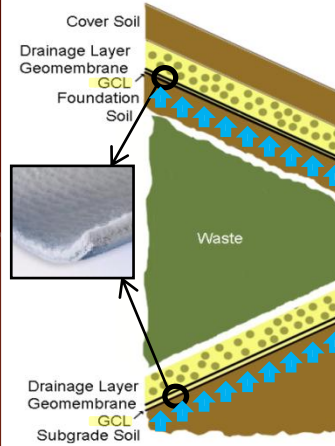


What is a GCL?

- Na bentonite sandwiched between two geotextiles
- Only ~7 mm thick
- Interlayer Na cations allow the bentonite to swell which reduces the hydraulic conductivity to $< 10^{-8}$ cm/s
- Advantageous to use as a waste containment liner/cover.
- Disadvantageous due to cation exchange which is a process where Na^+ is replaced by divalent cations (e.g. Ca^{2+} , Mg^{2+}) in the bentonite which reduces the propensity to swell and increases hydraulic conductivity.

Hypothesis

Conceptual Model of GCL-Subgrade Hydration in a Municipal Solid Waste Composite Cover and Liner System



Water and cations migrate from subgrade pore water initiating cation exchange and causing increases in hydraulic conductivity (excessive leakage).

Materials and Lab Setup

Laboratory Hydration Test Set up and Subgrade Soils

Boardman Silt (ML)



GCLs are hydrated under a confining stress of 10 kPa for 30 or 90 days

Geotextile
GCL
Geomembrane
Compacted Subgrade

Torpedo Sand (SW)



Cedar Rapids Clay (CL)



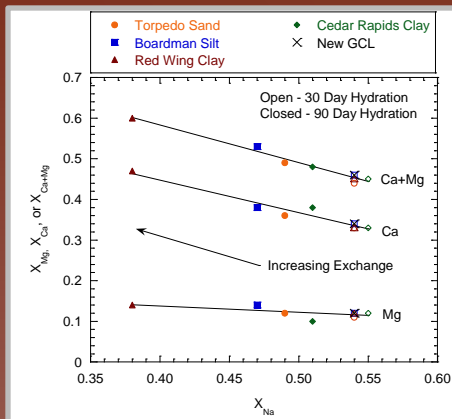
Red Wing Clay (CL)



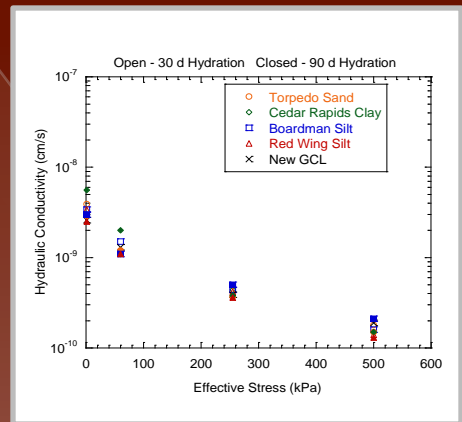
Subgrade Soil	Pore Water Property								
	Ca (mM)	Na (mM)	Mg (mM)	K (mM)	I_c (mM)	RMD ($M^{1/2}$)	pH	EC ($\mu\text{s}/\text{cm}$)	Redox (mV)
Torpedo	0.49	0.29	0.58	0.01	2.2	0.01	8.11	350	140
Cedar Rapids	1.26	0.24	0.34	0.01	3.3	0.01	7.80	770	150
Boardman	0.69	3.47	0.3	0.01	3.7	0.12	7.38	500	170
Red Wing	0.6	2.51	0.12	<0.005	2.7	0.09	7.57	600	170

Results & Conclusions

- Little to no cation exchange occurs in 30 days of subgrade hydration but at 90 days of hydration the bentonite is exchanging up to 30 % of the original Na for Ca
- The amount of cation exchange occurring in each GCL does not correspond to the divalent cation concentrations in the subgrade pore water



- The hydraulic conductivity is not altered by the amount of cation exchange that occurred in both 30 and 90 days of subgrade hydration



Future Work

- Perform hydration experiments for 6 and 12 months to observe greater cation exchange that may occur in a cover system
- Model the unsaturated solute transport to predict the rate of GCL-subgrade cation exchange

