

NM1-63

**Permit
Application**

Vol 3

Part 2 of 8

10/12/16

**APPLICATION FOR PERMIT
OWL LANDFILL SERVICES, LLC**

**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN**

**ATTACHMENT III.1.B
LINER LONGEVITY ARTICLE:
*GEOSYNTHETICS MAGAZINE, OCT/NOV 2008***

How long will my liner last?

| What is the remaining service life of my HDPE geomembrane?

By Ian D. Peggs, P.E., P.Eng., Ph.D.

Introduction

In his keynote lecture at the GeoAmericas-2008 conference last March, Dr. Robert Koerner (et al., 2008) of the Geosynthetic Institute (GSI) reported the ongoing Geosynthetic Research Institute (GRI) work to make the first real stab at assessing the service lives of high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), reinforced PE, ethylene propylene diene terpolymer (EPDM), and flexible polypropylene (fPP) exposed geomembranes.

The selected environment simulated that of Texas, USA, in sunny ambient temperatures between ~7°C (45°F) and 35°C (95°F). Of course, an exposed black HDPE geomembrane in the sun will achieve much higher temperatures, probably in excess of 80°C (176°F).

I do not know what the temperature would be at 150-300mm above the liner (for those still specifying this parameter), but it is quite immaterial. The only temperature of concern is the actual geomembrane temperature.

The lifetimes are shown in **Table 1**, but it must be recognized that these data are for specific manufactured products with specific formulations. The “greater than” notation indicates that laboratory exposures (incubations) are still on-going, not

that some samples have failed after the indicated time period. The PE-R-1 material is a thin LLDPE, so it might be expected to be the first to reach the defined end of life; the half-life—the time to loss of 50% of uniaxial tensile properties.

It is interesting to note that HDPE-1 and LLDPE-1 are proceeding apace, but it would be expected that the LLDPE-1 would reach its half-life earlier than HDPE-1. However, this does not automatically follow. With adequate additive formulations, perhaps LLDPE could be left exposed and demonstrate more weathering resistance than some HDPEs. This demonstrates the fact that all PEs, whether HD or LLD, are not identical—they can have different long-term performances dependent on the PE resin used and the formulation of the stabilizer package. However, such differences are not evident in the conventional mechanical properties such as tensile strength/elongation, puncture and tear resistances, and so on.

The two fPPs are performing well. However, there had also been an fPP-1, one of the first PP geomembranes that did not perform well. This was due to a totally inappropriate stabilizer formulation. That particular product lasted 1.5 years in service. In

Final Inspection continued on page 44

Type	Specification	Predicted Lifetime in Texas, USA
HDPE-1	GRI-GM13	>28 years (Incubation ongoing)
LLDPEE-1	GRI-GM17	>28 years (Incubation ongoing)
EPDM-1	GRI-GM21	>20 years (Incubation ongoing)
PE-R-1	GRI-GM22	≈17 years (reached halflife)
fPP-2	GRI-GM18 (temp. susp.)	>27 years (Incubation ongoing)
fPP-3	GRI-GM18 (temp. susp.)	>17 years (Incubation ongoing)

Table 1 | Estimated exposed geomembrane lifetimes

| Ian Peggs is president of I-CORP International Inc. and is a member of *Geosynthetics* magazine's Editorial Advisory Committee.

Final Inspection continued from page 56

the QUV weatherometer, it lasted 1,800 light hours at 70°C (158°F). Therefore, the lab/field correlation is that 1,000 QUV light hours is equivalent to a 0.83yr service life under those specific environmental conditions.

At another location in Texas, Korrner/GRI found 1,000hr of QUV exposure was equivalent to 1.1 year actual field exposure. Consequently, for Texas exposures GRI is using a correlation of 1000hr QUV exposure as equivalent to 1yr of in-service exposure. Clearly, the correlation would be different in less sunny and colder environments.

The failed fPP-1 liner was replaced with a correctly stabilized fPP that, subsequently, performed well.

So how can we evaluate the condition of our exposed liners in a simple and practical manner to ensure they will continue to provide adequate service lifetimes and to get sufficient warning of impending expiration?

For each installation, a baseline needs to be established, and changes from that baseline need to be monitored.

A liner lifetime evaluation program

Rather than be taken by surprise when a liner fails or simply expires, it should be possible to monitor the condition of the liner to obtain a few years of notice for impending expiration. One can then plan for a timely replacement without the potential for accidental environmen-

values that generally significantly exceed the specification.

A final option for the baseline would be to use the values at the time of the first liner assessment.

The first liner condition assessment would consist of a site visit during which a general visual examination would be done together with a mechanical probing of the edges of welds. A visual examination would include the black/gray shades of different panels that might indicate low carbon contents.

A closer examination should be done using a loupe (small magnifier) on suspect areas such as wrinkle peaks, the tops and edges of multiple extrusion weld beads, and the apex-down creases of round die-manufactured sheet.

The last detail is significant because the combination of oxidizing surface and exposed surface tension when the liner contracts at low temperatures and the crease is pulled flat can be one of the first locations to crack. The apex-up creases do not fail at the same time because the oxidized exposed surface is under compression (or less tension) when the crease is flattened out.

Appropriate samples for detailed laboratory testing will be removed.

It may be appropriate to do a water lance electrical integrity survey on the exposed sideslopes, but this would only be effective on single liners, and on double liners with a composite primary liner, a conductive geomembrane, or a geocomposite with a conductive geotextile on top.

A sampling and testing regime

A liner lifetime evaluation program should be simple, meaningful, and cost-effective.

While it will initially require expert polymer materials science/engineering input to analyze the test data and to define the critical parameters, it should ultimately be possible to use an expert system to automatically make predictions using the input test data.

Small samples will be taken from deep in the anchor trench and from appropriate

... it should be possible to monitor the condition of the liner to obtain a few years of notice for impending expiration.

While estimated correlations might be made for other locations using historical weather station sunshine and temperature data, there is no question that the best remaining lifetime assessments will be obtained using samples removed from the field installation of interest.

A lifetime in excess of 28yr, demonstrated for a recently-made HDPE geomembrane, is comparable to the present actual service periods of as long as 30-35yr. However, actual lifetimes of as low as ~15yr have also been experienced.

Do service lifetimes now exceeding 30yr mean that we might expect to see another round of stress cracking failures as exposed liners finally oxidize sufficiently on the surface to initiate stress cracking?

This would be frustrating after resolving the early 1980s problems with stress cracking failures at welds and stone protrusions when the liners contracted at low temperatures, but it is the way end-of-life will become apparent. And will that be soon or in another 5-20 years? It would be useful to know.

tal damage and undesirable publicity. A program of periodic liner-condition assessment is proposed.

For baseline data, it would be useful to have some archive material to test, but that is not usually available. Manufacturers often discard retained samples after about 5 years. Perhaps facility owners should be encouraged to keep retained samples at room temperature and out of sunlight. The next best thing is to use material from the anchor trench or elsewhere that has not experienced extremes in temperature and that has not been exposed to UV radiation or to expansion/contraction stresses.

Less satisfactory options are to use the original NSF 54 specifications, the manufacturer's specifications, or the GRI-GM13 specifications at the appropriate time of liner manufacturing. The concern with using these specifications is that while aged material may meet them, there is no indication of whether the measured values have significantly decreased from the actual as-manufactured

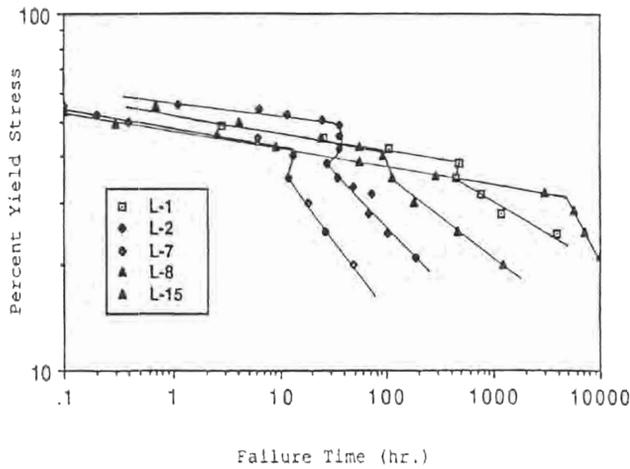


Figure 1 | Standard stress rupture curves for five HDPE geomembranes (Hsuan, et al. 1992)

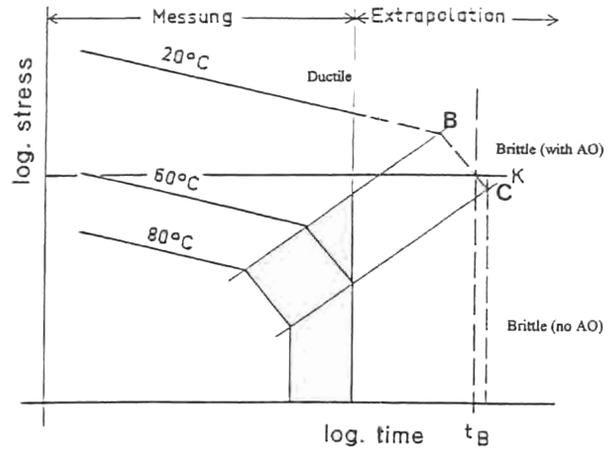


Figure 2 | Stress rupture curves showing third stage (Brittle no AO) oxidized limit. (Gaubé, et al. 1985)

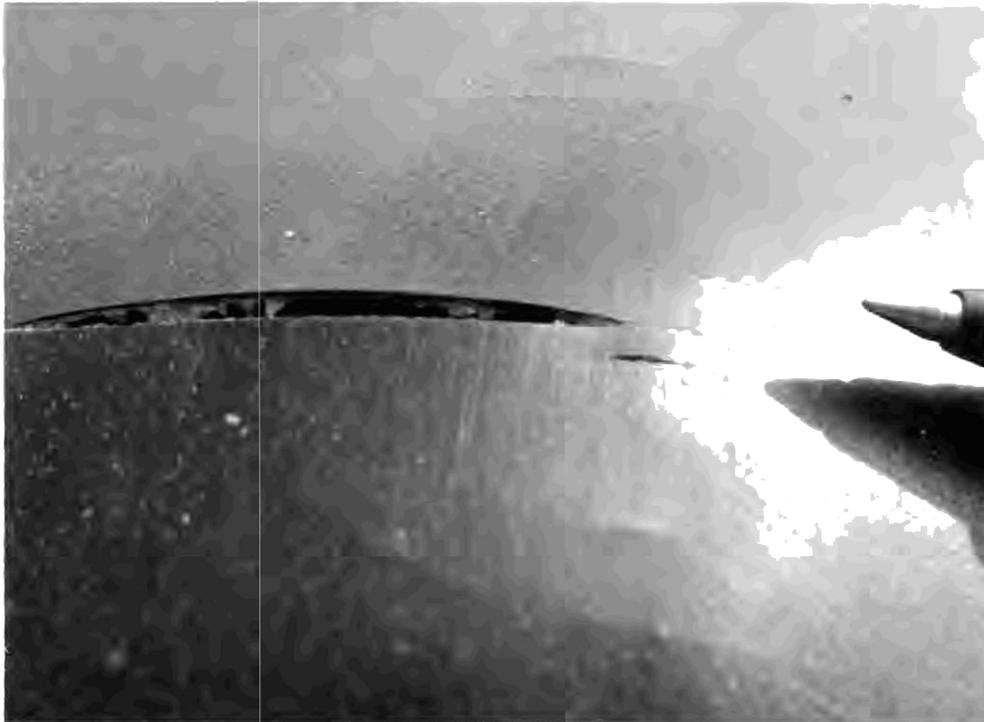


Figure 3 | Stress crack initiated by extruder die line at stone protrusion

The exposed samples will be tested as follows:

- Carbon content (ASTM D1603)
- Carbon dispersion (ASTM D5596)
- Single-point SCR on molded plaque (ASTM D5397)
- Light microscopy of exposed surface, through-thickness cross sections, and thin microsections (~15 μm thick) as necessary
- HP-OIT on 0.5-mm-thick exposed surface layers from basic sheet and from sheet at edge of extruded weld bead (ASTM D5885), preferably at a double-weld bead
- FTIR-ATR on exposed surface to determine CI
- Oven aging/HP-OIT on 0.5mm surface layer (GRI-GM13)
- UV resistance/HP-OIT on 0.5 mm surface layer (GRI-GM13)

Carbon content is done to ensure adequate basic UV protection. Carbon dispersion is done to ensure uniform surface UV protection and to evaluate agglomerates that might act as initiation sites for stress cracking.

HP-OIT is used to assess the remaining amount of stabilizer additives, both in the liner panels and in the sheet adjacent to an extrusion weld. Most stress cracking is observed at the edges of extrusion

exposed locations. Potential sites for future sample removal by the facility owner for future testing will be identified and marked by the expert during the first site visit.

The baseline sample(s) will be tested as follows:

- Single-point stress cracking resistance (SCR) on a molded plaque by ASTM D5397

- High-pressure oxidative induction time (HP-OIT) by ASTM D5885
- Fourier transform infrared spectroscopy (FTIR-ATR) on upper surface to determine carbonyl index (CI) on nonarchive samples only
- Oven aging/HP-OIT (GRI-GM13)
- UV resistance/HP-OIT (GRI-GM13)

weld beads in the lower sheet, so it is important to monitor this location.

While standard OIT (ASTM D3895 at 200°C) better assesses the relevant stabilizers effective at processing (melting) and welding temperatures, the relevant changes in effective stabilizer content during continued service, including in the weld zone, will be provided by measurement of HP-OIT. There will be no future high temperature transient where knowledge of S-OIT will be useful. It is expected that the liner adjacent to the weld bead will be more deficient in stabilizer than the panel itself. Therefore, S-OIT is not considered in this program.

Note that HP-OIT is measured on a thin surface layer because the surface layer may be oxidized while the body of the geomembrane may not. If material

from the full thickness of the geomembrane is used it could show a significant value of OIT, implying that there is still stabilizer present and that oxidation is far from occurring. However, the surface layer could be fully oxidized with stress cracks already initiated and propagating. A crack will then propagate more easily through unoxidized material than would initiation and propagation occur in unoxidized material.

The fact that the HP-OIT meets a certain specification value in the as-manufactured condition provides no guarantee that thermo- and photo-oxidation protection will be provided for a long time. Stabilizers might be consumed quickly or slowly while providing protection. They may also be consumed quickly to begin with, then more slowly, or vice versa.

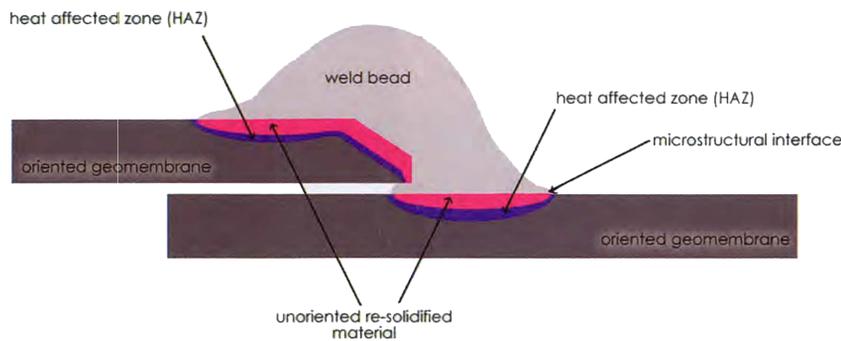


Figure 4 | Schematic of microstructure at extrusion weld

Hence, the need for continuing oven (thermal) aging and UV resistance tests. These two parameters, assessed by measuring retained HP- OIT, are critical to the assessment of remaining service life.

Oven (thermal) aging and UV resistance tests performed in this program will provide an extremely valuable data base that relates laboratory testing to in-service performance and that will further aid in more accurately projecting in-service performance from laboratory testing results.

Special considerations

Because we do not know, by OIT measurements alone, whether the surface layer is or is not oxidized (unless OIT is zero), and since we do not yet know at what level of OIT loss there might be an oxidized surface layer (the database has not yet been generated), FTIR directly on the surface of the geomembrane is performed using the attenuated total reflectance (ATR) technique to deny or confirm the presence of oxidation products (carbonyl groups).

Following the practice of Broutman, et al. (1989) and Duvall (2002) on HDPE pipes, if the ratio of the carbonyl peak at wave number 1760 cm^{-1} and the C-H stretching (PE) peak at wave number 1410 cm^{-1} is more than 0.10, there is a sufficiently oxidized surface layer that

stress cracking might be initiated. For those familiar with the two slope stress rupture curve (Figure 1) where the brittle stress cracking region is the steeper segment below the knee, there is a third vertical part of the curve (Figure 2) where the material is fully oxidized and fracture occurs at the slightest stress. This is what will happen at the end of service life. But first note the times to initiation of stress cracking (the knees in the curves) in Figure 1—they range from ~10/hr to

~5,000/hr—clearly confirming that all HDPEs are not the same. Some are far more durable than others.

At the end of service life, at some level of OIT, there will be a critically oxidized surface layer that when stressed, such as at low temperatures by an upwards protruding stone, or by flexing due to wind uplift, will initiate a stress crack on the surface that will propagate downward through the geomembrane, as shown by the crack in Figure 3.

This crack, initiated at a stress concentrating surface die mark, occurred when the liner contracted at low temperatures, and tightened over an upwardly protruding stone. The straight morphology of the crack, and the ductile break at the bottom surface as the stress in the remaining ligament rose above the knee in the stress rupture curve, are typical of a stress crack. Note the shorter stress cracks initiated along other nearby die marks.

Stress cracks are preferentially initiated along the edges of welds because the adjacent geomembrane has been more depleted of stabilizers during the high temperature welding process. Thus, under further oxidizing service conditions, it will become the first location to

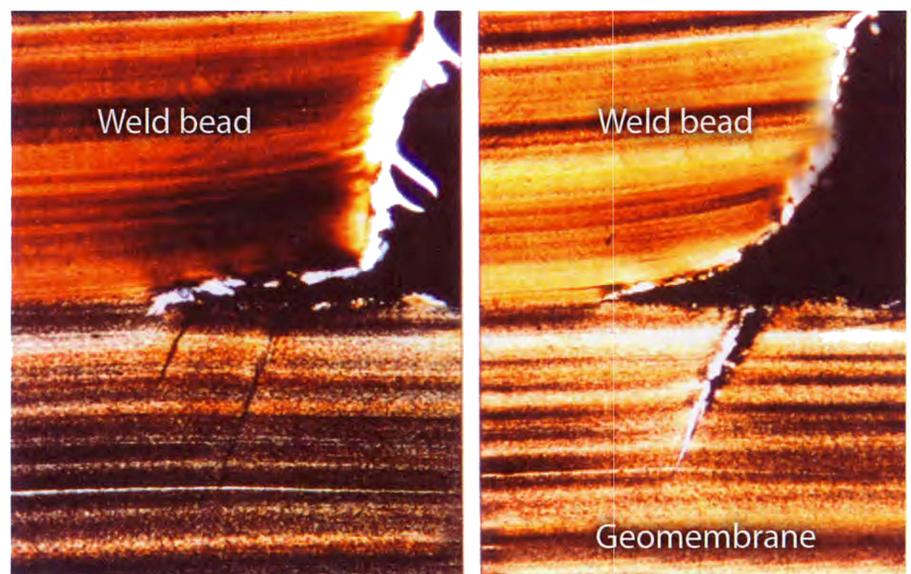


Figure 5 | Typical off-normal angle of precursor crazes (left) and stress crack (right) at edge of extrusion weld.

Type	Specification	Predicted Lifetime in Texas, USA
Side wall exposed	54	5
Side wall concrete side	81	71
Lower launder exposed	16	3
Lower launder concrete side	145	1

Table 2 | S-OIT values on solution and concrete liner surfaces (Peggs, 2008).

be oxidized to the critical level at which stress cracks will be initiated under any applied stress. In addition, the geometrical notches at grinding gouges and at the edges of the bead increase local stresses to critical levels for SC to occur.

I also believe that an internal microstructural flaw exists between the originally oriented geomembrane structure and the pool of more isotropic melted and resolidified material at the edge of the weld zone, as shown schematically in **Figure 4**. Most stress cracks occur at an off-normal angle at the edge of the weld bead that may be related to the angle of this molten-pool to oriented-structure interface (**Figure 5**). It is also known that stress increases the extraction of stabilizers from polyolefin materials.

With all of these agencies acting synergistically, it is not surprising that stress cracking often first occurs adjacent to extrusion welds.

Looking ahead

With the first field assessment test results available to us, and the extent of changes from the baseline sample known, removal of a second set of samples by the facility owner (at locations previously identified and marked by the initial surveyor), will be planned for a future time, probably in 2 or 3 years.

Why 2 or 3 years? In an extreme chemical environment, extensive reductions in

S-OIT of studded HDPE concrete protection liners in mine solvent extraction facilities using kerosene/aromatic hydrocarbon/sulfuric acid process solutions at 55°C (131°F) have been observed on the solution and concrete sides of the liner (**Table 2**) within 1 year (Peggs 2008). But it is unlikely that such rapid decreases will be observed in air-exposed material.

With this second set of field samples, and with three sets of data points, practically reliable extrapolations of remaining lifetime can start to be made.

It is expected that a few years of notice for impending failures will be possible.

The key point to note in making these condition assessments is that, while all HDPE geomembranes have very similar conventional index properties, they can have widely variable photo-oxidation, thermal-oxidation, and stress-cracking resistances. Therefore, some HDPEs are more durable than others.

Thus, while one HDPE geomembrane manufactured in 1990 failed after 15 years in 2005, another HDPE geomembrane made in 1990 from a different HDPE resin (or more correctly a medium-density polyethylene [MDPE] resin), and with a better stabilizer additive package, could still have a remaining lifetime of 5, 20, or 30 years.

So, keep a close eye on those exposed liners and we'll learn a great deal more about liner performance and get notice of

the end of service lifetime. And if owners can retain some archive material from new installations, so much the better.

References

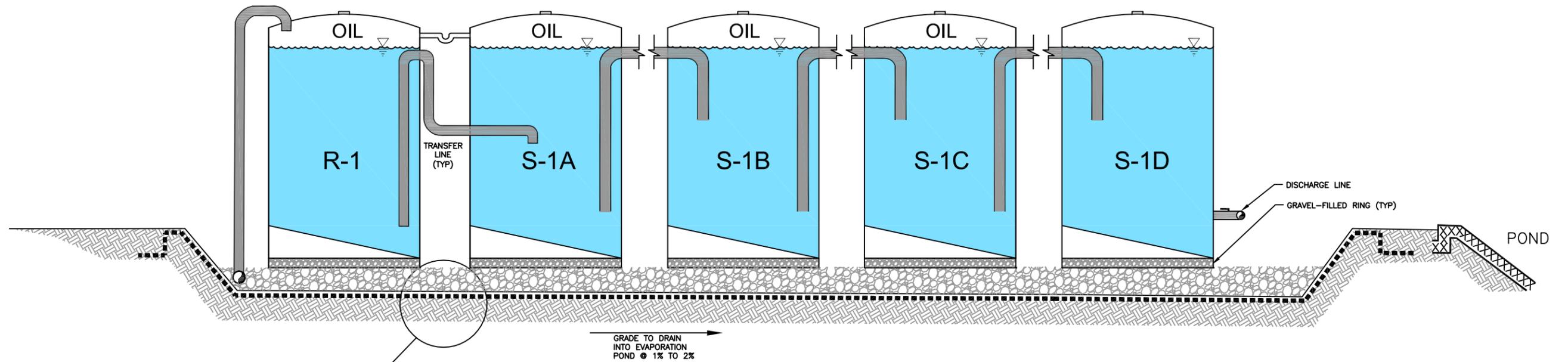
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- Peggs, I.D., (2008). "The Performance of Concrete Protection liners in Mine SX/EW Mixers and Settlers: The Need for Chemical Resistance Testing." Proceedings of GeoAmericas 2008, IFAI, Roseville, Minn., USA. **G**

**APPLICATION FOR PERMIT
OWL LANDFILL SERVICES, LLC**

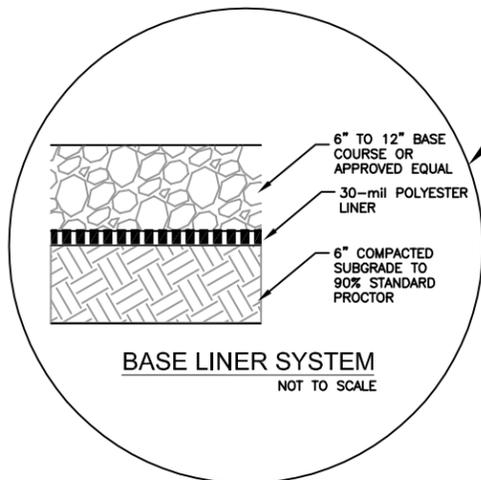
**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN**

ATTACHMENT III.1.C

TYPICAL RECEIVING TANK INSTALLATION DETAILS



ELEVATION - SECTION A-A'
NOT TO SCALE



TYPICAL RECEIVING TANK
INSTALLATION DETAILS

OWL LANDFILL SERVICES, LLC
LEA COUNTY, NEW MEXICO



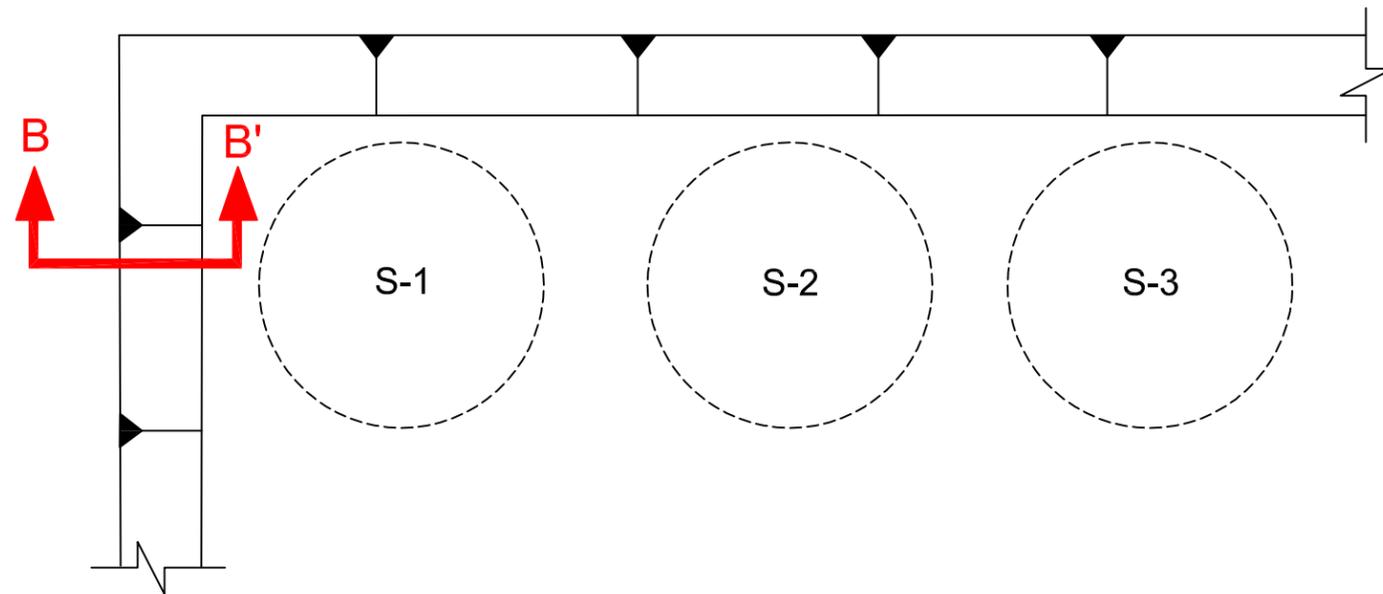
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 09/20/2016	CAD: TANK ELEV.dwg	PROJECT #: 560.01.02
DRAWN BY: DMI	REVIEWED BY: CWF	
APPROVED BY: IKG	gei@gordonenvironmental.com	ATTACHMENT III.1.C

**APPLICATION FOR PERMIT
OWL LANDFILL SERVICES, LLC**

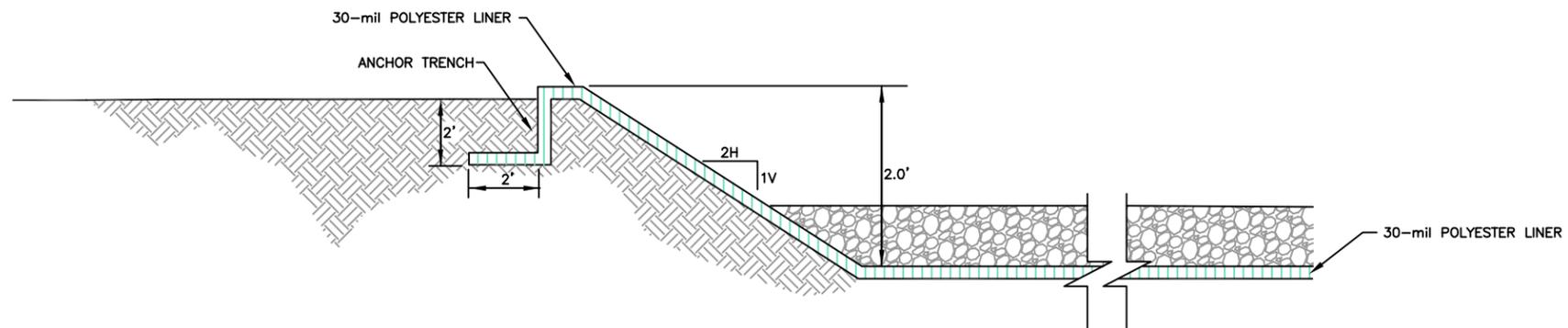
**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN**

**ATTACHMENT III.1.D
TYPICAL SALES TANK INSTALLATION DETAILS**



PLAN VIEW
NOT TO SCALE

LEGEND



CROSS SECTION B-B'
NOT TO SCALE

**TYPICAL SALES TANK
INSTALLATION DETAILS**

OWL LANDFILL SERVICES, LLC
LEA COUNTY, NEW MEXICO



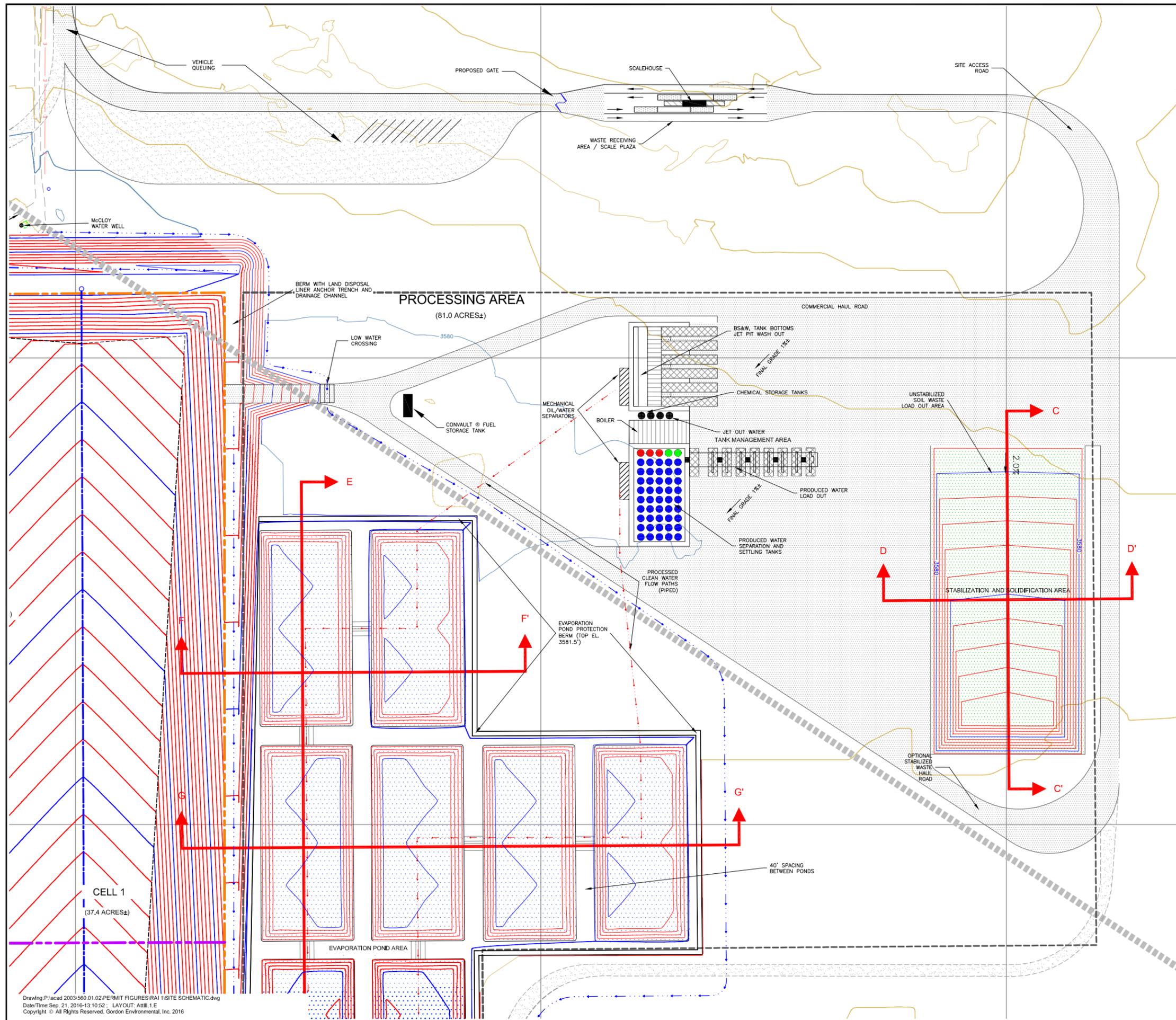
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 09/20/2016	CAD: TYP TANK.dwg	PROJECT #: 560.01.02
DRAWN BY: DMI	REVIEWED BY: CWF	
APPROVED BY: IKG	gei@gordonenvironmental.com	ATTACHMENT III.1.D

**APPLICATION FOR PERMIT
OWL LANDFILL SERVICES, LLC**

**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN**

**ATTACHMENT III.1.E
SITE SCHEMATIC**



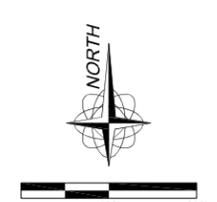
LEGEND

- 588° 50' 44.28" E 2647.98' SITE BOUNDARY WITH BEARING AND DISTANCE (559.5 ACRES±)
- SURFACE WASTE MANAGEMENT FACILITY BOUNDARY (500.0 ACRES)
- SOLID WASTE DISPOSAL AREA LIMITS (224.3 ACRES±)
- PROCESSING AREA LIMITS (81.0 ACRES±)
- UNIT 1 BOUNDARY (34.8 ACRES±)
- CELL BOUNDARY
- EXISTING 2FT CONTOUR
- 3550 EXISTING 10FT CONTOUR
- EXISTING 2FT DEPRESSION CONTOUR
- 3550 EXISTING 10FT DEPRESSION CONTOUR
- EXISTING UNPAVED ROAD
- E E EXISTING OVERHEAD ELECTRIC LINE
- o EXISTING POWER POLE
- 3550 PROPOSED 2FT BASE GRADE CONTOUR
- 3550 PROPOSED 10FT BASE GRADE CONTOUR
- PROPOSED UNPAVED ROAD (GRAVEL)
- PROPOSED UNPAVED ROAD (SOIL)
- x x x PROPOSED 3-STRAND BARBED WIRE FENCE
- FINAL DRAINAGE FLOW LINE AND DIRECTION OF FLOW
- PROPOSED PROCESS WATER FLOW PATHS
- o PRODUCED WATER TANK
- o CRUDE OIL RECOVERY TANK
- o OIL SALES TANK
- CROSS-SECTION LOCATION
- o SURVEY CONTROL POINT
- SITE GRID

- NOTES:**
- AERIAL TOPOGRAPHIC SURVEY BY AEROTECH MAPPING INC., 6565 AMERICAN PARKWAY N.E., ALBUQUERQUE, NM 87111 PHONE: (520-561-6537) FAX (505-256-3328) EMAIL: TimBurrows@atmiv.com DATE OF PHOTOGRAPHY: 06-06-2015.
 - SURVEY CONTROL POINTS BY HARCROW SURVEYING, INC., 2314 W. MAIN ST., ARTESIA, NM 88210 PHONE: (575-746-2158).
 - THE DESIGN OF THE FACILITIES SHOWN IS PRELIMINARY. CONSTRUCTION PLANS AND SPECIFICATIONS FOR EACH MAJOR ELEMENT WILL BE SUBMITTED TO OCD IN ADVANCE OF INSTALLATION.

CONTROL POINT DATA				
POINT	NORTHING	EASTING	PANEL ELEVATION	DESCRIPTION
7001	434845.57	782160.25	3530.07	PP-7001
7002	438508.13	782138.97	3561.67	PP-7002
7003	442131.34	782096.47	3600.88	PP-7003
7004	434859.95	785795.31	3548.81	PP-7004
7005	438509.15	785767.60	3577.54	PP-7005
7006	442207.86	785773.10	3598.28	PP-7006
7007	434883.93	789423.36	3567.38	PP-7007
7008	438485.16	789417.70	3577.60	PP-7008

- NOTES:**
- ALL POINTS ARE FLUSH WITH THE GROUND.
 - THE COORDINATES AND ELEVATIONS FOR THE PHOTO CONTROL POINTS ON THE ABOVE REFERENCED PROJECT ARE MODIFIED (SURVEYED) NEW MEXICO STATE PLANE COORDINATES - EAST ZONE, NAD 83 AND HAVE BEEN ADJUSTED USING AN "ORIG SOLUTION" TO OBTAIN TRUE STATE PLANE GRID COORDINATES. MULTIPLY THE COORDINATES BELOW BY THE PROJECT AVERAGE COMBINED FACTOR OF = 0.99981059648. THE COORDINATES AND ELEVATIONS ARE EXPRESSED IN U. S. SURVEY FEET.



SITE SCHEMATIC

OWL LANDFILL SERVICES, LLC
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers

213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 09/21/2016	CAD: SITE SCHEMATIC	PROJECT #: 560.01.02
DRAWN BY: ASM	REVIEWED BY: CRK	
APPROVED BY: IKG	gek@gordonenvironmental.com	ATTACHMENT III.1.E

**APPLICATION FOR PERMIT
OWL LANDFILL SERVICES, LLC**

**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN**

**ATTACHMENT III.1.F
TANK AND POND CAPACITY CALCULATIONS**

ATTACHMENT III.1.F
Tank and Pond Capacity Calculations
OWL Landfill Services, LLC

OWL is a surface waste management facility.

- A. Produced Water is delivered by trucking companies into one of twelve proposed heated Produced Water Receiving Tanks located within a bermed, lined containment area:

Proposed Tank No.	Volume	Permitted
R-1	1000 bbls	Permitted under this Application
R-2	1000 bbls	Permitted under this Application
R-3	1000 bbls	Permitted under this Application
R-4	1000 bbls	Permitted under this Application
R-5	1000 bbls	Permitted under this Application
R-6	1000 bbls	Permitted under this Application
R-7	1000 bbls	Permitted under this Application
R-8	1000 bbls	Permitted under this Application
R-9	1000 bbls	Permitted under this Application
R-10	1000 bbls	Permitted under this Application
R-11	1000 bbls	Permitted under this Application
R-12	1000 bbls	Permitted under this Application

- i. The Receiving tanks serve to gravity separate solids and oil from the water. Solids collect in the bottoms and oil floats to the tops of the receiving tanks.
- ii. The Receiving Tanks bottoms are solidified and taken to the OCD permitted Landfill.
- iii. The Receiving Tanks are set on gravel or sand pads on top of a lined bermed impermeable pad.

- B. Water from each Receiving Tanks flows in series through four additional Settling Tanks to remove oil prior to discharge in the mechanical oil water separator:

Proposed Tank No.	Volume	Permitted
S-1A	1000 bbls	Permitted under this Application
S-1B	1000 bbls	Permitted under this Application
S-1C	1000 bbls	Permitted under this Application
S-1D	1000 bbls	Permitted under this Application
S-2A	1000 bbls	Permitted under this Application
S-2B	1000 bbls	Permitted under this Application
S-2C	1000 bbls	Permitted under this Application
S-2D	1000 bbls	Permitted under this Application
S-3A	1000 bbls	Permitted under this Application
S-3B	1000 bbls	Permitted under this Application
S-3C	1000 bbls	Permitted under this Application
S-3D	1000 bbls	Permitted under this Application
S-4A	1000 bbls	Permitted under this Application
S-4B	1000 bbls	Permitted under this Application
S-4C	1000 bbls	Permitted under this Application
S-4D	1000 bbls	Permitted under this Application
S-5A	1000 bbls	Permitted under this Application
S-5B	1000 bbls	Permitted under this Application
S-5C	1000 bbls	Permitted under this Application
S-5D	1000 bbls	Permitted under this Application
S-6A	1000 bbls	Permitted under this Application
S-6B	1000 bbls	Permitted under this Application
S-6C	1000 bbls	Permitted under this Application
S-6D	1000 bbls	Permitted under this Application
S-7A	1000 bbls	Permitted under this Application

S-7B	1000 bbls	Permitted under this Application
S-7C	1000 bbls	Permitted under this Application
S-7D	1000 bbls	Permitted under this Application
S-8A	1000 bbls	Permitted under this Application
S-8B	1000 bbls	Permitted under this Application
S-8C	1000 bbls	Permitted under this Application
S-8D	1000 bbls	Permitted under this Application
S-9A	1000 bbls	Permitted under this Application
S-9B	1000 bbls	Permitted under this Application
S-9C	1000 bbls	Permitted under this Application
S-9D	1000 bbls	Permitted under this Application
S-10A	1000 bbls	Permitted under this Application
S-10B	1000 bbls	Permitted under this Application
S-10C	1000 bbls	Permitted under this Application
S-10D	1000 bbls	Permitted under this Application
S-11A	1000 bbls	Permitted under this Application
S-11B	1000 bbls	Permitted under this Application
S-11C	1000 bbls	Permitted under this Application
S-11D	1000 bbls	Permitted under this Application
S-12A	1000 bbls	Permitted under this Application
S-12B	1000 bbls	Permitted under this Application
S-12C	1000 bbls	Permitted under this Application
S-12D	1000 bbls	Permitted under this Application

- i. The Settling Tanks increase the detention time available to provide additional gravity separation of oil from the water,
- ii. The Settling Tank bottoms are taken to the Stabilization/Solidification Area.
- iii. The Settling Tanks are set on gravel or sand pads on top of a lined bermed impermeable pad.

C. The separated oil flows into one of five heated Crude Oil Receiving Tanks:

Proposed Tank No.	Volume	Permitted
C-1	1000 bbls	Permitted under this Application
C-2	1000 bbls	Permitted under this Application
C-3	1000 bbls	Permitted under this Application
C-4	1000 bbls	Permitted under this Application
C-5	1000 bbls	Permitted under this Application

- i. The Crude Oil Receiving Tanks are set inside the proposed lined containment berm.
- ii. The Crude Oil Receiving Tanks are interconnected at the top of the tanks for oil removal.
- iii. Water recovered from the Crude Oil Receiving Tanks is redirected to the Produced Water Receiving Tanks.
- iv. Sludges recovered from the Crude Oil Receiving Tanks are stabilized, solidified and sent for landfill disposal.

D. The water from the Settling Tanks is discharged through one of up to four Dissolved Air Floatation (DAF) Units.

Proposed Tank No.	Volume	Permitted
D-1	10 bbls	Permitted under this Application
D-2	10 bbls	Permitted under this Application
D-3	10 bbls	Permitted under this Application
D-4	10 bbls	Permitted under this Application

- i. The DAF Units are situated on the lined Evaporation Pond berm in a location where any leakage would drain
- ii. The DAF use air bubbles to lift any remaining oil from the water prior to discharge into one of four Ponds.
- iii. The oil containing foam generated by the DAF is collected and discharged into the Crude Oil Receiving Tanks for further processing.

E.

Proposed Pond No.	Storage Volume	Permitted
P-1	73,700 bbls	Permitted under this Application
P-2	73,700 bbls	Permitted under this Application
P-3	73,700 bbls	Permitted under this Application
P-4	73,700 bbls	Permitted under this Application
P-5	73,700 bbls	Permitted under this Application

P-6	73,700 bbls	Permitted under this Application
P-7	73,700 bbls	Permitted under this Application
P-8	73,700 bbls	Permitted under this Application
P-9	73,700 bbls	Permitted under this Application
P-10	73,700 bbls	Permitted under this Application
P-11	73,700 bbls	Permitted under this Application
P-12	73,700 bbls	Permitted under this Application

- i. Surface aeration and bleach are used to maintain water chemistry parameters:
 - :O₂ at or above 0.5 ppm one foot off the bottom of the pond.
 - :pH above 8
- ii. H₂S monitors are placed around the pond covering the four major points on the compass.
- iii. The H₂S monitors continually monitor the ambient air.
- iv. Two chlorine monitors are placed around the ponds covering the North and West borders.
- v. Treatment capacity of each Pond is 73,994 bbls (~9.5 acre feet)
- vi. 3.5 Feet of Freeboard is proposed, storage volume does include freeboard
- vii. Volume including freeboard is 122,640 bbls (15.76 acre-feet)per pond
- viii. Inside grade shall be no steeper than 3H:1V
- ix. Levees shall have an outside grade no steeper than 3H:1V
- x. Levees' tops shall be wide enough to install an anchor trench and provide adequate room for inspection/maintenance.
- xi. Liner seams shall be minimized and oriented up and down, not across a slope
 - Each pond shall have a:
 - :primary liner (60-mil HDPE liner, UV resistant)
 - :secondary liner (60-mil HDPE liner, UV resistant)
- xii. Slope shall be 2% (2 ft V for 100 ft H)
- xiii. A mechanical evaporation system shall be installed in each pond to enhance evaporation.
- xiv. Approximate size of each pond is 200 x 420 feet x 7.6 feet deep

F. Bleach for H₂S management is stored in two proposed chemical tanks:

Proposed Tank No.	Volume	Permitted
B-1	60 bbls	Permitted under this Application
B-2	60 bbls	Permitted under this Application

- i. The Chemical Tanks are set on a bermed concrete pad that drains into the pond.
- ii. The Bleach is pumped through lines to discharge points in each of the ponds.

G. Water from Pond 1 (P-1) is:

- i. Pumped through lines to floating evaporators in Ponds 2, 3, and 4 (P-2, P-3, P-4).
- ii. Three floating evaporators are situated in each Pond.
- iii. Water that does not evaporate from Ponds 2, 3, or 4 is pumped to floating evaporators in Ponds 5 and 6.
- iv. Water that does not evaporate from Ponds 5 and 6 is pumped to floating evaporators in Ponds 7 and 8.
- v. Water that does not evaporate from Ponds 7 and 8 is pumped to floating evaporators in Ponds 9 and 10.

H. The Jet-Out Pit receives discharges from tankers bringing oil contaminated drilling mud, BS&W, tank bottoms and washout from tank cleanings.

Proposed Pit No.	Volume	Permitted
J-1	1000 bbls	Permitted under this Application

Proposed Tank No.	Volume	Permitted
WW-1	1000 bbls	Permitted under this Application
FW-1	1000 bbls	Permitted under this Application

- i. Wash-Water for the Jet-Out Pit is recycled through a line from Pond-10 to WW-1. A pump connected to WW-1 pumps the water through a line to one of six wash-out stations for use cleaning the tankers.
- ii. Fresh-Water for the Jet-Out Pit is discharged from the water supply through an air gap into FW-1. A pump connected to FW-1 pumps the water through a line to one of six wash-out stations for use cleaning the tanks.
- ii. Oil from the Jet-Out Pit is transferred through a line to the Crude Oil Receiving Tanks for further Processing..
- iii. Water from the Jet-Out Pit is transferred through a line to the Produced Water Receiving Tanks for processing.

iv. Sludges and sediments from the Jet Out Pit is removed with a bucket loader and transferred to the waste stabilization area for stabilization, solidification and disposal.

I. Oil from the Crude Oil Receiving Tanks C1-C5 completed the dewatering process with the finished product transferred to the Oil Sales Tanks.

Proposed Tank No.	Volume	Permitted
S-1	1000 bbls	Permitted under this Application
S-2	1000 bbls	Permitted under this Application
S-3	1000 bbls	Permitted under this Application
S-4	1000 bbls	Permitted under this Application
S-5	1000 bbls	Permitted under this Application

- i. The proposed Oil Sales Tanks are set inside the lined berm next to the Crude Oil Receiving Tanks.
- ii. Oil is removed from the Oil Sales tank to a tanker at the Oil Sales Load-Out

J. Pond Capacity Calculations:

Truncated Rectangular Pyramid Volume		
Dimension	Freeboard	Pond Volume
a	420	402
b	200	182
c	402	363
d	182	143
h	3	6.5
Volume (GAL)	1,762,291	3,028,410
Acre-FT	5.41	9.29
Barrels		72,075

- i. Calculated using:
<http://www.aqua-calc.com/calculate/volume-truncated-pyramid>
- ii. Truncated pyramid or frustum of a pyramid is a pyramid whose vertex is cut away by a plane parallel to the base. The distance between the bottom and the top bases is the truncated pyramid height h.

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SECTION 1: ENGINEERING DESIGN**

**ATTACHMENT III.1.G
PIPE WALL THICKNESS INFORMATION**

Table A-2 (cont'd)
PIPE WEIGHTS AND DIMENSIONS (IPS)
PE3608 (BLACK)

OD			SDR	Nominal ID		Minimum Wall		Weight	
Nominal in.	Actual			in.	mm.	in.	mm.	lb. per foot	kg. per meter
	in.	mm.							
			7	2.44	61.98	0.500	12.70	2.047	3.047
			7.3	2.48	63.08	0.479	12.18	1.978	2.943
			9	2.68	67.96	0.389	9.88	1.656	2.464
			9.3	2.70	68.63	0.376	9.56	1.609	2.395
			11	2.83	71.77	0.318	8.08	1.387	2.065
3	3.500	88.90	11.5	2.85	72.51	0.304	7.73	1.333	1.984
			13.5	2.95	74.94	0.259	6.59	1.153	1.716
			15.5	3.02	76.74	0.226	5.74	1.015	1.511
			17	3.06	77.81	0.206	5.23	0.932	1.386
			21	3.15	79.93	0.167	4.23	0.764	1.136
			26	3.21	81.65	0.135	3.42	0.623	0.927
			7	3.14	79.68	0.643	16.33	3.384	5.037
			7.3	3.19	81.11	0.616	15.66	3.269	4.865
			9	3.44	87.38	0.500	12.70	2.737	4.073
			9.3	3.47	88.24	0.484	12.29	2.660	3.958
			11	3.63	92.27	0.409	10.39	2.294	3.413
4	4.500	114.30	11.5	3.67	93.23	0.391	9.94	2.204	3.280
			13.5	3.79	96.35	0.333	8.47	1.906	2.836
			15.5	3.88	98.67	0.290	7.37	1.678	2.497
			17	3.94	100.05	0.265	6.72	1.540	2.292
			21	4.05	102.76	0.214	5.44	1.262	1.879
			26	4.13	104.98	0.173	4.40	1.030	1.533
			32.5	4.21	106.84	0.138	3.52	0.831	1.237
			7	3.88	98.51	0.795	20.19	5.172	7.697
			7.3	3.95	100.27	0.762	19.36	4.996	7.435
			9	4.25	108.02	0.618	15.70	4.182	6.224
			9.3	4.29	109.09	0.598	15.19	4.065	6.049
			11	4.49	114.07	0.506	12.85	3.505	5.216
5	5.563	141.30	11.5	4.54	115.25	0.484	12.29	3.368	5.012
			13.5	4.69	119.11	0.412	10.47	2.912	4.334
			15.5	4.80	121.97	0.359	9.12	2.564	3.816
			17	4.87	123.68	0.327	8.31	2.353	3.502
			21	5.00	127.04	0.265	6.73	1.929	2.871
			26	5.11	129.78	0.214	5.43	1.574	2.343
			32.5	5.20	132.08	0.171	4.35	1.270	1.890
			7	4.62	117.31	0.946	24.04	7.336	10.917
			7.3	4.70	119.41	0.908	23.05	7.086	10.545
			9	5.06	128.64	0.736	18.70	5.932	8.827
			9.3	5.11	129.92	0.712	18.09	5.765	8.579
			11	5.35	135.84	0.602	15.30	4.971	7.398
6	6.625	168.28	11.5	5.40	137.25	0.576	14.63	4.777	7.109
			13.5	5.58	141.85	0.491	12.46	4.130	6.147
			15.5	5.72	145.26	0.427	10.86	3.637	5.413
			17	5.80	147.29	0.390	9.90	3.338	4.967
			21	5.96	151.29	0.315	8.01	2.736	4.072
			26	6.08	154.55	0.255	6.47	2.233	3.322
			32.5	6.19	157.30	0.204	5.18	1.801	2.680

See ASTM D3035, F714 and AWWA C-901/906 for OD and wall thickness tolerances.
Weights are calculated in accordance with PPI TR-7.

Table A-2 (cont'd)
PIPE WEIGHTS AND DIMENSIONS (IPS)
PE3608 (BLACK)

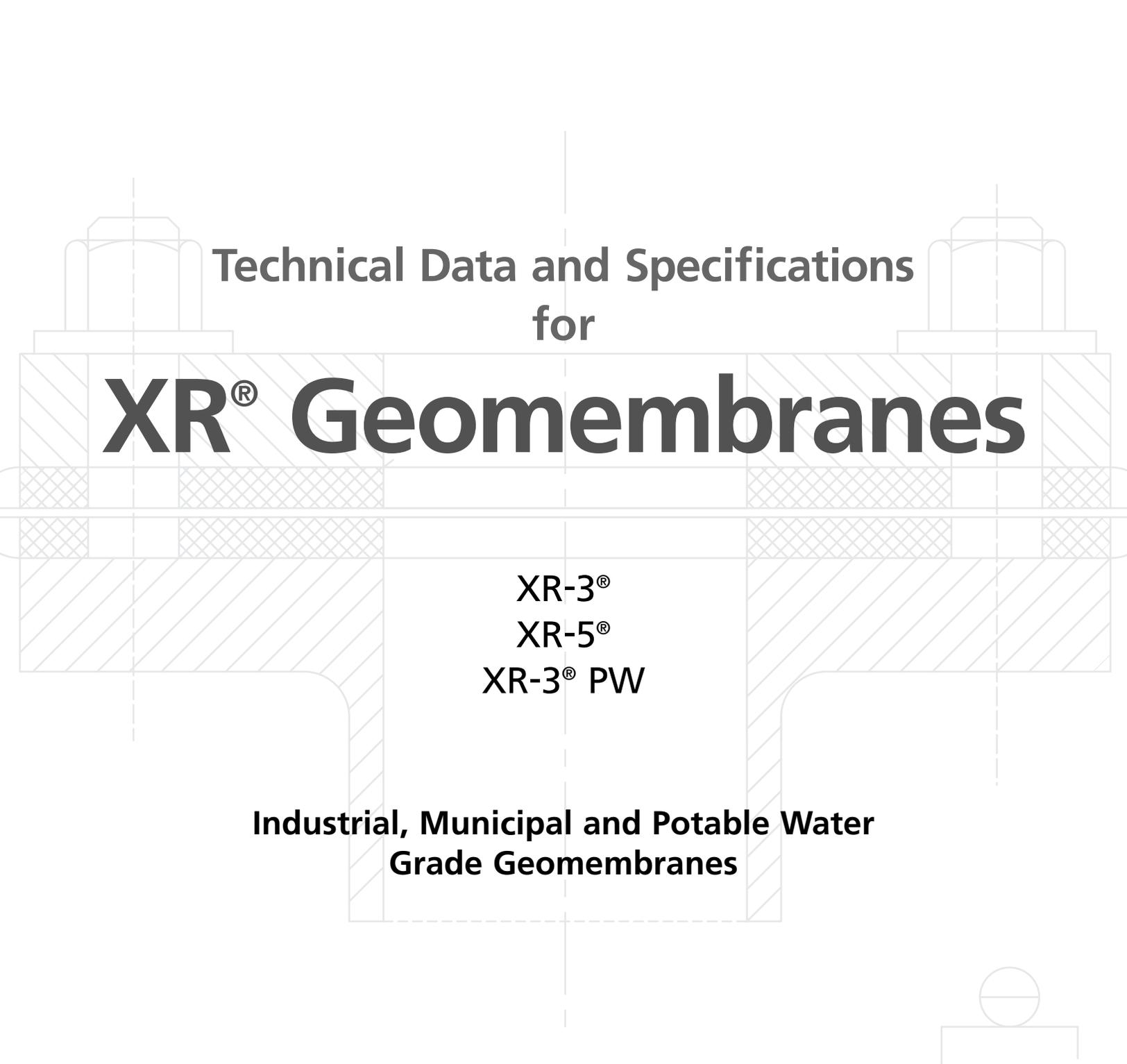
OD			SDR	Nominal ID		Minimum Wall		Weight	
Nominal in.	Actual			in.	mm.	in.	mm.	lb. per foot	kg. per meter
	in.	mm.							
			7	6.01	152.73	1.232	31.30	12.433	18.503
			7.3	6.12	155.45	1.182	30.01	12.010	17.872
			9	6.59	167.47	0.958	24.34	10.054	14.962
			9.3	6.66	169.14	0.927	23.56	9.771	14.541
			11	6.96	176.85	0.784	19.92	8.425	12.538
8	8.625	219.08	11.5	7.04	178.69	0.750	19.05	8.096	12.049
			13.5	7.27	184.67	0.639	16.23	7.001	10.418
			15.5	7.45	189.11	0.556	14.13	6.164	9.174
			17	7.55	191.76	0.507	12.89	5.657	8.418
			21	7.75	196.96	0.411	10.43	4.637	6.901
			26	7.92	201.21	0.332	8.43	3.784	5.631
			7	7.49	190.35	1.536	39.01	19.314	28.743
			7.3	7.63	193.75	1.473	37.40	18.656	27.764
			9	8.22	208.73	1.194	30.34	15.618	23.242
			9.3	8.30	210.81	1.156	29.36	15.179	22.589
			11	8.68	220.43	0.977	24.82	13.089	19.478
10	10.750	273.05	11.5	8.77	222.71	0.935	23.74	12.578	18.717
			13.5	9.06	230.17	0.796	20.23	10.875	16.184
			15.5	9.28	235.70	0.694	17.62	9.576	14.251
			17	9.41	239.00	0.632	16.06	8.788	13.078
			21	9.66	245.48	0.512	13.00	7.204	10.721
			26	9.87	250.79	0.413	10.50	5.878	8.748
			32.5	10.05	255.24	0.331	8.40	4.742	7.058
			7	8.89	225.77	1.821	46.26	27.170	40.433
			7.3	9.05	229.80	1.747	44.36	26.244	39.056
			9	9.75	247.57	1.417	35.98	21.970	32.695
			9.3	9.84	250.03	1.371	34.82	21.353	31.777
			11	10.29	261.44	1.159	29.44	18.412	27.400
12	12.750	323.85	11.5	10.40	264.15	1.109	28.16	17.693	26.330
			13.5	10.75	272.99	0.944	23.99	15.298	22.767
			15.5	11.01	279.56	0.823	20.89	13.471	20.047
			17	11.16	283.46	0.750	19.05	12.362	18.397
			21	11.46	291.16	0.607	15.42	10.134	15.081
			26	11.71	297.44	0.490	12.46	8.269	12.305
			32.5	11.92	302.73	0.392	9.96	6.671	9.928
			7	9.76	247.90	2.000	50.80	32.758	48.750
			7.3	9.93	252.33	1.918	48.71	31.642	47.089
			9	10.70	271.84	1.556	39.51	26.489	39.420
			9.3	10.81	274.54	1.505	38.24	25.745	38.313
			11	11.30	287.07	1.273	32.33	22.199	33.036
14	14.000	355.60	11.5	11.42	290.05	1.217	30.92	21.332	31.746
			13.5	11.80	299.76	1.037	26.34	18.445	27.449
			15.5	12.09	306.96	0.903	22.94	16.242	24.170
			17	12.25	311.25	0.824	20.92	14.905	22.181
			21	12.59	319.70	0.667	16.93	12.218	18.183
			26	12.86	326.60	0.538	13.68	9.970	14.836
			32.5	13.09	332.40	0.431	10.94	8.044	11.970

See ASTM D3035, F714 and AWWA C-901/906 for OD and wall thickness tolerances.
Weights are calculated in accordance with PPI TR-7.

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**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
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**ATTACHMENT III.1.H
TECHNICAL DATA AND SPECIFICATIONS FOR XR GEOMEMBRANES**



Technical Data and Specifications
for

XR[®] Geomembranes

XR-3[®]
XR-5[®]
XR-3[®] PW

Industrial, Municipal and Potable Water
Grade Geomembranes



Seaman Corporation

1000 Venture Blvd.
Wooster, Ohio 44691
(330) 262-1111
www.xr-5.com

Section 1: Product Overview/Applications

Product Application Chart

Section 2: Physical Properties

Part 1: Material Specifications

8130/8138 XR-5

6730 XR-5

8228 XR-3

8130 XR-3 PW

Part 2: Elongation Properties

8130/8138 XR-5

6730 XR-5

8228 XR-3

Section 3: Chemical/Environmental Resistance

Part 1: Chemical Resistance

XR-5 Chemical Resistance

Chemical Resistance Chart

Vapor Transmission Data

Seam Strength

Long Term Seam Adhesion

Fuel Compatibility

XR-3 Chemical Resistance Statement (Summary)

Part 2: Comparative Chemical Resistance (XR-5)

Part 3: Weathering Resistance

Section 4: Comparative Physical Properties

XR-5/HDPE Physicals - Comparative Properties

XR-5/Polypropylene Tensile

Puncture Strength Comparison

Coated Fabric Thermal Stability

Section 5: Sample Specifications

Section 6: Warranty Information

Seaman Corp. XR Geomembranes

Section 1 - Product Overview/Applications

- All XR Geomembrane products are classified as an Ethylene Interpolymer Alloy (EIA)
- XR-5 grade is high strength and chemically resistant for maximum resistance to high temperature, and broad chemical resistance, including acids, oils and methane
- XR-3 grade for moderate chemical resistant requirement applications such as stormwater and domestic wastewater
- NSF 61 approved XR-3 PW grade for potable water contact
- Heat weldable-thermal weldable for seams as strong as the membrane. Factory panels over 15,000 square feet (1400 sq meters) for less field seaming
- Stability is excellent, with low thermal expansion-contraction properties
- 30+ year application history

Product Application Chart

	XR-5			XR-3	XR-3 PW
	8130	8138	6730	8228	8130
High Puncture Resistance	X	X	X		X
UV Resistance	X	X	X	X	X
High Strength Applications	X	X	X		X
Floating Covers (Nonpotable)	X	X	X	X	
Diesel/Jet Fuel Containment	X	X	X		
Industrial Wastewater	X	X	X		
Stormwater	X	X	X	X	
Municipal/Domestic Wastewater	X	X	X	X	
Floating Diversion Baffles/Curtains	X		X		X
Potable Water					X
<-65 Deg F Applications	Contact Seaman Corp.				
Chemically Resistant Applications	X	X	X		

XR-5® is a registered trademark of Seaman Corporation
 XR-3® is a registered trademark of Seaman Corporation
 XR® is a registered trademark of Seaman Corporation

Section 2 - Physical Properties

Part 1- Material Specifications

Property	Test Method	8130 XR-5	8138 XR-5	6730 XR-5
Base Fabric Type	ASTM D 751	Polyester	Polyester	Polyester
Base Fabric Weight		6.5 oz/yd ² nominal (220 g/m ² nominal)	6.5 oz/yd ² nominal (220 g/m ² nominal)	7 oz/yd ² nominal (235 g/m ² nominal)
Thickness	ASTM D 751	30 mils min. (0.76 mm min.)	40 mils nom. (1.0 mm nom.)	30 mils min. (0.76 mm min.)
Weight	ASTM D 751	30.0 + 2 oz/sq yd (1017 + 2 g/m ²)	38.0 + 2 oz/sq yd (1288 + 70 g/m ²)	30.0 +- 2 oz/sq yd (1017 +- 70 g/m ²)
Tear Strength	ASTM D 751 Trap Tear	40/55 lbs. min. (175/245 N min.)	40/55 lbs. min. (175/245 N min.)	600/550 lbs. min. (2,670/2,447 N min.)
Breaking Yield Strength	ASTM D 751 Grab Tensile	550/550 lbs. min. (2,447/2,447 N min.)	550/550 lbs. min. (2,447/2,447 N min.)	550/550 lbs. min. (2,447/2,447 N min.)
Low Temperature Resistance	ASTM D 2136 4 hrs-18" Mandrel	Pass @ -30° F Pass @ -35° C	Pass @ -30° F Pass @ -35° C	Pass @ -30° F Pass @ -35° C
Dimensional Stability	ASTM D 1204 100° C-1 Hr.	0.5% max. each direction	0.5% max. each direction	0.5% max. each direction
Hydrostatic Resistance	ASTM D 751 Procedure A	800 psi min. (5.51 MPa min.)	800 psi min. (5.51 MPa min.)	800 psi min. (5.51 MPa min.)
Blocking Resistance	ASTM D 751 180° F	#2 Rating max.	#2 Rating max.	#2 Rating max.
Adhesion-Ply	ASTM D 413 Type A	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)
Adhesion (minimum) Heat Welded Seam	ASTM D 751 Dielectric Weld	40 lbs./2in. RF weld min. (17.5 daN/5 cm min.)	40 lbs./2in. RF weld min. (17.5 daN/5 cm min.)	15 lbs./in. RF weld min. (15 daN/5 cm min.)
Dead Load Seam Strength	ASTM D 751, 4-Hour Test	Pass 220 lbs/in @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in @ 160° F (Pass 534 N/2.54 cm @ 70° C)	Pass 220 lbs/in @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in @ 160° F (Pass 534 N/2.54 cm @ 70° C)	
Bonded Seam Strength	ASTM D 751 Procedure A, Grab Test Method	550 lbs. min. (2,450 N min.)	550 lbs. min. (2,450 N min.)	550 lbs. min. (2,560 N min.)

Abrasion Resistance	ASTM D 3389 H-18 Wheel 1 kg Load	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss
Weathering Resistance	Carbon-Arc ASTM G 153	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min. with no appreciable change or stiffening or cracking of coating
Water Absorption	ASTM D 471, Section 12 7 Days	0.025 kg/m ² max. @70° F/21° C 0.14 kg/m ² max at 212° F/100° C	0.025 kg/m ² max. @70° F/21° C 0.14 kg/m ² max at 212° F/100° C	0.025 kg/m ² max. @70° F/21° C 0.14 kg/m ² max at 212° F/100° C
Wicking	ASTM D 751	1/8" max (0.3 cm max)	1/8" max. (0.3 cm max)	1/8" max. (0.3 cm max.)
Bursting Strength	ASTM D 751 Ball Tip	750 lbs. min. (3,330 N min.)	750 lbs. min. (3,330 N min.)	750 lbs. min. (3,330 N min.)
Puncture Resistance	ASTM D 4833	275 lbs. min. 1,200 N min.	275 lbs. min. 1,200 N min.	275 lbs. min. 1,200 N min.
Coefficient of Thermal Expansion/ Contraction	ASTM D 696	8 x 10 ⁻⁵ in/in/° F max. (1.4 x 10 ⁻⁵ cm/cm/° C max.)	8 x 10 ⁻⁵ in/in/° F max. (1.4 x 10 ⁻⁵ cm/cm/° C max.)	8 x 10 ⁻⁵ in/in/° F max. (1.4 x 10 ⁻⁵ cm/cm/° C max.)
Environmental/Chemical Resistant Properties		See Chemical Resistance Table, Page 8	See Chemical Resistance Table, Page 8	See Chemical Resistance Table, Page 8
Puncture Resistance	FED-STD-101C Method 2031	350 lbs. (approx.)	350 lbs. (approx.)	350 lbs. (approx.)
Cold Crack	ASTM D 2136 4 Hrs, 1/8" Mandrel	Pass at -30° F/-34° C	Pass @ -30° F/-34° C	Pass @ -30° F/-34° C

Section 2 - Physical Properties

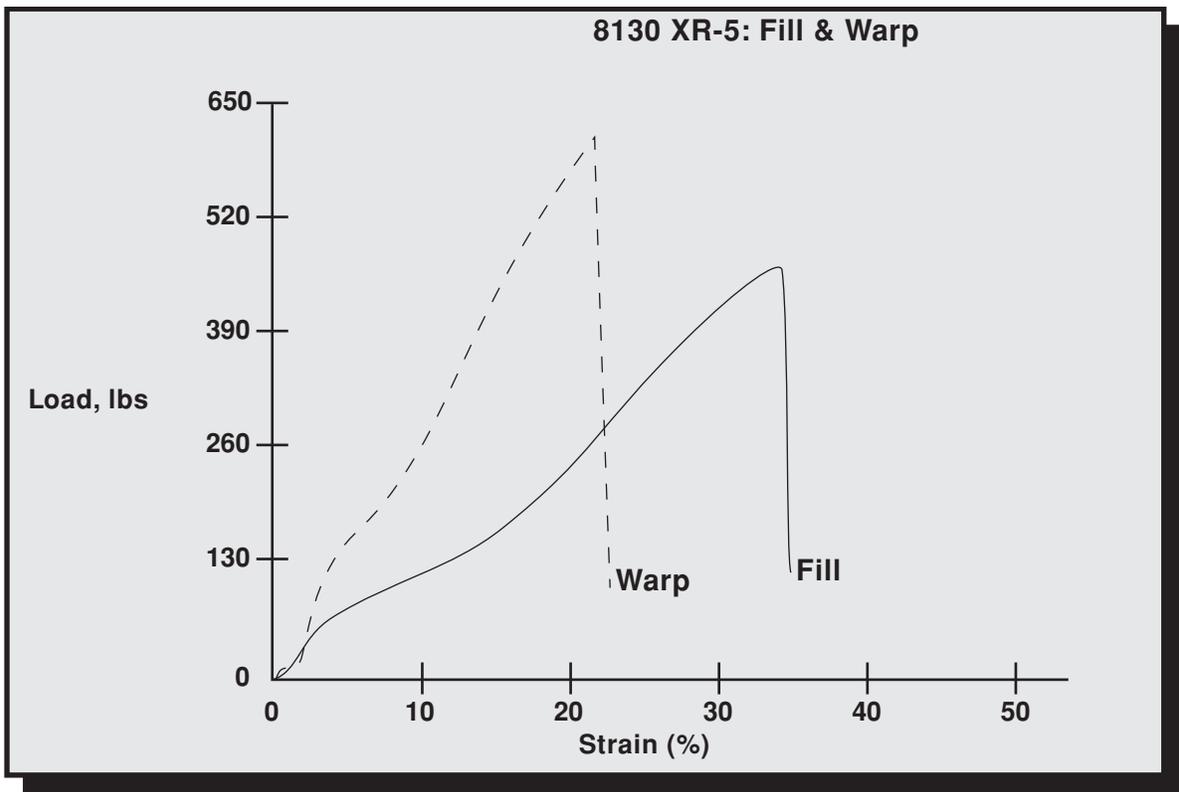
Part 1- Material Specifications (cont.)

Property	Test Method	8130 XR-3 PW	8228 XR-3
Base Fabric Type	ASTM D 751	Polyester	Polyester
Base Fabric Weight		6.5 oz/yd ² nominal (220 g/m ² nominal)	3.0 oz/yd ² nominal (100 g/m ² nominal)
Thickness	ASTM D 751	30 mils min. (0.76 mm min.)	30 mils min. (0.76 mm min.)
Weight	ASTM D 751	30.0 +- 2 oz./sq. yd. (1017 +- 70 g/sq. m)	28.0 +- 2 oz./sq. yd. (950 +- 70 g/sq. m)
Tear Strength	ASTM D 751 Trap Tear	40/55 lbs. min. (175/245 N min.)	30/30 lbs. nom. (133/133 N nom.)
Breaking Yield Strength	ASTM D 751 Grab Tensile	550/550 lbs. min. (2,447/2447 N min.)	250/200 lbs. min. (1,110/890 N min.)
Low Temperature Resistance	ASTM D 2136 4hrs-1/8" Mandrel	Pass @ -30° F (Pass @ -35° C)	Pass @ -25° F (Pass @ -32° C)
Dimensional Stability	ASTM D 1204 100° C-1 hr.	0.5% max. each direction	5% max. each direction
Hydrostatic Resistance	ASTM D 751 Method A	800 psi min. (5.51 MPa min.)	300 psi min. (2.07 MPa min.)
Blocking Resistance	ASTM D 751 180° F	#2 Rating max.	#2 Rating max.
Adhesion-Ply	ASTM D 413 Type A	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	12 lbs./in. (approx.) (10 daN/5 cm approx.)
Adhesion-Heat Welded Seam	ASTM D 751 Dielectric Weld	40 lbs./2in. min. (17.5 daN/5 cm min.)	10 lbs./in min. (9 daN/5 cm min.)
Dead Load Seam Strength	ASTM D 751, 4-Hour Test	Pass 220 lbs/in. @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in. @ 160° F (Pass 534 N/2.54 cm @ 70° C)	Pass 100 lbs/in @ 70° F (Pass 445 N @ 21° C) Pass 50 lb @ 160° F (Pass 220 N @ 70° C)
Bonded Seam Strength	ASTM D 751 Procedure A, Grab Test Method	550 lbs. min. (2,450 N min.)	250 lbs. (approx.) (1,112 N min.)

Abrasion Resistance	ASTM D 3389 H-18 Wheel 1 kg Load	2000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2000 cycles min.
Weathering Resistance	ASTM G 153	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min.
Water Absorption	ASTM D 471, Section 12 7 Days	0.025 kg/m ² max. @ 70° F/21° C 0.14 kg/m ² max @ 212° F/100° C	0.05 kg/m ² max. @ 70° F/21° C (approx.) 0.28 kg/m ² max. @ 212° F/100° C (approx.)
Wicking	ASTM D 751	1/8" max. (0.3 cm max.)	1/8" max (0.3 cm max.)
Bursting Strength	ASTM D 751 Ball Tip	750 lbs. min. (3330 N min.)	350 lbs. (approx.) (1557 N min.)
Puncture Resistance	ASTM D 4833	275 lbs. min. 1200 N min.	50 lb typ. (225 N typ.)
Coefficient of Thermal Expansion/ Contraction	ASTM D 696	8 x 10 ⁻⁵ in/in/° F max. (1.4 x 10 ⁻⁵ cm/cm/° C max.)	8 x 10 ⁻⁵ in/in/° F max. (approx.) (1.4 x 10 ⁻⁵ cm/cm/° C max. approx.)
Environmental/Chemical Resistant Properties	ASTM D 741 7-Day Total Immersion With Exposed Edges	NSF 61 approved for potable water	Crude oil 5% max. weight gain Diesel fuel 5% max. weight gain
Puncture Resistance	FTMS 101C Method 2031	350 lbs. (approx.)	205 lbs. (approx.)
Tongue Tear	ASTM D 751		50 lbs. (approx.)

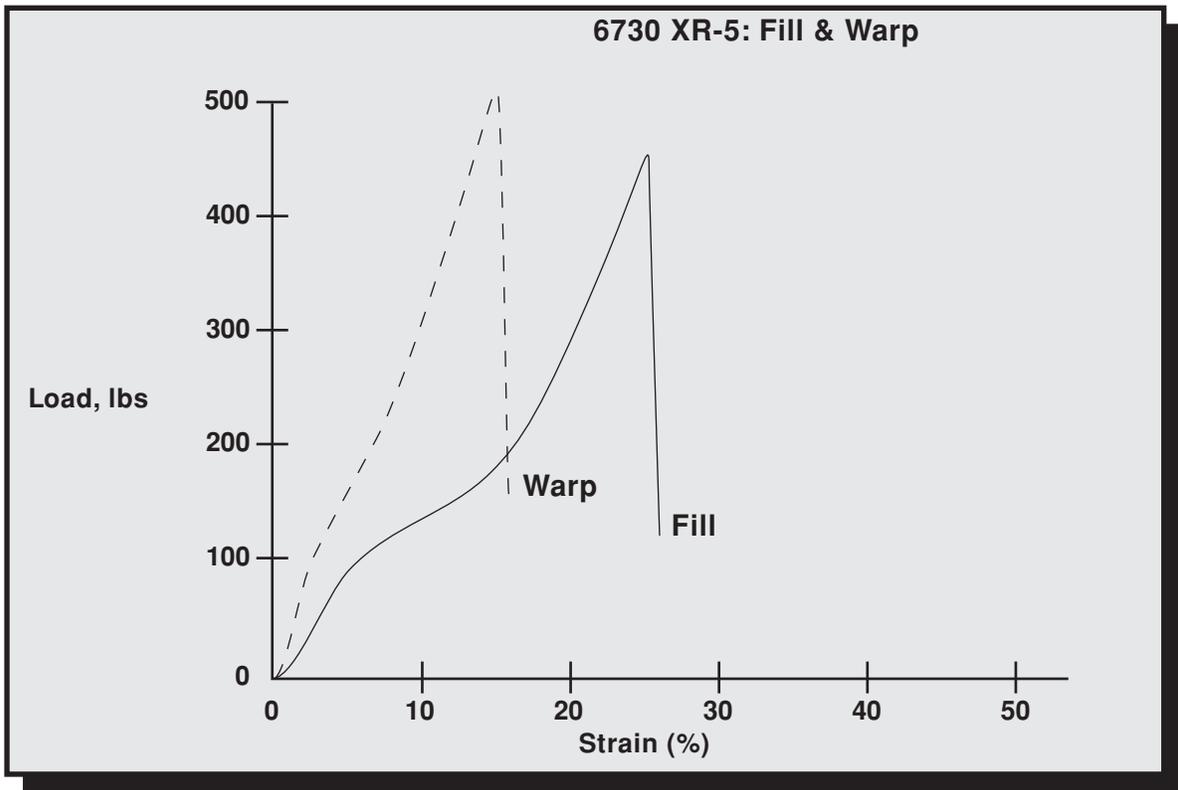
Part 2 - Elongation Properties Test

8130 XR-5



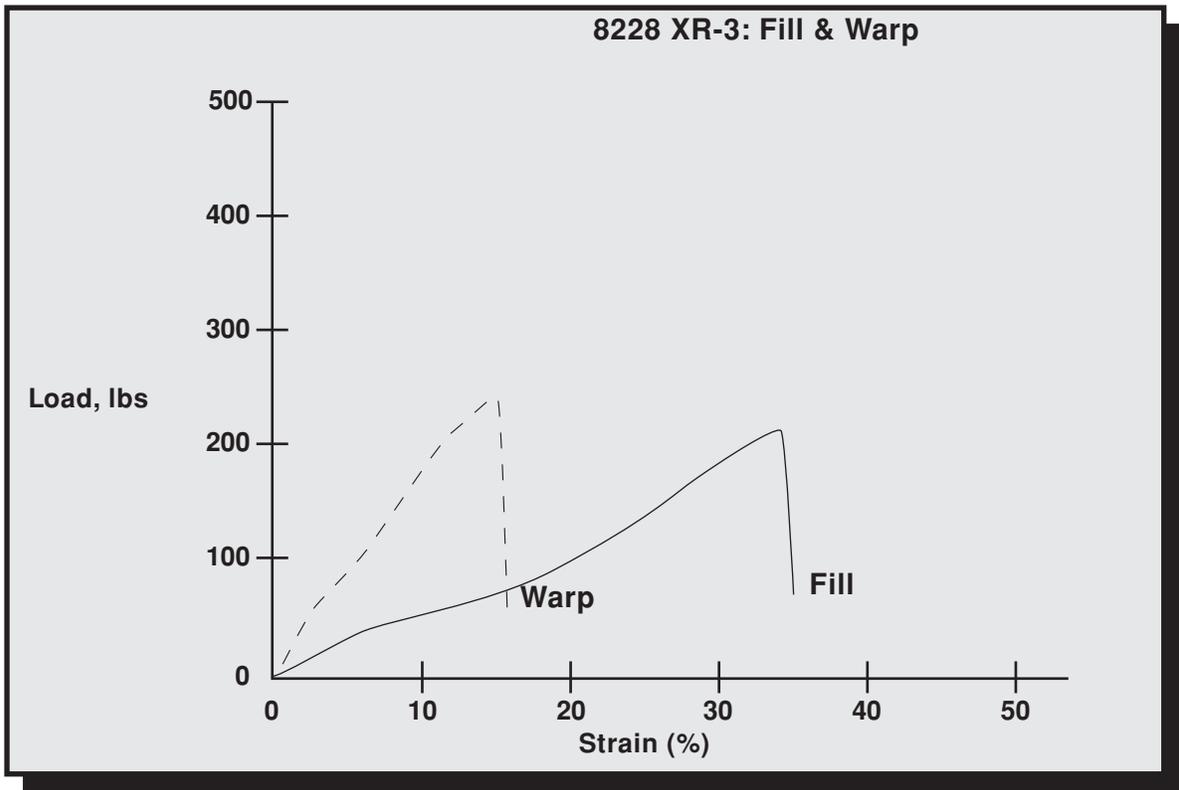
Part 2 - Elongation Properties Test

6730 XR-5



Part 2 - Elongation Properties Test

8228 XR-3



Section 3 - Chemical/Environmental Resistance

Part 1 - XR-5® Fluid Resistance Guidelines

The data below is the result of laboratory tests and is intended to serve only as a guide. No performance warranty is intended or implied. The degree of chemical attack on any material is governed by the conditions under which it is exposed. Exposure time, temperature, and size of the area of exposure usually varies considerably in application, therefore, this table is given and accepted at the user's risk. Confirmation of the validity and suitability in specific cases should be obtained. Contact a Seaman Corporation Representative for recommendation on specific applications.

When considering XR-5 for specific applications, it is suggested that a sample be tested in actual service before specification. Where impractical, tests should be devised which simulate actual service conditions as closely as possible.

EXPOSURE	RATING	EXPOSURE	RATING
AFFF	A	JP-4 Jet Fuel	A
Acetic Acid (5%)	B	JP-5 Jet Fuel	A
Acetic Acid (50%)	C	JP-8 Jet Fuel	A
Ammonium Phosphate	T	Kerosene	A
Ammonium Sulfate	T	Magnesium Chloride	T
Antifreeze (Ethylene Glycol)	A	Magnesium Hydroxide	T
Animal Oil	A	Methanol	A
Aqua Regia	X	Methyl Alcohol	A
ASTM Fuel A (100% Iso-Octane)	A	Methyl Ethyl Ketone	X
ASTM Oil #2 (Flash Pt. 240° C)	A	Mineral Spirits	A
ASTM Oil #3	A	Naphtha	A
Benzene	X	Nitric Acid (5%)	B
Calcium Chloride Solutions	T	Nitric Acid (50%)	C
Calcium Hydroxide	T	Perchloroethylene	C
20% Chlorine Solution	A	Phenol	X
Clorox	A	Phenol Formaldehyde	B
Conc. Ammonium Hydroxide	A	Phosphoric Acid (50%)	A
Corn Oil	A	Phosphoric Acid (100%)	C
Crude Oil	A	Phthalate Plasticizer	C
Diesel Fuel	A	Potassium Chloride	T
Ethanol	A	Potassium Sulphate	T
Ethyl Acetate	C	Raw Linseed Oil	A
Ethyl Alcohol	A	SAE-30 Oil	A
Fertilizer Solution	A	Salt Water (25%)	B
#2 Fuel Oil	A	Sea Water	A
#6 Fuel Oil	A	Sodium Acetate Solution	T
Furfural	X	Sodium Bisulfite Solution	T
Gasoline	B	Sodium Hydroxide (60%)	A
Glycerin	A	Sodium Phosphate	T
Hydraulic Fluid- Petroleum Based	A	Sulphuric Acid (50%)	A
Hydraulic Fluid- Phosphate Ester Based	C	Tanic Acid (50%)	A
Hydrocarbon Type II (40% Aromatic)	C	Toluene	C
Hydrochloric Acid (50%)	A	Transformer Oil	A
Hydrofluoric Acid (5%)	A	Turpentine	A
Hydrofluoric Acid (50%)	A	Urea Formaldehyde	A
Hydrofluosilicic Acid (30%)	A	UAN	A
Isopropyl Alcohol	T	Vegetable Oil	A
Ivory Soap	A	Water (200°F)	A
Jet A	A	Xylene	X
		Zinc Chloride	T

Ratings are based on visual and physical examination of samples after removal from the test chemical after the samples of Black XR-5 were immersed for 28 days at room temperature. Results represent ability of material to retain its performance properties when in contact with the indicated chemical.

Rating Key:

- A – Fluid has little or no effect
- B – Fluid has minor to moderate effect
- C – Fluid has severe effect
- T – No data - likely to be acceptable
- X – No data - not likely to be acceptable

Vapor Transmission Data

Tested according to ASTM D814-55 Inverted Cup Method

Perhaps a more meaningful test is determination of the diffusion rate of the liquid through the membrane. The vapor transmission rate of Style 8130 XR-5® to various chemicals was determined by the ASTM D814-55 inverted cup method. All tests were run at room temperature and results are shown in the table.

Chemical	8130 XR-5 Black g/hr/m ²
Water	0.11
#2 Diesel Fuel	0.03
Jet A	0.11
Kerosene	0.15
Hi-Test Gas	1.78
Ohio Crude Oil	0.03
Low-Test Gas	5.25
Raw Linseed Oil	0.01
Ethyl Alcohol	0.23
Naphtha	0.33
Perchloroethylene	38.58
Hydraulic Fluid	0.006
100% Phosphoric Acid	7.78
50% Phosphoric Acid	0.43
Ethanol (E-96)	0.65
Transformer Oil	0.005
Isopropyl Alcohol	0.44
JP4 (E-96)	0.81
JP8 (E-96)	0.42
Fuel B (E-96)	6.28
Fuel C (E-96)	7.87

Note: The tabulated values are measured Vapor Transmission Rates (VTR). Normal soil testing methods to determine permeability are impractical for synthetic membranes. An "equivalent hydraulic" permeability coefficient can be calculated but is not a direct units conversion. Contact Seaman Corporation for additional technical information.

Seam Strength

Style 8130 XR-5 Black Seam Strength After Immersion

Two pieces of Style 8130 were heat sealed together (seam width 1 inch overlap) and formed into a bag. Various oils and chemicals were placed in the bags so that the seam area was entirely covered. After 28 days at room temperature, the chemicals were removed and one inch strips were cut across the seam and the breaking strength immediately determined. Results are listed below.

Chemical	Seam Strength
None	340 Lbs. Fabric Break- No Seam Failure
Kerosene	355 Lbs. Fabric Break- No Seam Failure
Ohio Crude Oil	320 Lbs. Fabric Break- No Seam Failure
Hydraulic Fluid- Petroleum Based	385 Lbs. Fabric Break- No Seam Failure
Toluene	0 Lbs. Adhesion Failure
Naphtha	380 Lbs. Fabric Break- No Seam Failure
Perchloroethylene	390 Lbs. Fabric Break- No Seam Failure

Even though 1-inch overlap seams are used in the tests to study the accelerated effects, it is recommended that XR-5 be used with a 2-inch nominal overlap seam in actual application. In some cases where temperatures exceed 160°F and the application demands extremely high seam load, it may be necessary to use a wider width seam.

Long Term Seam Adhesion

11 Years Immersion

ASTM D 751

Lbs./In.

Seam samples of 8130 XR-5[®] were dielectrically welded together and totally immersed in the liquids for 11 years. The samples were taken out, dried for 24 hours and visually observed for any signs of swelling, cracking, stiffening or degradation of the coating. The coating showed no appreciable degradation and no stiffening, swelling, cracking or peeling.

The adhesion, or resistance to separation of the coating from the base cloth, was then measured by ASTM D 751. Results show 8130 XR-5 maintains seam strength over this long period (11 years).

	Control	Crude Oil	JP-4 Jet Fuel	Diesel Fuel	Kerosene	Naphtha
8130 XR-5	20+	18	33	25	40	33*

Values in lbs./in.

*The naphtha sample was sticky.

We believe this information is the best currently available on the subject. We offer it as a suggestion in any appropriate experimentation you may care to undertake. It is subject to revision as additional knowledge and experience are gained. We make no guarantee of results and assume no obligation or liability whatsoever in connection with this information.

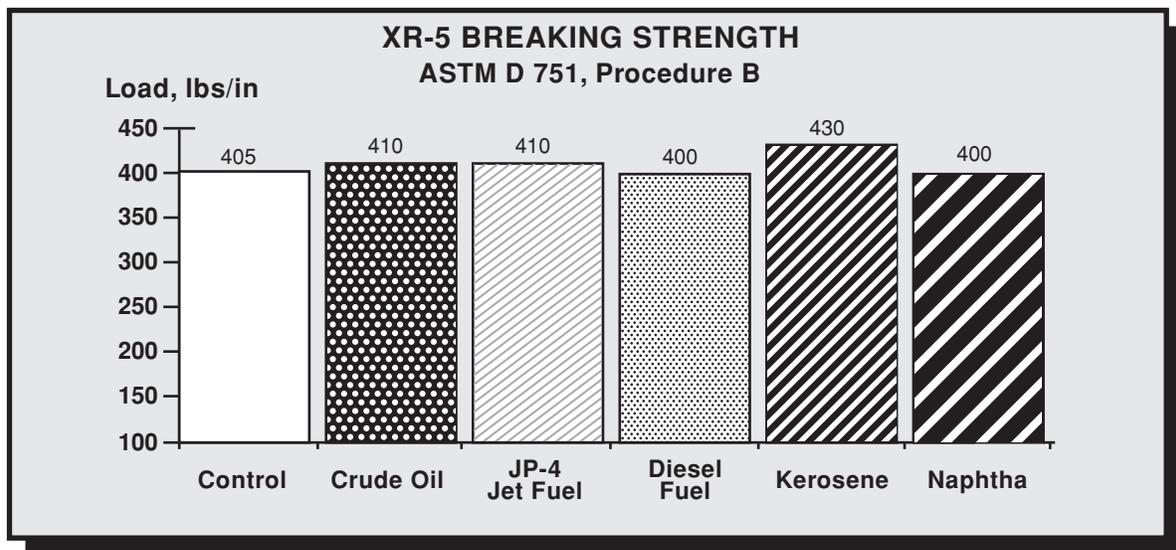
Fuel Compatibility - Long Term Immersion

Test: Samples of 8130 XR-5® Black were immersed in Diesel Fuel, JP-4 Jet Fuel, Crude Oil, Kerosene, and Naphtha for 6 1/2 years.

The samples were then taken out of the test chemicals, blotted and dried for 24 hours. The samples were observed for blistering, swelling, stiffening, cracking or delamination of the coating from the fiber.

Results: It was found in all cases that the 8130 XR-5, after immersion for six years, maintained its strength and there was no evidence of blistering, swelling, stiffening, cracking or delamination.

The strip tensile strength, or breaking strength, of the samples was measured after six years of immersion and the following are the results.



XR-3 Chemical Resistance Statement (Summary)

XR-3® is recommended for moderate chemical resistant applications such as stormwater and municipal wastewater and is not recommended for prolonged contact with pure solutions. XR-3 PW® membranes are recommended only for contact with drinking water and are resistant to low levels of chlorine found in drinking water. XR-5 has a broad range of chemical resistance which is detailed in this section.

Part 2: XR-5® Comparative Chemical Resistance

Chemical Resistance Chart

Comparative Chemical Resistance

	<u>XR-5</u>	<u>HDPE</u>	<u>PVC</u>	<u>Hypalon</u>	<u>Polypropylene</u>
Kerosene	A	B	C	C	C
Diesel Fuel	A	A	C	C	C
Acids (General)	A	A	A	B	A
Naphtha	A	A	C	B	C
Jet Fuels	A	A	C	B	C
Saltwater, 160° F	A	A	C	B	A
Crude Oil	A	B	C	B	C
Gasoline	B	B	C	C	C

A= Excellent B= Moderate C= Poor

Source: Manufacturer's Literature

XR-5 data based on conditions detailed in Section 3, Part 1.

Part 3: Weathering Resistance

Accelerated Weathering Test

XR-5 has been tested in the carbon arc weatherometer for over 10,000 hours of exposure and in the Xenon weatherometer for over 12,000 hours of exposure. The sample showed no loss in flexibility and no significant color change. Based on field experience of Seaman Corporation products and similar weatherometer exposure tests, XR-5 should have an outdoor weathering life significantly longer than competitive geomembranes, particularly in tropical or subtropical applications.

EMMAQUA Testing: ASTM E-838-81 was performed on a modified form of XR-5, FiberTite, used in the single-ply roofing industry. After 3 million Langleys in Arizona, no signs of degradation were noted with no evidence of cracking, blistering, swelling or adhesion delamination failure of the coating.

Natural Exposure

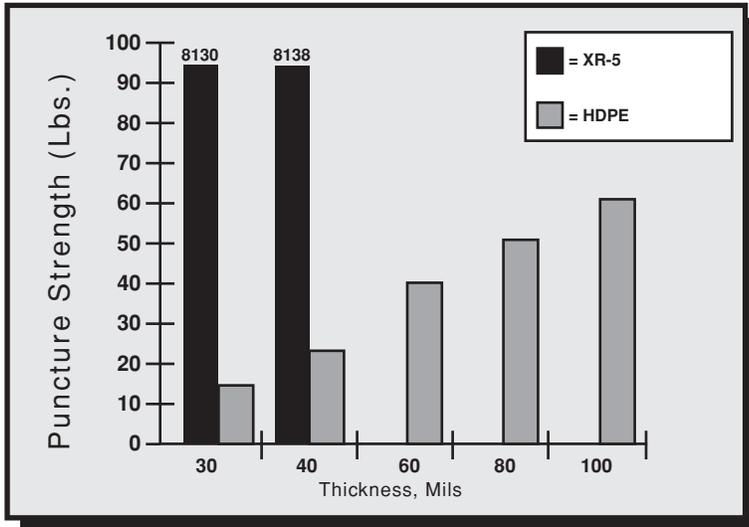
After over 17 years as a holding basin at a large oil company in the Texas desert, XR-5 showed no signs of environmental stress cracking, thermal expansion/contraction, or low yield strength problems. Temperature ranges from near zero to over 100° F.

In service approximately 17 years in a solar pond application at a research facility in Ohio, UV exposed samples, as well as immersed samples, retained over 90% of the tensile strength. Examination of the material determined there was little effect on the coating compound. The solar pond was exposed to temperatures from below zero to over 100° F.

XR5 was exposed for 12½ years in Sarasota, Florida, on a weathering rack, facing the southern direction at 45°. No significant color loss, cracking, crazing, blistering, or adhesion delamination failure of the coating was noted.

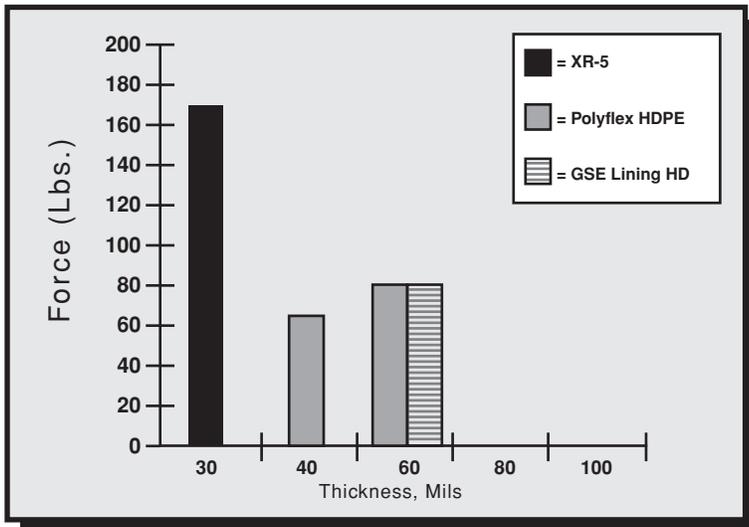
Section 4 - Comparative Physical Properties

XR-5/HDPE Comparative Properties

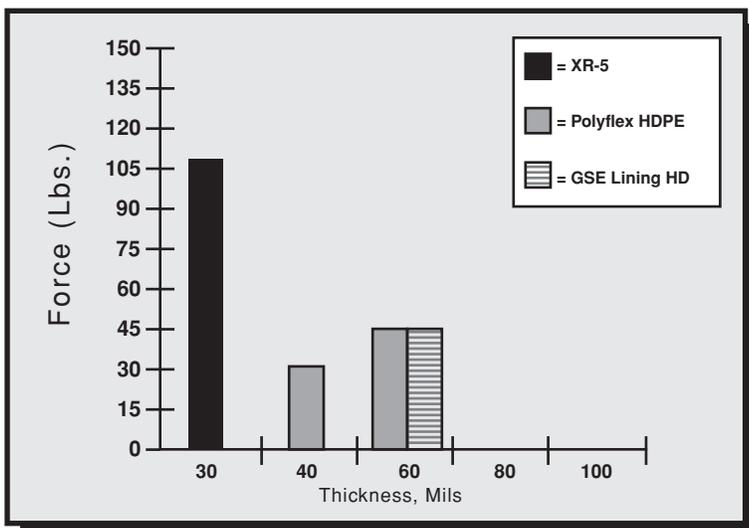


Puncture Resistance

1. ASTM D 751, Screwdriver Tip, 45° Angle (Room Temperature) Puncture Resistance, XR5 vs. HDPE



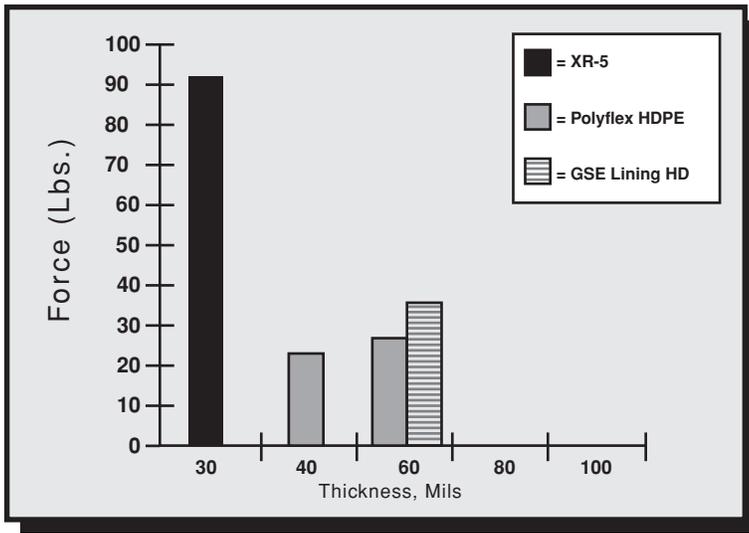
2. FED-STD-101C Method 2065 (Room Temperature)*



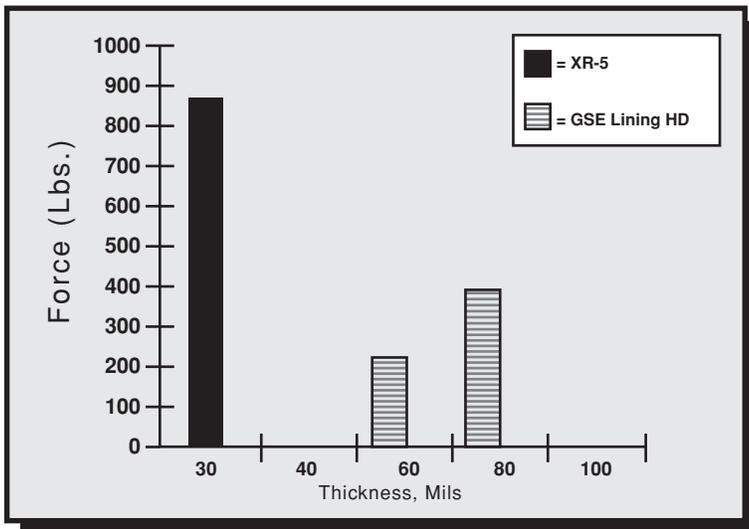
3. FED-STD-101C Method 2065 (70°C)*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

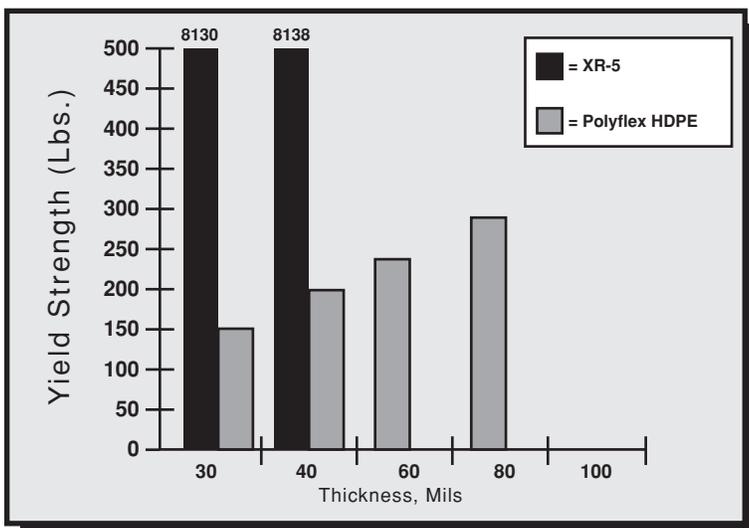
GSE is a registered trademark of GSE Lining Technology, Inc.



4. FED-STD-101C Method 2065 (100°C)*



5. ASTM D 751 Ball Burst Puncture



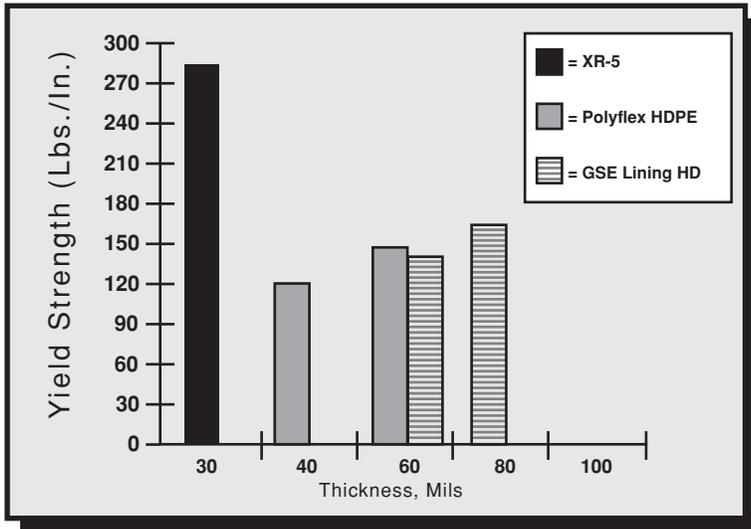
Yield Strength

1. Yield Strength, XR-5 vs. HDPE

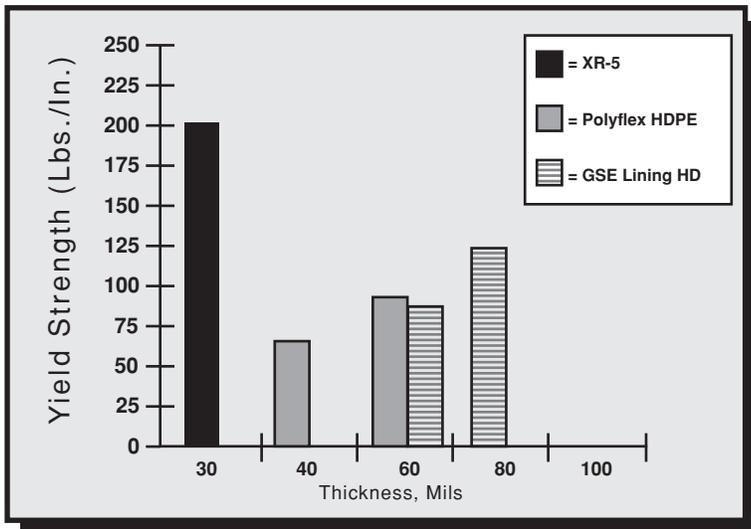
Test Method: Grab Tensile, ASTM D 751, 70° C

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

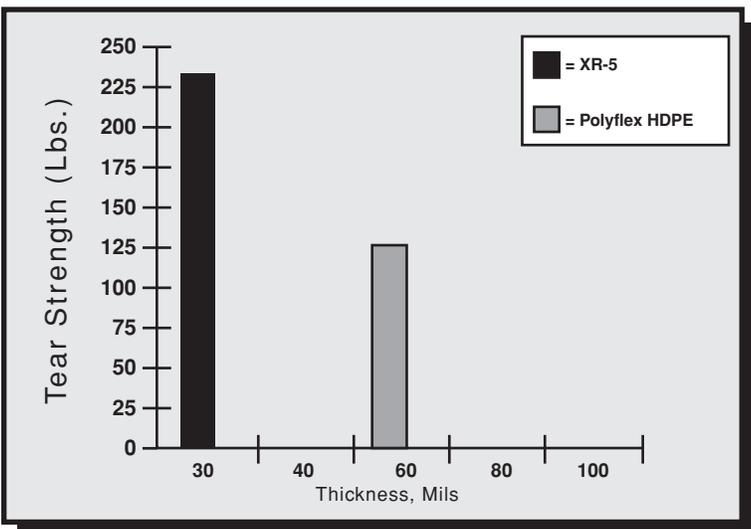
GSE is a registered trademark of GSE Lining Technology, Inc.



2. Strip Tensile, ASTM D 751, Room Temperature*



3. Strip tensile, ASTM D 751, 70°C*

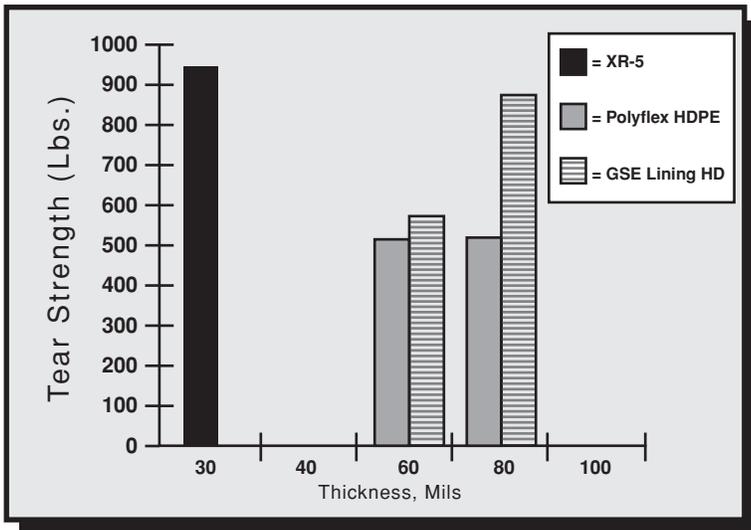


Tear Strength

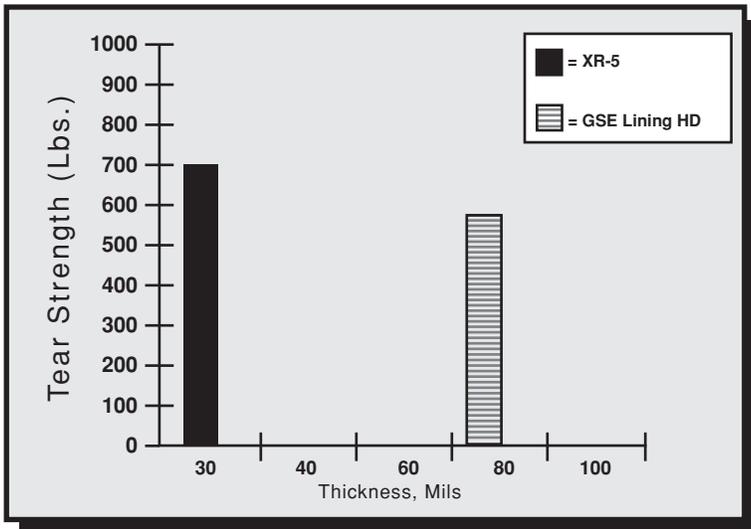
1. Tongue Tear (8" x 10" Specimens), ASTM D 751, Room Temperature*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

GSE is a registered trademark of GSE Lining Technology, Inc.



1. Graves Tear, ASTM D 624, Die C, Room Temperature*

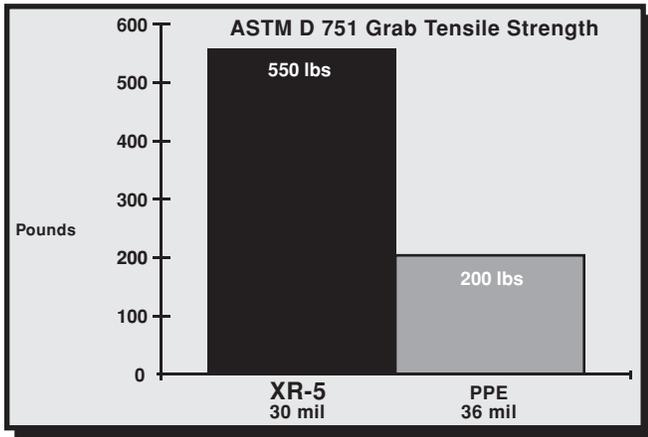


2. Graves Tear, ASTM D 624, Die C, 70°C*

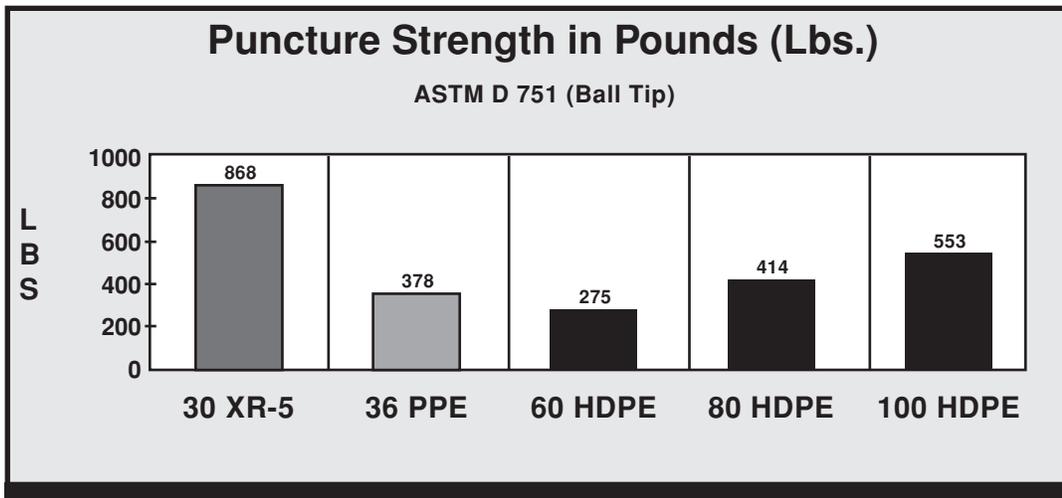
* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

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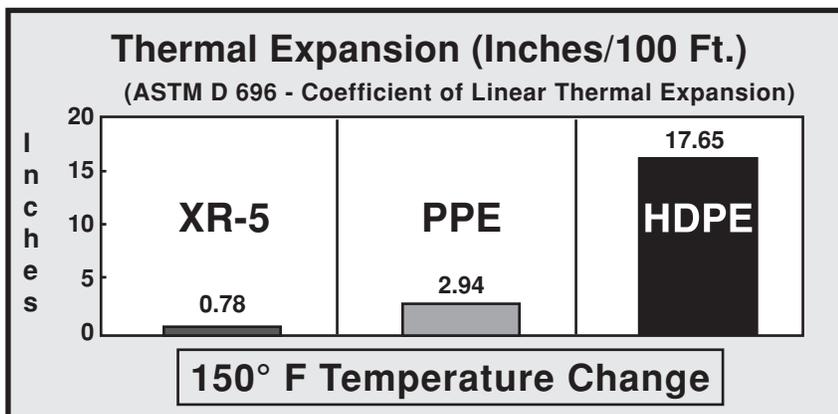
Grab Strength – XR-5® vs. Polypropylene Tensile



Puncture Strength Comparison



Coated Fabric Thermal Stability



Specification For Geomembrane Liner

(Sample specification: 8130 XR-5®. For other product specifications, go to www.xr-5.com)

General

1.01 Scope Of Work

Furnish and install flexible membrane lining in the areas shown on the drawings. All work shall be done in strict accordance with the project drawings, these specifications and membrane lining fabricator's approved shop drawings.

Geomembrane panels will be supplied sufficient to cover all areas, including appurtenances, as required in the project, and shown on the drawings. The fabricator/installer of the liner shall allow for shrinkage and wrinkling of the field panels.

1.02 Products

The lining material shall be 8130 XR-5 as manufactured by Seaman Corporation (1000 Venture Boulevard, Wooster, OH 44691; 330-262-1111), with the following physical specifications:

Base- (Type)	Polyester
Fabric Weight (ASTM D 751) .....	.6.5 oz./sq. yd.
Finished Coated Weight (ASTM D 751) .....	.30 ± 2 oz./sq. yd.
Trapezoid Tear (ASTM D 751) .....	.40/55 lbs. min.
Grab Yield Tensile (ASTM D 751, Grab Method Procedure A) .....	.550/550 lbs. min.
Elongation @ Yield (%) .....	.20% min.
Adhesion- Heat Seam (ASTM D 751, Dielectric Weld) .....	.40 lbs./2in. weld min.
Adhesion- Ply (ASTM D 413, Type A) .....	.15 lbs./in. or film tearing bond
Hydrostatic Resistance (ASTM D 751, Method A) .....	.800 psi min.
Puncture Resistance (ASTM D 4833) .....	.275 lbs. min.
Bursting Strength (ASTM D 751 Ball Tip) .....	.750 lbs. min.
Dead Load (ASTM D 751) Room Temperature .....	.220 lbs. min.
(2" overlap seam, 4 hours) 160°F .....	.120 lbs. min.
Bonded Seam Strength .....	.575 lbs. min.
(ASTM D 751 Grab Test Method, Procedure A)	
Low Temperature (ASTM D 2136, 4 hours- 1/8" Mandrel) .....	.Pass @ -30°F
Weathering Resistance ASTM G 153 Carbon Arc .....	.8,000 hours min.
	With no appreciable changes or stiffening or cracking of coating
Dimensional Stability (ASTM D 1204, 212°F 1 Hour, Each Direction) .....	.0.5% max.
Water Absorption (ASTM D 471, 7 Days) .....	.0.025 kg/m ² max. @ 70°F
	.0.14 kg/m ² max. @ 212°F
Abrasion Resistance ASTM D 3389, .....	.2000 cycles before fabric exposure;
H-18 Wheel, 1000 g load .....	.50 mg/100 cycles max. wgt. Loss
Coefficient of Thermal Expansion/Contraction (ASTM D 696) .....	.8 x 10 ⁻⁶ in/in/° F max.

1.03 Submittals

The fabricator of panels used in this work shall prepare shop drawings with a proposed panel layout to cover the liner area shown in the project plans. Shop drawings shall indicate the direction of factory seams and shall show panel sizes consistent with the material quantity requirements of 1.01.

Details shall be included to show the termination of the panels at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring.

Placement of the lining shall not commence until the shop drawings and details have been approved by the owner, or his representative.

1.04 Factory Fabrication

The individual XR-5® liner widths shall be factory fabricated into large sheets custom designed for this project so as to minimize field seaming. The number of factory seams must exceed the number of field seams by a factor of at least 10.

A two-inch overlap seam done by heat or RF welding is recommended. The surface of the welded areas must be dry and clean. Pressure must be applied to the full width of the seam on the top and bottom surface while the welded area is still in a melt-type condition. The bottom welding surface must be flat to insure that the entire seam is welded properly. Enough heat shall be applied in the welding process that a visible bead is extruded from both edges being welded. The bead insures that the material is in a melt condition and a successful chemical bond between the two surfaces is accomplished.

Two-inch overlapped seams must withstand a minimum of 240 pounds per inch width dead load at 70° F. and 120 pounds per inch width at 160° F. as outlined in ASTM D 751. All seams must exceed 550 lbs. bonded seam strength per ASTM D 751 Bonded Seam Strength Grab Test Method, Procedure A.

1.05 Inspection And Testing Of Factory Seams

The fabricator shall monitor each linear foot of seam as it is produced. Upon discovery of any defective seam, the fabricator shall stop production of panels used in this work and shall repair the seam, and determine and rectify the cause of the defect prior to continuation of the seaming process.

The fabricator must provide a Quality Control procedure to the owner or his representative which details his method of visual inspection and periodic system checks to ensure leak-proof factory fabrication.

1.06 Certification and Test Reports

Prior to installation of the panels, the fabricator shall provide the owner, or his representative, with written certification that the factory seams were inspected in accordance with Section 1.05.

1.07 Panel Packaging and Storage

Factory fabricated panels shall be accordian-folded, or rolled, onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each factory fabricated panel shall be prominently and indelibly marked with the panel size. Panels shall be protected as necessary to prevent damage to the panel during shipment.

Panels which have been delivered to the project site shall be stored in a dry area.

1.08 Qualifications of Suppliers

The fabricator of the lining shall be experienced in the installation of flexible membrane lining, and shall provide the owner or his representative with a list of not less than five (5) projects and not less than 500,000 square feet of successfully installed XR-5 synthetic lining. The project list shall show the name, address, and telephone number of an appropriate party to contact in each case. The manufacturer of the sheet goods shall provide similar documentation with a 10 million square foot minimum, with at least 5 projects demonstrating 10+ years service life.

The installer shall provide similar documentation to that required by the fabricator.

1.09 Subgrade Preparation By Others

Lining installation shall not begin until a proper base has been prepared to accept the membrane lining. Base material shall be free from angular rocks, roots, grass and vegetation. Foreign materials and protrusions shall be removed, and all cracks and voids shall be filled and the surface made level, or uniformly sloping as indicated

on the drawings. The prepared surface shall be free from loose earth, rocks, rubble and other foreign matter. Generally, no rock or other object larger than USCS sand (SP) should remain on the subgrade in order to provide an adequate safety factor against puncture. Geotextiles may be used to compensate for irregular subgrades. The subgrade shall be uniformly compacted to ensure against settlement. The surface on which the lining is to be placed shall be maintained in a firm, clean, dry and smooth condition during lining installation.

1.10 Lining Installation

Prior to placement of the liner, the installer will indicate in writing to the owner or his representative that he believes the subgrade to be adequately prepared for the liner placement.

The lining shall be placed over the prepared surface in such a manner as to assure minimum handling. The sheets shall be of such lengths and widths and shall be placed in such a manner as to minimize field seaming.

In areas where wind is prevalent, lining installation should be started at the upwind side of the project and proceed downwind. The leading edge of the liner shall be secured at all times with sandbags or other means sufficient to hold it down during high winds.

Sandbags or rubber tires may be used as required to hold down the lining in position during installation. Materials, equipment or other items shall not be dragged across the surface of the liner, or be allowed to slide down slopes on the lining. All parties walking or working upon the lining material shall wear soft-sole shoes.

Lining sheets shall be closely fit and sealed around inlets, outlets and other projections through the lining. Lining to concrete seals shall be made with a mechanical anchor, or as shown on the drawings. All piping, structures and other projections through the lining shall be sealed with approved sealing methods.

1.11 XR-5 Field Seaming

All requirements of Section 1.04 and 1.05 apply. A visible bead should be extruded from the hot air welding process.

Field fabrication of lining material will not be allowed.

1.12 Inspection

All field seams will be tested using the Air Lance Method. A compressed air source will deliver 55 psi minimum to a 3/16 inch nozzle. The nozzle will be directed to the lip of the field seam in a near perpendicular direction to the length of the field seam. The nozzle will be held 4 inches maximum from the seam and travel at a rate not to exceed 40 feet per minute. Any loose flaps of 1/8" or greater will require a repair.

Alternatively all field seams should also be inspected utilizing the Vacuum Box Technique as described in Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber (ASTM D 5641-94 (2006)), using a 3 to 5 psi vacuum pressure. All leaks shall be repaired and tested.

All joints, on completion of work, shall be tightly bonded. Any lining surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade, shall as directed by the owner or his representative be replaced or covered, and sealed with an additional layer of lining of the proper size, in accordance with the patching procedure.

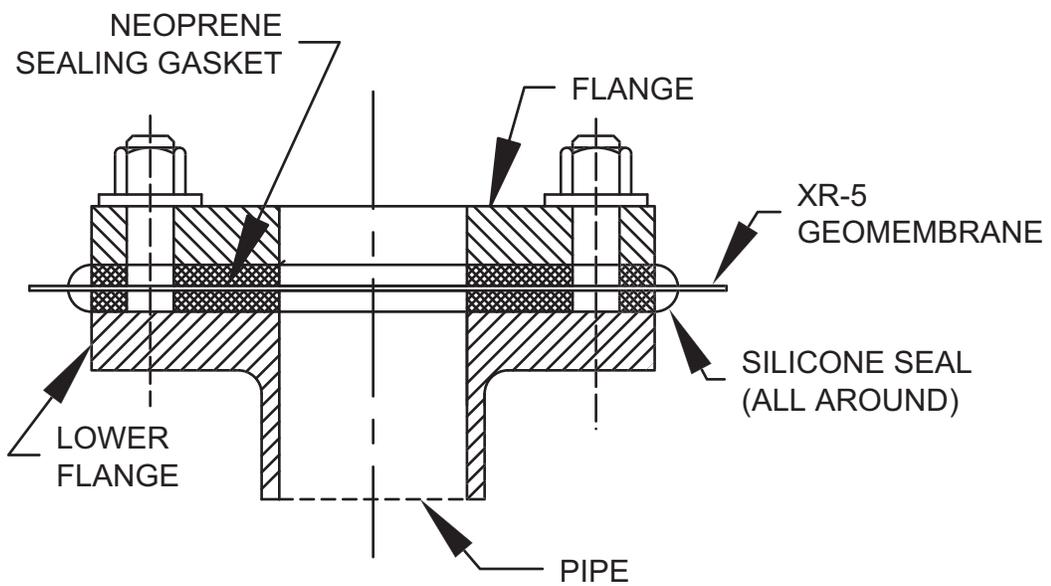
1.13 Patching

Any repairs to the lining shall be patched with the lining material. The patch material shall have rounded corners and shall extend a minimum of four inches (4") in each direction from the damaged area.

Seam repairs or seams which are questionable should be cap stripped with a 1" wide (min.) strip of the liner material. The requirements of Section 1.11 apply to this cap stripping.

1.14 Warranty

The lining material shall be warranted on a pro-rated basis for 10 years against both weathering and chemical compatibility in accordance with Seaman Corporation warranty for XR-5® Style 8130. A test immersion will be performed by the owner and the samples evaluated by the manufacturer. Workmanship of installation shall be warranted for one year on a 100% basis.



Seaman Corporation

ENGINEERED PRODUCTS GROUP

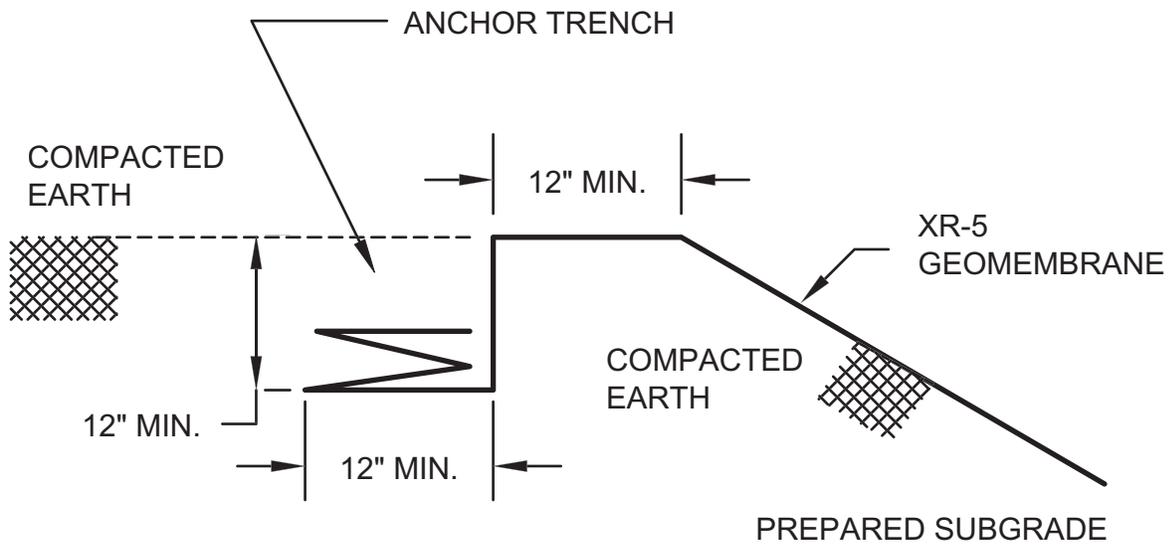
1000 Venture Blvd., Wooster, Ohio 44691

FLANGE CONNECTION TO PIPE SECTION

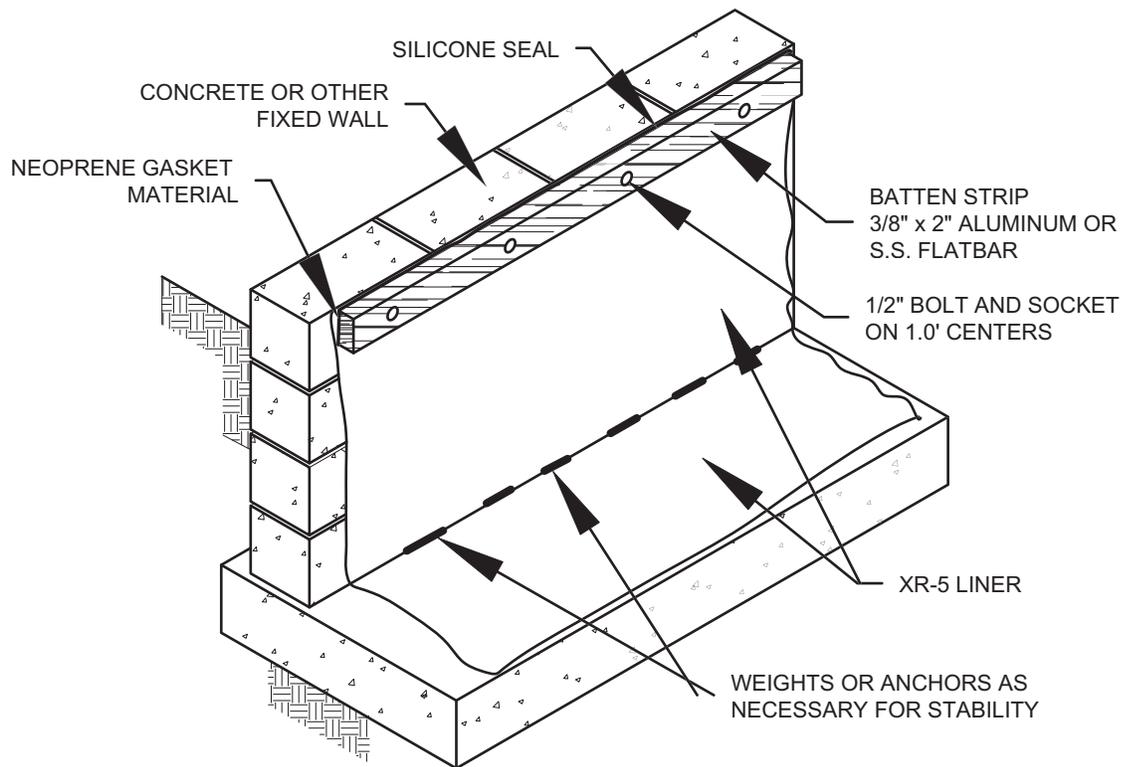
SCALE: NONE

SHEET 1 of 1

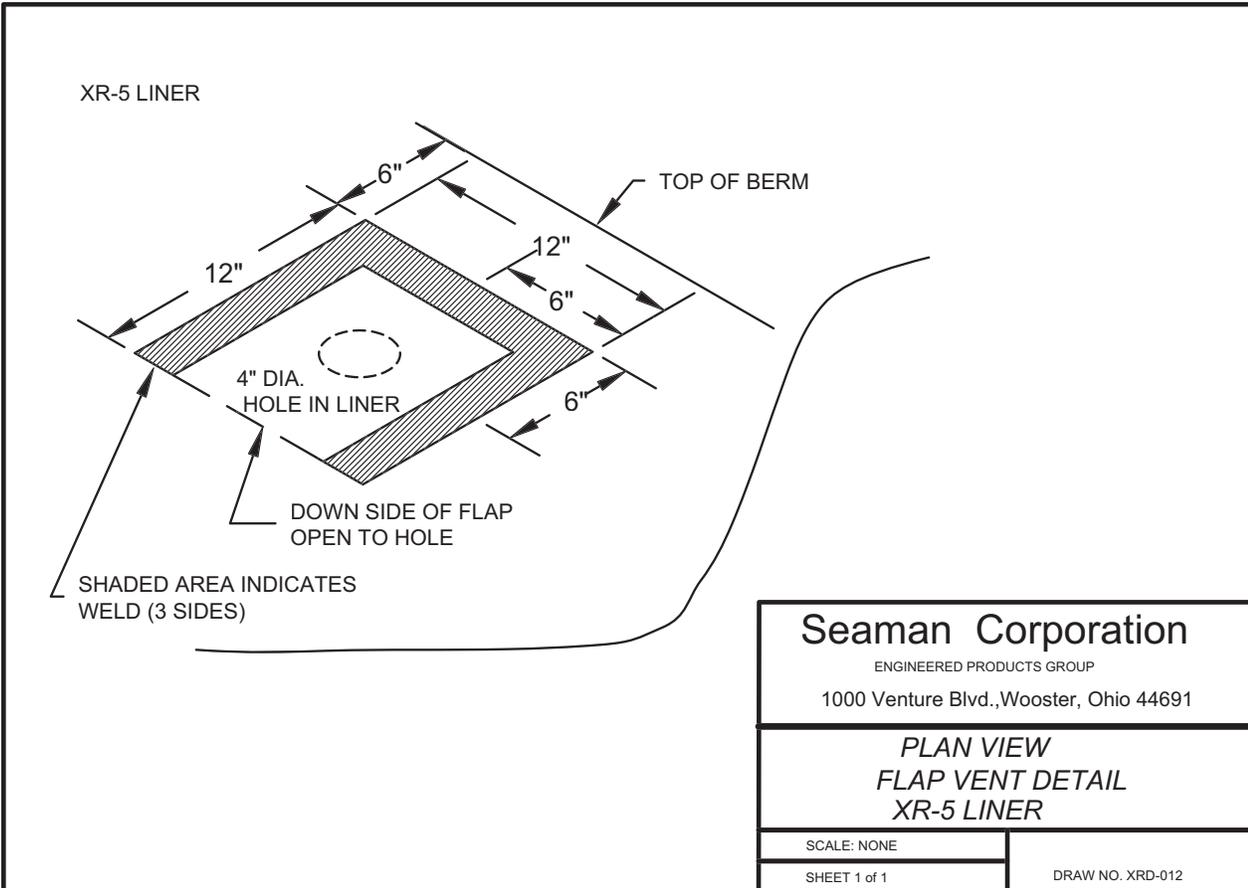
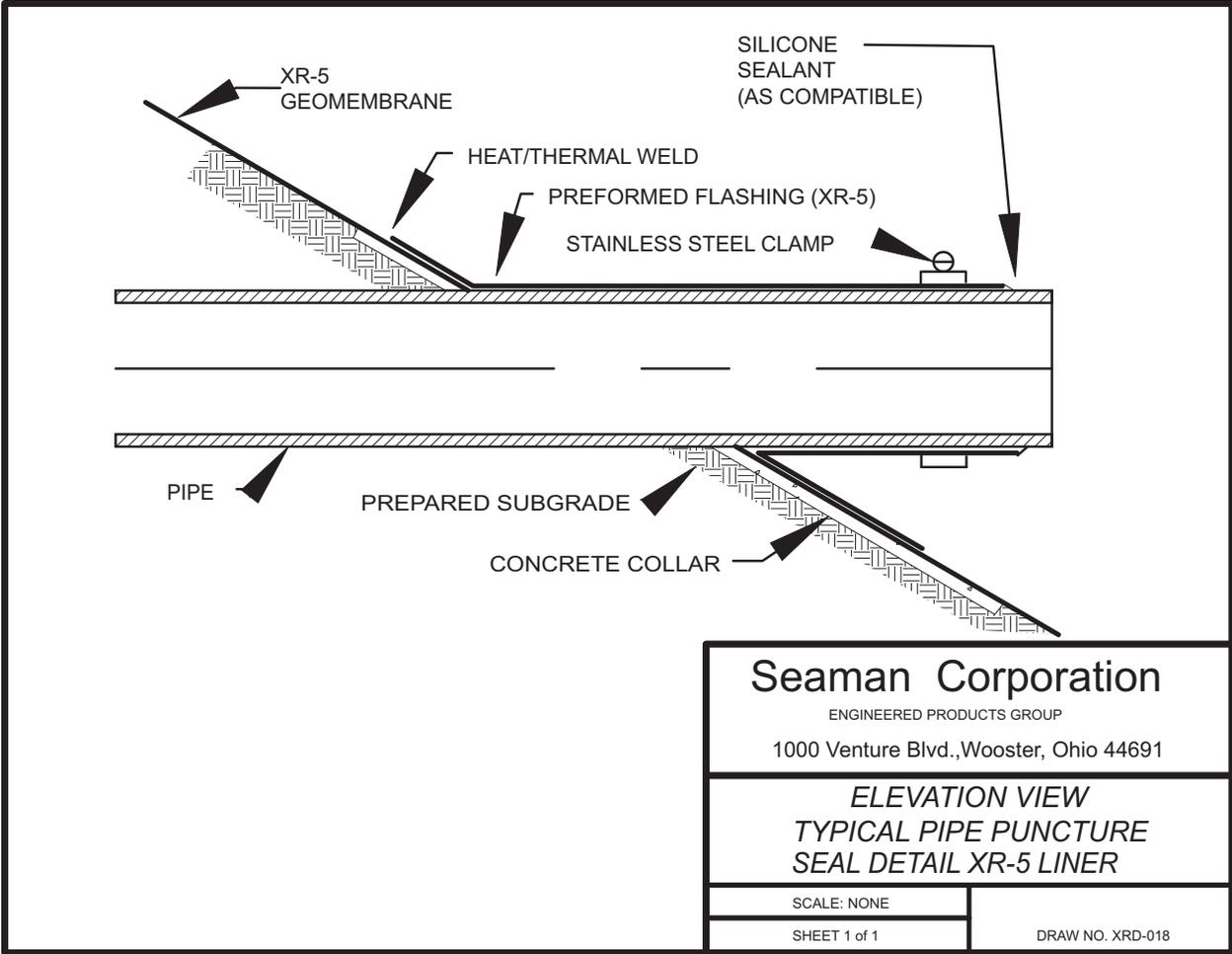
DRAW NO. XRD-019



<p>Seaman Corporation ENGINEERED PRODUCTS GROUP 1000 Venture Blvd., Wooster, Ohio 44691</p>	
<p><i>ELEVATION VIEW TYPICAL ANCHOR DETAILS XR-5 LINER</i></p>	
<p>SCALE: NONE</p>	<p>DRAW NO. XRD-001</p>
<p>SHEET 1 of 1</p>	



<p>Seaman Corporation ENGINEERED PRODUCTS GROUP 1000 Venture Blvd., Wooster, Ohio 44691</p>	
<p><i>ANCHORING DETAIL XR-5 LINER TO FIXED WALL</i></p>	
<p>SCALE: NONE</p>	
<p>SHEET 1 of 1</p>	<p>DRAW NO. XRD-023</p>



Section 6 - Warranty Information

Warranty

XR-5® is offered with Seaman Corporation standard warranty which addresses weathering and chemical compatibility for a 10-year period. A test immersion is required with subsequent testing and approval by Seaman Corporation.

Instructions for XR-5 Test Immersions and Warranty Requests

1. Completely immerse six Style 8130 XR-5 samples (8-1/2" x 11" size) in the liquid to be contained.
2. At the end of approximately thirty days, retrieve three of the samples. The samples should be rinsed with fresh water and dried.
3. Send the three samples to:
Attn: Geomembrane Department
Seaman Corporation
1000 Venture Blvd.
Wooster, OH 44691
4. Keep the other three samples immersed until further notice in case longer immersion data is required.
5. Complete and return the information form on the liner application.

8228 XR-3® and all PW Geomembranes are offered with a standard 10-year warranty for weathering. The attached information form should be completed.

XR[®] Membrane Application and Utilization Form

Installation Owner and Address:

Physical Location of Installation:

Expected Date of Installation: _____

Expected Beginning Date of Service: _____

Description of Application:

(Example: impoundment used to contain brine on an emergency basis.)

Physical Features of Application:

(Example: 1.3 million gallon earthen impoundment with overall top dimensions of 160' x 160' with 3:1 slopes and 10' deep.)

Description of Liquid:

(Describe content of liquid including pollutants and expected temperature extremes in basin and at application point. Attach analysis of liquid chemistry, composition taken on a representative basis.)

Operational Characteristics:

(Describe the operation of the facility such as filling schedules, fluctuating liquid levels, operating temperatures, etc.)

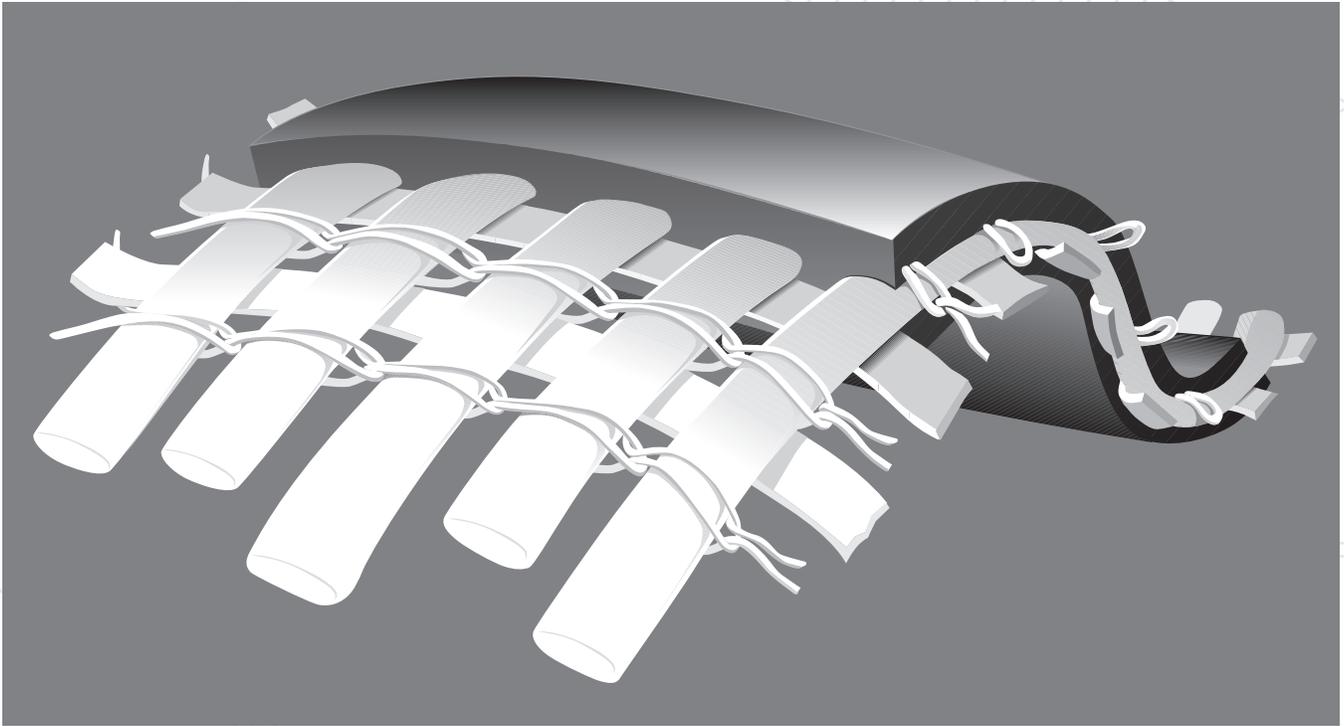
Performance Requirements, Etc:

(State any other requirements, such as rate of permeability required.)

Owner represents the information herein is complete and accurate, and understands and agrees that issuance of Seaman Corporation Warranty for XR products are conditioned upon such completeness and accuracy.

OWNER'S SIGNATURE

Reference Materials:



XR-5®: High Performance Composite Geomembrane



Seaman Corporation

1000 Venture Blvd.
Wooster, Ohio 44691
(330) 262-1111
www.xr-5.com

**APPLICATION FOR PERMIT
OWL LANDFILL SERVICES, LLC**

**VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN**

**ATTACHMENT III.1.I
SMOOTH HDPE GEOMEMBRANE**

SMOOTH HDPE GEOMEMBRANE

ENGLISH UNITS

Minimum Average Values

Property	Test Method	30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mils	ASTM D 5199					
minimum average		30	40	60	80	100
lowest individual reading		27	36	54	72	90
Sheet Density, g/cc	ASTM D 1505/D 792	0.940	0.940	0.940	0.940	0.940
Tensile Properties¹	ASTM D 6693					
1. Yield Strength, lb/in		63	84	126	168	210
2. Break Strength, lb/in		114	152	228	304	380
3. Yield Elongation, %		12	12	12	12	12
4. Break Elongation, %		700	700	700	700	700
Tear Resistance, lb	ASTM D 1004	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	54	72	108	144	180
Stress Crack Resistance ² , hrs	ASTM D 5397 (App.)	300	300	300	300	300
Carbon Black Content ³ , %	ASTM D 1603	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596			--Note 4--		
Oxidative Induction Time (OIT)						
Standard OIT, minutes	ASTM D 3895	100	100	100	100	100
Oven Aging at 85°C	ASTM D 5721					
High Pressure OIT - % retained after 90 days	ASTM D 5885	60	60	60	60	60
UV Resistance ⁵	GRI GM11					
High Pressure OIT ⁶ - % retained after 1600 hrs	ASTM D 5885	50	50	50	50	50
Seam Properties	ASTM D 6392 (@ 2 in/min)					
1. Shear Strength, lb/in		57	80	120	160	200
2. Peel Strength, lb/in - Hot Wedge		45	60	91	121	151
- Extrusion Fillet		39	52	78	104	130
Roll Dimensions						
1. Width (feet):		23	23	23	23	23
2. Length (feet)		1000	750	500	375	300
3. Area (square feet):		23,000	17,250	11,500	8,625	6,900
4. Gross weight (pounds, approx.)		3,470	3,470	3,470	3,470	3,470

1 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

Yield elongation is calculated using a gauge length of 1.3 inches; Break elongation is calculated using a gauge length of 2.0 inches.

2 The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.

3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.

4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.

5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice. REV. 11/06