Geosyntec consultants

Surviving the Pour

Protection Considerations When Installing a Vapor Barrier Membrane for New Construction Buildings

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Greenwich, New York and Denver, Colorado

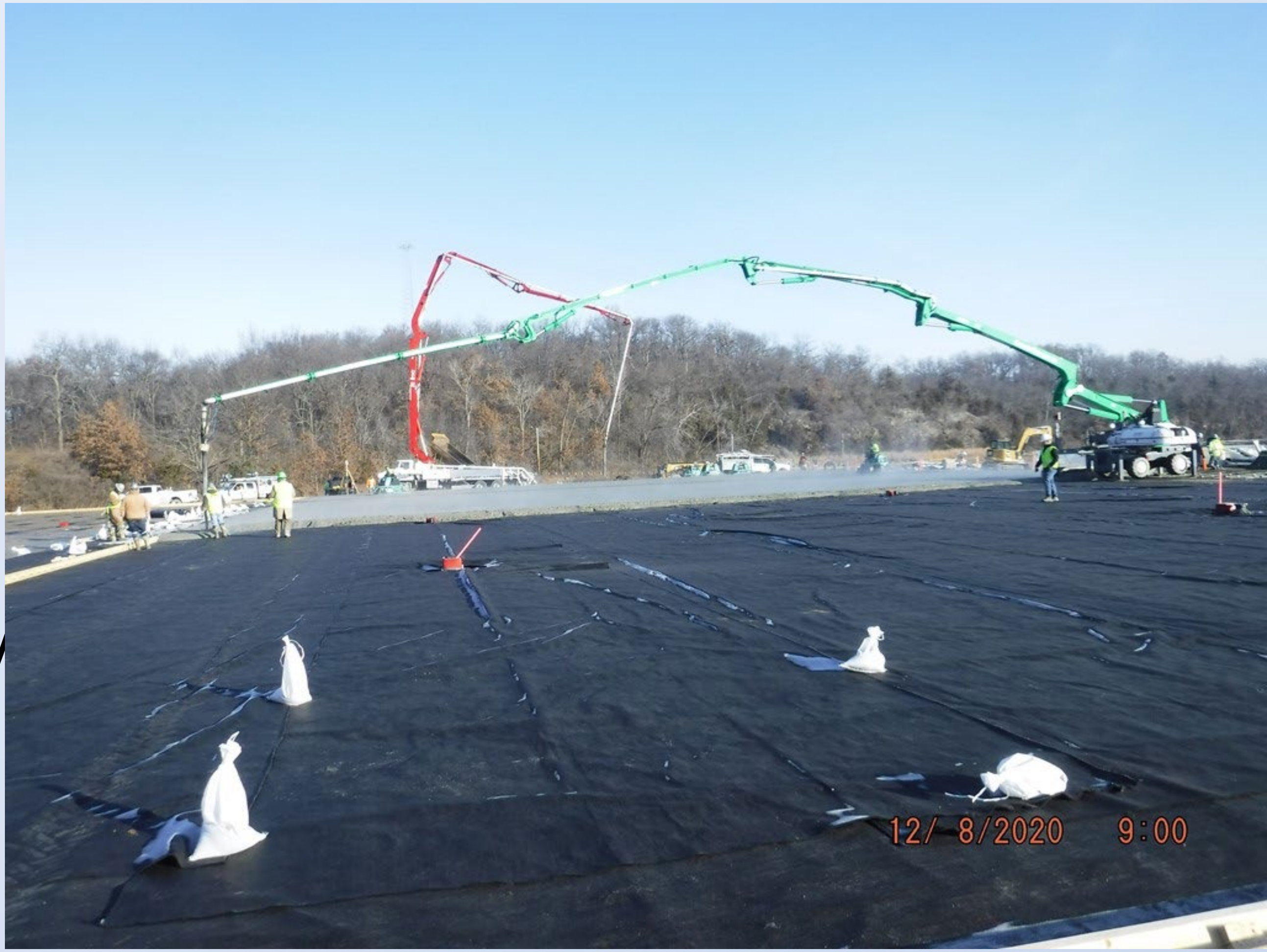
Backstory – How We Got Here

Question from Client – “Can We ‘Tailgate’ The Concrete on the Vapor Barrier”?



"Competing Interests"

- Competing Interests
  - Clients
  - Contractors
  - Regulators
  - System Designers
- Limited Durability Data
- Cost and Schedule Concerns
- Design should work and meet industry standards
- Lack of standardization in VI industry compared to landfill industry



Problem Statement

- VI membranes improve efficiency of a VIMS by:
  - reducing leakiness of slab
  - (in some cases) reduce potential for diffusive flux through the slab
- Damage to the VI membrane during construction could negate its intended function

PROTECTION NEEDED?	NO PROTECTION NEEDED?
• VIMS needs to function properly • Regulatory requirements may dictate robust design	• Client pressures to save costs • Contractor pressure for schedule • Added construction challenges

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Is damage during construction a legitimate concern?

Literature Review

- US Dept. of Interior Bureau of Land Reclamation, 2018 *Design Standards No. 13*
- GSE, 2002 – *Geomembrane Protection Design Manual*
- Folkes, Hunter – 1985 *Oil Spill Containment Liners for Artificial Drilling Islands*

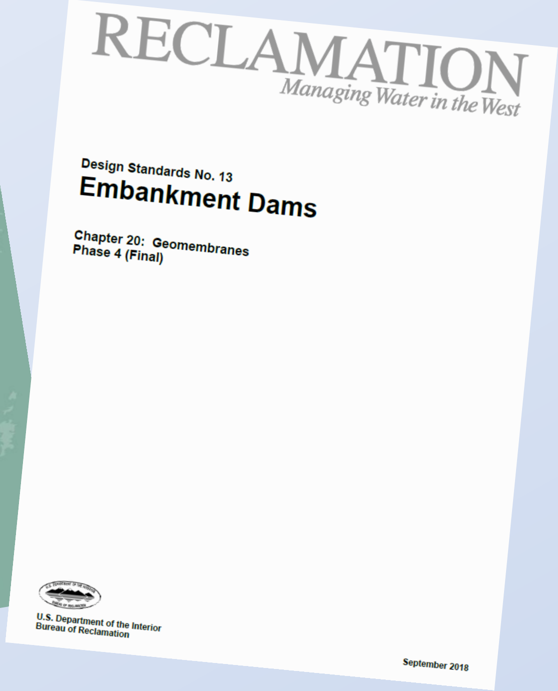
GSE

Geomembrane Protection Design Manual

Co-Authors:

Dhani Narejo, Ph.D.
GSE Lining Technology, Inc.
and
Greg Corcoran, P.E.
GeoSyntec Consultants, Inc.

First Edition



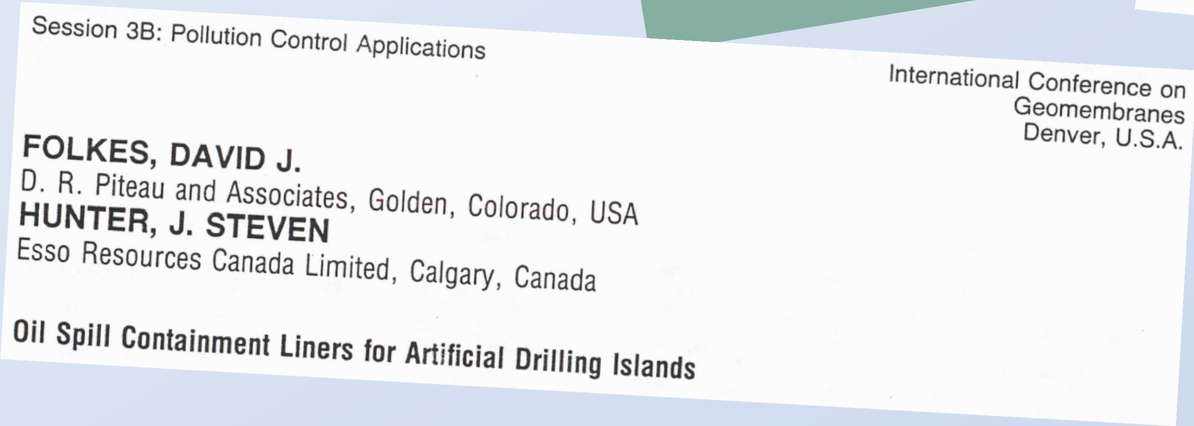
RECLAMATION
Managing Water in the West

Design Standards No. 13
Embankment Dams

Chapter 20: Geomembranes
Phase 4 (Final)

U.S. Department of the Interior
Bureau of Reclamation

September 2018



Session 3B: Pollution Control Applications

International Conference on Geomembranes
Denver, U.S.A.

FOLKES, DAVID J.
D. R. Piteau and Associates, Golden, Colorado, USA
HUNTER, J. STEVEN
Esso Resources Canada Limited, Calgary, Canada

Oil Spill Containment Liners for Artificial Drilling Islands

Literature Review – Key Take Aways

- Vapor Barrier Puncture Causes
  - Aggregate/soil particles
  - Sticks
  - Boots
  - Equipment Tires/tracks
- Stress concentration at the point of contact between the geomembrane and the culprit object – GSE, 2002
- Required vapor barrier protection strength is a function of:
  - Exerted pressure
  - Shape of puncture object (angularity)
  - Scale factors for: installation damage, creep, chemical and biological degradation

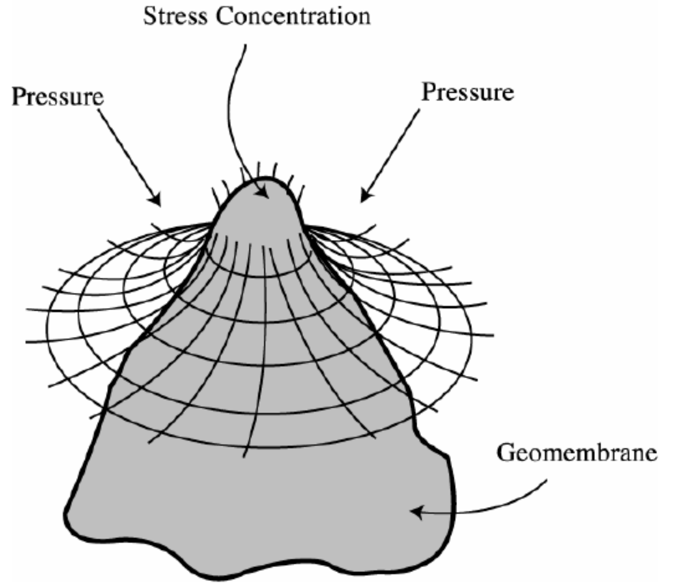


Figure 1.1 Illustration of Stress Concentration in Geomembranes Due to Puncturing Objetcs (from Koerner, 1998).

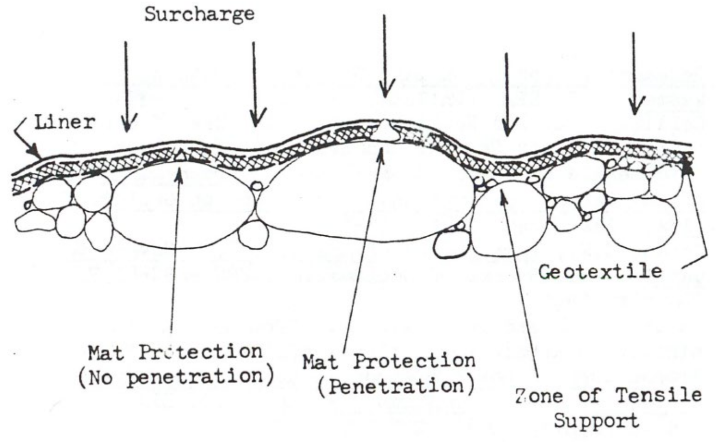


Fig. 11. Geotextile support of geomembranes.

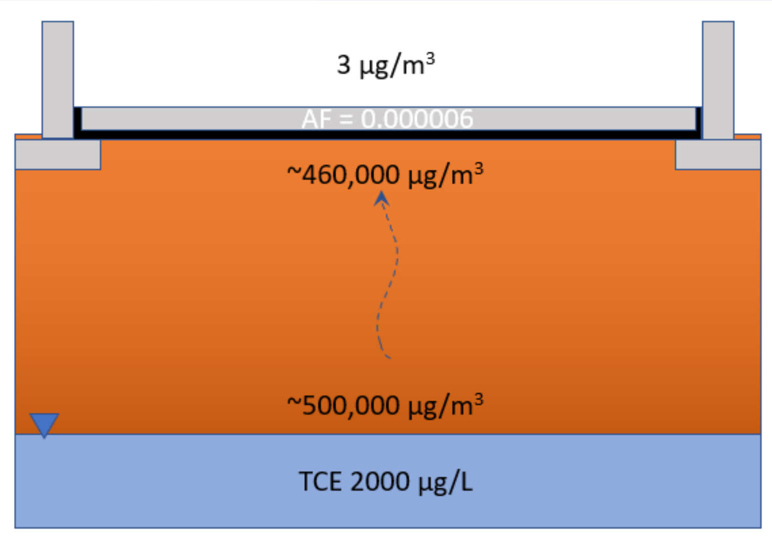
Membrane Protection

- GSE – “Use of mechanisms, techniques, and materials to prevent membrane puncture to the extent that the primary function of the membrane is not compromised”
  - Advective flow
  - Diffusive transport
- Types of protection
  - Nonwoven Geotextile
  - Sand
  - Gravel
  - Thicker Membrane

VIMS Design Components

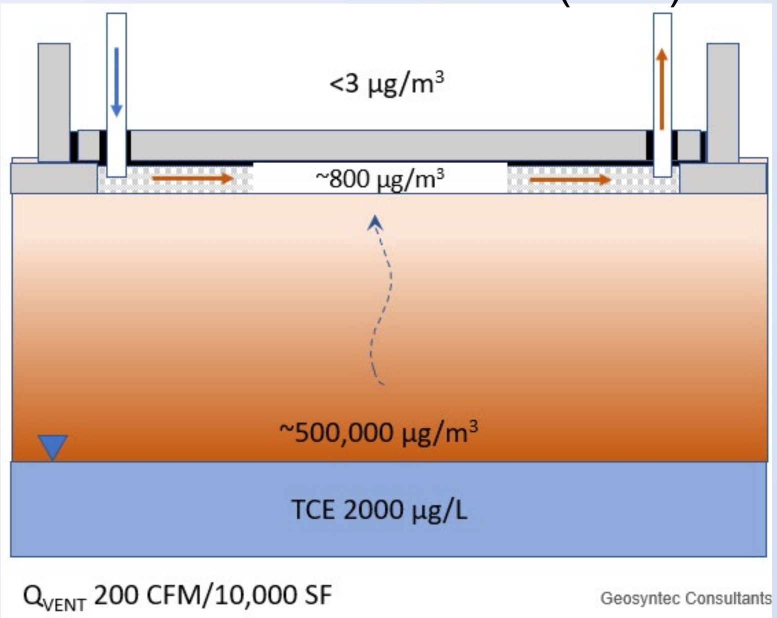
How will the membrane be used to control the VI pathway?

Barrier Below Slab



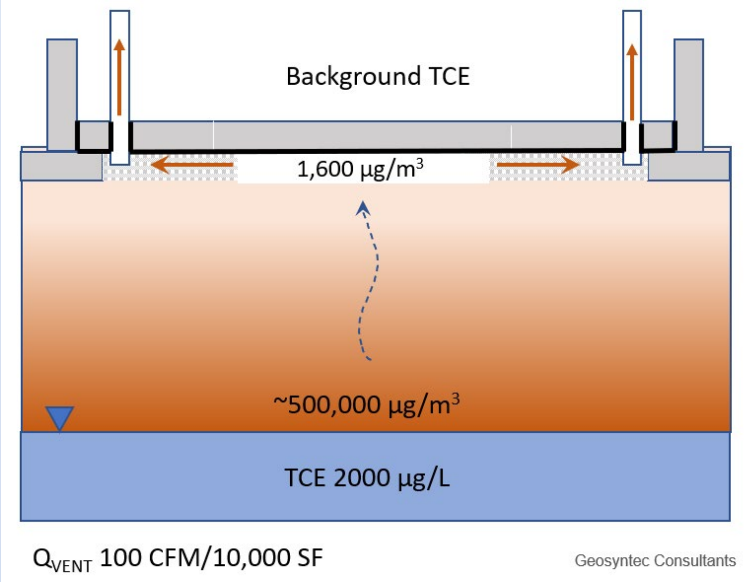
Passive

Sub-Slab Ventilation (SSV)



Passive or Active

Sub-Slab Depressurization (SSD)



Active

Thickness Required?

EPA (2008) commonly referenced

- recommends min 40 mil for passive barriers (HDPE)

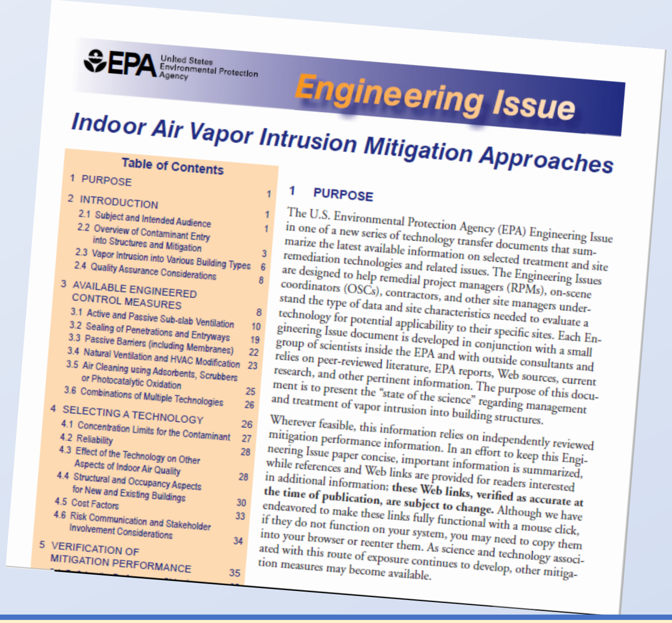
Several 20-30 mil barriers developed since then

- EPRO EV40
- LST NitraShield
- Raven VaporBlock Plus
- Stego Drago
- CETCO VI-20

EPA (2008) has no barrier criteria for active systems

New advances – Newer composite membranes provide increased strength, flexibility, and diffusion control, including 20, 30, and 40 mil liner systems

*No product endorsements are made or implied by this presentation



EPA United States Environmental Protection Agency

Engineering Issue

Indoor Air Vapor Intrusion Mitigation Approaches

Table of Contents

1 PURPOSE

The U.S. Environmental Protection Agency (EPA) Engineering Issue in one of a new series of technology transfer documents that summarize the latest available information on selected treatment and site remediation technologies and related issues. The Engineering Issues are designed to help remedial project managers (RPMs), on-scene coordinators (OSCs), contractors, and other site managers understand the type of data and site characteristics needed to evaluate a technology for potential applicability to their specific sites. Each Engineering Issue document is developed in conjunction with a small group of scientists inside the EPA and with outside consultants and relies on peer-reviewed literature, EPA reports, Web sources, current research, and other pertinent information. The purpose of this document is to present the "state of the science" regarding management and treatment of vapor intrusion into building structures.

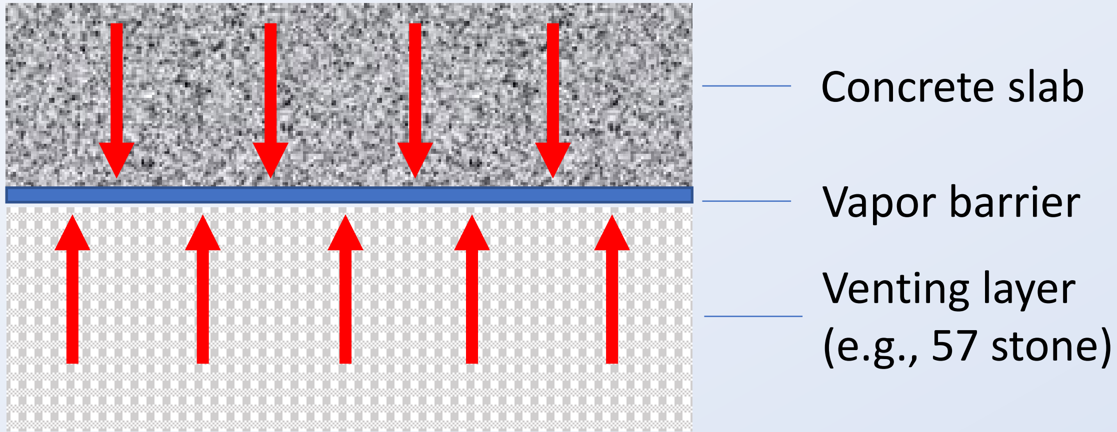
Wherever feasible, this information relies on independently reviewed mitigation performance information. In an effort to keep this Engineering Issue paper concise, important information is summarized, while references and Web links are provided for readers interested in additional information; **these Web links, verified as accurate at the time of publication, are subject to change.** Although we have endeavored to make these links fully functional with a mouse click, if they do not function on your system, you may need to copy them into your browser or reenter them. As science and technology associated with this route of exposure continues to develop, other mitigation measures may become available.

Key Points

- EPA 2008 thickness criteria are outdated
- Select barrier based on properties not thickness alone
- Active systems do not need (but benefit from) barriers

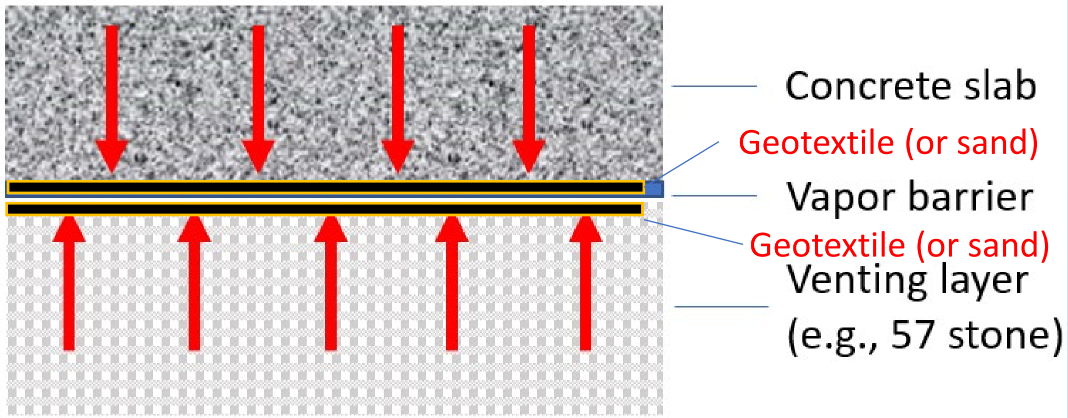
Common VIMS Design Concepts

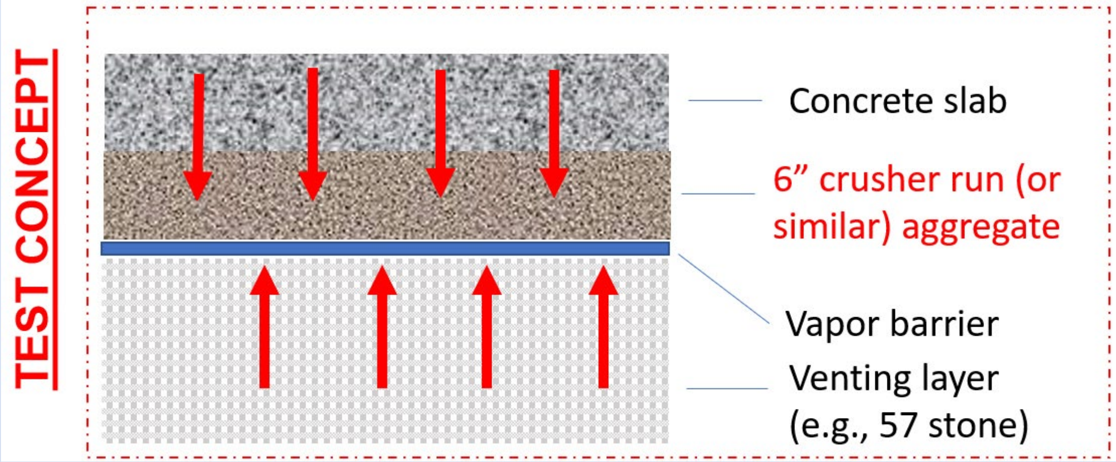
No Protection Concept



- Potential stresses can be on top and bottom of VIMS membrane
  - Loose aggregate above
  - Compacted aggregate below

Typical Protection Concepts





Equipment Used During Construction

Typical Equipment

- Laser Screed – 18,000 pounds
- Line Pump – 1,500 pounds
- Concrete truck – 65,000 pounds

Test Equipment

AASHTO #57 Stone

Item 4 “Crusher Run” Gravel

Telehandler – 16,000 pounds

Tractor Trailer
Unloaded
20,000 pounds

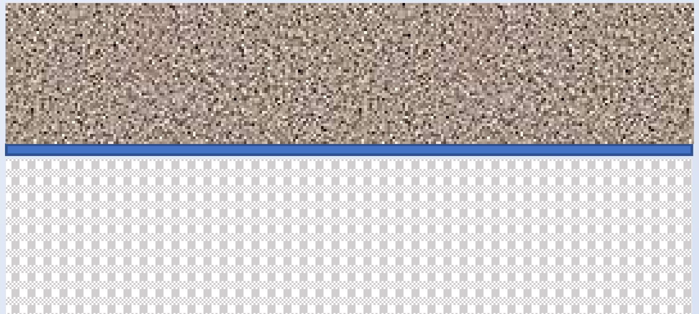
Typical Equipment

- Laser Screed – 18,000 pounds (~60 psi)
- Line Pump – 1500 pounds (~ 5 psi)
- Concrete truck – 65,000 pounds (~3,500psi)

Gravel—VBM–Aggregate

Test Layout

- 16,000 lb telehandler, 2 passes. No turns
- 20,000 lb tractor trailer (unloaded) 2 passes. No turns



6” Item 4 (crusher run), lightly compacted

Vapor barrier

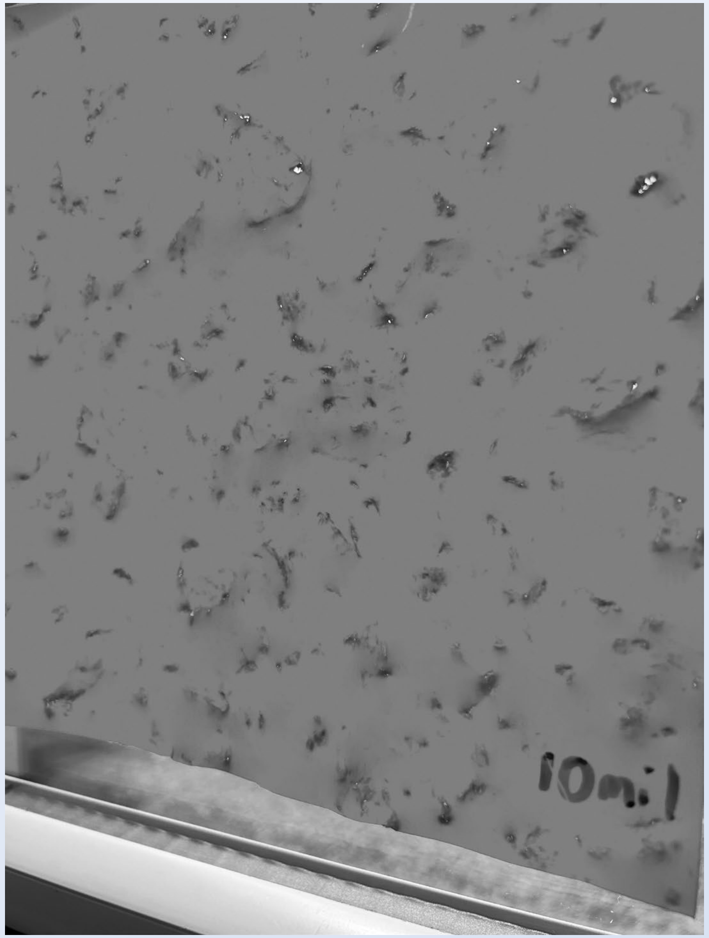
6” #57 Stone, lightly compacted

Vapor Barriers Tested

- 10 mil
- 15 mil
- 20 mil
- 20 mil w 3oz/yd^2 nonwoven geotextile
- 30 mil

Test #1 Results

10 mil



15 mil

Key Points

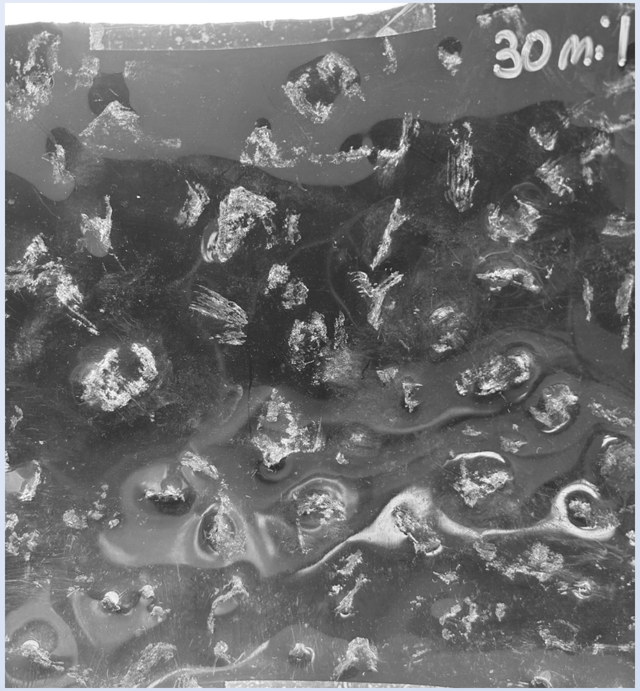
- Neither intact
- Pinholes (psf)
  - 10 mil – 81
  - 15 mil – 33
- Unlikely to achieve goal

Test #1 Results

20 mil

20 mil + 3oz Geotextile

30 mil



Key Points

- Pinholes (psf)
  - 20 mil – 21
  - 20 mil + 3oz/yd2 geo – 0
  - 30 mil – 2.4
- Protection geotextile may be “worth” more than 10 mils of thickness

Gravel–VBM

Test Layout

- 16,000 lb telehandler, 2 passes. No turns

Vapor Barriers Tested

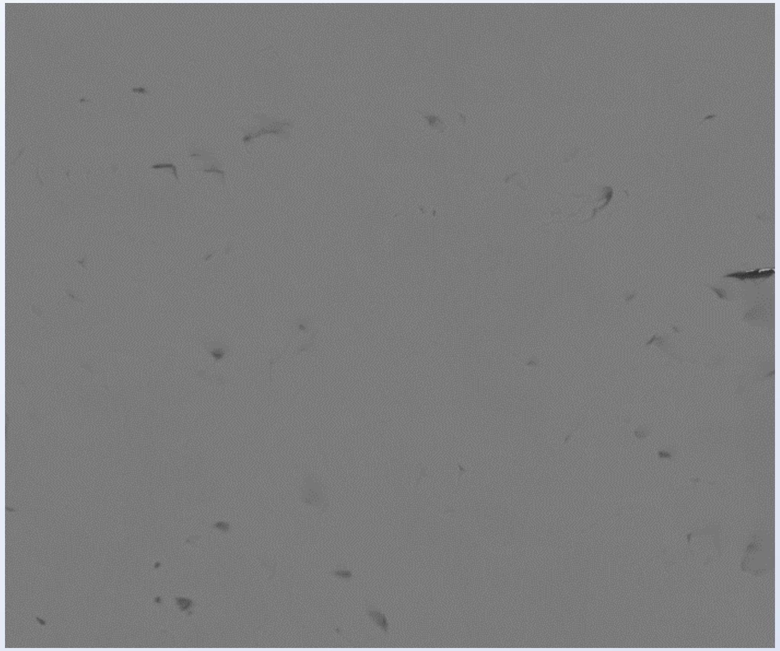
Vapor barrier

6” #57 Stone, lightly compacted

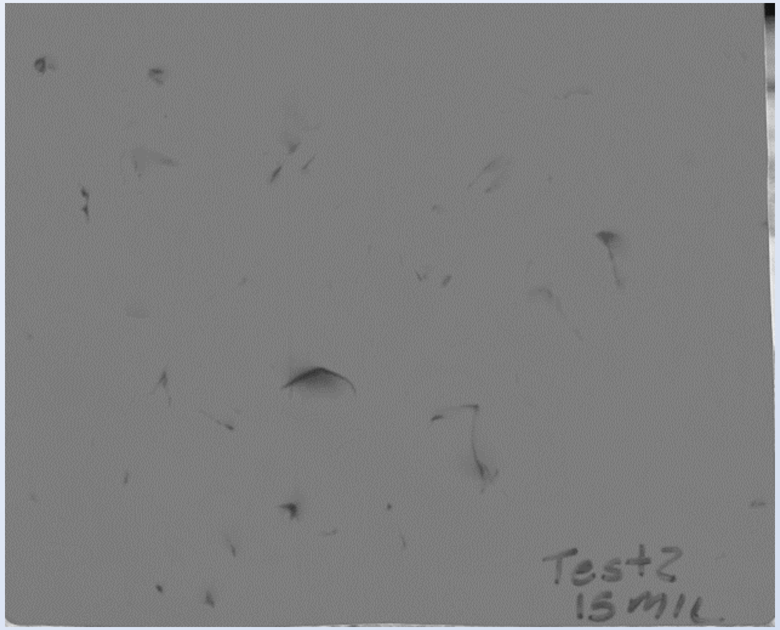
- 10 mil
- 15 mil
- 20 mil
- 20 mil w 3oz/yd^2 nonwoven geotextile
- 30 mil

Test #2 Results

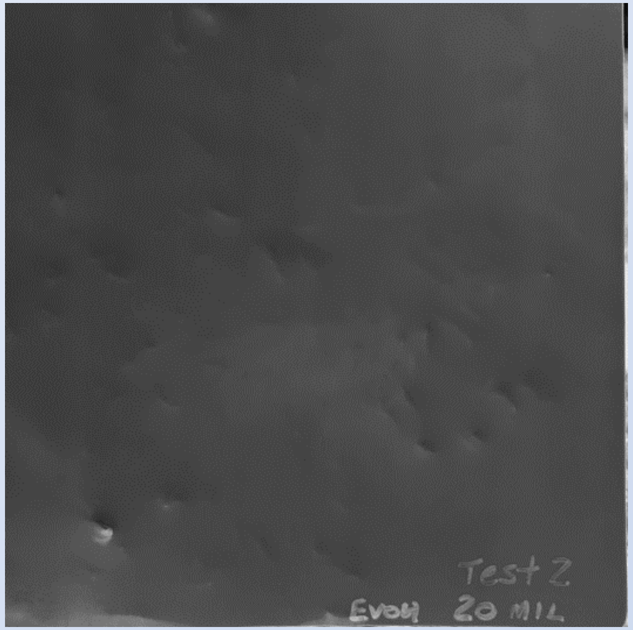
10 mil



15 mil



20 mil

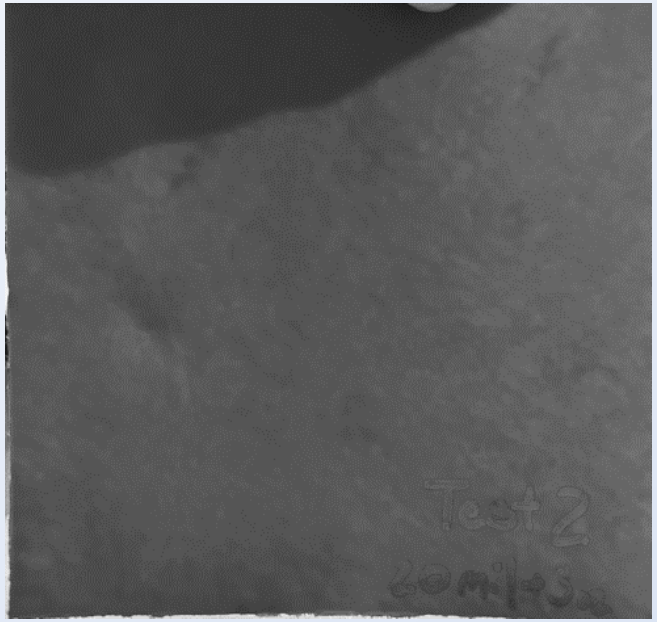


Key Points

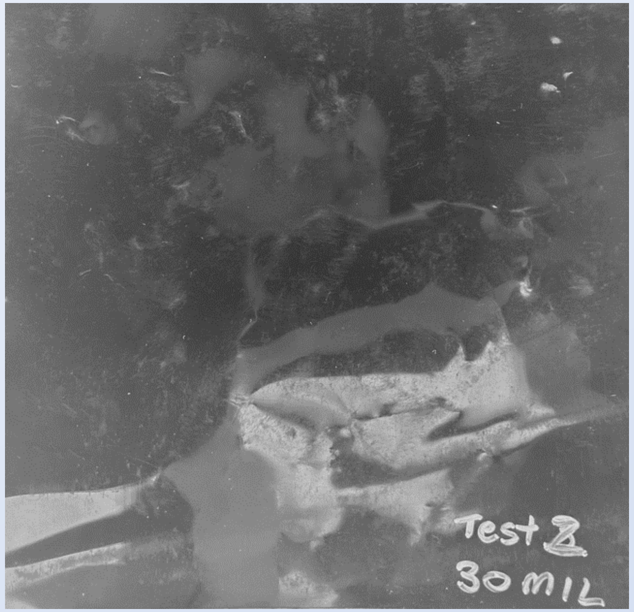
- Pinholes (psf)
  - 10 mil – 0
  - 15 mil – 0
  - 20 mil – 0

Test #1 Results

20 mil + 3oz Geotextile



30 mil



Key Points

- Pinholes (psf)
  - 20 mil + 3oz/yd2 geo – 0
  - 30 mil – 0
- However…

Real World Problems

- Plan for the real world
- Concrete aggregate under screed outriggers
  - Test 1 scenario (item 4 over membrane)
- Screed needs to turn
  - Torque on membrane

Conclusions

- Understand purpose and intent of VIMS design
- Membrane selection not based on thickness alone
- Understand construction environment
- Forces imparted on membranes occur from above and below
- Landfill industry has done significant research on vapor barrier membrane protection
- Protection geotextile above and below membrane is cheap "insurance"
- Construction CQA is critical

THANK YOU!

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