes in water levels of up to 3 ft (1 m)
Designed to move collected surface water under the cover

SUBMITTALS

Product Data:
Provide test reports on cover material properties and characteristics

Shop Drawings:
Cover panel layout showing size, number, position and sequence of placing all panels, and indicating the location of all field seams
Anchoring details
Rainwater drainage/removal system
Hatches, air vents, and other site-specific appurtenances
Samples: Prior to ordering materials proposed for the reservoir floating cover, submit a five square foot section to the Engineer for approval. Submit also the following items to the Engineer for approval:
   a. Sample of wedge welded seam
   b. Sample of extrusion welded seam
   c. Sample of float end closure proposed to be used
   d. One sample of each type (single and double) of weight attachment strap (two total)
   e. Sample of half-tube air vent sub-assembly
   f. Material Safety Data Sheets (MSDS) of all materials used in fabricating the cover

QUALITY ASSURANCE

Installer’s Quality Assurance Requirements:
The requirements of Installer's quality assurance shall be to ensure that the highest standards of workmanship and performance are exercised in the execution of the work; that the work is in complete compliance with the contract documents; and to implement a quality assurance program that will:
• Verify and document, through testing, that all materials are in accordance with the minimum stated specification requirements
• Verify and document that all materials adjacent to the existing liner and new floating cover materials are placed in accordance with the specifications and in such a manner that the integrity of the liner and floating cover installation is not compromised
• Verify and document, through monitoring, that all liner and floating cover materials are protected and installed in accordance with the specifications
• Record the results of Quality Assurance activities on the project in the form of a Final Report
WARRANTY
The Contractor shall guarantee the entire work constructed under the Contract to be free of defects in materials and workmanship for a period of two (2) years following the date of acceptance of the work by the Owner. Manufacturer shall provide, through the approved Fabricator/Installer, a written exposed UV weathering warranty on the floating cover material. A fifteen (15) year standard weathering warranty is available on Enviro Liner® 7000FLEX® geomembrane at no additional cost. A twenty five (25) year extended warranty is available on approved applications. Fabricator shall warrant the factory fabrication of all accessories against defective factory fabrication workmanship for period of two (2) years from final acceptance by the Owner.

MANUFACTURERS
The Cover material shall be manufactured by Layfield Canada Ltd., Richmond, British Columbia. Substitutions: Equal as approved by the Engineer.

MATERIALS
See material specification table on page 5.

FABRICATION
The Contractor shall fabricate floating cover appurtenances (such as sand tubes, sand tube tabs, wrapped floats, hatches, vents, steps, rainwater removal sumps, etc.) in the factory. Field fabrication of floating cover appurtenances is only acceptable where factory fabrication is not possible or would result in a lower-quality field installation (at the determination of the Engineer).

INSTALLATION
The Contractor shall sequentially assemble the cover panels within a staging area approved by the Engineer, and deploy the cover across the reservoir floor and side slope areas using the procedure indicated in the Contractor’s Work Plan.

Repairs:
All punctures, cuts, tears, severe abrasions, and similar damage or abuse suffered by Enviro Liner® material shall be repaired by patching to the satisfaction of the Engineer.

Inspection and Seam Testing:
Tensile Strength Test: Specimens from any given factory or field seam test sample shall be per manufacturer’s specification.

Floating Cover Inflation Test:
Upon completion of the floating cover, inflate the entire cover for two (2) hours, visually observe for any cover damage and complete repair of all damaged areas. This procedure shall also include a visual inspection for holes from under the cover during inflation. The Installer shall take this opportunity to train the Owner’s staff in proper cover inflation procedures and attendant safety considerations.

CLEANING
Cleanup of Contractor’s materials and debris within and about the reservoir shall be an ongoing responsibility of the Contractor throughout the course of the work. Special care shall be taken to ensure that no dirt, scraps, trash, tools, or other unwanted materials are trapped on top of or beneath the liner or the floating cover.

The above is a sample specification only. For a full “CSI” specification please contact Layfield.
SECTION 10
INSTALLATION SPECIFICATIONS

Subgrade Preparation

1. Ensure subgrade is compacted and surface finished as to not impair installed geomembrane.

2. Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade.

3. A smooth drum rolled surface is preferable.

4. Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.

5. If a suitable sub-grade is not available, a cushion layer of 100 mm (4 inches) of clean sand and LP8 nonwoven geotextile shall be placed prior to liner placement.

6. 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.

7. Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

8. 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 drawings.

9. Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.

10. A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

Geomembrane 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.

Figure 23. Approved subgrade for an oilsands project in Northern Alberta
SECTION 10

INSTALLATION SPECIFICATIONS

4. Weather Conditions at Time of Installation:
   • 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.
   • Installation of geomembrane 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.
   • Do not install the geomembrane during precipitation or in the presence of excessive moisture.
   • Do not install in weather conditions that may be detrimental to the function of the geomembrane.

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:
   • A qualification seam will be run prior to any field seams.
   • A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.
   • Machine conditions and operator used for welding must be the same as those used for the qualification weld.
   • Qualification seam must be tested in shear and peel, and meet the specified requirements for the material as stated in the materials section.
   • A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every four (4) hours.

10. Field Seams:
    • Field seams will be sampled for testing in a way that does not compromise the installed liner.
    • One sample to be tested for every 150 m (500 ft) of field seam.
    • Test samples are to be removed from the ends of seams, from the anchor trench, or other locations that do not introduce a defect into the liner.
    • Samples to be approximately 100 mm (4 inches) long to permit testing of one shear and two peel specimens (ASTM D6392).
    • Test samples immediately after seaming.
    • Record date, location and pass/fail description.
    • A written record will be maintained for all field seam tests.
    • All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).
SECTION 11
TYPICAL DRAWINGS

Anchor Trench

Vent Detail
• Martin, D. (2005). UV Resistance in Thin Film Geomembranes, Accelerated and Natural Weathering Studies, GeoFrontiers 2005, IFAI, Austin, TX, USA.
• USDA – Natural Resources Conservation Service, Conservation Practice Standard, POND SEALING OR LINING – FLEXIBLE MEMBRANE, Code 521A.
• Subtitle D. Code of Federal Regulations, Title 40, Chapter 1, Subchapter 1, §258.40, Subpart D of the Resource Conservation and Recovery Act (RCRA).

Please Note:

If you have any further questions please call your Layfield representative. Layfield product information is provided free of charge for your consideration. The comments offered are for discussion purposes only. While this information is based on Layfield’s experience, this information may not be relied upon for any specific application as the nature of applications and site conditions are beyond Layfield’s control. It is the user’s responsibility to satisfy themselves as to the suitability of this information and to determine the suitability of this information for their specific application. Layfield shall not be liable for any loss or damages whatsoever that may occur from the use of this information. No warranty against patent infringement is offered or implied.