

GMB and GCL covers: construction, maintenance, monitoring, repair and replacement

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Limitations

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Construction related causes of cover problems

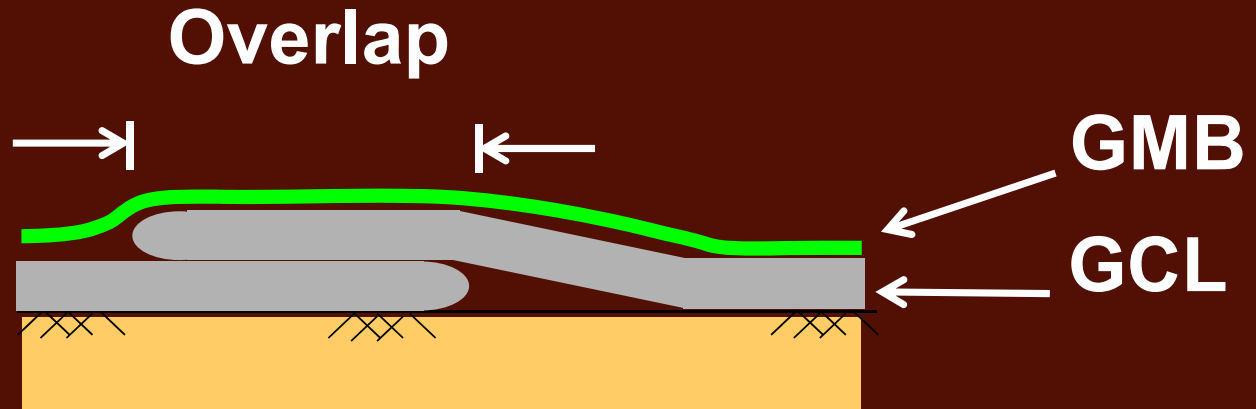
include failure to:

- adhere to design and specification (e.g., substituting a cheaper “equivalent” material that is not really equivalent)
- place cover soil in a timely manner or, for composite liners to be exposed for some time,
- to select a GCL suitable for longer-term exposure (some GCLs are far more susceptible to problems if composite liner is not covered in a timely manner)

Construction related causes of cover problems

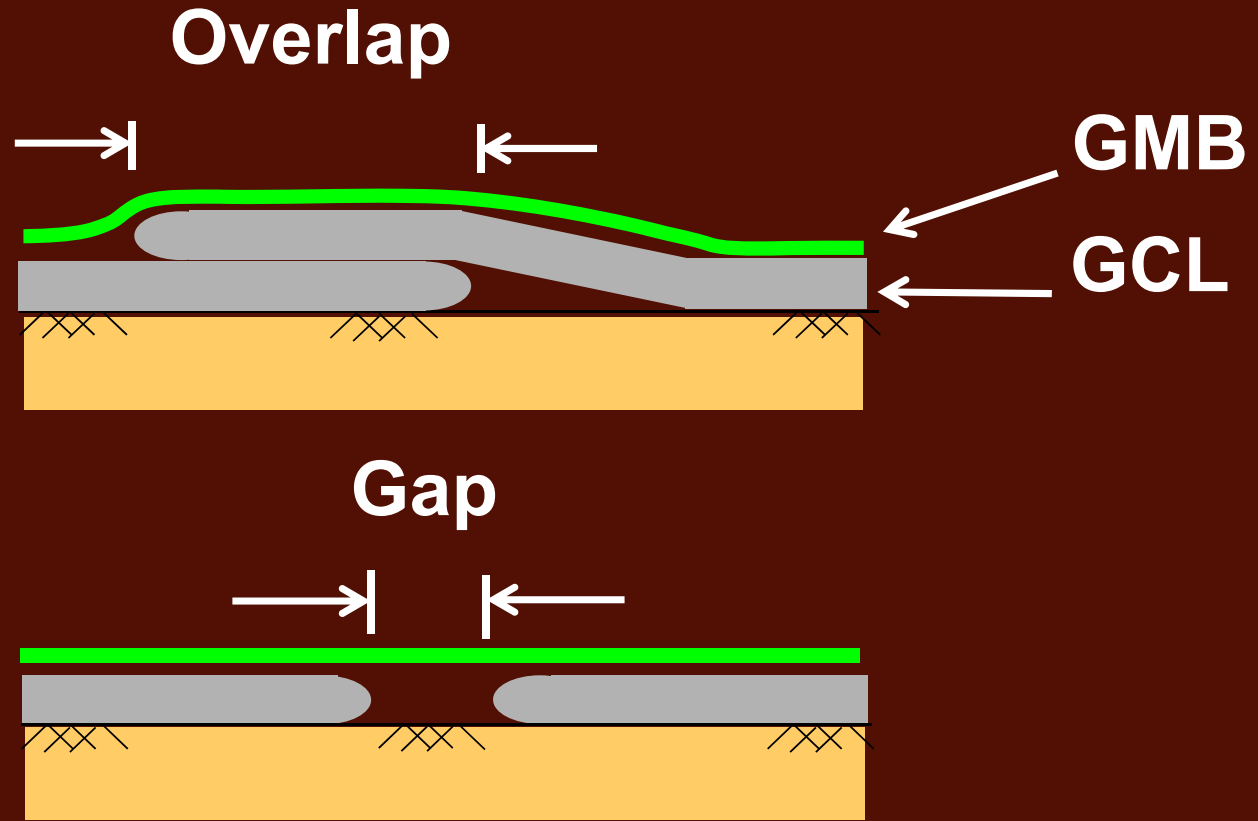
- GCL manufacturers' installation guidelines indicate that timely covering is very important for obtaining good performance
- However composite liners are often left exposed for months to years
- How do different GCLs respond to exposure?

Overlap



If you cover the liner as per manufacturers' guidelines this is how it will remain –
BUT if you leave the composite liner uncovered you may get:

Overlap loss due to shrinkage



Observed Field Shrinkage

(Thiel et al. 2006)

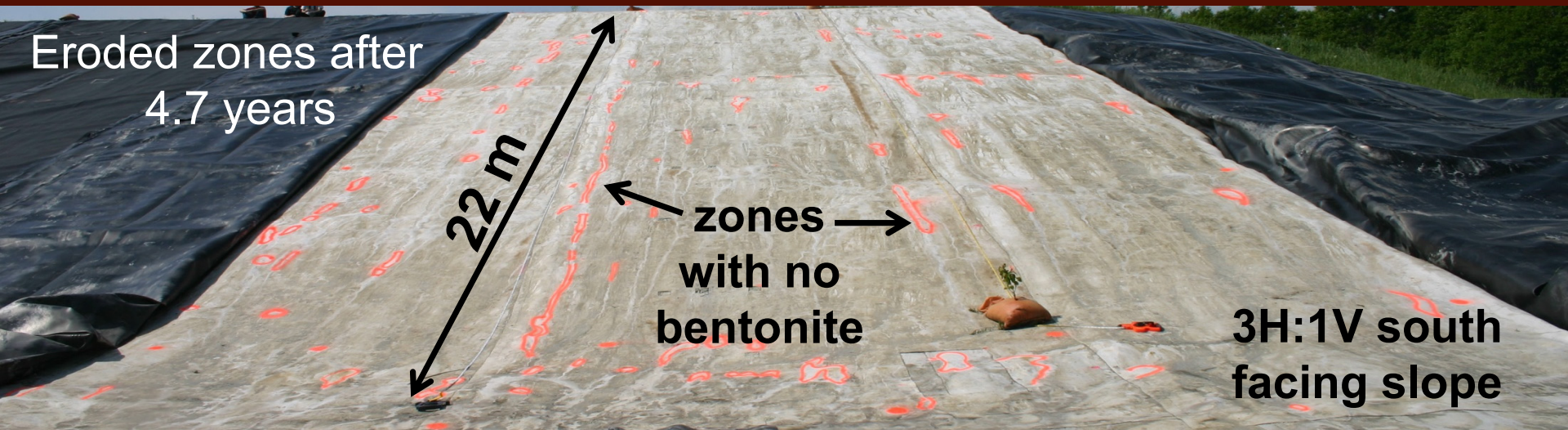
GCL	Slope	Maximum separation (gap) (mm)	Exposure period (months)
GCL3	18°	200	15
GCL3	4°	300	2
GCL4	34°	1200	36
GCL4	18°	300	5
GCL4	4°	450	2

Initial placed overlap: 150 mm

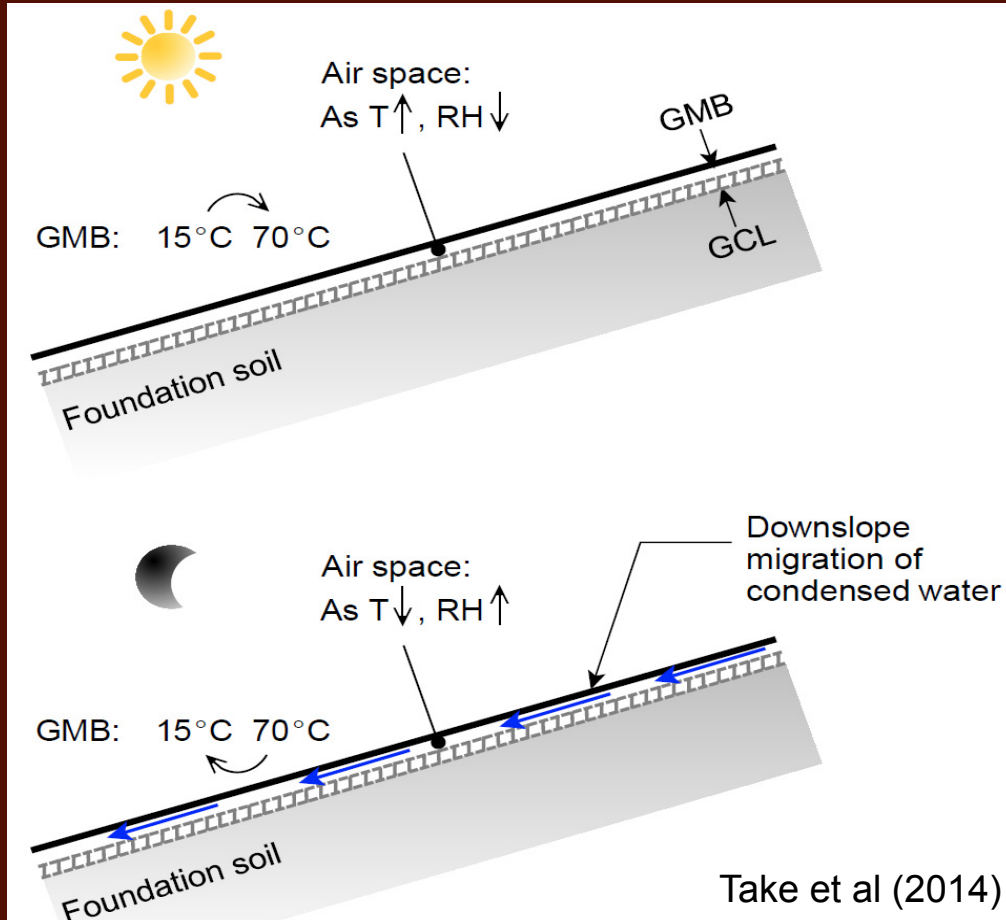
Problems from not following manufacturer's guidelines

GCLs covered only by a black GMB and left exposed for long periods of time may

- shrink causing loss of overlap, and/or
- experience bentonite migration due to small amounts of condensed water trickling on the GCL below EXPOSED GMB (problem does not occur if GMB is covered by soil)



Moisture cycle from thermal cycle when exposed



- GCL hydrates with moisture from subsoil
- on heating:
 - GCL loses moisture to GMB/GCL interface
 - vapour migrates towards wrinkles
- on cooling:
 - vapour condenses on underside of GMB
 - condensed moisture trickles downslope

Polymer coated GCL in exposed liner



Upper GTX: Slit-film woven with impregnated polypropylene coating

- no erosion after 28 months
(some other GCLs had significant erosion in this time)
- coating prevented loss of moisture to GMB/GCL interface

Cautionary Remark

- Some GCLs can experience downslope erosion and shrinkage,
- BUT CCLs desiccate even faster when left without suitable cover;
- **Problems can be eliminated by timely covering**
BUT CCLs must be covered faster than GCLs

These can be avoided by:

- following good procedure, or**
- selecting and placing GCL suitable for longer exposure**



Common causes of cover problems

include the failure to:

- maintain an adequate system for collecting the water from a drainage layer
- avoid blockage of the drainage outlets
- manage surface water and cover soil erosion

GMB and GCL covers: maintenance

- All covers require maintenance.
- When covered by a soil layer, the GMB and GCLs do not require maintenance in and of themselves, but
 - surface water drainage needs to be maintained to prevent significant erosion of the soil cover;
 - if there is a drainage layer, then maintenance may be required to avoid blockage of drainage outlets or drainage layer (e.g., by roots);
 - deep rooted plants (that could penetrate the GCL) need to be avoided/controlled

GMB and GCL covers: monitoring

- All covers have the potential to leak and hence, if there is potential for a negative environmental impact, some monitoring will be required.
- When covered by a soil layer, the GMB and GCLs do not require monitoring over and above that normally required with a waste rock cover.
- Exposed GMBs would benefit from periodic visual inspection due to the potential for damage from external (e.g., human/animal) sources.

GMB and GCL covers: repair

- Minor local damage to **exposed** HDPE GMBs (e.g., a local hole) can be readily patched but requires right equipment and a trained operator.
- LLDPE may be more difficult to weld when aged.
- **With good design and assuming that an appropriate soil cover has maintained** (e.g., avoid deep erosion gullies; vegetation is controlled; drainage layers do not block) **the GMB/GCL is not likely to experience post-construction physical damage.**

GMB and GCL covers: repair

In the event of damage to a buried liner, after removal of the overburden at and near the damaged area:

- minor local damage to HDPE GMBs (e.g., a local hole) can be readily patched but does require the right equipment. LLDPE may be more difficult to weld when aged,
- minor local damage to GCLs can be easily repaired by patching according to manufacturers' guidelines.

GMB and GCL covers: replacement

- Service life of **exposed** GMB liners will depend on (a) material used (especially the antioxidant/stabilizer package used), and (b) location/exposure conditions. However they will likely need replacement after a several decades.
- If a GMB is to be replaced, a decision will need to be made about what to do with existing cover (will depend on many factors).
- If existing cover is removed, placing new GMB follows similar procedures to initial installation.

GMB and GCL covers: replacement

- Service life of **buried** GMB liners will depend on (a) material used, and (b) location/exposure conditions. However with good design (including materials), construction, and maintenance of cover soils they will likely last centuries provided liner temperature $< 25^{\circ}\text{C}$.
- If a buried liner needs to be replaced, a decision will need to be made about what to do with existing liner. This will depend on many factors, but may be best to leave in place (subject to a stability check).

GMB and GCL covers: replacement

- If existing cover is removed, or if it is left in place with some soil above it, placing new liner follows similar procedures to initial installation.

Conclusions

- Intact GMB is essentially impermeable to water and oxygen
- Leakage occurs through holes in GMB
- Composite (GMB/CL) liners perform MUCH better than single GMB or clay liners.
- Composite liners with a GCL generally perform MUCH better than a composite liner with a CCL

Conclusions

- Need an appropriate design for the local conditions
- Manufacturers produce MANY different GCLs and GMBs – choose wisely!
- Good construction is critical to good performance (true for all low permeability covers with or without GMBs and GCLs)
- A well designed/constructed cover with a GMB and GCL can be expected to perform well for a long time



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