January 10, 2025

Oregon Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, OR. 97232

Attention: Kevin Dana

Amended Basis of Design and Engineering Approach
Proposed Mixed Occupancy Building
8500 NE Siskiyou Street
Portland, Oregon
Project: DharmaRain-1-12

INTRODUCTION

NV5 is pleased to submit this amended Basis of Design and Engineering Approach for the proposed mixed occupancy building located at 8500 NE Siskiyou Street in Portland, Oregon (subject property). The subject property and surrounding area are shown on Figure 1. GeoDesign, Inc. (now NV5) previously prepared the Basis of Design and Engineering Approach dated August 20, 2012 that was included as Exhibit C in the Prospective Purchasers Agreement (PPA) between the Dharma Rain Zen Center and the Oregon Department of Environmental Quality (DEQ). This amended Basis of Design and Engineering Approach provides landfill gas (LFG) mitigation design information for the proposed mixed occupancy building. The proposed building will be a two-story structure with a stem-wall foundation and wooden floor system. Details of the LFG mitigation system to help prevent the accumulation of LFG below the structure are provided below.

BACKGROUND

The subject property is an approximately 14-acre parcel of land located on the eastern half of the approximately 26-acre former H.G. LaVelle Landfill. The H.G. Lavelle Landfill is a former quarry pit that was operated by Rose City Sand and Gravel Company. Rose City Sand and Gravel developed the site as a sand and gravel mining operation and mined the pit to depths of up to 80 feet below ground surface. The quarry pit was subsequently operated as a demolition landfill by LaVelle and Yett, Inc. beginning in 1972. The H.G. LaVelle Landfill was permitted to receive building and demolition debris, wood products, metals, heavy industrial debris, and similar materials.

Approximately 2 million cubic yards of solid waste fill was deposited into the landfill between 1972 and the landfill's closure in 1982. Following closure, the landfill was capped with a soil cover. An active LFG recovery system is in place and operational. The system includes a network of extraction wells connected to a header pipe running along the perimeter of the subject property. In addition, passive vents and numerous gas monitoring wells exist at various locations around the perimeter of the landfill. The extraction blower and enclosure structure are located to the west of the subject property.

Under the PPA, redevelopment at the subject property began in approximately 2013 consisting of multiple phases of site improvements and construction of subject property structures. Documentation of site improvements and construction was provided in the following reports:

- *Completion Progress Report* prepared by GeoDesign, Inc. dated December 15, 2016. GeoDesign Project No.: DharmaRain-1-08.
- *Updated Completion Progress Report* prepared by GeoDesign, Inc., dated October 9, 2018. GeoDesign Project No.: DharmaRain-1-09.

These reports are on file with DEQ for reference.

BASIS OF DESIGN

Based on our understanding of the site history and requirements of the PPA, engineering controls consisting of LFG mitigation will be incorporated into the proposed mixed occupancy building. The primary objectives for the basis of design are to:

- mitigate potential for methane to accumulate in a confined space or structure at concentrations exceeding 25 percent by volume of the lower explosive limit (i.e., 1.25 percent by volume [pbv]).
- ensure that the proposed improvements do not exacerbate existing conditions on the subject property; for example, resulting in or increasing off-site methane migration through utility corridors or by accumulation beneath paved areas on the subject property.
- ensure that if the proposed site improvements or access improvements result in disturbance to the current methane monitoring and/or extraction system, the disturbances are minimal and temporary.

LFG MITIGATION DESIGN ELEMENTS

To mitigate methane accumulation under the proposed mixed occupancy building, a low-permeable membrane and passive sub-slab venting system has been incorporated into the overall building design. The low-permeable membrane will consist of a 60-mil, high density polyethylene (HDPE) geomembrane placed across the entire building footprint. The HDPE geomembrane will be placed below the wooden floor system, which will consist of standard flooring, underlain with two layers of ¾-inch thick plywood and expanded polystyrene (EPS) insulation foam board. The HDPE geomembrane will be placed below the EPS foam board and attached to foundation elements with a batten strip system. Utility penetrations through the low-permeable membrane will be fitted with boots to help seal around the penetrations. The HDPE geomembrane will be installed in accordance with the manufacturer's instructions and inspected by qualified personnel. A representative technical data sheet and installation quality assurance manual for a 60-mil HDPE geomembrane manufactured by

Solmax is attached. The Solmax product was previously installed under the workshop building at the subject property. The same product has also been used extensive at Bridgeport Village Shopping Center in Tualatin, Oregon. The passive sub-slab venting system will consist of 4-inch diameter perforated piping connected to two 2-inch-diameter, vertical vent risers. The perforated pipe will be placed in a layer of gravel that will be a minimum of 8-inches thick. Based on our experience on this project and similar projects in Oregon, the LFG mitigation design is based on the Los Angeles Department of Building and Safety Methane Mitigation Standard Plan and has been accepted by DEQ for LFG mitigation in Oregon. The extent of the low-permeable membrane and sub-slab vent piping are shown on Figure 2. Details of the design are presented on Figure 3.

CONCLUSION

This amended Basis of Design and Engineering provides the LFG mitigation design elements for the proposed mixed occupancy building planned for the subject property. The LFG mitigation design uses proven construction practices and mitigation measures to help prevent the accumulation of methane under the structure and in confined spaces at concentrations greater than 1.25 pbv. On behalf of Dharma Rain Zen Center, NV5 respectfully requests DEQ's written concurrence that the design is acceptable and protective of human health and the environment.

♦ ♦ ♦

We appreciate DEQ's continued support on this project. Please call if you have questions concerning the information provided.

Sincerely,

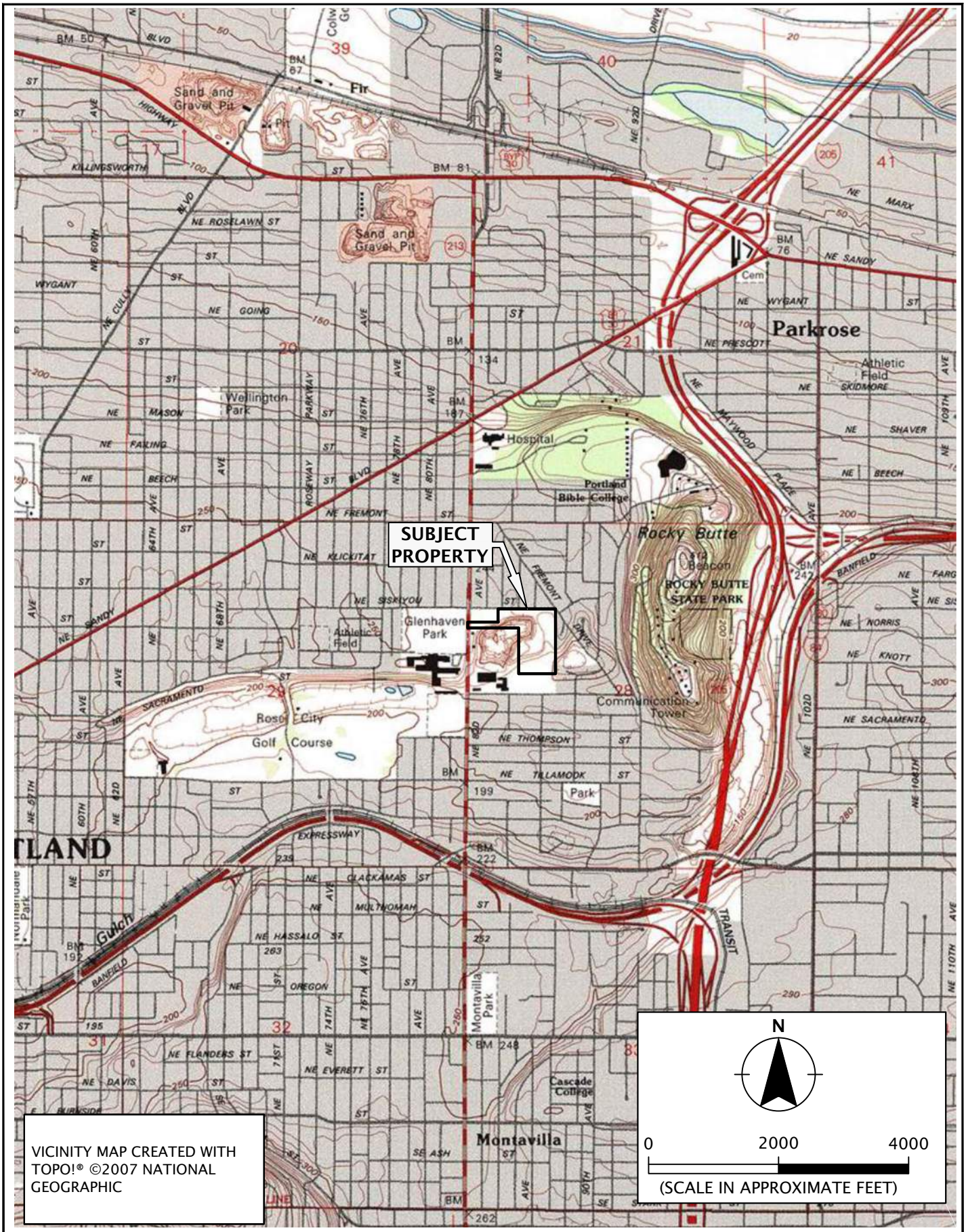
NV5

Mike F. Coenen, P.E.
Principal Engineer

cc: Kakumyo Lowe-Charde, Dharma Rain Zen Center
Sarah Greenfield, DEQ
Ryan Lewis, DEQ

MFC:mfc
Attachments
One copy submitted
Document ID: DharmaRain-1-12-011025-envl.docx

FIGURES



VICINITY MAP CREATED WITH TOPO!® ©2007 NATIONAL GEOGRAPHIC

NIV5	DHARMARAIN-1-12	**VICINITY MAP**	
	JANUARY 2025	PROPOSED MIXED OCCUPANCY BUILDING PORTLAND, OR	**FIGURE 1**

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File Name: J:\A-D\DharmaRain\DharmaRain-1\DharmaRain-1-12\Figures\CAD\DharmaRain-1-12-VM01.dwg | Layout: FIGURE 1

LOW PERMEABLE MEMBRANE AND SUB-SLAB VENT PIPE LAYOUT

FIGURE 2

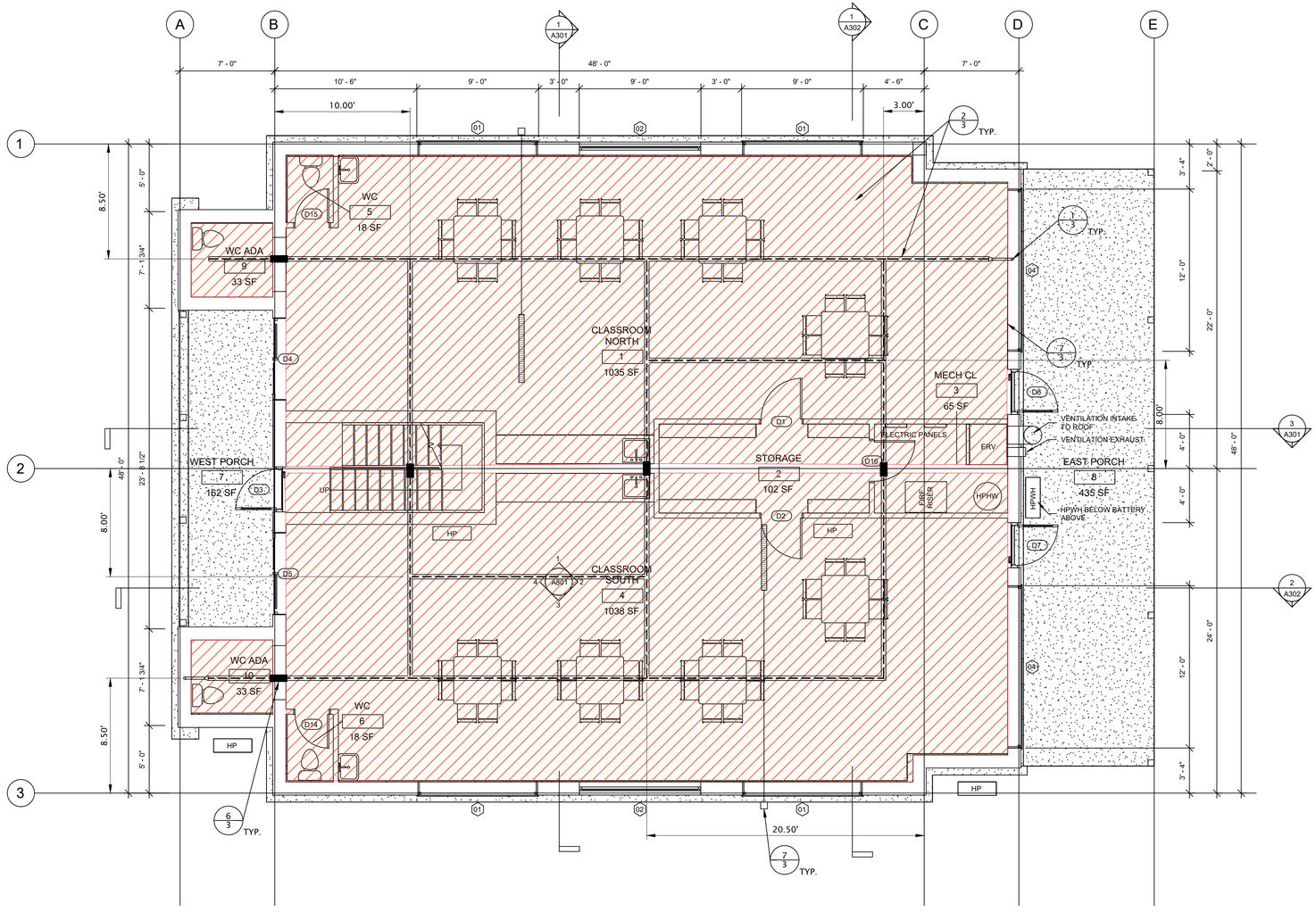
PROPOSED MIXED OCCUPANCY BUILDING
PORTLAND, OR

DHARMARAIN-1-12

JANUARY 2025

LEGEND:

- SUB-SLAB VENT PIPE
- VENT RISER
- SUB-SLAB MONITORING PROBE
- EXTENT OF LOW-PERMEABLE GEOMEMBRANE AND GRAVEL BLANKET



NOTES:

1. SUB-SLAB VENT PIPE SHALL BE PLACED SUCH THAT NO PORTION OF THE BUILDING IS MORE THAN 12.5 FEET FROM A VENTILATION PIPE BASED ON A 2-INCH- DIAMETER VENT RISER.
2. THE TOTAL PIPE PERFORATION AREA SHALL BE AT LEAST EQUAL TO OR GREATER THAN 5 PERCENT OF THE PIPE SURFACE AREA.
3. NON-DESTRUCTIVE TESTING SHALL BE CONDUCTED ON THE INSTALLED LOW-PERMEABLE MEMBRANE TO CONFIRM THE SEAMS, EDGES, AND PENETRATIONS ARE PROPERLY SEALED. NON-DESTRUCTIVE TESTING SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. SMOKE TESTING IS AN ACCEPTABLE SUBSTITUTION IF THE MANUFACTURER'S RECOMMENDED NON-DESTRUCTIVE TEST METHODS ARE NOT APPLICABLE.

N

0 5 10
(SCALE IN FEET)

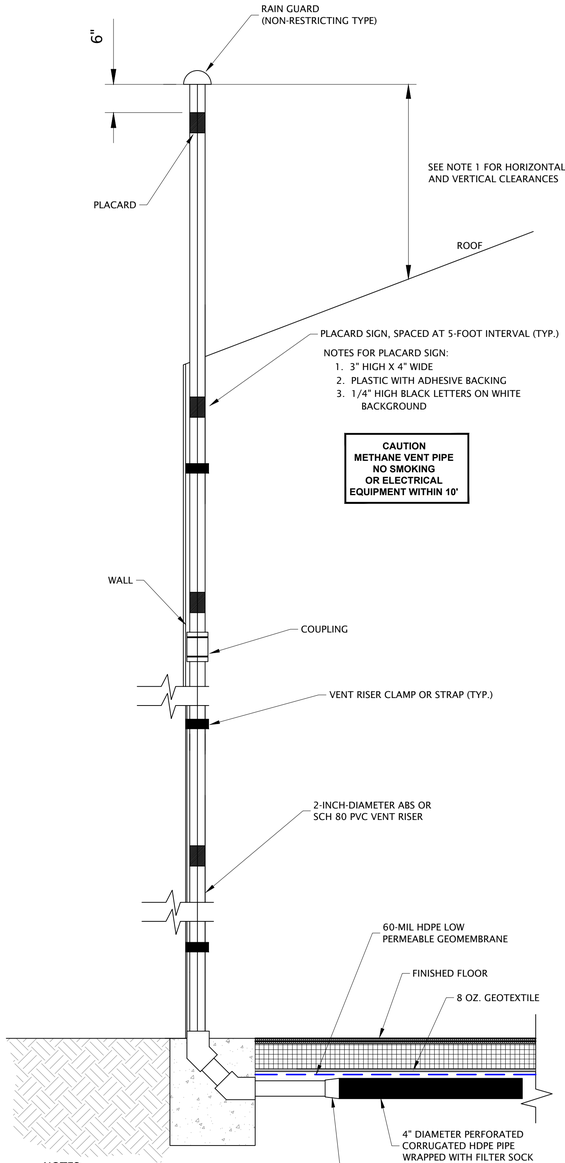
NOTE:

1. SITE PLAN BASED ON IMAGE OF SHEET A110, FLOOR 1 PLAN, DATED 5/8/2024, PREPARED BY CULTIVATE.

NO.	DATE	REVISION DESCRIPTION	BY	APPR.

DESIGNED BY:
DRAWN BY:
GDI ENG
GDI CAD
CHECKED BY:
APPROVED BY:

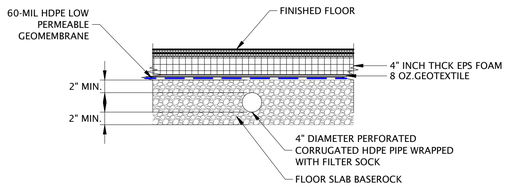
NV15



NOTES:

1. TERMINATION OF VENT RISER SHALL BE:
   - A. 10' MINIMUM ABOVE GRADE;
   - B. 10' MINIMUM AWAY FROM ANY WINDOW, DOOR, DOOR HATCH, OPENING, OR AIR INTAKE INTO THE BUILDING;
   - C. 3' MINIMUM ABOVE HIGHEST POINT OF ROOF WITHIN A 10' RADIUS OF OUTLET;
   - D. 4' MINIMUM AWAY FROM PROPERTY LINE; AND
   - E. 5' MINIMUM AWAY FROM ELECTRICAL DEVICES.
   - F. 3' AWAY FROM ANY PARAPET.
2. WRAP AND PROTECT ALL PIPING THROUGH CONCRETE SLAB OR FLOOR.
3. SUPPORT ALL PIPING ACCORDING TO APPLICABLE CODES.
4. CONTRACTOR SHALL VERIFY EXACT TYPE OF CONSTRUCTION AT EACH VENT RISER CALLED OUT ON THE PLANS. RISER MUST AVOID WINDOWS AND MUST NOT BE INSTALLED WHERE STRUCTURAL MEMBERS PROHIBIT.

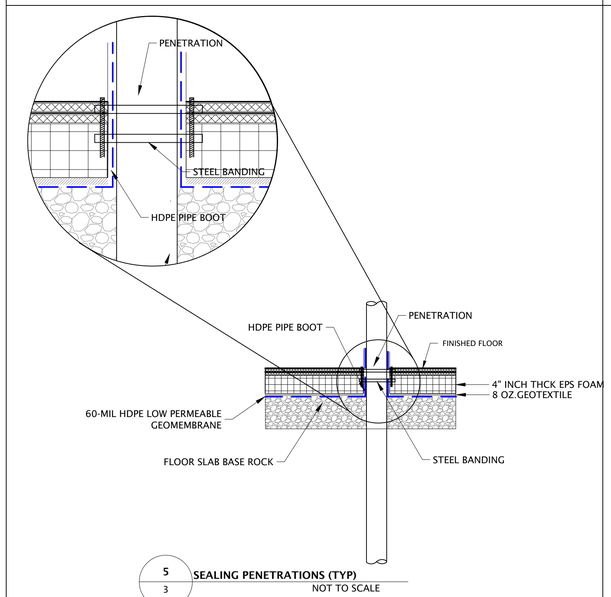
1/3 TYPICAL VERTICAL VENT RISER
NOT TO SCALE



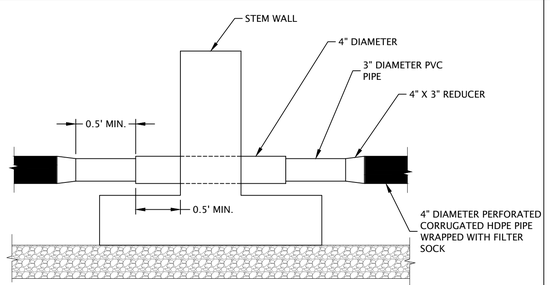
NOTE:

1. 60-MIL HDPE LINER SHALL COMPLETELY COVER FLOOR SLAB BASE ROCK WITHIN BUILDING FOOTPRINT. ATTACH TO FOOTINGS ACCORDING TO MANUFACTURER'S SPECIFICATIONS.
2. SEAM OVERLAP SHALL BE A MINIMUM OF 6 INCHES IN GENERAL ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.

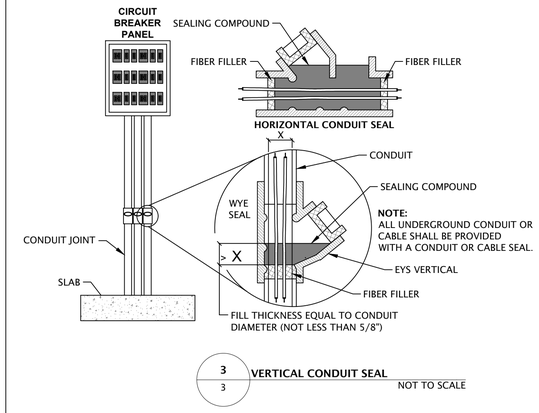
2/3 60-MIL HDPE LINER AND VENT PIPE DETAIL (TYPICAL)
NOT TO SCALE



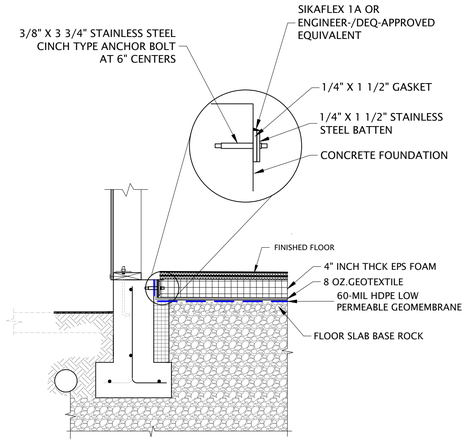
5/3 SEALING PENETRATIONS (TYP)
NOT TO SCALE



6/3 STEM WALL PENETRATION
NOT TO SCALE



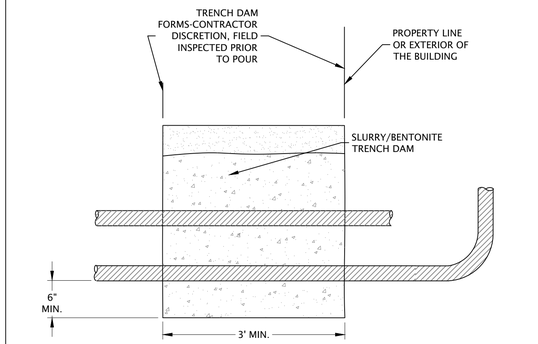
3/3 VERTICAL CONDUIT SEAL
NOT TO SCALE



NOTE:

1. BATTEN STRIP SHALL BE PLACED CONTINUOUSLY AT ALL LOCATIONS WHERE LOW-PERMEABLE MEMBRANE IS ATTACHED TO CONCRETE FOUNDATION ELEMENTS.

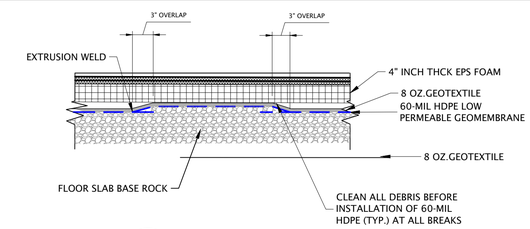
7/3 TYPICAL CONCRETE FOUNDATION
NOT TO SCALE



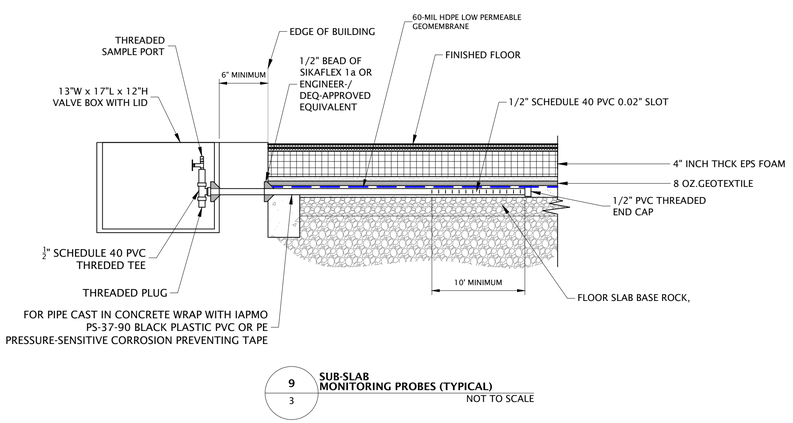
NOTES:

1. TRENCH DAMS SHALL BE INSTALLED IN THE TRENCH IMMEDIATELY ADJACENT TO THE EXTERIOR PERIMETER OF THE BUILDING FOUNDATION.
2. TRENCH DAMS SHALL BE INSTALLED IN ALL ELECTRICAL, GAS, PLUMBING, OR OTHER TRENCHES BENEATH THE BUILDING FOUNDATION.
3. TRENCH DAMS SHALL BE INSTALLED IN TRENCHES CONTAINING PIPE AND CONDUIT THAT CONNECT FROM THE UTILITY LINES IN THE STREET. LOCATE TRENCH DAM WHERE TRENCHES CROSS THE PROPERTY LINE
4. THE WIDTH OF TRENCH DAM SHALL BE ONE-HALF THE LENGTH. THE LENGTH SHALL BE A MINIMUM OF 3 FEET LONG.
5. TRENCH DAMS SHALL BE CONSTRUCTED OF ONE OF THE FOLLOWING:
   - A. BENTONITE-CEMENT SLURRY - A MIXTURE OF 4% TYPE II CEMENT AND 2% POWDERED BENTONITE.
   - B. COMPACT NATIVE SOIL BACKFILL - NATIVE SOIL SHALL BE COMPACTED TO AT LEAST 90% RELATIVE COMPACTION IN ACCORDANCE WITH ASTM D 1557 TESTING PROCEDURES.
   - C. CONCRETE MIXES OTHER THAN BENTONITE-CEMENT SLURRY MAY BE USED PROVIDED CONDUIT OR PIPING IS WRAPPED WITH HIGH DENSITY PVC FOAM TAPE, CLOSED CELLS, ADHESIVE BACKED, 1/4" THICK BY 1/2" WIDE, SHALL BE APPLIED TO CLEAR SURFACE WITH ENDS BUTTED TOGETHER AT MOST VISIBLE LOCATIONS IN TRENCH DAM.
6. PIPING AND CONDUIT SHALL BE PROTECTED FROM CORROSION AND STRUCTURAL SETTLEMENT AS FOLLOWS;
   - A. TAPE SHALL BE APPLIED ON CONDUIT AND PIPING ENCASED IN CEMENT SLURRY OR CONCRETE.
   - B. TAPE SHALL BE PS-37-90, BLACK PLASTIC PVC OR PE PRESSURE-SENSITIVE CORROSION PREVENTION TAPE.

4/3 UTILITY TRENCH DAM DETAIL
NOT TO SCALE



8/3 TYPICAL PATCH DETAIL
NOT TO SCALE



9/3 SUB-SLAB MONITORING PROBES (TYPICAL)
NOT TO SCALE

DETAILS

FIGURE 3

PROPOSED MIXED OCCUPANCY BUILDING
PORTLAND, OR

DHARMARAIN-1-12

JANUARY 2025

NO.	DATE	REVISION DESCRIPTION	BY	APPR.

DESIGNED BY:
DRAWN BY: GDI CAD
GDI ENG
CHECKED BY:
APPROVED BY:

NIV5

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File Name: J:\A-D\DharmaRain\DharmaRain-1\DharmaRain-1-12\Figures\CAD\DharmaRain-1-12-det01.dwg | Layout: FIGURE 3

ATTACHMENT

TECHNICAL DATA SHEET

HDPE 60 mils / 1.50 mm White Reflective Smooth

PROPERTY(1)	TEST METHOD	FREQUENCY	UNIT Imperial	1101444
SPECIFICATIONS				
Thickness (min. avg.)	ASTM D5199	Every roll	mils	60.0
Thickness (min.)	ASTM D5199	Every roll	mils	54.0
Resin Density	ASTM D1505	One per batch	g/cc	> 0.932
Melt Index - 190°C/2.16 kg (max.)	ASTM D1238	One per batch	g/10 min	1.0
Density	ASTM D792	Every 10 rolls	g/cm³	≥ 0.940
Carbon Black Content	ASTM D4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D5596	Every 10 rolls	Category	Cat. 1 & Cat. 2
OIT - Standard (min. avg.)	ASTM D8117	One per batch	min	100
Tensile Properties (min. avg) (2)	ASTM D6693	Every 2 rolls		
Strength at Yield			lbs/in	132
Elongation at Yield			%	13
Strength at Break			ppi	243
Elongation at Break			%	700
Tear Resistance (min. avg.)	ASTM D1004	Every 5 rolls	lbf	42
Puncture Resistance (min. avg.)	ASTM D4833	Every 5 rolls	lbf	109
Dimensional Stability	ASTM D1204	Certified	%	± 2
Stress Crack Resistance (SP-NCTL)	ASTM D5397	One per batch	hr	500
Oven Aging - % retained after 90 days	ASTM D5721	Per formulation (5)		
HP-OIT (min. avg.)	ASTM D5885		%	80
UV Resistance - % retained after 1,600 hr	ASTM D7238	Per formulation (5)		
HP-OIT (min. avg.)	ASTM D5885		%	50
Low Temperature Brittleness	ASTM D746	Certified	°F	- 106
SUPPLY SPECIFICATIONS(Roll dimensions may vary ±1%)				
Roll Dimension - Width	-		ft	22.5
Roll Dimension - Length	-		ft	560
Area (Surface/Roll)	-		ft²	12600
Color (one side) (4)	-			White

NOTES

1. Testing frequency based on standard roll dimensions and one batch is approximately 180,000 lbs (or one railcar).
2. Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
4. Smooth edge may not have the same consistent shade of color as the membrane itself. The colored layer may cause the carbon black content results to be higher than 3%.
5. Certified by core (black) formulation on geomembrane roll or molded plaque.

* All values are nominal test results, except when specified as minimum or maximum.
* The information contained herein is provided for reference purposes only and is not intended as a warranty or guarantee. Final determination of suitability for use contemplated is the sole responsibility of the user. SOLMAX assumes no liability in connection with the use of this information.

Solmax is not a design professional and has not performed any design services to determine if Solmax's goods comply with any project plans or specifications, or with the application or use of Solmax's goods to any particular system, project, purpose, installation or specification.

SOLMAX.COM

Revision date 21-Jan-2022

SOLMAX

GEOMEMBRANE PRODUCTS

INSTALLATION QUALITY ASSURANCE MANUAL

AMERICAS

TABLE OF CONTENTS

1.0 INTRODUCTION

This manual provides an overview of the SOLMAX Installation Quality Assurance procedures consistent with industry accepted practices to ensure that the SOLMAX's geomembrane products installed will best perform for its intended purpose. All installation work will be performed in strict accordance per the customer's specifications.

2.0 MATERIAL DELIVERY

A. Upon arrival on site, QA personnel will take stock of all materials on-site.
B. Roll numbers will be logged on the Inventory Check List and cross-referenced with the Bill of Lading.
Copies of the Inventory Check List and signed Bill of Lading should be sent to SOLMAX corporate headquarters while the on-site QA personnel retains the original copies.
Any visible damage to roll materials should be noted on the roll and Inventory Check List.

3.0 UNLOADING & STORAGE PROCEDURES

A. Rolls of material shall be unloaded with equipment that will not damage the geomembrane.
B. Fabric-straps, spreader bars, stinger bars, or other approved equipment shall be used for handling rolls of geomembrane.
C. Materials should be stored in a flat, dry and well drained area.
D. The surface shall be free of sharp rocks or other objects that could damage the materials.

4.0 SUBGRADE PREPARATION

A. The general contractor is responsible for preparing and maintaining the subgrade. The subgrade should be prepared and maintained per the job specifications.
B. The site manager shall be responsible for assuring that the subgrade surface has been properly prepared for deployment of geosynthetics. After each day's deployment the Subgrade Surface Acceptance form will be signed by all parties.

5.0 PANEL PLACEMENT

A. Each panel will be assigned a number as described below.
    2. When there is one layer, panels may be designated with only a number, e.g., 1, 2, 3, 4 etc.
    3. When two or more layers are required, use a letter and number, i.e.
        a. Primary Liner P1, P2, P3, P4 etc.
        b. Secondary Liner S1, S2, S3, S4 etc.
        c. Tertiary Liner T1, T2, T3, T4 etc.
B. This numbering system should be used whenever possible. Agreement to a panel numbering system should be made at the pre-construction meeting. However, it is essential that the installer, the owner representative and third party QA inspector agree.
C. Panel numbers shall be written in large block letters in the center of each deployed panel. The roll number, date of deployment and length (gross) should be noted below the panel number. All notes should be made, so that they are easily visible from a distance. On long panels it is beneficial to write information on both ends.
D. Panel numbers shall be logged on the Panel Placement Log along with the roll number and other information neccessary to complete the form.
E. If there is a partial roll left after deployment, it is important to write the last four digits of the roll number in several locations on the roll along with the estimated length for future identification.

F. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:
    1. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage. Solmax Leak Location should be installed with Conductive layer facing down.
    2. Place temporary ballast, such as sandbags, on geomembrane that will not damage the geomembrane and to prevent wind uplift.
    3. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking is not permitted on the geomembrane.
    4. Do not allow heavy vehicular traffic directly on geomembrane. Rubber tired and tracked ATV's and equipment are acceptable if contact pressure is less than 8 psi.
        a. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.
        b. Prior to driving on any geomembrane layer, please check for sharp edges, embedded rocks, or other foreign objects that may protrude in the tires and tracks.
        c. Path driven on geomembranes shall be as straight as possible with no sharp turns, sudden stops or quick starts.
        d. Areas where driving occurs shall be continuously and thoroughly inspected throughout the deployment process by the contractor and the third party CQA.

G. In the past, it has been a common practice to turn to leak surveys once the project has been constructed and the barrier system performance has been found unsatisfactory. A current state-of-the-practice geosynthetic installation would plan ahead for both post-installation/exposed, pre-cover soil placement survey (commonly done utilizing ASTM D 7240 or ASTM D 7002) AND a post soil cover survey (commonly done utilizing ASTM D 7007). Proper execution of these surveys and protocols are best applied before installation. State-of-the-art welding techniques, proper isolation of sections for testing, and other details can be simply and inexpensively addressed during installation, but may be expensive and complicated to recreate if a leak is discovered after the facility has been placed into service.

6.0 TRIAL WELDS

A. Seaming apparatus shall be allowed to warm up a minimum of 10 minutes before performing trial welds.

B. Each seaming apparatus along with a welding technician will pass a trial weld prior to use. Trial welds to be performed in the morning and afternoon, as a minimum, as well as whenever there is a power shutdown.

C. Fusion or wedge welds will always be performed or conducted on samples at least 6.0 ft (1.8 m) long. Extrusion welds will be done on samples at least 3.0 ft (0.9 m) long. Note: Always perform trial welds in the same conditions that exist on the job. Run the trial welds on the ground, not the installed liner. Do not use a wind break unless you are using one on the job.

D. Operating temperatures should be monitored while welding. The welding technician should verify that the equipment is capable of maintaining temperature while welding.

E. Sampling Procedure
    1. Cut five 1.0 in (2.54 cm) wide specimens from the trial weld sample. Specimens will always be cut using a 1.0 in (2.54 cm) die cutter.
    2. The inside and outside tracks on the coupon should be identified to assist in troubleshooting problems in case the weld fails. The outside track will be defined as the track, which would be peeled if pulling the overlap exposed in a typical installation, or the seam that is closest to the edge of the top sheet. The inside track is the seam closest to the edge of the bottom sheet.

F. Cutter
   1. Only cut one specimen at a time to avoid damaging the die cutter.
   2. Samples should be free of sand and grit prior to cutting sample.
   3. Inspect the die edge weekly for nicks, dents or signs of dullness. Dullness of the cutting edge may damage the specimens.
   4. Remove die when edge has been dulled and lightly reshape it with a medium hand file. When wear is excessive return it for a replacement die.
   5. When the cutting board becomes deeply scored and/or interferes with coupon cutting it should be replaced.
   6. To adjust the depth of the die cut into the cutting board, after replacing the cutting board or sharpening the die, 0.015 in (0.03 cm) washer shims can be added or removed between the cutting ram and the ram extension. Only add shims when cutting is difficult due to lack of depth of cut.

G. Trial Weld Testing
   1. Allow specimens to cool prior to testing. Avoid separating the coupons while hot as failure of the sheet may be initiated and false readings indicated.
   2. In extreme heat the coupons may need to be cooled, using water or an insulated cooler prior to peel testing. Lab conditions specify 70°F (21°C) (plus or minus 4°). Coupon temperatures greater than 70°F/21°C degrees may result in lowered strengths.
   3. Visually inspect the coupons for squeeze-out, footprint, pressure and general appearance.
   4. Each of the five coupons will be tested in peel on the field tensiometer at a separation rate of 2 in per minute (for HDPE). Shear tests, in addition to the peel tests, will be performed.

H. Pass/Fail Criteria
   1. Criteria for passing trial welds will be as follows:
      a. Seam must exhibit film tear bond (FTB). Seam separation equal to or greater than 25% of the track width shall be considered a failing test.
      b. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 1 for HDPE smooth or textured sheet (@ 2 in/min) /(5.08 cm/min).
      c. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 2 for LLDPE smooth or textured sheet (@ 20 in/min) /(50.8 cm/min).
      d. Both tracks of fusion welded samples must pass for the trial weld to be considered acceptable. If any of the five coupons fail due to seam incursion (no FTB) or low strength values, the trial weld must be performed again.
      e. The QA personnel will give approval to proceed with welding after observing and recording all trial welds.
   2. All trial weld data will be logged on the Trial Weld Log.
   3. When logging fusion welded peel values on the Trial Weld Log (Appendix E) indicate the values for the outside track first, followed by the inside track.
   4. Speed and temperature settings will be recorded for each machine trial weld as appropriate.

7.0 GEOMEMBRANE FIELD SEAMING

A. The seam number takes the identity of the panels on each side. The seam between panels 1 & 2 becomes seam 1/2.
B. Welding technicians will record their initials, machine number, date and time at the start of every seam and on the Seam Log. The technician should also periodically mark temperatures along the seam and at the end of the seam.
C. Approved processes for field seaming and repairing are fusion welding and extrusion welding. All welding equipment shall have accurate temperature monitoring devices installed and working to ensure proper measurement.

D. Fusion welding shall be used for seaming panels together and is not used for patching or detail work. The site manager shall verify that:
   1. The equipment used is functioning properly.
   2. All work is performed on clean surfaces and done in a professional manner. No seaming will be performed in adverse weather conditions.

E. Extrusion welding shall be used primarily for repairs, patching and special detail fabricating and may be used for seaming. The site manager shall verify that:
   1. Equipment used is functioning properly.
   2. Welding personnel are purging the extrusion welders of heat degraded extrudate prior to actual use.
   3. All work is performed on clean surfaces and done in a professional manner. No seaming will be performed in adverse weather conditions.

F. For seam preparation, the welding technician shall verify that:
   1. Prior to seaming, the seaming area is free of moisture, dust, dirt, sand or debris of any nature.
   2. The seam is overlapped properly for fusion welding.
   3. The seam is overlapped or extended beyond damaged areas at least 4.0 in (10.16 cm) when extrusion welding.
   4. The seam is properly heat tacked and abraded prior to extrusion welding.
   5. Seams are welded with fewest number of unmatched wrinkles or ”fishmouths”.

G. No seaming will be performed in ambient air temperatures or adverse weather conditions that would jeopardize the integrity of the liner installation.

8.0 FIELD DESTRUCTIVE TESTING

The process and protocol of obtaining destructive samples may result in a geosynthetic system that is weaker and less effective. Destructive samples are necessary for verifying the effectiveness of the welding process.

Everything that can be done to remove destructive sample locations from within the geosynthetic system should be done i.e. taking samples from runouts, anchor trenches, and practice pads. Within the body of the installation, sample locations should be removed from critical areas such as, the toe of sloped areas, near panel connections, adjacent to penetrations, etc. Ideally the destructive samples will be taken at as low a frequency as possible, within flat areas of the installation where the impact of a hole in the liner can be minimized.

A. Destructive seam tests shall be performed to evaluate bonded seam strength. The frequency of sample removal shall be according to the site specifications. Location of the destructive samples will be selected and marked by the QA technician or third party QA inspector. Field testing should take place as soon as possible after seam is completed.

B. Samples should be labeled in numerical order, i.e. DS-1, DS-2 etc. This should carry through any layer and/or multiple ponds; do not start numbering from 1 again. The size of samples and distribution should be approximately 12 in x 39 in (30.48 cm x 99.06 cm) (Size may vary depending on job requirements) and distributed as follows:
   1. 12 in x 12 (30.48 cm x 30.48 cm) in piece given to QA technician for field testing.
   2. 12 in x 12 (30.48 cm x 30.48 cm) in piece sent to the Solmax’s corporate headquarters for testing, if required.
   3. 12 in x 12 (30.48 cm x 30.48 cm) in piece given to third party for independent testing or to archive. NOTE: All samples will be labeled showing test number, seam number, machine number, job number, date welded and welding tech number.

C. The sample given to the QA technician in the field shall have ten coupons cut and be tested with a tensiometer adjusted to a pull rate as shown below. The strength of four out of five specimens should meet or exceed the values below, and the fifth specimen must meet or exceed 80% of the value below.

1. Seam must exhibit film tear bond (FTB). Seam separation should be < 25% of the track width.
2. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 1 for HDPE smooth or textured sheet (@ 2 in/min) /(5.08 cm/min).
3. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 2 for LLDPE smooth or textured sheet (@ 20 in/min) (50.8 cm/min).

D. All weld destructive test data will be logged on the Destructive Test Log.
E. When logging fusion welded peel values on the Destructive Test Log, indicate the values for the outside track first, followed by the inside track.
F. Test results will be noted in the Destructive Test Log as Pass (P) or Fail (F).
G. If a test fails, additional samples will be cut, approximately 10 ft on each side of the failed test, and retested. These will be labeled A (After) & B (Before). This procedure will repeat itself until a sample passes. Then the area of failed seam between the two tests that pass will be capped or reconstructed.

9.0 NON-DESTRUCTIVE TESTING

A. All seams shall be non-destructively tested over their full length using an air pressure, vacuum box or spark test device.
B. For air pressure testing, the following procedures are applicable to those seams welded with a double seam fusion welder.
    1. The equipment used shall consist of an air tank or pump capable of producing a minimum 30 psi and a sharp needle with a pressure gauge attached to insert into the air chamber.
    2. Seal both ends of the seam by heating and squeezing them together. Insert the needle with the gauge into the air channel. Pressurize the air channel to 30 psi.
    Note time test starts and wait a minimum of 5 minutes to check. If pressure after five minutes has dropped less than 4 psi then the test is successful (Thickness of material may cause variance).
    3. Cut opposite seam end and listen for pressure release to verify full seam has been tested.
    4. If the test fails, follow these procedures.
        a. While channel is under pressure, walk the length of the seam listening for a leak.
        b. While channel is under pressure, apply a soapy solution to the seam edge and look for bubbles formed by air escaping.
        c. Re-test the seam in smaller increments until the leak is found.
    5. Once the leak is found using one of the procedures above, cut out the area and retest the portions of the seams between the leak areas per 4a to 4b above. Continue this procedure until all sections of the seam pass the pressure test.
    6. Repair the leak with a patch.
C. For vacuum testing, the following procedures are applicable to those seams welded with an extrusion welder.
    1. The equipment used shall consist of a vacuum pumping device, a vacuum box and a foaming agent in solution.
    2. Wet a section with the foaming agent, place vacuum box over wetted area. Evacuate air from the vacuum box to a pressure suitable to affect a seal between the box and geomembrane. Observe the seam through the viewing window for the presence of soap bubbles emitting from the seam.
    3. If no bubbles are observed, move box to the next area for testing. If bubbles are observed, mark the area of the leak for repair and re-test. Note: If vacuum testing fusion welded seams, the overlap flap must be cut off to perform the tests
    4. All non-destructive tests will be noted in the Non-Destructive Logs.
D. At locations where seams cannot be nondestructively tested using the the previously described methods, such as pipe penetrations, alternate nondestructive spark testing or equivalent should be substituted.

10.0 DEFECTS AND REPAIRS

A. All seams and non-seam areas of the geomembrane lining system shall be examined for defects.
B. Identification of the defect should be made using the following procedures:
    1. For any defect in the seam or sheet that is an actual breach (hole) in the liner, installation personnel shall circle the defect and mark with the letter P along side the circle. The letter P indicates a patch is required.
    2. For any defect that is not an actual hole, installation personnel shall circle the defect indicating that the repair method may be only an extruded bead and that a patch is not required.
    3. Each suspect area that has been identified shall be repaired and tested in the non-destructive method. After all work is completed, the site manager will conduct a final walk-through to confirm all repairs have been completed and debris removed. Only after this final evaluation by the site manager, the owner, and the agent shall any material be placed over the installed liner.

11.0 REPAIR PROCEDURES

A. A. Any portion of the geomembrane lining system exhibiting a defect that has been marked for repair may be repaired with any one or combination of the following procedures:
    1. Patching - used to repair holes, tears, undispersed raw materials in the sheet.
    2. Grind and Reweld - used to repair small sections of extrusion welded seams.
    3. Spot Welding - Used to repair small minor, localized flaws.
    4. Flap Welding - Used to extrusion weld the flap of a fusion weld in lieu of a full cap.
    5. Capping - Used to repair failed seams.
B. The following conditions shall apply to the above methods:
    1. Surfaces of the geomembrane which are to be repaired shall be prepared according to this section.
    2. All surfaces must be clean and dry at the time of the repair.
    3. All seaming equipment used in repairing procedures shall be qualified.
    4. All patches and caps shall extend at least 4 in beyond the edge of the defect, and all patches must have rounded corners.
    5. All cut out holes in liner must have rounded corners of 3.0 in (7.62 cm) minimum radius.
C. Patches should be labeled in numerical order, i.e. RP-1, RP-2, etc. This should carry through any layer and/or multiple ponds, and do not start with the number 1 again.

12.0 AS-BUILT DRAWINGS

The installer shall provide the following:

A. As-built drawings will be provided at the completion of the project.
B. As-built drawings will include geomembrane panels and panel numbers with the last four digits of the roll number.
C. Panel numbers and the full roll numbers will correspond with the Panel Placement Log.
D. All destructive testing and repair locations will be placed on the as-built drawings.

Inventory Check List

Project:_____Site Manager: _____ Date:

Project # _____QA Technician: _____ Page: _____ of ____

Material	Roll #	Used	Material	Roll #	Used	Material	Roll #	Used	Material	Roll #	Used

APPENDIX B: SUBGRADE SURFACE ACCEPTANCE

Date: _____

Project: _____ Site Manager: _____

Project #: _____

Location: _____ Partial: _____ Final: _____

This document only applies to the acceptability of surface conditions for installation of geosynthetic products. SOLMAX does not accept responsibility for compaction, elevation or moisture content, nor for the surface maintenance during deployment. Structural integrity of the subgrade and maintenance of these conditions are the responsibility of the owner or earthwork contractor.

_____

_____

_____

_____

_____

Geosynthetic Installer :

_____

_____

For Owner / Contractor:

_____

_____

Acceptance Number: _____ Area Accepted: _____s.f Total Area Accepted to date: _____ s.f.

APPENDIX C: PANEL PLACEMENT LOG

Project name: _____

Location: _____

Site Supervisor:_____

Job number: _____ QA Technician: _____

Type of materials: _____ Sheet thickness: _____

Panel Number	Roll Number	Deployment Date	Width (Feet/meters)	Length (Feet/meters)	Feet/meters	Feet/meters (Cumulative)	A/T 1	A/T 2

APPENDIX D: SEAM STRENGTH PROPERTIES

TABLE 1. HDPE SEAM STRENTH PROPERTIES

Material (Mil/mm)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40 mil/1 mm	80	60	52
60 mil/1.5 mm	120	91	78
80 mil/2 mm	160	121	104
100/2.5 mm	200	151	130

TABLE 2. LLDPE SEAM STRENTH PROPERTIES

Material (Mil/mm)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40 mil/1 mm	60	50	44
60 mil/1.5 mm	90	75	66
80 mil/2 mm	120	100	88
100/2.5 mm	150	125	114

APPENDIX E: TRIAL WELD LOG

Project Name: _____
Location: _____
Job Number: _____
Q.A.: _____

Site Supervisor: _____
Type of Material: _____
Sheet Thickness: _____

Fusion (ppi) Extrusion (ppi)
Min. Peel _____ Min. Peel_____
Min. Sheer _____ Min. Sheer_____

Trial No.	Date of Trial	Time of Trial	Technicians ID Number	Ambient Temp.	Welder Type	Wedge Mass	Speed Preheat	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppii	Pass Fail

APPENDIX F: SEAM LOG

Project Name: _____

Location: _____ Site Supervisor: _____

Job Number: _____ Type of Materials: _____

Q.A. Tech.: _____ Sheet Thickness: _____

Seam Number	Time of Weld	Date of Weld	Type of Weld	Length of Seam	Machine Number	Technician ID Number

APPENDIX G: DESTRUCTIVE TEST LOG

Project Name: _____ Site Supervisor: _____ Fusion (ppi) Extrusion (ppi)

Location: _____ Type of Material: _____ Min. Peel _____ Min. Peel_____

Job Number: _____ Sheet Thickness: _____ Min. Sheer _____ Min. Sheer_____

Q.A.:_____

Sample Number	Date Welded	Seam Number	Technicians ID Number	Machine Type & No.	Location	Testing Frequency	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Peel ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Shear ppi	Pass Fail

APPENDIX H: REPAIR LOG - VACUUM TEST

Project Name: _____

Location: _____ Site Supervisor: _____

Job Number: _____ Type of Materials: _____

Q.A. Tech.: _____ Sheet Thickness: _____

Repair Number	Weld Date	Machine Number	Tech ID	Location	Test Date	Tech ID	Pass/Fail

APPENDIX I: NON-DESTRUCTIVE LOG - AIR TEST

Project Name: _____

Location: _____ Site Supervisor: _____

Job Number: _____ Type of Materials: _____

Q.A. Tech.: _____ Sheet Thickness: _____

Seam Number	Test Date	Technician ID Number	Air Pressure Test psi start	Air Pressure Test psi finish	Test Result (P or F)	Location

APPENDIX J: NON-DESTRUCTIVE LOG - AIR TEST / LEAK LOCATION SEAM ISOLATION TEST

Project Name: _____

Location: _____ Site Supervisor: _____

Job Number: _____ Type of Materials: _____

Q.A. Tech.: _____ Sheet Thickness: _____

Seam Number	Test Date	Technician ID Number	Air Pressure Test psi start	psi finish	Test Result (P or F)	Seam Isolation Test (M ohms) S1	S2	Test Result (P or F)

APPENDIX K: LINER INTEGRITY SURVEY LOG

Project Name: _____

Location: _____ Site Supervisor: _____

Job Number: _____ Type of Materials: _____

Q.A. Tech.: _____ Sheet Thickness: _____

ASTM Liner Integrity Protocol Used: _____

Panel Number	Date of Test	Time of Test	Technician ID Number	Spark Tester ID	Pass/Fail	Location of Repairs

OUR LOCATIONS

HEADQUARTER
VARENNES, QC | CANADA

SOLMAX.COM