Operation and Maintenance Guideline for Geosynthetic Lined Water Reservoirs

Fabricated Geomembrane Institute

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1. Introduction and Purpose

This guideline recommends regular inspections and maintenance for geosynthetic-lined reservoirs. A well-defined, site-specific inspection and repair program ensures long-term effectiveness of lined reservoirs. Floating covers, similarly, benefit from an inspection program. Documented inspections enable operators to detect and address various signs of potential leakage – while minor and repairable. Without this well-defined operation, inspection, and maintenance program and its necessary documentation, many, if not most, geomembranes will develop signs that show a potential for leakage of the stored water and ultimate failure.

A geomembrane providing containment for a water reservoir is subject to many potential sources of stress over it's operational lifetime, which can compromise the integrity of the bottom liner system. Many of these post-installation stresses are created by environmental factors (wind, hail, ice, UV, etc.), operational conditions (i.e. water-level changes, human/mechanical traffic), and wildlife – each of which have the potential to cause tears, punctures, and other damage. Other sources of damage may include improper design and/or construction of the subgrade and/or installation of the geosynthetics, which are not addressed herein because the focus is on post-installation damage. To prevent excessive damage from such failures after a reservoir is placed into service, visual inspection of the system should be made during first filling of the reservoir. Thereafter, throughout the life of the reservoir it is recommended that regular quarterly inspections be performed (see **Table 1**). More frequent inspections may be needed based on frequency of operational activities and/or wildlife in the project area. If failures in the geomembrane are observed or suspected, a more detailed inspection should be conducted by a Geosynthetics consultant or the installer who may be able to provide a more in depth analysis of the damage and a suitable repair. The reservoir may need to be lowered to determine whether damage exists below the water surface and the extent of the damage. If defects are discovered, the causes should be

determined and appropriate repairs made immediately by the installer or a repair contractor.

2. Worker Safety

This guideline does not purport to address all of the safety concerns, if any, associated with its use, especially in the hot and Ultraviolet Radiation (UV) intensive environment in and around a water reservoir. It is the responsibility of the user of this guideline to establish appropriate safety for each particular work environment. In water reservoir environments, winds can be strong due to the large open area such that work in the area is often interrupted for safety reasons. As a result, appropriate safety measures should be readied and implemented in strong winds.

Proper safety procedures should be observed at all times when working in or around a reservoir including when inspection, operation, or maintenance work is being performed with the reservoir in service. Specifically, the following minimum safety rules should be adopted and enforced by the utility:

- No fewer than two workers should be present at a location when work of any nature is taking place along a water reservoir.
- The workers also should be able to swim.
- A life jacket or flotation vest should be worn by any individual working on a geosynthetic lined reservoir slope and a hi-visibility safety vest or garment while on site.
- Sharp knives should be properly sheathed and secured to prevent personal injury and damage to the geosynthetics/geomembrane.
- All individuals accessing the top of a geomembrane should be advised that the geomembrane may be slippery when wet. All individuals should be advised of egress locations, life ring locations, and site emergency protocols, such as, the proper emergency telephone number, e.g., 911.
- As much as possible, all workers should walk on access pathways where provided. However, some inspections may require walking on limited areas of the geomembrane and this should be done so as to not damage the geomembrane.
- Never step on any unsecured geosynthetic material (scrap, rubsheet, etc.).
- A minimum of 100 ft (30 m) of rope attached to a suitable life ring should be readily available to workers while work is taking place on the reservoir sideslope. Additional rope length may be needed to reach the bottom of the reservoir depending on the slope length.
- Ropes should be permanently installed on slope walls to aid in exiting the reservoir.
- Electrical tools used to facilitate repairs to the geomembrane while it remains in service must be protected by an appropriate ground fault circuit interrupting (GFCI) device at the source of power.
- If the reservoir contains hazardous materials, appropriate Personal Protective Equipment (PPE) should be used.
- Any repair tools should be used properly to ensure worker safety.

3. Terminology

Some terms from this guideline are defined within this section.

***Geomembrane*:** Geomembranes are synthetic membrane liners or barriers that are used to control fluid migration in a manmade project, structure, or system. They are made from relatively thin continuous polymeric sheets that are sometimes made from the infusion of geotextiles with asphalt, elastomer, or polymer sprays.

***Pipe boot*:** are flexible pipe attachments that stop leaks where pipes penetrate the geomembrane. The apron of the boot is welded to the geomembrane. The sleeve of the boot seals to the pipe with a variety of options depending on the type of geomembrane used. For factory fabricated geomembranes, butyl tape is usually wrapped around the pipe beneath the sleeve and a stainless steel pipe clamp over the sleeve. For HDPE geomembranes, an extrusion weld is sometimes used when attaching to an HDPE pipe. Boots are custom made for the particular pipe size and material.

***Batten bar*:** refers to a geomembrane sealing to concrete structures using wood, aluminum, or stainless-steel batten bars. A butyl sealant should be placed between the geomembrane and concrete to prevent leakage. Anchors can be powder-actuated fasteners such as Hilti or Ramset, with washers. Stainless steel expansion anchors are also acceptable for connecting the batten to the concrete.

***Electric Leak Location (ELL)*:** refers to electrical leak location surveys that are conducted on the primary or secondary geomembranes. Depending on the application, these surveys may be performed either on the bare geomembrane or covered by either water or soil.

***Factory welded seam*:** refers to a geomembrane seam that is welded in the factory usually using a variety of welding technologies.

***Factory welded seam*:** refers to a geomembrane seam that is welded in the field usually using a hot wedge welder.

***Fabricated panel*:** refers to a geomembrane panel fabricated at a manufacturing facility into a larger panel than the original roll stock material. A fabricated panel may be a larger rectangular panel of geomembrane or may be a specific fabricated shape or may contain special job-specific detail work. The fabricated panel can be folded and/or rolled as defined below.

***Accordion-folded panel*:** refers to a fabricated panel where the material is folded back and forth in a "Z" formation in the same principal direction as the seams. This folding takes a wider panel of material and makes it into a narrow stack. For example, a 30 m by 30 m prefabricated panel could be accordion-folded into a 3 m wide stack of material 10 layers deep and 30 m long.

***Accordion-folded and rolled panel*:** refers to an accordion-folded fabricated panel that is first accordion-folded to the desired width and then rolled to form a finished, rolled bundle for transport.

***Double accordion-folded panel*:** refers to an accordion-folded fabricated panel that is accordion-folded to the desired width and then accordion-folded in the length direction onto a pallet (or into a container). Double accordion-folded panels typically appear as a "cube" of material with square corners.

***Rolled panel*:** refers to a fabricated panel that is rolled from one end or in some cases from both ends to the middle.

***Fabricator*:** the person or organization by whom the geomembrane material is fabricated into a fabricated panel.

4. Geomembrane Protection

This section provides some best practices for protecting the geomembrane in water researvoir applications.

A. Ancillary Activities Beyond Geomembrane

It is important to remember that damages to a geomembrane does not only occur while people are working within the reservoir itself. In fact, a lot of damage occurs while people are not working within the reservoir, e.g., environmental, wildlife, etc.. Damage also tends to occur from ancillary work surrounding the reservoir, e.g., during access road maintenance, fence installation, etc.. The following suggestions may help minimize and expedite identification of damages in this regard:

- Train all personnel working within close proximity to the reservoir on how easily the geosynthetics can be damaged and the implications of damage, even if minor.
- Train all personnel regularly working in the area on identification of common visual indicators of damage, many of which are illustrated pictorially later in this document.
- Consider using video cameras, both for security and identification of damage with daily monitoring of captured images.

B. Activities On Geomembrane/Geosynthetics

Proper equipment and geosynthetics protection protocols should be used at all times when performing inspections and maintenance work so the geosynthetics, and in particular, the geomembrane, are not damaged.

Specifically, to protect the geomembrane from damage, the following equipment protocols should be followed:

- Sharp knives, objects, and/or tools should not be brought onto the deployed geomembrane panels unless absolutely required for the repair. When required, approved knives and other sharp tools should be used only by properly trained personnel and used in an approved manner that will not damage the geosynthetics. When not in use, these

tools should be properly sheathed and secured to prevent damage to the geosynthetics/geomembrane.

- No heavy equipment, e.g., generators, on the geosynthetics. Heavy equipment should be left at the top of slope (properly secured) and not on the geosynthetics. However, if the allowable electrical cord cannot reach the repair location from the top of slope, the heavy equipment should be placed and properly secured on a pad and not directly on the geosynthetics.
- Do not use any sharp hooks, probes, or knives to check the integrity of the geomembrane seams.
- Do not park vehicles or place equipment, e.g., a pump or hose with hose clamps, directly on or immediately adjacent to geomembrane and geosynthetics so hydrocarbon spills do not occur as shown in **Figure 6** below. Place a sacrifical geomembrane under the equipment or ATV so no leakage on the reservoir geosynthetics occur.
- Any repair tools should be used and set on rub sheet or pad rather than directly on the geomembrane to prevent damage to the liner system.

Additionally, other general protocols that should be followed to minimize the potential to damage to the geomembrane are as follows:

- Wear non-sharp boots and footwear.
- Remove rocks and any other objects from the bottom of your boots and footwear before walking on the geomembrane and geosynthetics.
- When low ground pressure equipment such as ATV's are allowed on the geomembrane/geosynthetics, a rub sheet should be placed at the access point. Once the equipment is driven onto the rub sheet, it should be parked and secured. An inspection should be performed of the tires and any rocks or other objects must be removed from the tires before driving on the geomembrane.
- Smoking on the geomembrane is prohibited.
- No chemicals can be left on top of the geomembrane.
- Whenever solvents are used, they must be capped immediately after use and technicians should be using proper PPE. While not in use, solvents should be stored in their original packaging and in a protected location.
- Geomembrane welding personnel must be informed of the risks of using a solvent and use appropriate personal protection equipment (PPE), such as gloves and masks during the operation.

5. Reservoir Operation

Reservoir operators should closely monitor and, if possible, control reservoir operating levels whenever ice has formed on or beneath the surface of a geomembrane. If ice has formed beneath the geomembrane, there may be a leak on the geomembrane and the geomembrane should be carefully inspected. Wide fluctuations in reservoir levels can result in ice damage to a geomembrane, particularly along sloping sidewalls. As a result, a reservoir operating range not

exceeding 1 vertical ft (0.3 m) is typically recommended during freezing weather conditions.

Complete inspections of the geomembrane and other geosynthetics should be performed at regular intervals to check for possible leaks, buildup of debris, separation of seams or patches, damage caused by vandalism, etc. Inspections should also check for proper operation of pumps and drains. A careful record of any required maintenance should be developed and preserved for future reference.

6. Project Information

The inspector should record the following project information so it is readily available:

- Job Name
- Date/Time of inspection
- Current site activity
- Material(s) inspected
- Inspector's contact information (i.e., Cell Phone Number, email)
- Date of inspection
- Date of last inspection
- Date of next inspection due
- Prior repairs that are visible or available in project documentation that should be provided to the inspector so they can properly inspect the prior repairs
- Electric Leak Location (ELL) Performed? Yes_____ No_____
- Recommend ELL be performed if conditions permit? Yes_____ No_____
- Inspector Name:
- Inspector Signature: _____

7. Geomembrane Inspection

A checklist should be developed listing all necessary visual observations to be made during each inspection. **Table 1** shows a sample inspection and maintenance checklist and schedule. The schedule is intended only as a guide. Site-specific written procedures should be developed by reservoir operators. Factors such as climatic conditions, location of geomembrane, age and condition of geomembrane and other geosynthetics, type of geomembrane material/polymer, reservoir size, jurisdictional and regulatory agency requirements, and other factors, should be considered when developing site-specific procedures. As a minimum, the intervals for inspection indicated in **Table 1** are recommended. An accompanying field checklist is presented in Appendix A and can be completed during the visual inspection.

During this inspection, if geomembrane damage is observed, the installer or a repair contractor should be contacted to schedule repairs. The installer or repair contractor should document the location and type of repair completed and the inspection issue addressed. Depending on the level

of damage observed, an electric leak location may be needed. It is recommended that an electric leak location be conducted every five years regardless of the inspections to reduce water loss.

The following list details some of the visual observations and inspections of the geomembrane that should be made during the periodic inspections:

- The perimeter and exposed portion of the bottom liner system should be inspected for vegetation. Vegetation can grow on or below the geomembrane due to the presence of water. For example, **Figure 1** shows vegetation growing under the geomembrane along the perimeter of the bottom liner system of a potable water reservoir. If present, this vegetation should be removed before it becomes large and creates a void under the geomembrane.
- All geomembrane panels or sheets should be inspected for punctures, tears, splits, and evidence of leakage. Where the integrity of the geomembrane is questioned, the installer or a repair contractor should be consulted.
- All subgrade traversed should be inspected for rutting, excess settlement, softening, pooling water, or degredation beneath the geomembrane.
- All mechanical anchorage points should be visually inspected for pullout or leakage. Where pullout or leakage is detected, the cause of the failure should be determined before repairs are made. Repairs should be made by the installer or a repair contractor.
- All bonding, e.g., caulk, mastic, adhesive, of the geomembrane to appurtenances, e.g., columns, pipe penetration, valves, and other components, should be visually inspected and rebounded where necessary by the installer or repair contractor. Any damage identified should be photographed and documented (e.g., size, location, possible repair. etc.).

8. Electric Leak Location

Owners and operators should perform electric leak location surveys to maintain their liner system after installation. This can be done on a routine basis or as damage or leakage becomes evident. The post installation surveys will extend the service of the liner system.

The electric leak location method is a powerful tool used to detect electrical paths through leaks in a geomembrane. Many forms of the ELL exist depending on the geosynthetics involved, i.e., presence of conductive and non-conductive materials. In general, a voltage is applied to an electrode placed in the soil or water covering the geomembrane and to an electrode placed in the leak detection zone for double-lined systems or connected to earth ground for single-lined systems. Because the geomembrane is an electrical insulator, electrical current will flow only through leaks in the geomembrane. This current produces localized anomalous areas of high current density near the leaks. Electrical measurements are then made on the soil, in the water, or on bare geomembrane to locate these points of current flow through the leaks.

Areas where the geomembrane is not in intimate contact with the underlying subgrade should be documented and more thoroughly examined because they may limit the effectiveness of an ELL. This is due to ELL not being able to work in areas with insultating features, such as, wrinkles filled with air (unless conductive geomebrane is used), bridging, and other stuations where the geomembrane is not in contact with the subgrade. In most cases, these would happen and be addressed during installation, but any areas of exposed geomembrane will be subject to heat/cooling cycles and can develop wrinkles which limit the effectiveness of ELL. Such areas should have a thorough visual inspection performed, which may require cleaning of the geomembrane, which again must be done in a manner that does not damage or harm the geomembrane and other geosynthetics.

Electric leak location should be considered in the following situations:

- Immediately after geomembrane installation as part of the final CQA and acceptance.
- As a part of a preventive maintenance schedule to test the geomembrane on a scheduled basis of every 2, 3 or 5 years depending on the project.
- As an integral part of locating damage due to a known leak in the system resulting in water loss.
- As a follow-up to repair of reservoir geomembrane damage or routine maintenance repair.

Table 1. Inspection checklist for geosynthetic lined water reservoirs.

					Responsible Entity		
		Weekly	Quarterly	Annually	Department Engineer	Dam Operator	Independent Dam Safety Engineer
External Embankment or Dam Periodic Inspections & Monitoring	Monitor Weather Forecasts	As Needed			✓	✓	
	Presence of vegetation growing on or under geomembrane – (see **Figure 1**)		✓		✓	✓	✓
	Erosion protection measures – vegetation, mats, and geotextiles		✓		✓	✓	✓
	Routine Inspections – sloughing, cracking, settlement, sinkholes		✓		✓	✓	✓
	Seepage Observations		✓		✓	✓	
	Regular Dam Safety		✓		✓	✓	
	Reservoir Level – (see **Figure 2**)		✓		✓	✓	
	Formal Dam Safety		✓		✓	✓	✓
	Animal intrusion – deer, rodents		✓	✓	✓	✓	✓
Special Inspections	After Unusual Event	As Needed			✓	✓	✓
	If Unusual Conditions	As Needed			✓	✓	✓
Outlet Works Pipe	Internal Inspection	Every 5 years			✓		✓

		Weekly	Quarterly	Annually	Responsible Entity		
					Department Engineer	Dam Operator	Independent Dam Safety Engineer
Primary Geomembrane (GM) and Geosynthetics Inspection	Observe all GM seams and patches – identify any loose seams or extrusion welds; clean as needed for inspection		✓		✓		✓
	Observe exposed GM – (see **Figure 3**)		✓		✓		✓
	Observe GM tightness, which can cause cracking at batten strips, pipe boots, other attachments, etc.		✓		✓		✓
	Check all attachments and seals (see **Figures 4 and 5**)		✓		✓		✓
	Anchor trenches (see **Figure 6**)		✓		✓		✓
	Inlet and outlet diversion ditches		✓		✓		✓
	Damage to protective materials and/or GM-(see **Figure 7**)		✓		✓		✓
	GM cracking or delamination (see **Figures 8, 9, and 10**)		✓		✓		✓
	GM decolorization – oxidation (see **Figure 3**)		✓		✓		✓
	GM oxidation – color on hand wipe or chalky		✓		✓		✓
	GM wrinkles and folds		✓		✓		✓
	Material separation – cracking, exposed scrim, etc. (see **Figures 4, 7, and 8**)		✓		✓		✓
	Check slopes and reservoir for subgrade softening and failures - (see **Figure 11** (tire ruts) and **Figure 12** (settlement))		✓		✓		✓
	Check slopes and reservoir for subgrade settlement and improper remedial measures - (see **Figure 13**)		✓		✓		✓

	Check slopes & reservoir for geomembrane whales or bubbles – (see **Figure 14**)		✓		✓		✓
		Weekly	Quarterly	Annually	Responsible Entity: Department Engineer	Responsible Entity: Dam Operator	Responsible Entity: Independent Dam Safety Engineer
Embankment/Dam Instrumentation Electric Leak Location (ELL)	Check all instrumentation: piezometers in embankment, liquid level in pipes, sump indicators, surface monuments, flow meters (inflow and outflow) If GM damage is observed, ELL may be needed Conduct ELL every five years regardless of inspections to reduce water loss - tests 100% of lining area	As Needed or as required by dam safety			✓		✓

Figure 1. Vegetation growing: (a) under geomembrane batten strip and (b) around reservoir instrumentation within bottom liner system.

Figure 2. Geomembrane damage (see arrow) due to floating ice.

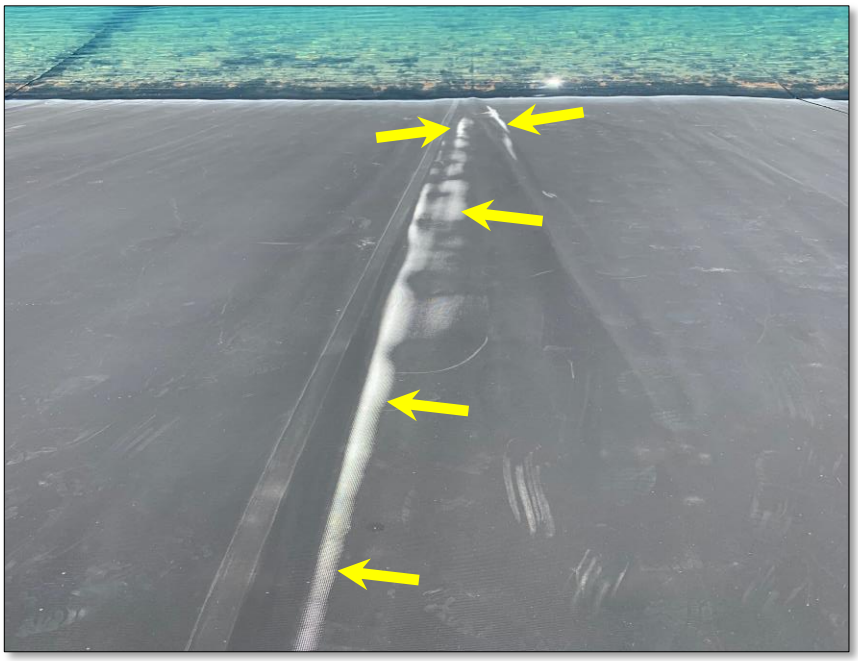


Figure 3. **UV degradation of parent geomembrane, which should have been observed earlier to prevent further degradation and failure of the geomembrane.**

Figure 4. **Pipe clamp loosened over time and now the clamp and butyl should be replaced and the clamp retightened and caulk applied to seal the geomembrane to the pipe.**

Figure 5. Detached caulk over time and now the butyl and caulk should be replaced and the clamp retightened. Also recommended but not shown in this photo is a sacrificial piece of geomembrane underneath the clamps to help prevent damage to the geomembrane

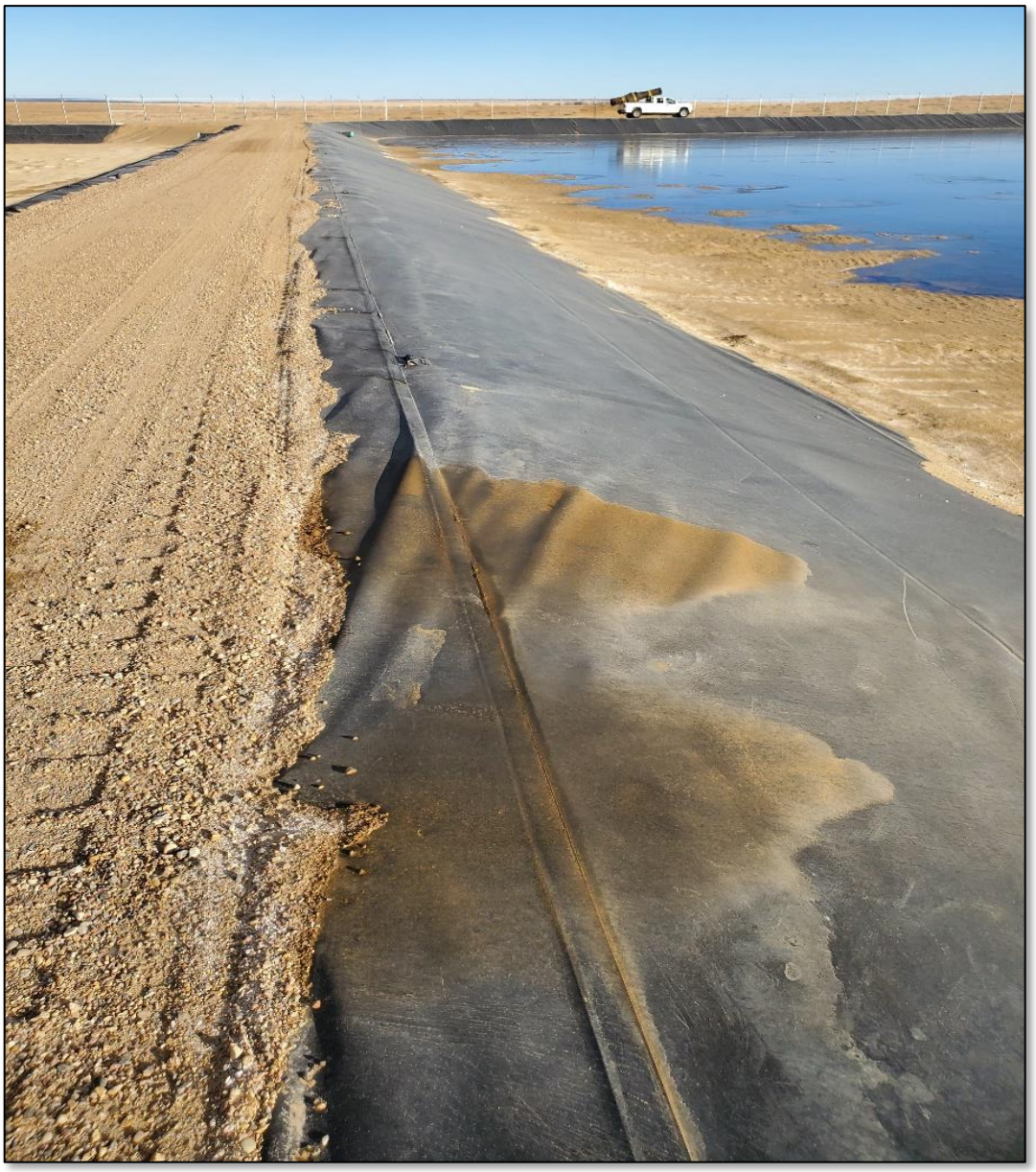


Figure 6. **Photograph showing: (1) hydrocarbon spills on geosynthetics and driving too close to the geosynthetics, (2) horizontal seam along the crest of the slope, which is not recommended due to applied tensile stresses and should be addressed during the design phase, and (3) geomembrane on top of pickup truck may damage the material and is not safe.**

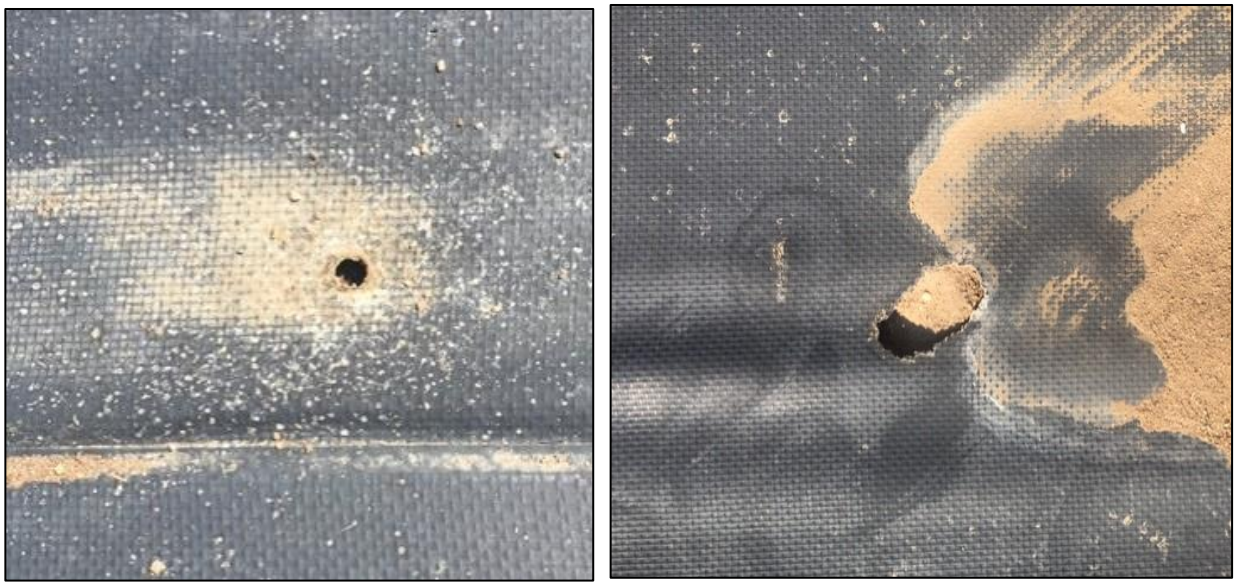


Figure 7. Hole in geomembrane due to rodent(s) identified via visual inspection.

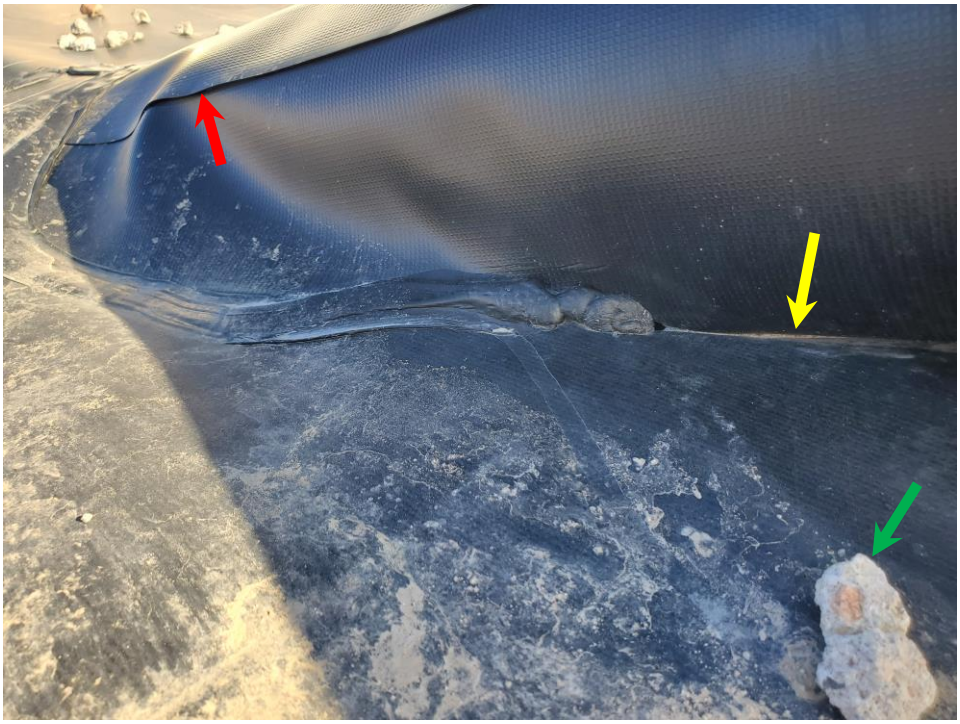


Figure 8. Photograph showing: (1) leakage around extrusion weld (see exposed subgrade at yellow arrow), (2) large glob of extrudate at the seam end, (3) rock on geomembrane that should be removed (see green arrow), and (4) edge of seam flap exposed (see red arrow).

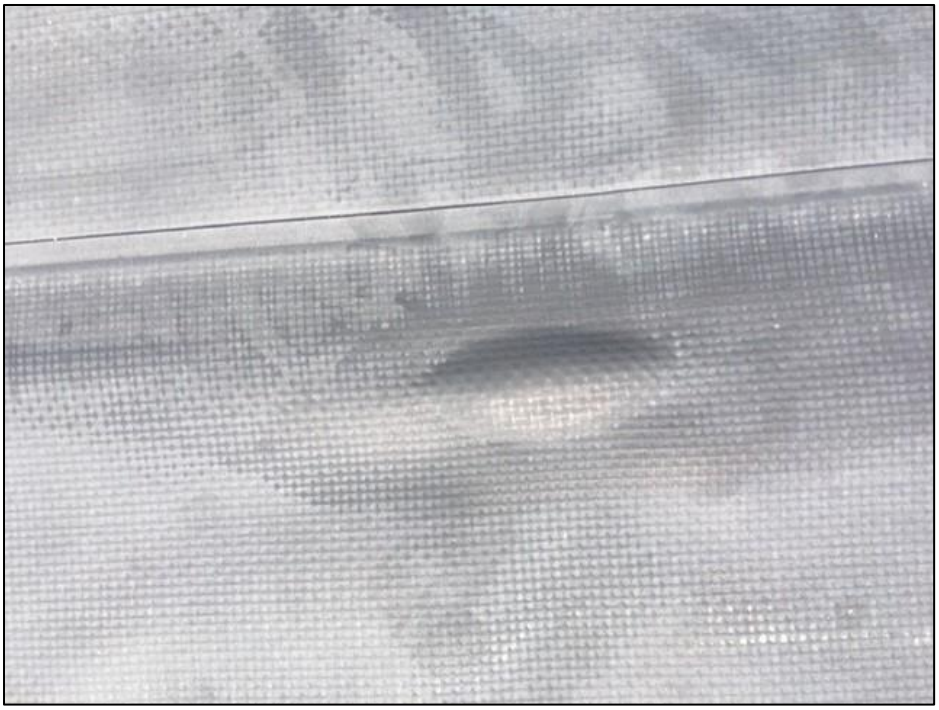
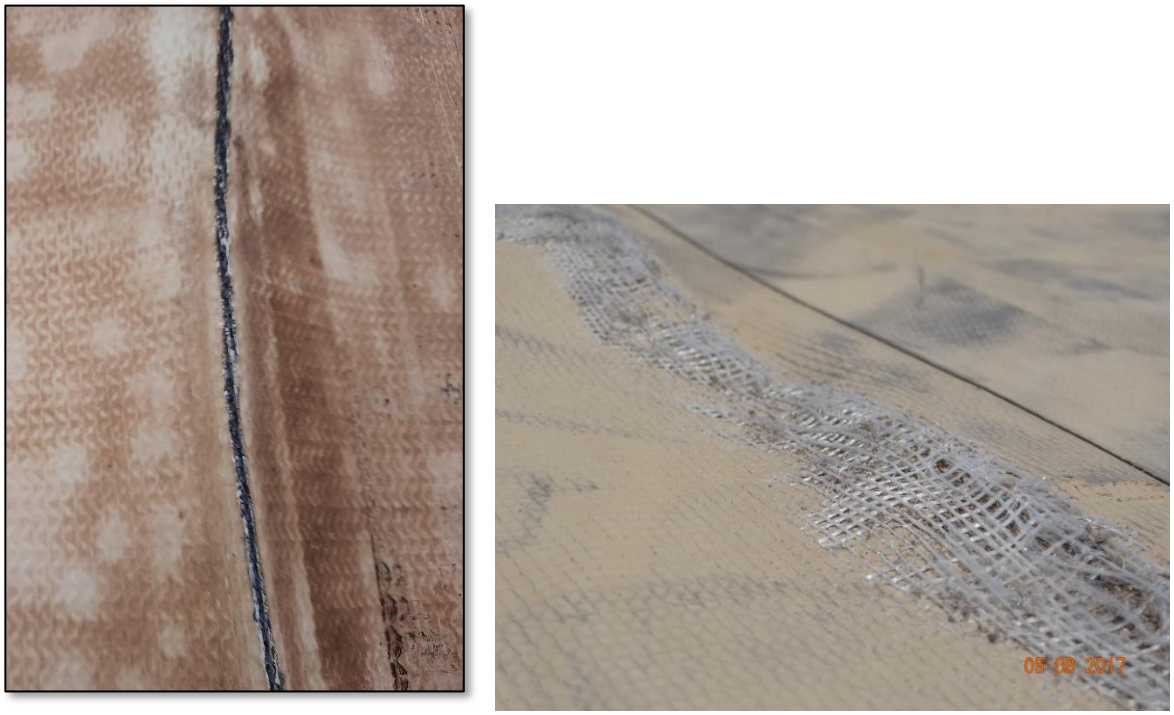


Figure 9. Delamination of top layer of reinforced geomembrane and creation of a blister.



(a) (b)

Figure 10. Geomembrane experiencing: (a) cracking and (b) delamination.

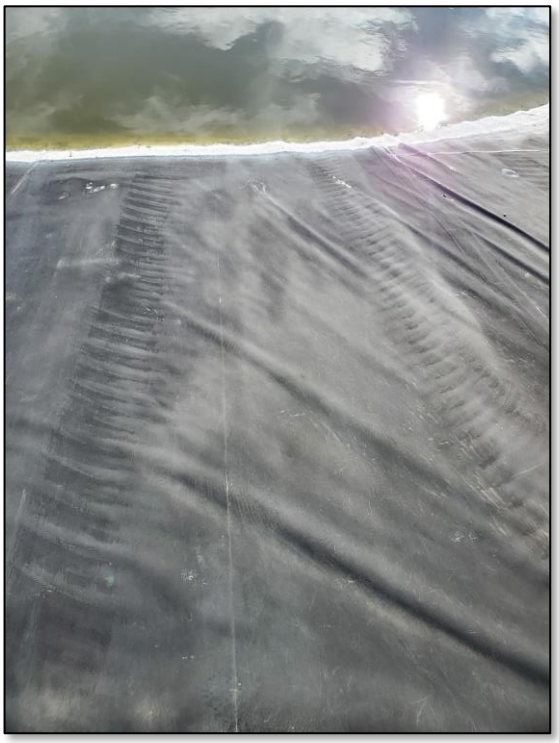


Figure 11. Tire imprints in geomembrane indicating equipment was driven directly on top of the geomembrane. Equipment should never be driven on geosynthetics to repair geosynthetics or remove debris and sediment unless it has low ground-pressure (approved by design engineer) and on a suitable access ramp.

Figure 12. Subgrade failure and sloughing under the geomembrane.

Figure 13. **Subgrade settlement and blocks being used to support pipe, which may damage the underlying geomembrane as well as pipe union if the block were not present. If a block or pipe union has to be placed on a geomembrane, a rubsheet or other sacrificial material should be placed underneath it.**

Figure 14. Geomembrane whales due to gas buildup below geomembrane.

9. Geomembrane Repairs

Geomembrane repairs should be performed by properly trained maintenance personnel using materials and methods recommended by the geomembrane manufacturer. Original project specifications and requirements should be considered by the inspector as part of the repair process. Repair work should not be attempted with the geomembrane in service if repaired areas can come into contact with the potable water during the procedure. Because taste- and odor-causing chemicals may be used in making the repairs, extreme caution must be taken to ensure that any excess materials are thoroughly dissipated once repairs are completed.

Repairs along reservoir sidewalls can often be completed by temporarily lowering the operating level in the reservoir. Repair crews should carefully follow the manufacturer's repair recommendations. An improperly repaired area will likely fail again.

When performing any repairs to the geomembrane, it is important to recognize that incidental damages associated with the repair may occur (foot traffic, equipment traffic, etc.). Therefore it is recommended that prior to performing repairs, a plan be implemented (in conjunction with proper safety protocols) to minimize the area subject to repair related traffic. Such pathways should be marked off with cones, sandbags (gently placed, not tossed), or other approved methods and all personnel directed to stay within these pathways. Thus, a post-repair visual inspection (and/or ELL) can remain focused to these particular work areas/access/egress pathways.

10. Summary

If regular inspections of the geosynthetic liner system are performed and problems quickly addressed, field experience shows geomembrane containment systems will perform successfully

for many decades. Once damaged, liner systems deteriorate rapidly. Repairing soon after detection can prevent more costly degradation, embankment damage, and/or uncontrolled discharge.

For example, the geomembrane used for freshwater containment date back to 1957 when the U.S. Bureau of Reclamation (USBR) installed a small experimental test section of a PVC geomembrane in an irrigation canal on the Shoshone Project in Wyoming (Hickey, 1969). The first PVC installation under construction specifications (604C-72) was on the Helena Valley Canal, Montana, in 1968 (Geier and Morrison, 1968). Based on these early installations, the USBR concluded that buried geomembranes provide satisfactory service for seepage control and are viable alternatives for areas not suitable for concrete or compacted earth linings (Morrison and Comer, 1995). Some of the these canals are still operating successfully. As a result, if regular inspections of the geosynthetic liner system are performed and problems quickly addressed, the geomembrane containment systems will perform successfully for many years.

11. Acknowledgements

This document is the product of the FGI Operation and Maintenance (O&M) Subcommittee, which consists of in alphabetic order Ron Frobel, Matt Kemnitz, and Duff Simbeck. It is anticipated that additional O&M guidelines will be created for other applications to improve the service life of the geomembrane and other geosynthetics.

12. References

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Geier, F. H. and Morrison, W. R. (1968). “Buried asphalt membrane canal lining,” Research Report No. 12. A Water Resources Technical Publication. Bureau of Reclamation, Denver, Colorado, 1968.

Morrison, W. R. and Comer, A.I. (1993). “Use of Geomembranes in Bureau of Reclamation Canals, Reservoirs, and Dam Rehabilitation,” U.S. Bureau of Reclamation, Report # REC-95-01, Denver, CO, December, 203 p. https://www.usbr.gov/tsc/techreferences/hydraulics_lab/pubs/REC/REC-ERC-95-01.pdf.

13. Appendix A – Inspector Checklist

FIELD INSPECTION AND MAINTENANCE FORM

Date:

Project Information		Geomembrane Information	
Project Name:		Date of Installation:	
Location:		Geomembrane Material Type:	
Date of Last Inspection:		Mil Thickness:	
Date Next Inspection Due:		Reinforced (Yes or No):	

Inspection Personnel		Site Conditions At Time of Inspection			
Inspector(s):		Weather:			
Organization:		Water Level:	Depth-	(or)	Freeboard-
Phone or e-mail:					

Instructions: Visually Inspect all interior and exterior areas of site for each of the following conditions. Complete the General checklist and document any items noted as "Monitor" or "Action Required" with photos, comments, measurements, and locations in Section 3 " Specific Data" of this form.

Section 1- Interior Conditions	Map ID # (As Marked on Attached Site Plan/As-Built)	Check One: Acceptable	Monitor	Action Required	Remarks/ Notes - Use Section 3 for Additional Description, Location, etc.
Exposed Geomembrane					
Mechanical Damage or Punctures					
UV Deterioration					
Seam Integrity-Factory/ Field					
Repairs- Patches					
Pipe Penetrations-					
Seal to Pipe (Banding)					
Pipe Boot Welds					
Attachment to Structures					
Ballast System					
Voids Below or Bridging of Liner					
Floating liner "Whales" or Loose Liner					
Floating Debris					
Wave Action/ Damage					
Other- Ice, Debris, Wind, Wildlife					
Other-					

FIELD INSPECTION AND MAINTENANCE FORM (Cont.)

Date:

Leak Location Survey

Survey Performed		YES		NO	Date(s) of Survey
Survey Technician					Type of Survey
Survey Company					***RECORD EACH LEAK FOUND IN SECTION 3***

Section 2- Exterior Conditions	Map ID # (As Marked on Attached Site Plan/As-Built)	Check One: Acceptable	Monitor	Action Required	Remarks/ Notes - Use Section 3 for Additional Description, Location, etc.
Cell Perimeter					
Anchor Trench- Settling/Erosion					
Animal Burrows					
Adjacent Structures or Tanks					
Vegetation					
Erosion					
Seepage/ Wet Areas					
Settlement/ Sloughing					
Perimeter or Access Roadways					
Gates/Fences/Locks					
Monitoring Equipment/Piezometers					
Stormwater Conveyance Ditches					
Sediment Accumulation					
Pooling or Ponding					
Slope Integrity					
Erosion Protection					
Obstruction of Culverts					
Other					
Other					
Additional Items of Note					

FIELD INSPECTION AND MAINTENANCE FORM (Cont.)

Date:

Section 3- Specific Items

(Print Multiple Section 3 Sheets As Needed)

Map ID# -Note ID # and Location on Attached Site Plan

Size- Measured ___ or Estimated ___ (Check One)

Location - Use GPS, Tape, or Wheel

Item Description / Condition

Recommended Maintenance

Attached: Photo___ Sketch___

Map ID# -Note ID # and Location on Attached Site Plan

Size- Measured ___ or Estimated ___ (Check One)

Location - Use GPS, Tape, or Wheel

Item Description / Condition

Recommended Maintenance

Attached: Photo___ Sketch___

Map ID# -Note ID # and Location on Attached Site Plan

Size- Measured ___ or Estimated ___ (Check One)

Location - Use GPS, Tape, or Wheel

Item Description / Condition

Recommended Maintenance

Attached: Photo___ Sketch___

Inspector Signature ______________________

FIELD INSPECTION AND MAINTENANCE FORM (Cont.)	SITE PLAN

INSERT INSTALLATION AS-BUILT OR SITE PLAN DRAWING HERE

NOTE LOCATIONS AND MAP ID # TO CORELATE WITH ITEMS NOTED IN SECTIONS 1-3