

POND SEALING OR LINING

FLEXIBLE MEMBRANE: HDPE, LLDPE & PP

CONSTRUCTION SPECIFICATION

1. SCOPE

The work shall consist of placing a high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), or polypropylene geomembrane in a pond to the elevations, grades, and cross sections as shown on the drawings, and/or as staked in the field.

the scope of the manufacturer's recommendations, the engineer's approval must be obtained.

Non-woven geotextile shall meet the requirements of Table 4.

2. MATERIALS

The geomembrane shall meet the requirements of Tables 1, 2, or 3, as specified in Section 16.

Each package delivered to the job site shall bear the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material.

The manufacturer shall meet the National Sanitation Foundation Standard 54 requirements for Flexible Membrane Liners, and shall have at least five (5) years continuous experience in the manufacture of geomembrane and/or experience totaling 10,000,000 square feet of manufactured geomembrane.

All seaming and welding materials, and all boots, coupling bands, channels and other appurtenances, shall meet the geomembrane manufacturer's recommendations. For materials outside

3. SUBGRADE PREPARATION

Earthwork shall be done in accordance with Construction Specification PA313 or PA378.

In addition, the area to be lined shall be allowed to dry until the surface is firm and can support the personnel and equipment that must travel over it during installation of the geomembrane and geotextile. All cut slopes and fills in the area to be lined must be sloped no steeper than 2.5 horizontal to 1 vertical. All fills and excavated slopes shall be thoroughly compacted using a sheepsfoot or smooth wheel vibratory roller. The pond bottom shall be constructed on a minimum two percent slope for gas venting out of the bottom.

The foundation area shall be smooth and free of projections that can damage the geomembrane. Stumps and roots shall be removed. Rocks, hard clods, and other such material larger than 3/4-inch shall be removed or covered with a compacted cushion of fine soil.

When specified, an effective sterilant shall be applied to the subgrade at the rate recommended by the manufacturer.

An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be 18 inches deep and at least 15 inches wide.

Waste storage ponds (PA313) to be lined with a geomembrane shall have a 12-oz./S.Y. needle-punch, non-woven geotextile underliner pad between the subgrade and the geomembrane.

4. PLACEMENT

All geomembrane shall be free of damage or defect. The geomembrane shall be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, or other damage. The rolls shall be stored on a prepared surface (not wooden pallets) and should not be stacked more than two rolls high.

The installation of the liner shall be directed at all times by an installer certified by the manufacturer. The installer shall provide proof of certification upon request by the engineer.

The geotextile shall be loosely spread over the prepared subgrade. Minimum laps of four inches shall be provided for all joints. The leading edge of the geotextile shall be placed in the anchor trench so that the material extends across the trench bottom. Tack or weight sheets to hold them in place until geomembrane is installed.

If the geotextile becomes saturated with soil material (mud), it shall be removed and replaced. Constant dampness of fine grained subbase may require use of four inches of clean sand in lieu of geotextile.

Each geomembrane panel shall be laid out

and positioned to keep the number and length of the geomembrane field joint seams to a minimum and consistent with proper methods of geomembrane installation. Seams shall be oriented down, not across the slope. No horizontal seams are allowed on side slopes or within 5 feet of the toe or crest of a side slope. Sharp corners shall be avoided. On the floor of a facility, up-slope panel overlaps shall shingle down-slope. T-shaped seams shall not be placed on slopes. All T-seams, or seams where three or more panels come together, shall include a minimum 24-inch diameter extrusion welded patch centered over the seam intersection and installed in accordance with this specification. No base T-shaped seam shall be closer than 5 feet to the toe of the side slope. Seams shall be aligned with the least possible number of wrinkles and "fishmouths". All fishmouths shall be cut out and the area repaired by patching.

The method used to unroll the geomembrane panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil or underlying geotextile.

The geomembrane shall be loosely spread to allow for approximately 1-2 percent slack. Leave the geomembrane loose overnight to cycle through expansion and contraction to release tension on the membrane.

The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels). Ballast shall be used to prevent relocation of the compensating wrinkles by wind.

Adequate loading (e.g., sand bags or similar items that will not damage the geomembrane) shall be placed to prevent

uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.

Direct contact with the geomembrane shall be minimized, i.e., the geomembrane in traffic areas shall be protected by an overlayment of geotextile, extra geomembrane, or other suitable materials. Equipment shall be maintained such that no petroleum products come in contact with the liner or geomembrane.

The top edge of the geomembrane and geotextile shall be placed in the anchor trench and anchored with compacted backfill. Compact backfill by wheel rolling with light rubber tired equipment or manually directed power tamper.

5. SEAMING

Seaming shall not be allowed during precipitation events.

Field seams shall be made by overlapping adjacent sheets and fusion welding the overlapped sheets using the fabricator's seaming apparatus and required technique.

The primary seaming method will be hot double-wedge fusion welding. Hot air fusion or chemical fusion welding may be used for PP. Prior to fusion seaming, all areas which are to become seam interfaces will be cleansed of dust and dirt. Seam joining shall not take place unless the sheet is dry, and shall not be attempted when the ambient temperature is below 45 degrees F or above 90 degrees F.

Extrusion welders shall be used only at areas which cannot be welded using the

double fusion welder. All extrusion welds shall have their top edges and bottom contact surfaces beveled with an angle grinder prior to placement on the geomembrane to remove oxidation. For extrusion welds, the geomembrane shall be preheated and pressed together to align for welding. The extrusion welder shall be calibrated at least once per day at the beginning of the seaming period.

Hot air welding shall be accomplished by a single or double tracked fusion welder, approved by the liner manufacturer, and calibrated at least once per day at the beginning of the seaming period.

Chemical fusing agents shall be applied to both panel surfaces by a squeeze bottle or paintbrush. The width of application shall be a minimum of 2-inches. Light pressure shall be applied by an acceptable roller to force intimate contact between panels. Excess agent extruded from the seam shall be removed immediately.

No equipment or tools shall damage the geomembrane by handling, trafficking, or other means. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane. Use of metal tools shall be kept to a minimum.

6. REPAIR PROCEDURES

Small holes shall be repaired by extrusion cap welding. If the hole is larger than ¼ inch, it shall be patched.

Tears shall be repaired by patching. Tears with sharp ends and located on slopes or in areas of stress shall be rounded prior to patching.

Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

Surfaces of geomembrane which are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. No more than ten percent of the thickness shall be removed.

Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of six inches beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edges beveled with an angle grinder after placement on the geomembrane. Patches shall be applied using approved methods only.

Defective seams shall be restarted/reseamed as follows: The welding process shall be restarted by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least two inches. Reseaming over an existing seam without regrinding shall not be permitted.

Verification of Repairs – Each repair shall be thoroughly checked for continuous, completed, solid welds with a uniform bead.

7. LEAK DETECTION AND FOUNDATION DRAINAGE

All sites shall have leak detection systems as shown in the design. The collection line will be installed at the lowest elevation of the pond. An extra layer of geotextile shall be placed over the aggregate to provide added protection. A four-inch corrugated

polyethylene drain tubing, complying with the requirements of ASTM designation F405, shall be embedded in size 57 stone, ASTM designation C-33. Solid PVC SDR 26 pipe. ASTM designation D2241 or Schedule 40, ASTM D1785 shall be installed through the embankment. The outlet shall consist of at least ten feet of Schedule 40 pipe with an animal guard.

The leak detection system shall have a pipe outlet that discharges into an accessible sump or at the ground surface at least 50 feet from a stream or other water body. The leak detection system shall be separate and isolated from any groundwater drainage system that is installed around or under the facility.

8. VENTS

Provide relief vents within the top one foot around the perimeter of the structure to allow gases to escape from under the geomembrane. Locate vents on a maximum spacing of 30 feet. Construct vents as approved by the designer.

9. SEALING AROUND THE PENETRATIONS

Factory fabricated pipe boots shall be used wherever possible. Pipe boots fabricated in the field shall be from the same liner material and shall be clamped to the pipe, as recommended by the manufacturer to provide a leak-free attachment.

Metal battens shall be installed according to the drawings and the manufacturer's specifications. The battens shall be attached to structure concrete by bolts on 6-inch intervals to create a leak-free attachment.

The seals around any penetration shall be performed using a method approved by the designer.

10. FIELD QUALITY CONTROL

All seams and non-seam areas of the geomembrane shall be inspected by the Installer for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be brushed, blown, or washed by the Installer if the amount of dust or mud inhibits inspection.

All defects found during testing shall be repaired and retested. Such tests and adjustments shall be repeated until the repairs are complete. The Installer shall non-destructively test all field seams over their full length as directed by the designer. All test equipment shall be furnished by the Installer.

a. Field Tensionmeter Test (for double fusion seam only)

- (1) Conduct this test prior to startup and once every three hours throughout the day for each seaming apparatus.
- (2) Cut samples from the ends of field welds.
- (3) Use a tensionmeter to test for shear and peel.
- (4) Specimens to be one inch wide with a grip separation of four inches plus the width of the seam.

- (5) The seam shall be centered between the clamps.
- (6) The rate of separation shall be two inches per minute.
- (7) Test results for seam strength properties shall be the average of five specimens.
- (8) Four out of five specimens shall pass seam acceptance criteria.
- (9) Shear and peel tests shall result in Film Tearing Bond (FTB), which is a failure in ductile mode of one of the bonded sheets by tearing prior to complete separation in the bonded area.
- (10) If a test seam fails to meet field seam specifications, the seaming apparatus and/or seamer shall not be used for seaming until the deficiencies are corrected and a successful test seam is achieved.
- (11) If more than one of the five test specimens fails, another set of five specimens shall be tested. Failure of more than one, the second set of specimens will be cause for rejection of the seams represented by the failed specimens.

b. Air Pressure Test (for double fusion seam only)

The following procedure is applicable to those processes which produce a double seam with an enclosed space. Air pressure tests shall be performed in accordance with ASTM D5820, the geomembrane manufacturer's specification, and as set forth below:

- (1) Seal both ends of the seam to be tested.
- (2) Insert needle or other approved pressure feed device into the tunnel created by the double fusion weld.
- (3) Energize the air pump to a pressure between 25 and 30 psi, close valve, and sustain pressure for approximately five minutes.
- (4) If loss of pressure exceeds 4 psi, or pressure does not stabilize, locate faulty area, repair and retest.
- (5) Remove needle or other approved pressure feed device and seal.

c. Vacuum Box Test

This test shall be performed on all extrusion welds in accordance with ASTM D5641, the geomembrane manufacturer's specification, and as set forth below:

- (1) Apply soapy water solution to the seam area to be tested.
- (2) Center the box, equipped with a transparent viewing window, over the seam area and draw a vacuum of 3-5 psi.
- (3) Visually monitor the seam area for any soap bubbles for 15 seconds.
- (4) Overlap each successive test by a minimum of 3 inches.
- (5) Mark all defects for repair. All repaired seam areas shall be bounded by passing tests.

d. Final tests and inspections

Upon completion of the work, the installation shall be subjected to a final inspection. All work in the system therein being tested shall be complete, cleaned and ready for use. All work shall meet the requirements as to line, grade, cleanliness and workmanship. All discrepancies shall be repaired.

11. JOINING WITH CONCRETE

Concrete shall be placed in accordance with Construction Specification PA313 or PA378.

Concrete to be joined to the geomembrane, such as pads and ramps, shall be installed prior to placing the geomembrane and shall have prefabricated geomembrane embedment strips cast into them. The contractor shall obtain the embedment strips from the liner installer along with the geomembrane manufacturer's instructions. The embedment strips shall be stored where excessive heat and sunlight will not cause deformation of the strip. The strips shall be fully embedded into the concrete with no gaps. Joints between the strips shall be extrusion welded or an expanding sealant, approved by the manufacturer, placed under the joint.

Concrete or grout pillows placed over the geomembrane shall be constructed in such a manner that does not puncture the geomembrane or jeopardize the integrity of the geomembrane in any way. The contractor shall submit shop drawings to the Engineer at least five business days prior to installation for approval.

12. PROTECTION AND SAFETY

All facilities with exposed flexible membranes shall be equipped with a means of emergency egress at two or more locations. For those facilities with intended access points, emergency egress shall be provided at each access point. The means of egress shall be as shown in the drawings or in Section 16, and shall be approved by the engineer.

All facilities with exposed flexible membranes shall be fenced to protect the liners from livestock and wildlife. Fencing shall be installed in accordance with the applicable specification. Posts shall be set outside the anchor trench. Fence shall be five feet high. Safety signs shall be installed on each side of the storage.

Areas of concentrated surface flow into the pond shall be protected against erosion by means of installing an extra layer of geomembrane as required in the design.

13. BASIS OF ACCEPTANCE

The acceptability of the geomembrane shall be determined by inspections to check compliance with all the provisions of this specification with respect to the drawings, markings, the appurtenances, and the minimum installation requirements.

The installing contractor shall certify that the installation complies with the requirements of this specification. A written guarantee shall be furnished that protects the owner against defective workmanship and materials for not less than one year and that identifies the manufacturer and markings of the geomembrane.

14. VEGETATIVE COVER

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area outside of the geomembrane. The planting of vegetation shall conform to the requirements of Construction Specification 342, Critical Area Planting.

15. CONSTRUCTION OPERATIONS

Construction operations shall be performed in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property. The installation shall be completed in a workmanlike manner and present a neat and pleasing appearance.

16. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

TABLE 1 - Properties of Smooth HDPE Geomembranes

<u>Test Description</u>	<u>Test Method</u>	Minimum Average Roll Values ^{1/}		
		<u>30 mil</u>	<u>40 mil</u>	<u>60 mil</u>
Thickness – mils ^{2/}	ASTM D5199	28	36	54
Sheet Density, g/cc	ASTM D1505	0.94	0.940	0.940
Tensile Properties	ASTM D6693 (Type IV at 2 IPM)			
Strength @Break Pounds/In. Width		114	152	228
Strength @Yield Pounds/In. Width		63	84	126
Elongation @Break, %		700	700	700
Elongation @Yield, %		12	12	12
Tear Strength, lbs.	ASTM D1004	21	28	42
Puncture Resistance, lbs.	ASTM D4833	54	72	108
Seam Properties	ASTM D6392			
Fusion Shear, ppi		60	80	120
Fusion Peel, ppi		45	60	91
Extrusion Shear, ppi		60	80	120
Extrusion Peel, ppi		39	52	78

The carbon black content of all thicknesses shall be 2-3% in accordance with ASTM D1603, and the dispersion shall be 9% in Category 1 or 2, and 1% in Category 3 of ASTM D5596.

^{1/} MARV – calculated as the mean minus two standard deviations, yielding a 95% confidence level that the table value will be equaled or exceeded.

^{2/} lowest of 10 values

TABLE 2 - Properties of Smooth LLDPE Geomembranes

<u>Test Description</u>	<u>Test Method</u>	Minimum Average Roll Values^{1/}		
		<u>20 mil</u>	<u>40 mil</u>	<u>60 mil</u>
Thickness – mils ^{2/}	ASTM D5199	18	36	54
Sheet Density, g/cc	ASTM D1505	0.94	0.94	0.94
Tensile Properties	ASTM D6693 (Type IV at 2 IPM)			
Strength @Break Pounds/In. Width		76	152	228
Elongation @Break, %		800	800	800
Tear Strength, lbs.	ASTM D1004	11	22	33
Puncture Resistance, lbs.	ASTM D4833	30	56	84
Seam Properties	ASTM D6392			
Fusion Shear, ppi		30	60	90
Fusion Peel, ppi		25	50	75
Extrusion Shear, ppi		30	60	90
Extrusion Peel, ppi		22	44	66

The carbon black content of all thicknesses shall be 2-3% in accordance with ASTM D1603, and the dispersion shall be 9% in Category 1 or 2, and 1% in Category 3 of ASTM D5596.

^{1/} MARV – calculated as the mean minus two standard deviations, yielding a 95% confidence level that the table value will be equaled or exceeded.

^{2/} lowest of 10 values

TABLE 3 - Properties of Unreinforced PP Geomembranes

<u>Test Description</u>	<u>Test Method</u>	Minimum Average Roll Values^{1/}	
		<u>20 mil</u>	<u>40 mil</u>
Thickness – mils ^{2/}	ASTM D751	18	36
Sheet Density, g/cc	ASTM D792	0.9	0.9
Tensile Properties	ASTM D638		
Strength @Break Pounds/In. Width		36	72
Elongation @Break, %		700	700
Tear Strength, lbs.	ASTM D1004	8	12
Puncture Resistance, lbs.	ASTM D4833	14	30
Hydrostatic Resistance, psi	ASTM D751	300	350
Low Temp. Brittleness, °C	ASTM D2136	-40	-40
Seam Properties			
Bonded Strength, lbs/width	ASTM D751	200	200
Peel Adhesion, lb/in	ASTM D413	20	20

The carbon black content of all thicknesses shall be 2-3% in accordance with ASTM D1603, and the dispersion shall be 9% in Category 1 or 2, and 1% in Category 3 of ASTM D5596.

^{1/} MARV – calculated as the mean minus two standard deviations, yielding a 95% confidence level that the table value will be equaled or exceeded.

^{2/} lowest of 10 values

TABLE 4 - Properties of Non-Woven Geotextiles

<u>Test Description</u>	<u>Test Method</u>	<u>Minimum Average Roll Values</u> ^{1/}
Weight - oz/square yard	ASTM D3776	12
Thickness, mils ^{2/}	ASTM D1777	130
Grab Strength, lbs.	ASTM D4632	275
Grab Elongation, % maximum	ASTM D4632	50
Trap, Tear Strength, lbs.	ASTM D4533	115
Puncture Strength - lbs.	ASTM D4833	185
Mullen Burst Strength, psi	ASTM D3786	650
Permeability, cm/sec	ASTM D4491	0.2
Permittivity, sec ⁻¹ gal/min/ft ²	ASTM D4491	0.9 60
AOS, U. S. Standard Sieve	ASTM D4751	100

^{1/} MARV – calculated as the mean minus two standard deviations, yielding a 95% confidence level that the table value will be equaled or exceeded.

^{2/} lowest of 10 values