Short Course on

GEOMEMBRANES AND COMPOSITE LINERS IN LANDFILLS AND MINING: MOVING FORWARD

Sunday 17 Sept. 2023

1. Introduction - Basics

R. Kerry Rowe OC, FRS, FREng, NAE

Barrington Batchelor Distinguished University Professor and Canada Research Chair in Geotechnical and Geoenvironmental Engineering

The Geo Engineering Centre at Queen's-RMC

Queen's University Kingston Canada

www.geoeng.ca

Queen's University

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Objectives and Limitations

- Introduce concepts to those new to the field.
- Present some latest developments.
- The material presented is not complete in and of itself; it is intended only to provide direction. Examine published sources for more complete information.
- Reader is responsible for assessing the relevance and usefulness for any project
- Not all topics are covered.

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Theme

There have been a very large number of successful applications of geosynthetics in barrier systems.

Geosynthetics:

- work extremely well!!!
- are engineered materials and need to be treated with the same respect as other engineered materials (e.g., reinforced concrete)

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Theme (cont)

Manufacturers provide many options:

- Different products for different applications
- Salespeople can be very helpful BUT check claims and remember it **is the engineer's responsibility** to select the right materials for their application
- Warranties generally do not mean much.
- You might get what you ask (and pay) for
- Good engineering can be relied on
- Luck is fickle

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Barrier Systems

Used as bottom liners and covers for:

- Containing potable water
  - hydro dams and canals (non-aggressive water)
  - reverse osmosis water or chlorinated drinking water (both aggressive)
- Containing contaminated fluid (leachate ponds)
- Mineral and hydrocarbon extraction (heap leach pads; solar ponds; brine ponds for shale/coal oil/gas)
- Waste disposal:
  - municipal, hazardous and low level radioactive waste landfills
  - combustion ash, contaminated (e.g. hydrocarbon, PFAS) soil
  - mine tailings and acidic waste rock
- Contain gases (methane, oxygen, VOCs)
- Remediation and reuse of contaminated land

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Landfill Barrier System Design

Involves consideration of:

- Physical
- Chemical
- Thermal, and
- Biological process

within a system where component interactions are critical to overall system performance.

Enormous range in physical (µm-km) and time scales to be modelled

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Landfill Barrier System Design

Begins by asking the questions:

- How much leakage and/or fluid escape is acceptable.
- How long must the barrier system last (design life)? Remember: after it is built it is hard to change its service life.
- What is the environment in which it must function and how can that change during its design life?

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Landfill Barrier System Design

Usually involves:

- A low permeability material (resistance to flow).

but often to together with

- A drainage system (reduces the driving force for flow and/or captures flow though a component of the system).

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Landfill Barrier System Design

Often involves:

- Components that work together synergistically (geomembrane and clay liner as a composite liner) or antagonistically (a coarse gravel drainage layer and geomembrane),
- Conflicting criteria,

and

- rarely uses any material that does not have weaknesses that must be mitigated

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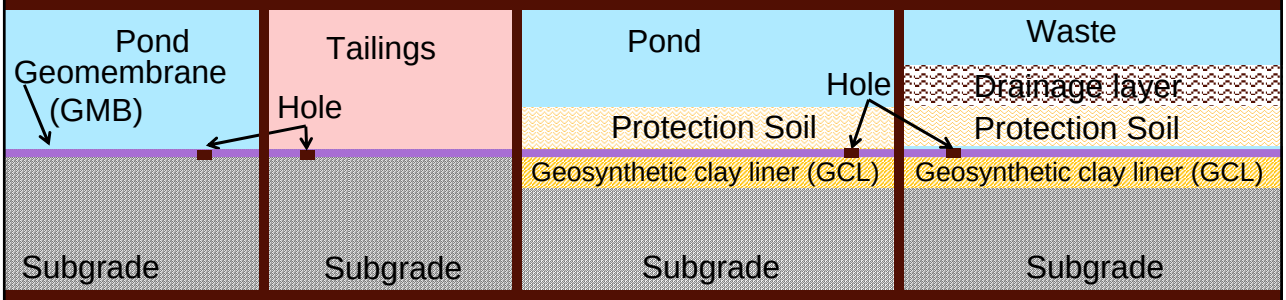
Single Liner Barrier Systems

Single Geomembrane Single Composite Liner



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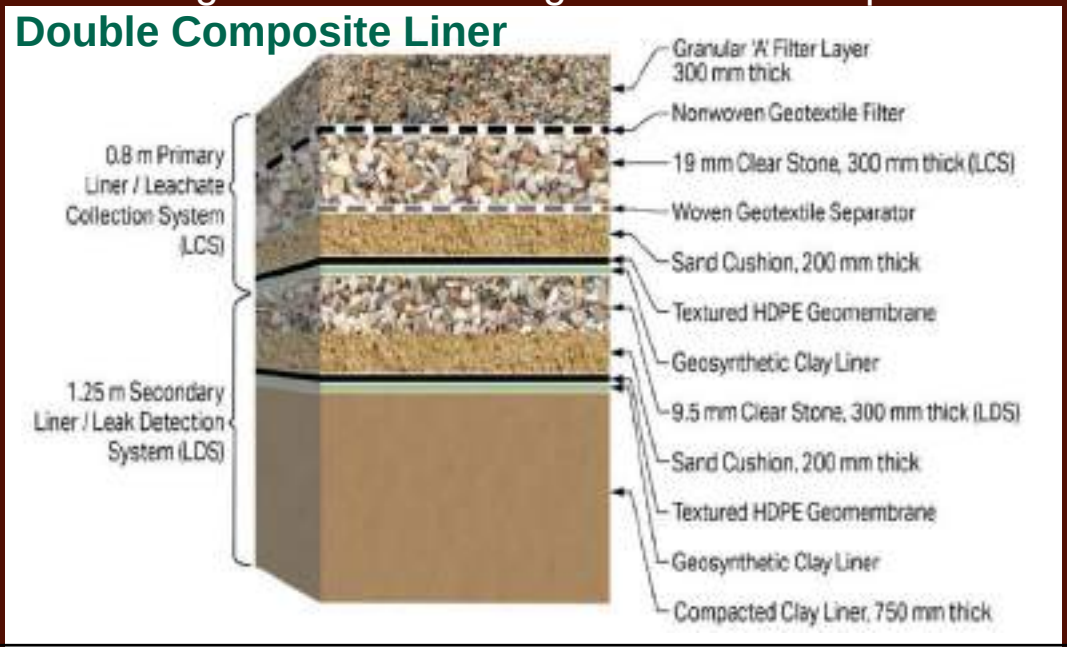
but when leakage is critical it can get far more complicated like :

Double Composite Liner



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Landfill Barrier System Design

- With a wide range of possible materials

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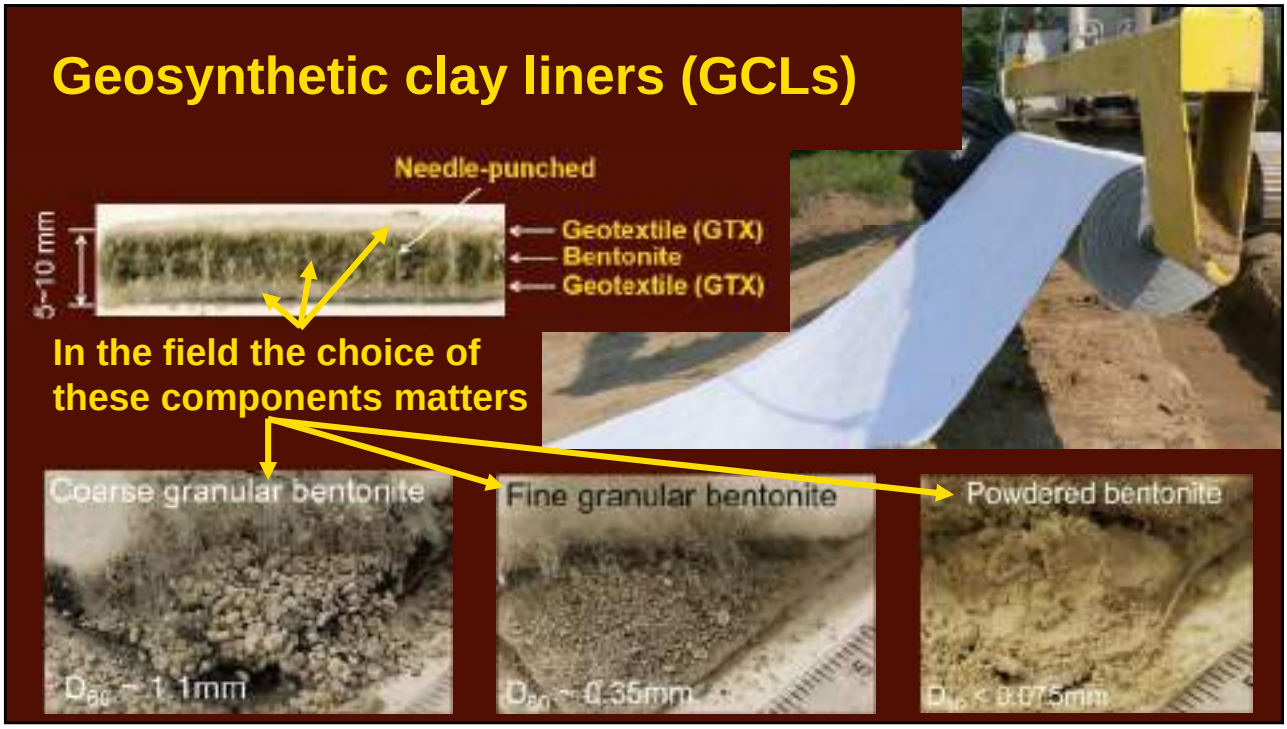

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Different Geotextile Configurations

Needle–punching cut and bentonite removed

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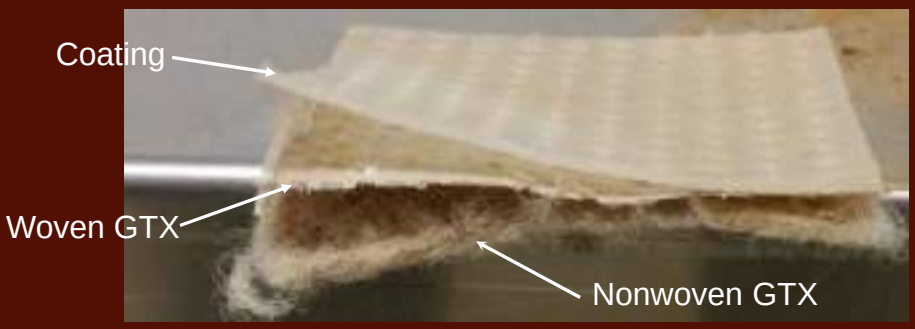
Multicomponent GCL



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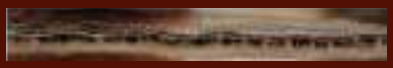
Multicomponent GCLs



Coated Laminated

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Coated GCL

Polypropylene needle punched nonwoven cover GTX

>4340 g/m^2 bentonite

Polypropylene scrim-reinforced carrier GTX

Coating

Polypropylene Cover GTX

Polypropylene Carrier GTX

Coating

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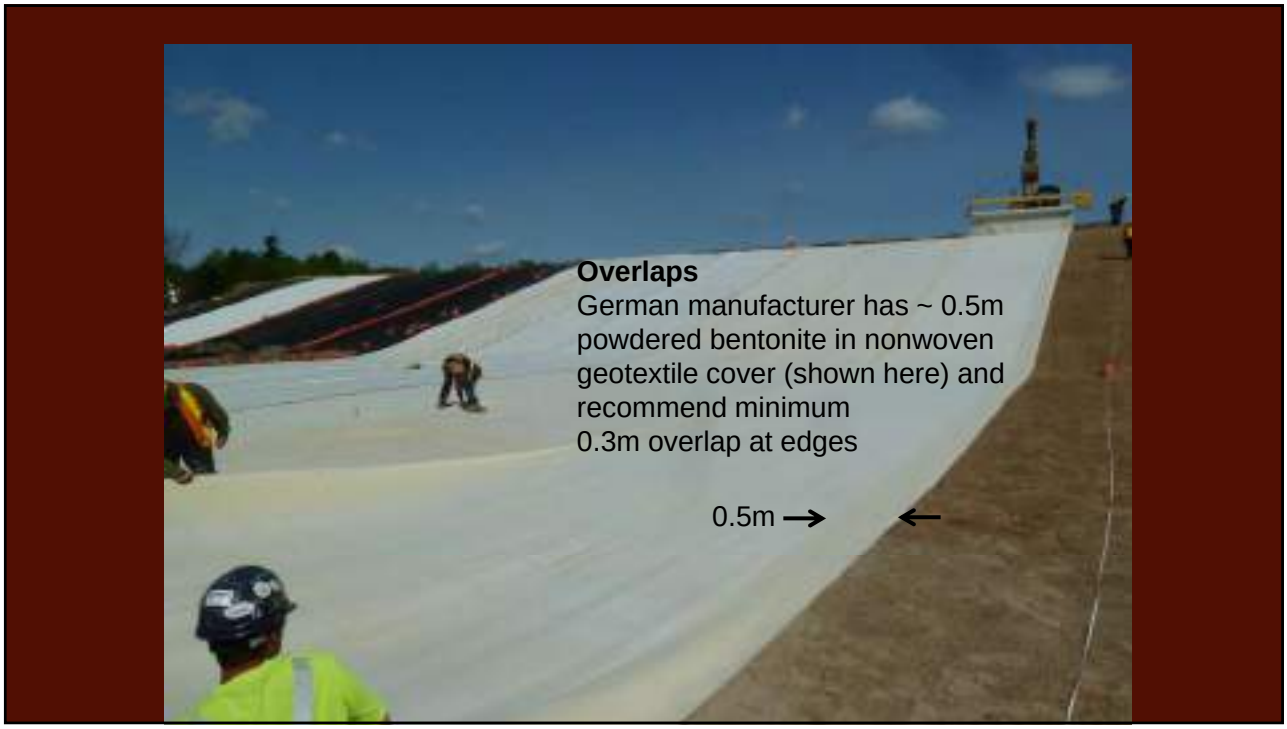

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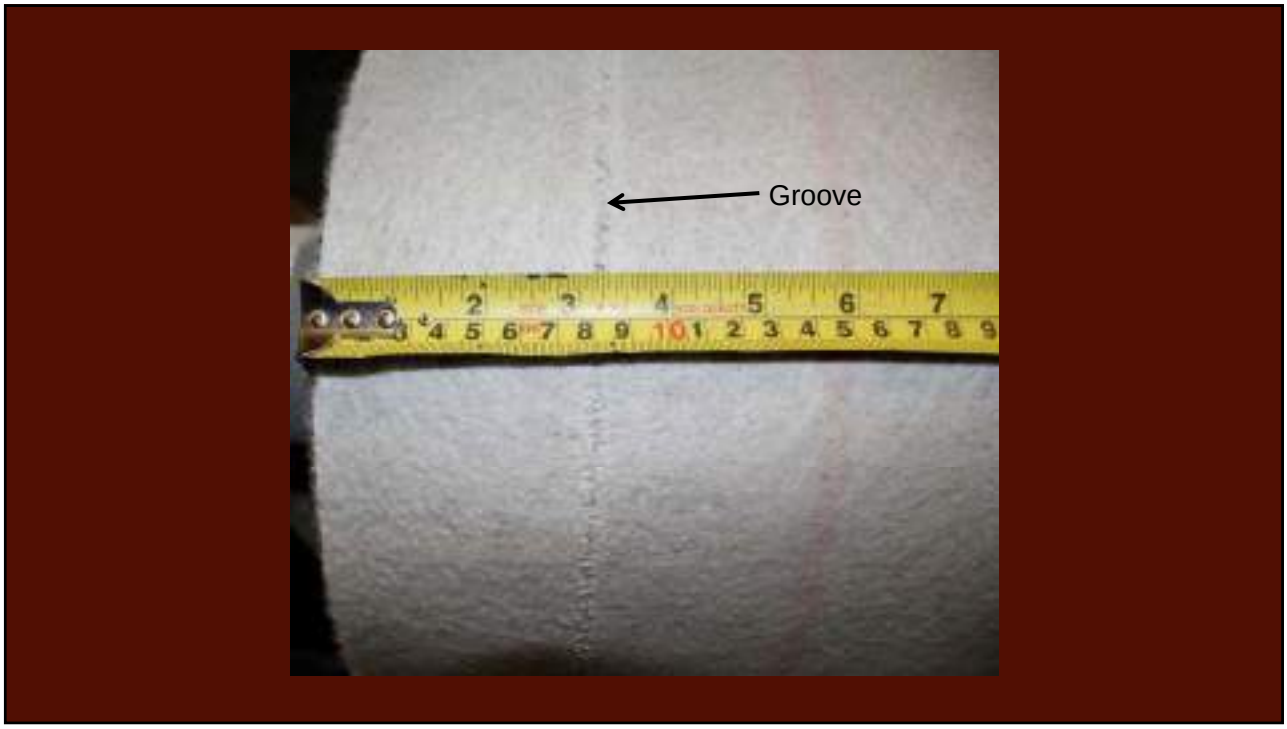

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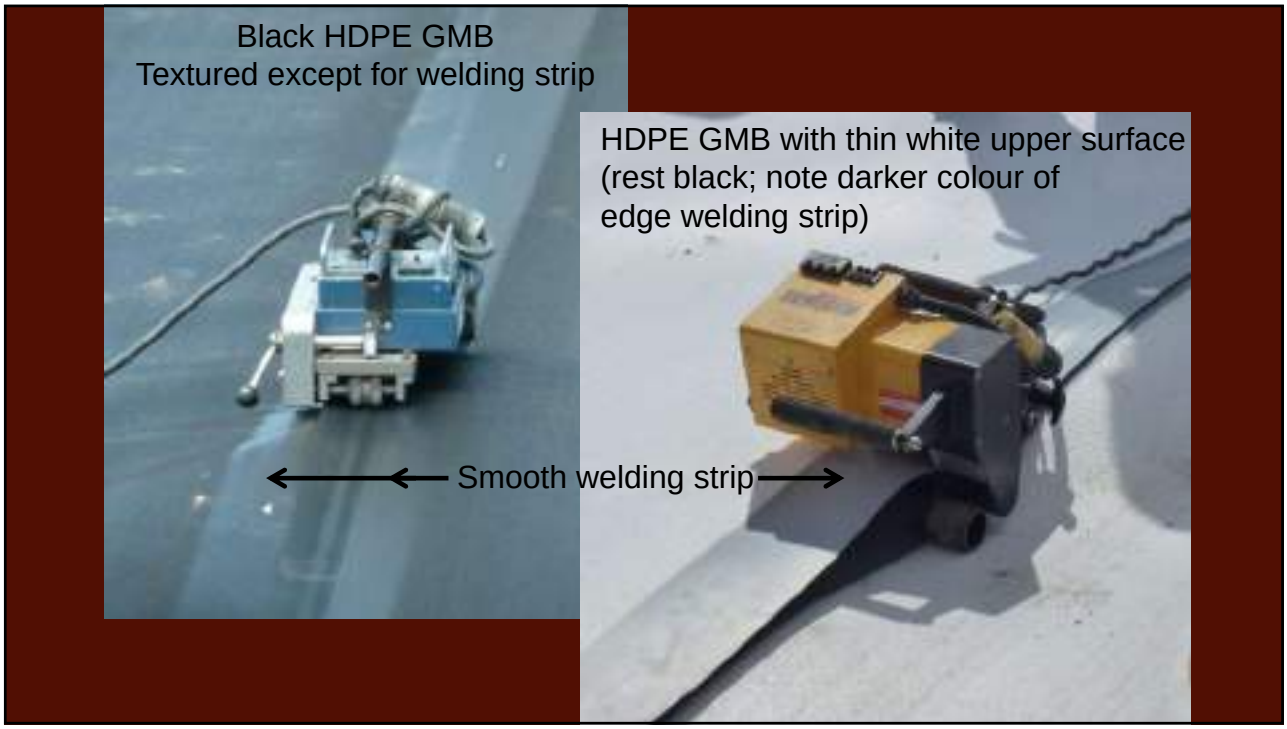

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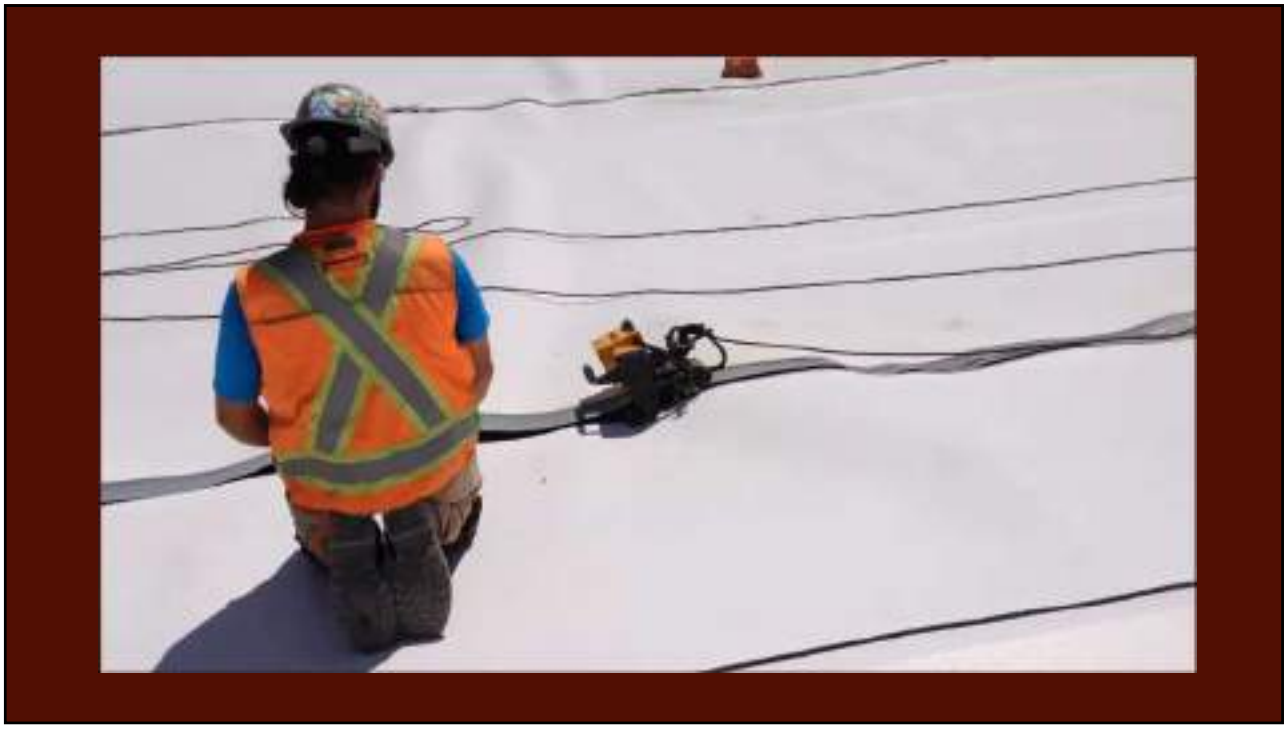

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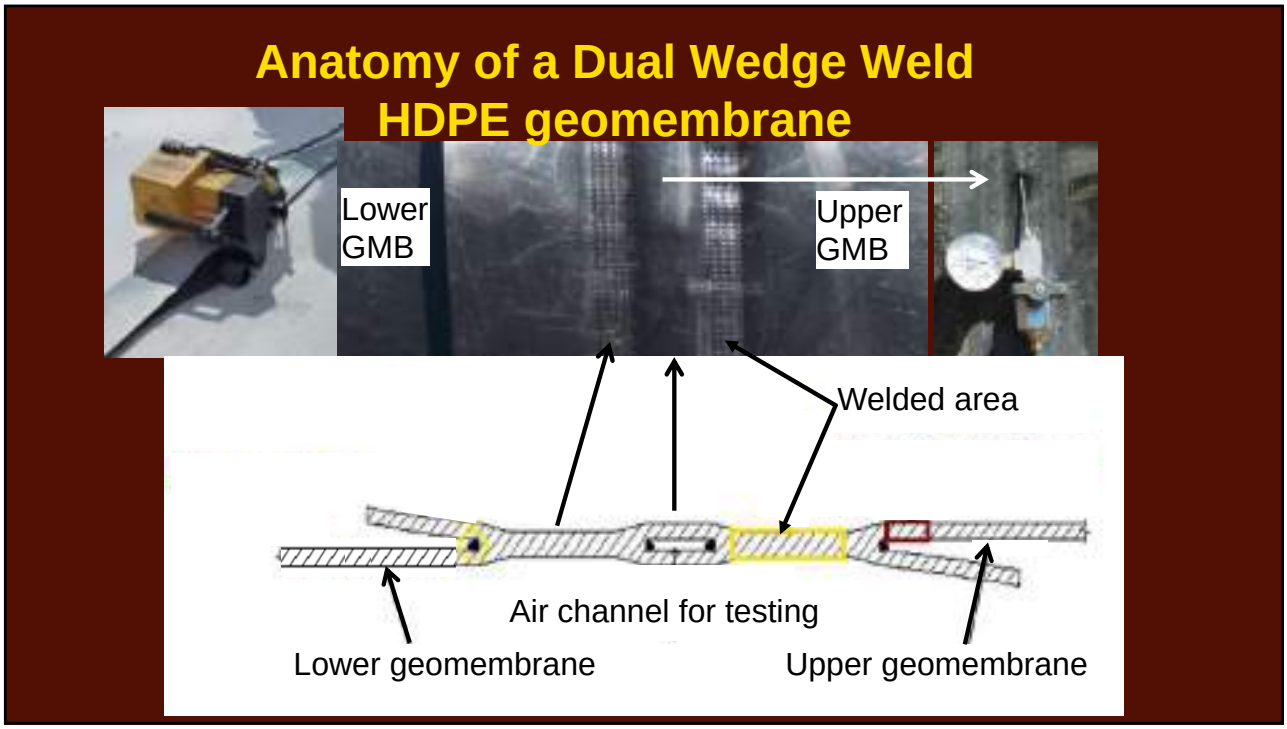

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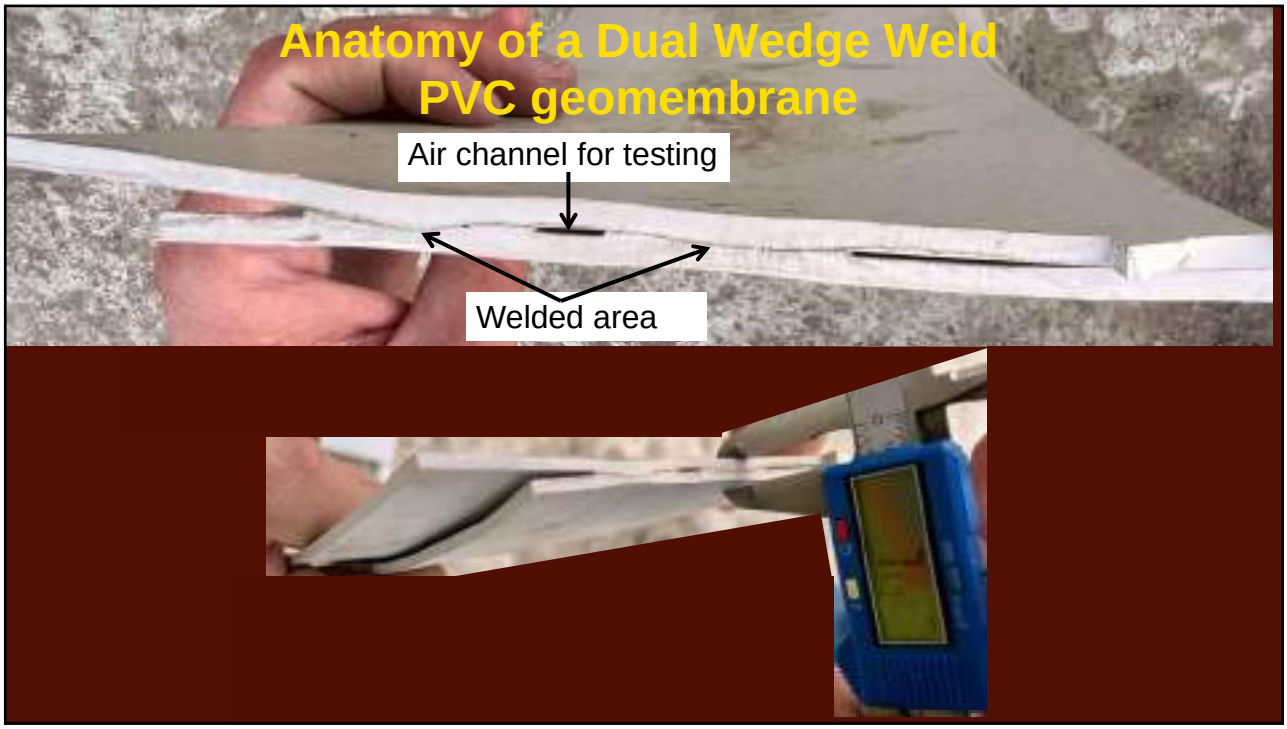

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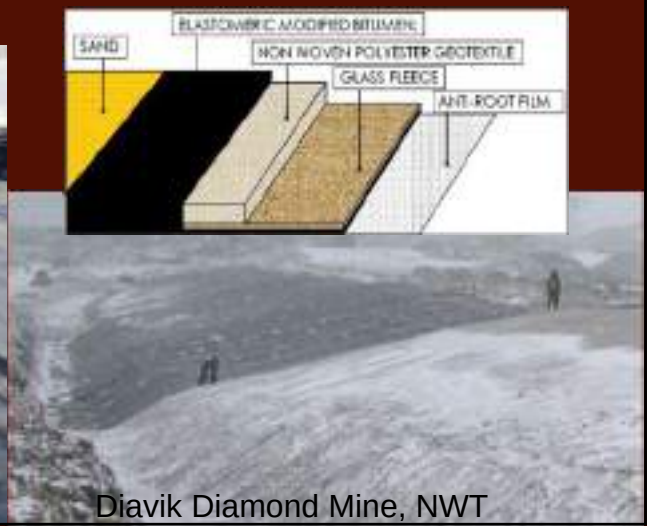
Bituminous geomembranes (BGMs)

- Used in canals and being promoted for other applications

Welding a BGM



Diavik Diamond Mine, NWT

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My rating of 3 common GMBs on issues

GMB / Issue	1.5 - 2 mm HDPE	2 - 3.5 mm PVC	~4 mm BGM
Good chemical compatibility	A	C	C
Excellent flexibility	B	A	C
Excellent welds	A	A	D
Extensive research to support use	A	C	D
Very long SL possible	A	C	C-D
Easy subgrade requirements	C	C	C
Minimal wrinkles in sun	C	A	A
Low stress cracking potential	C-B	A	A
Installation/use in cold temperatures	B	C	B
Installation/use in hot temperatures	B	B	C
Lower cost	A	C	B

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My rating of 3 common GMBs by application

GMB	1.5 - 2 mm HDPE	2 - 3.5 mm PVC	~4 mm BGM
Containment buried	A	C	D
Containment exposed	B	C	D
Covers buried	B	A-B	B-D
Covers exposed	B-C	A-B	B-D
Hydraulic (dams, canals) buried	B	A	B
Hydraulic exposed (dams, canals)	C	A	B

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