Long Term Effects of Polymer Treatment on Oil Sand Tailings

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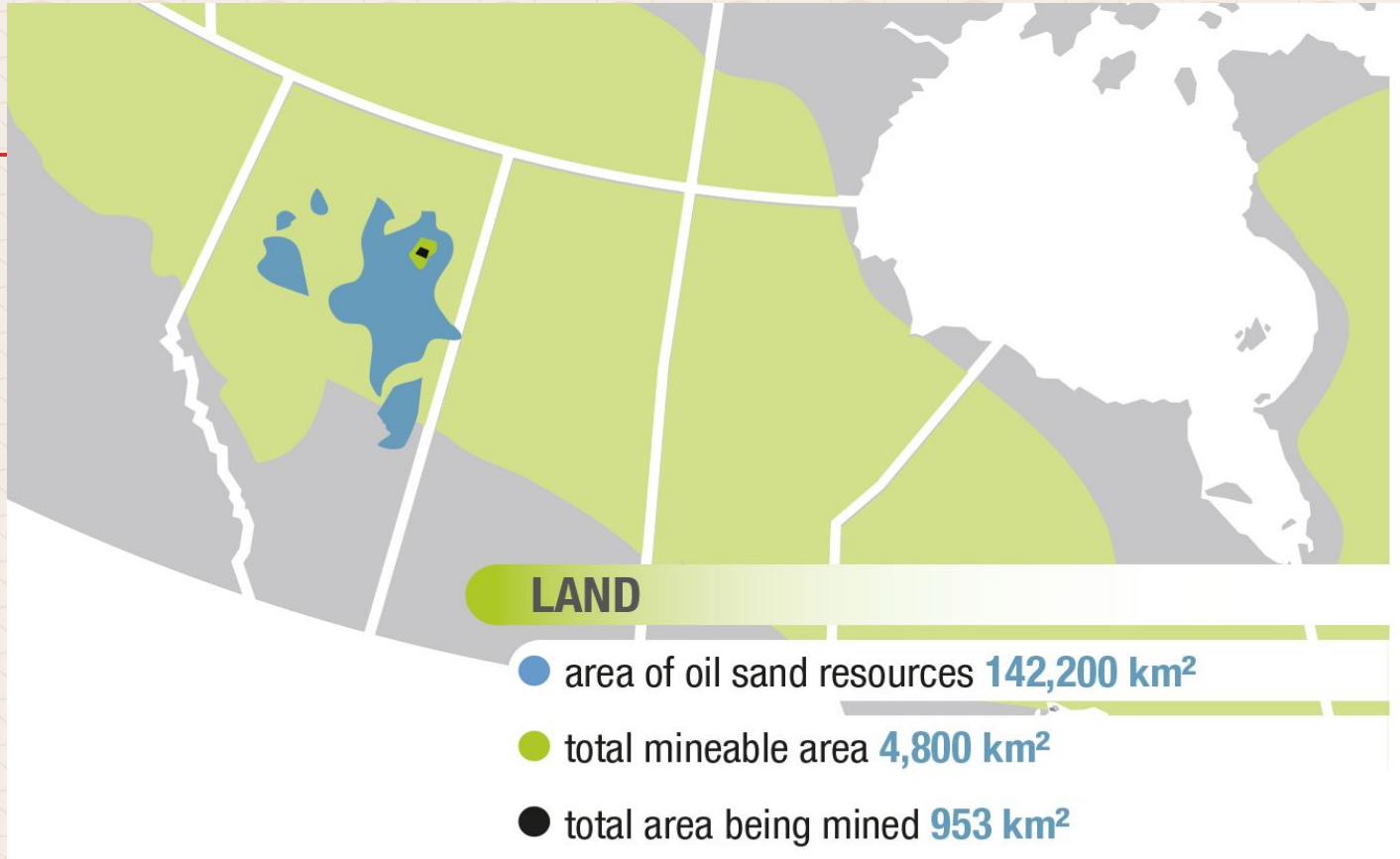
Introduction Oil Sand Tailings

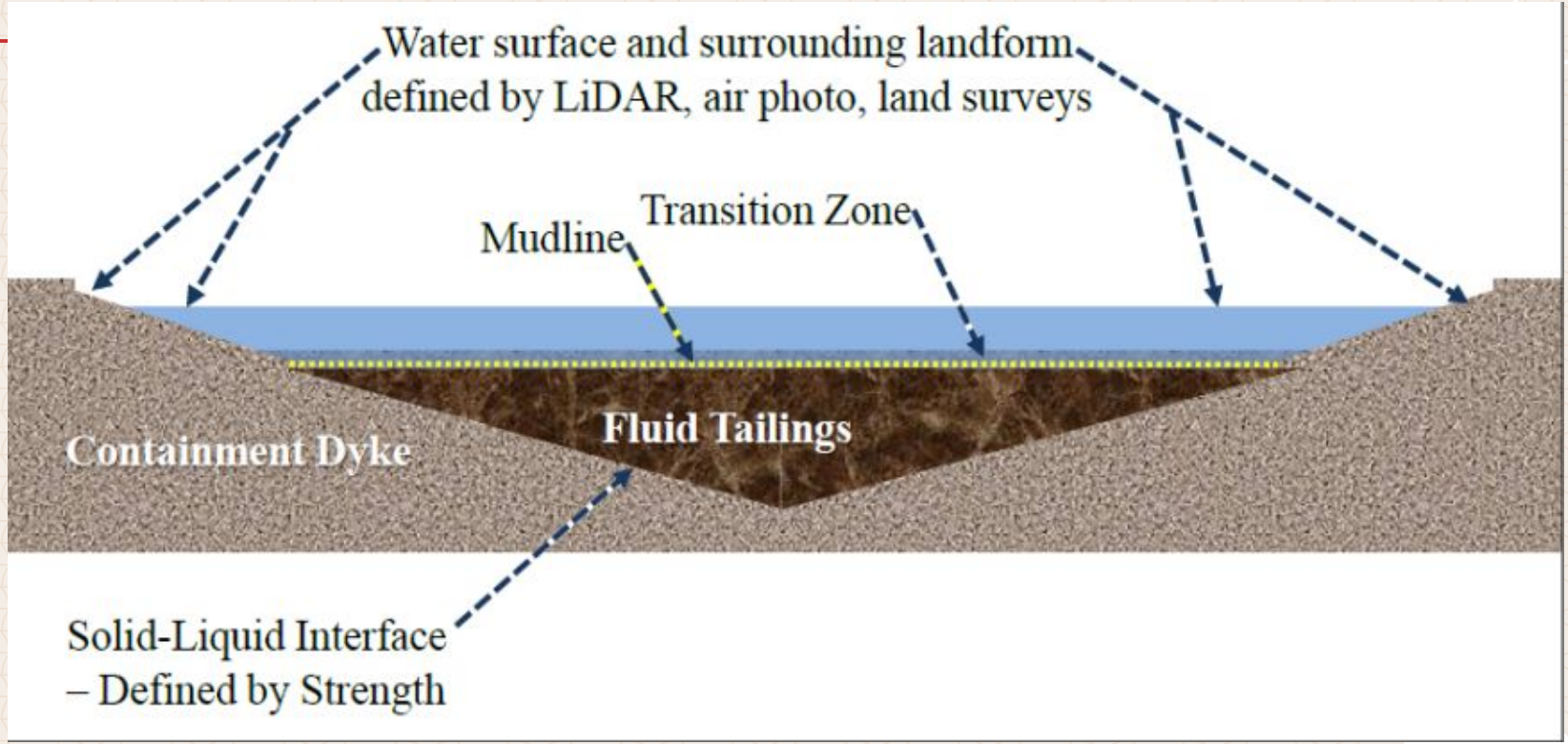
- Tailings are a waste byproduct of mining operations.
- It could be gold, coal, diamond, or in our case oil.
- Oil Sand tailings are especially important because of the toll it is taking on our environment.
- These tailing ponds are some of the largest deposits on this earth.
- There is 1.3 billion cubic metres of fluid fine tailings in northern Alberta alone,.
- The drive for reclamation is at an all time high. Regulators are incentivizing reclamation of old tailing ponds before additional ones are created.

Google Maps imagery, (2021)



Government of Canada Energy Facts, (2020)

What Does a Tailing Pond Look Like?



Syncrude, Tailings measurement plan (2018)

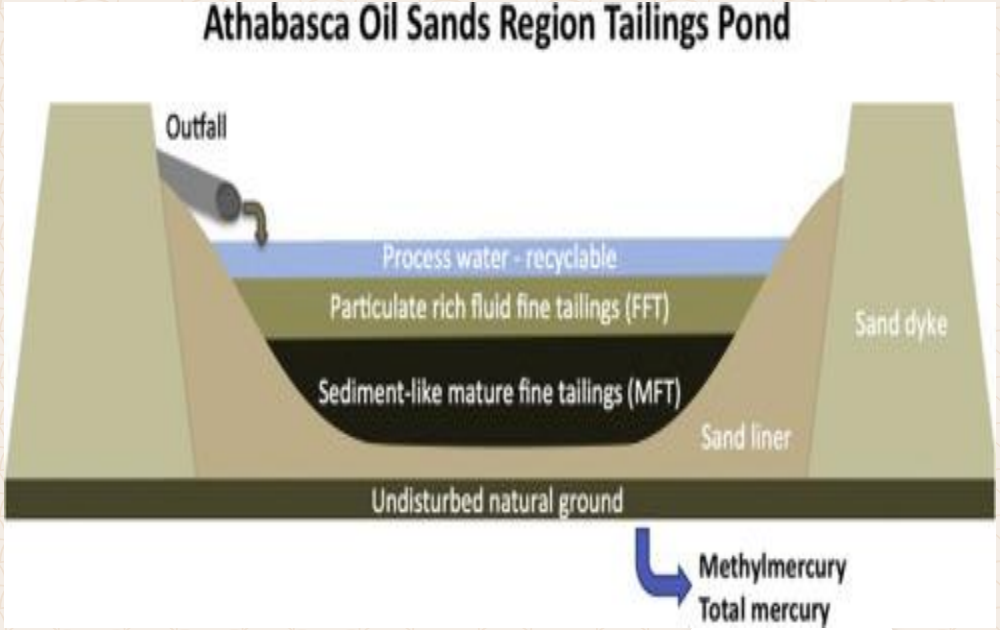
Untreated Material

MFT (Mature Fine Tailings)

Fluid Fine tailings that have settled to the bottom of a tailings pond

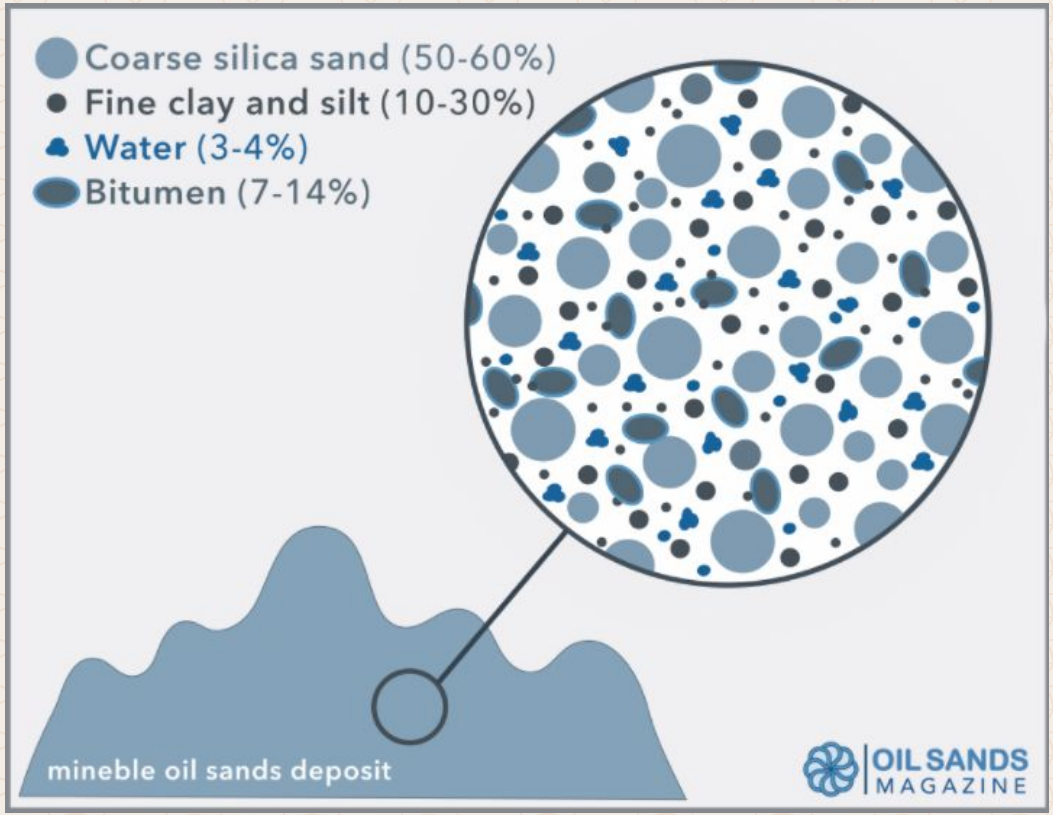
FFT (Fluid Fine Tailings)

The wet and fine waste byproduct of extracting oil from the oil sands

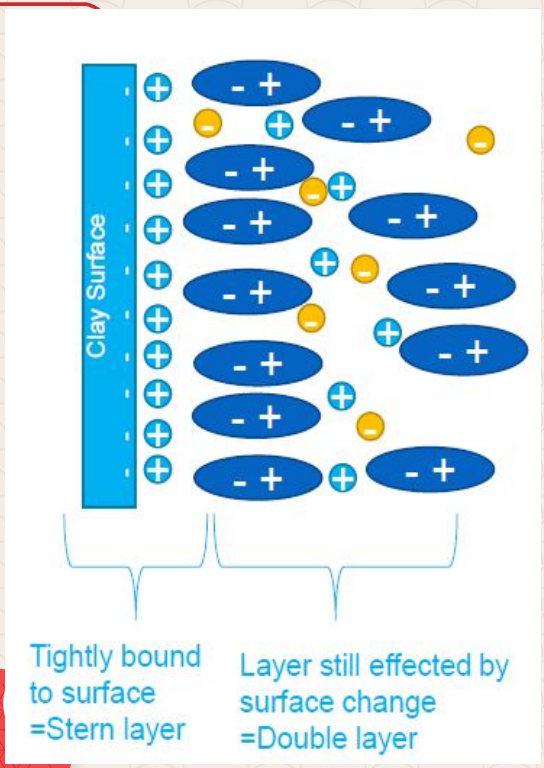


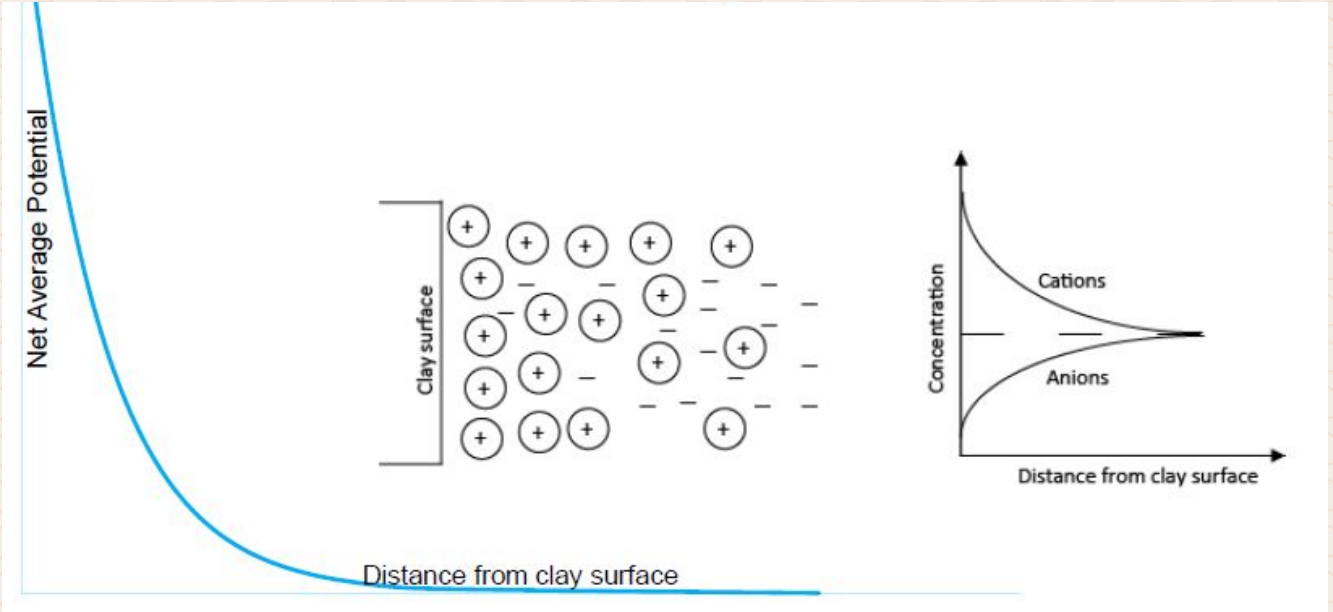
Willis et al., (2018)

What are Oil Sand Tailings Made Up of?



Forces at Play

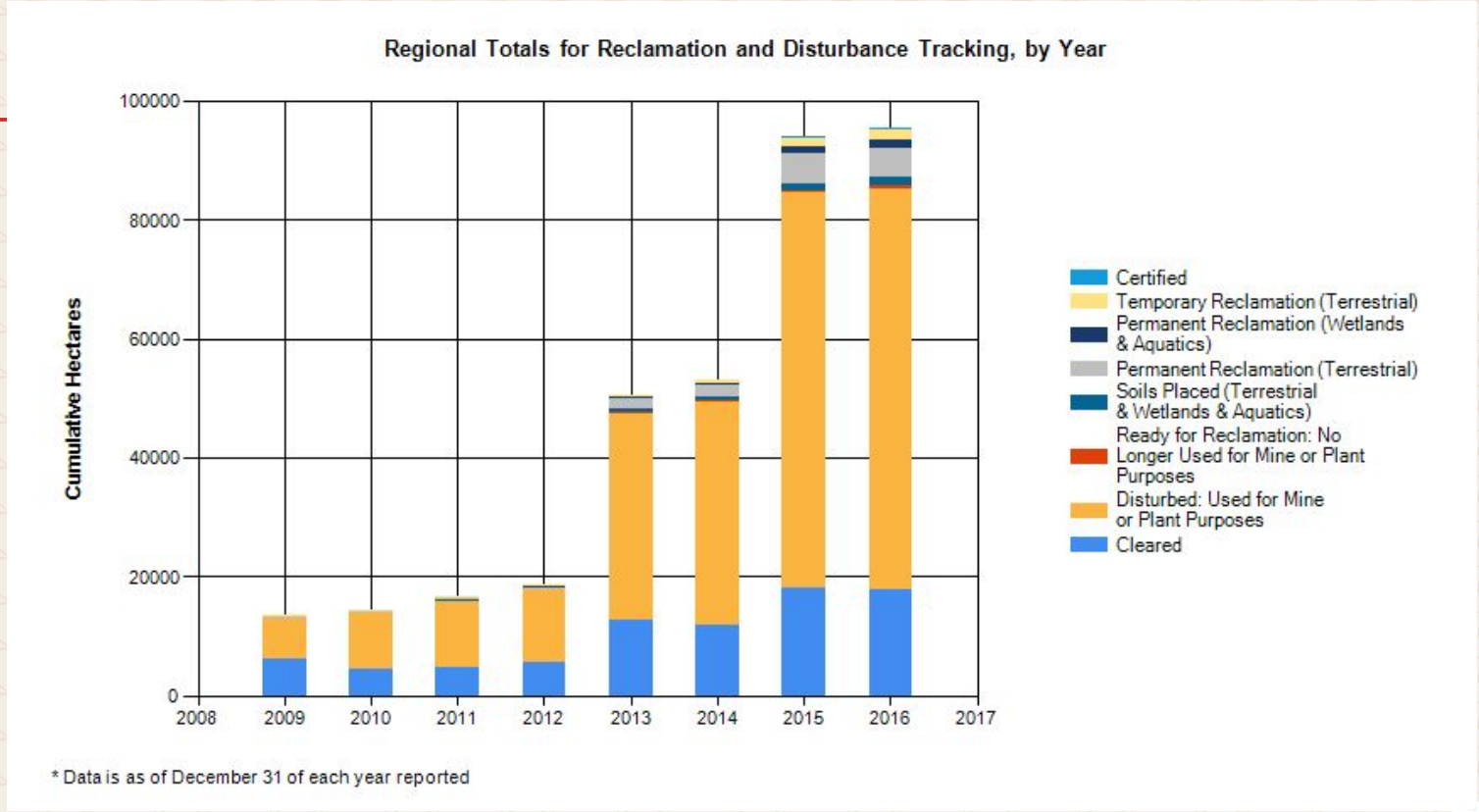




Kaminsky et al., (2016)

This is why it is extremely difficult to dewater oil sand tailings ->
The attraction to the surface is stronger than gravity

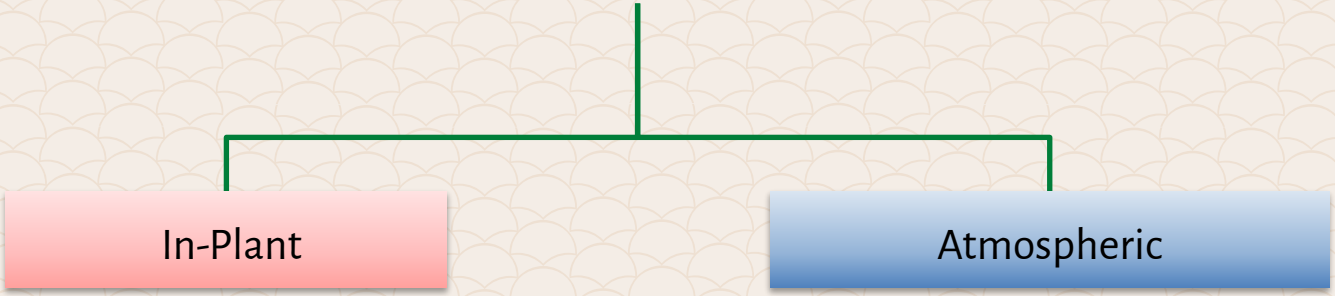
Disturbed Vs Reclaimed Land



It is quite apparent that while the amount of disturbed land is experiencing exponential growth, the amount of reclaimed land has remained largely stagnant.

Alberta Environment and Parks. (2017)

State of Practice Dewatering Technologies



- Thickening
- Centrifuging
- Flocculation or coagulation
- Among others

- Thin lift drying
- Freeze thaw cycles
- Among others

Assessment metrics: Hydraulic Conductivity & Void Ratio

Hydraulic Conductivity

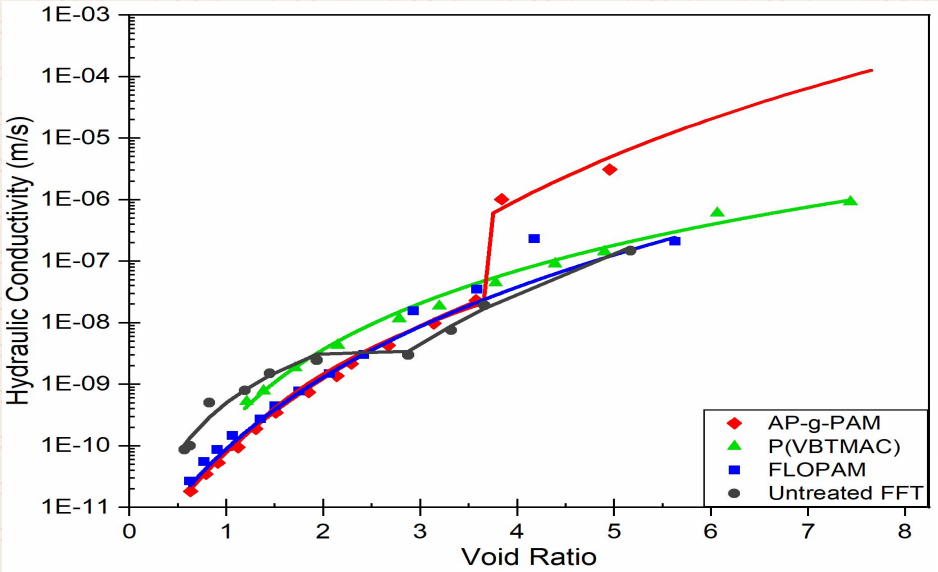
The rate at which water travels within the tailings measured by units of m/day or m/second

Void Ratio

The ratio between the volume of voids relative to the volume of solids, so it is unitless

How effective are these treatment methods?

When only short term results are measured, data can be misleading.
An example is graph below in which the treatment increases the hydraulic conductivity and consolidation rates.
However, when you collect data for a longer period of time, you begin to see the downward trend in the consolidation rate of the treated material.



$$k = f(e)$$

Abdulnabi, A., Amoako, K., Moran, D., Vanadara, K., Aldaeef. A. A., Esmaelizadeah, A., Beier, N. A., Soares, J., Simms, P. (2020). Evaluation of candidate polymers to maximize the geotechnical performance of oil sands tailings. Canadian Geotechnical Journal. (Accepted)

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So is this an actual phenomenon or a one off experimental error?

To investigate, we scanned flocculated tailings literature that compares the consolidation rate / hydraulic conductivity from several papers.

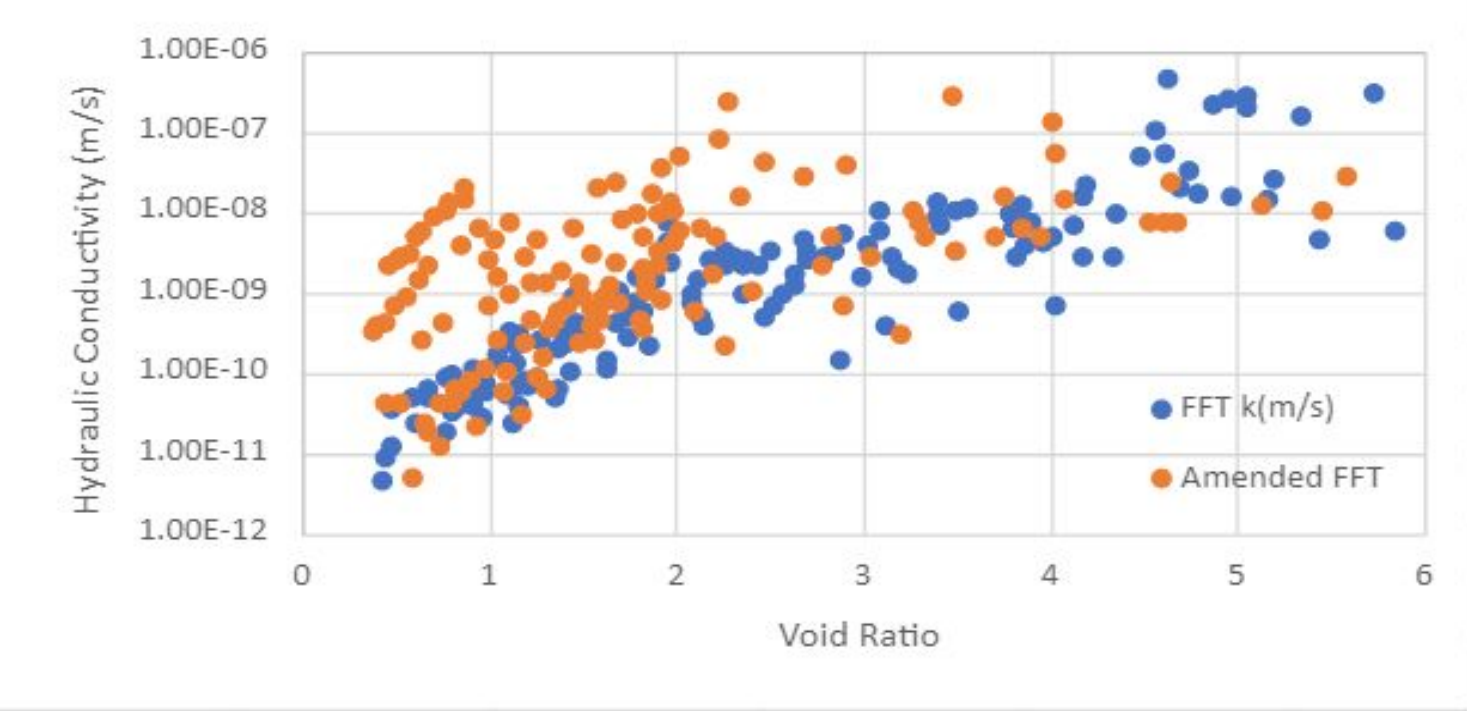
In the following slides we present the literature data that confirm that hypothesis - long term data collecting is critical when assessing chemical treatment of oil sands tailings.

Methodology

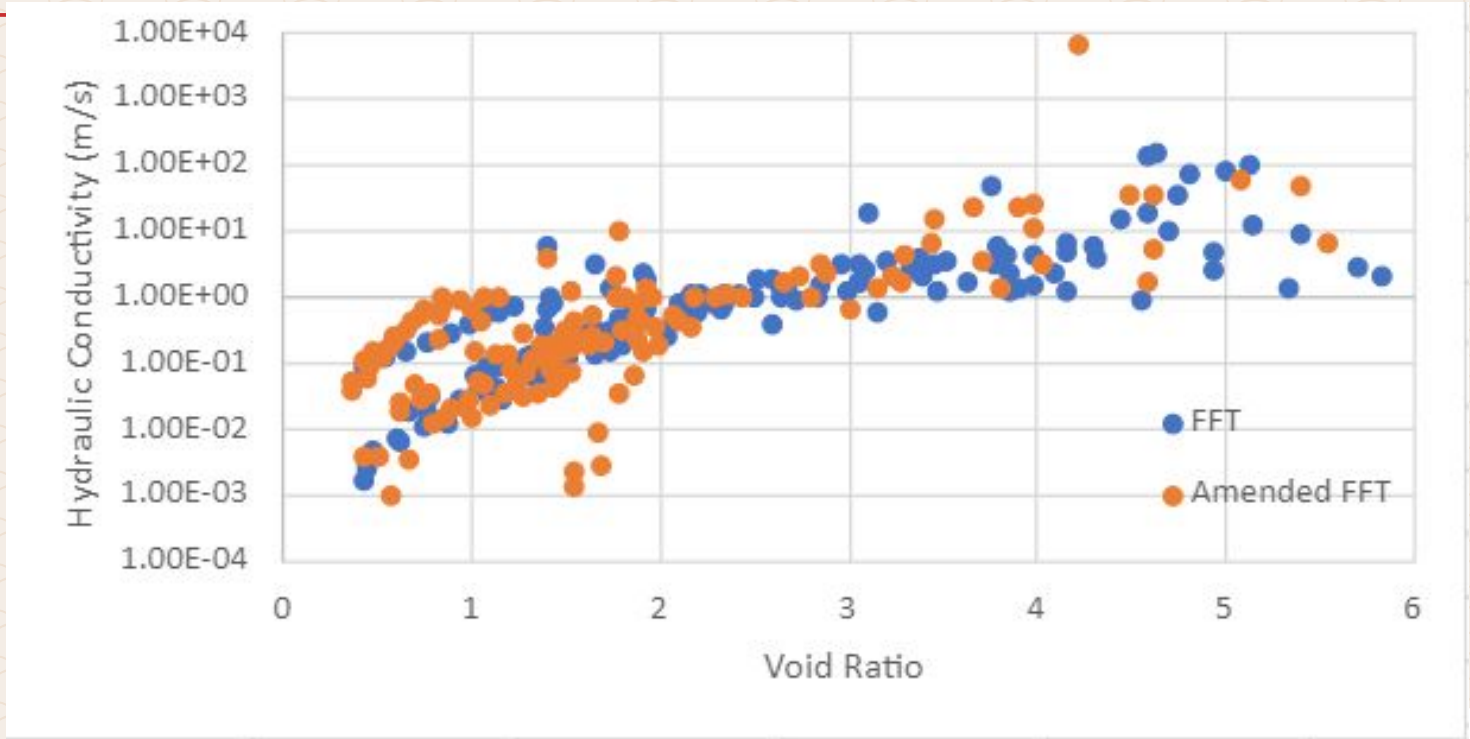
- Extracted graphs from papers that have collected data for longer periods of time.
- Extracted data from these graphs
- Refined the data and created graphs clearly indicating the results that are seen after measuring the data for extended periods of time

In the next few graphs you will be able to see how this data looks when it is measured for longer periods of time.

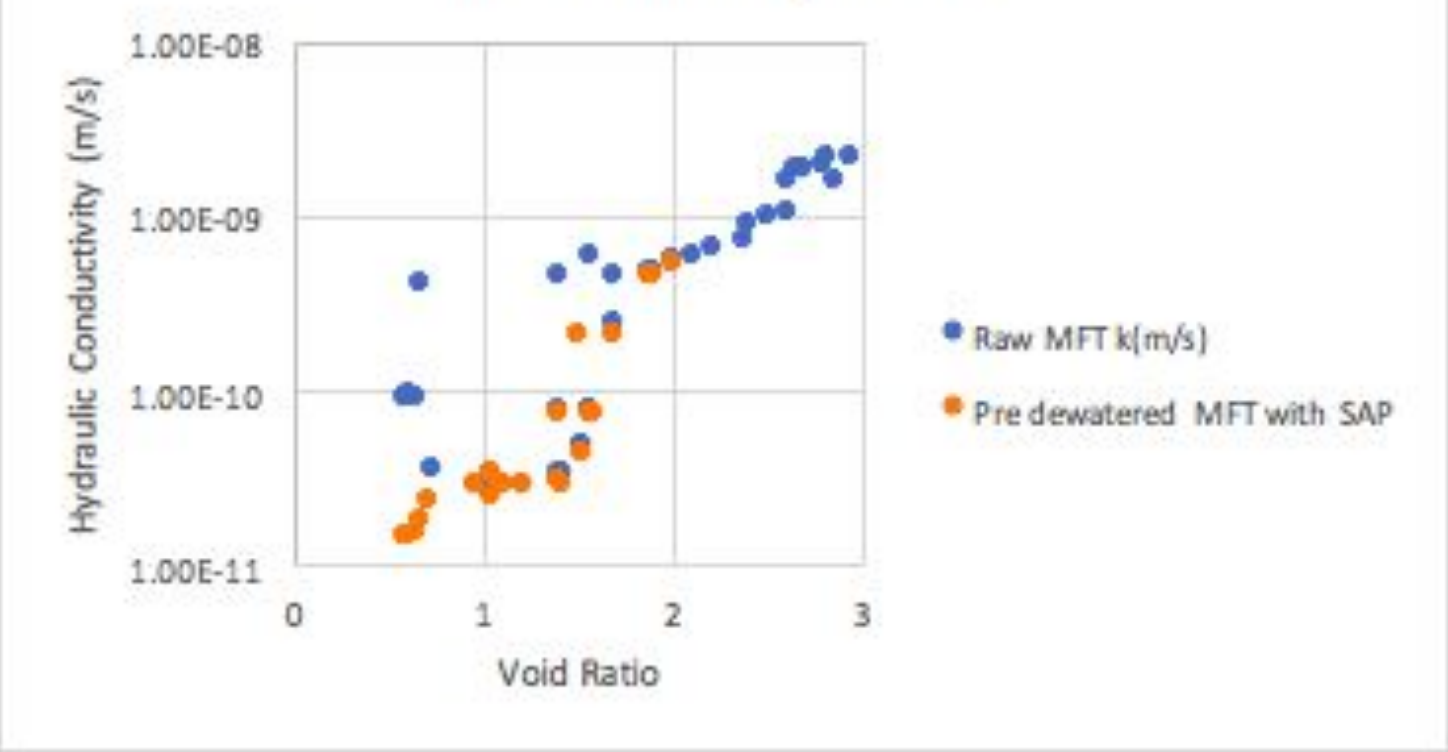
Babaoglu and Simms 2018 - Figure 1



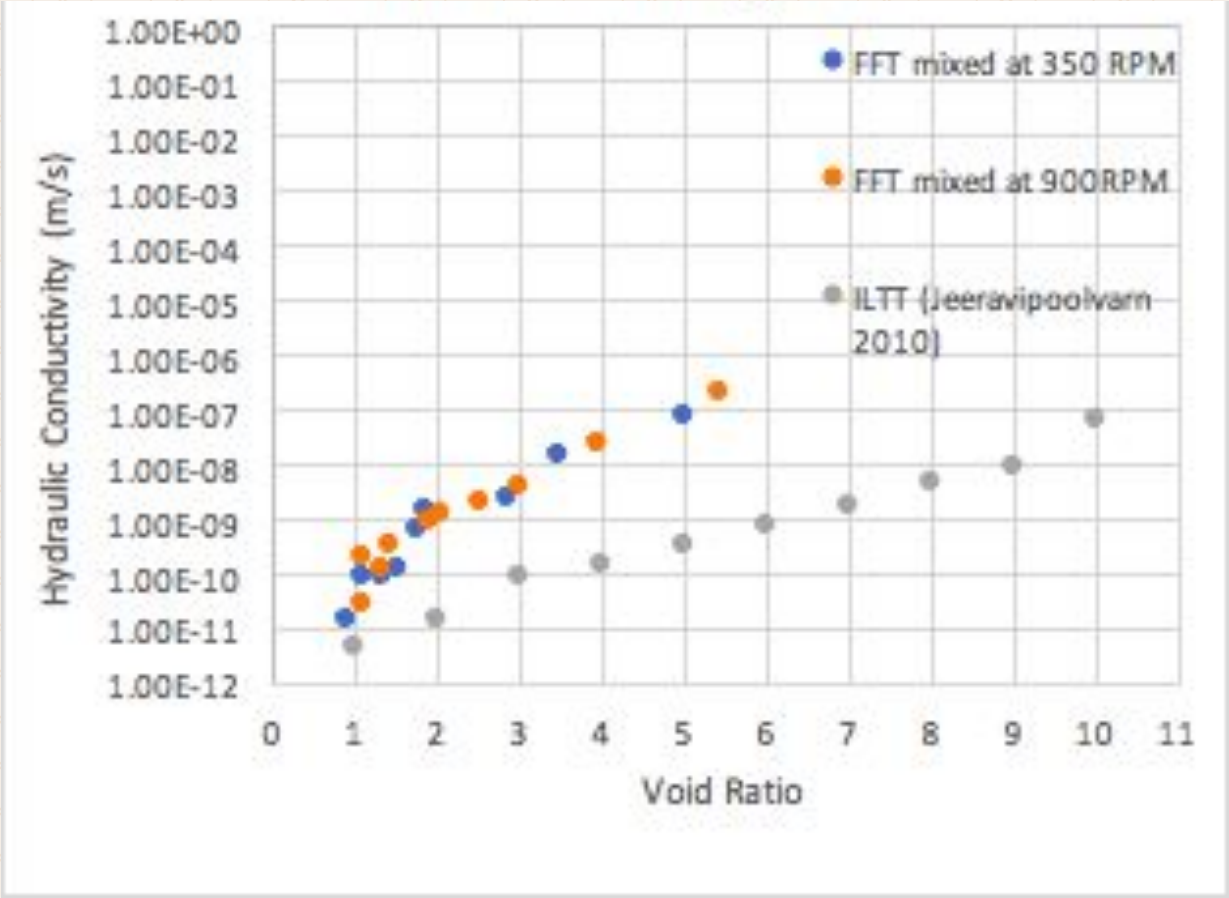
Babaoglu and Simms 2018 Figure 2



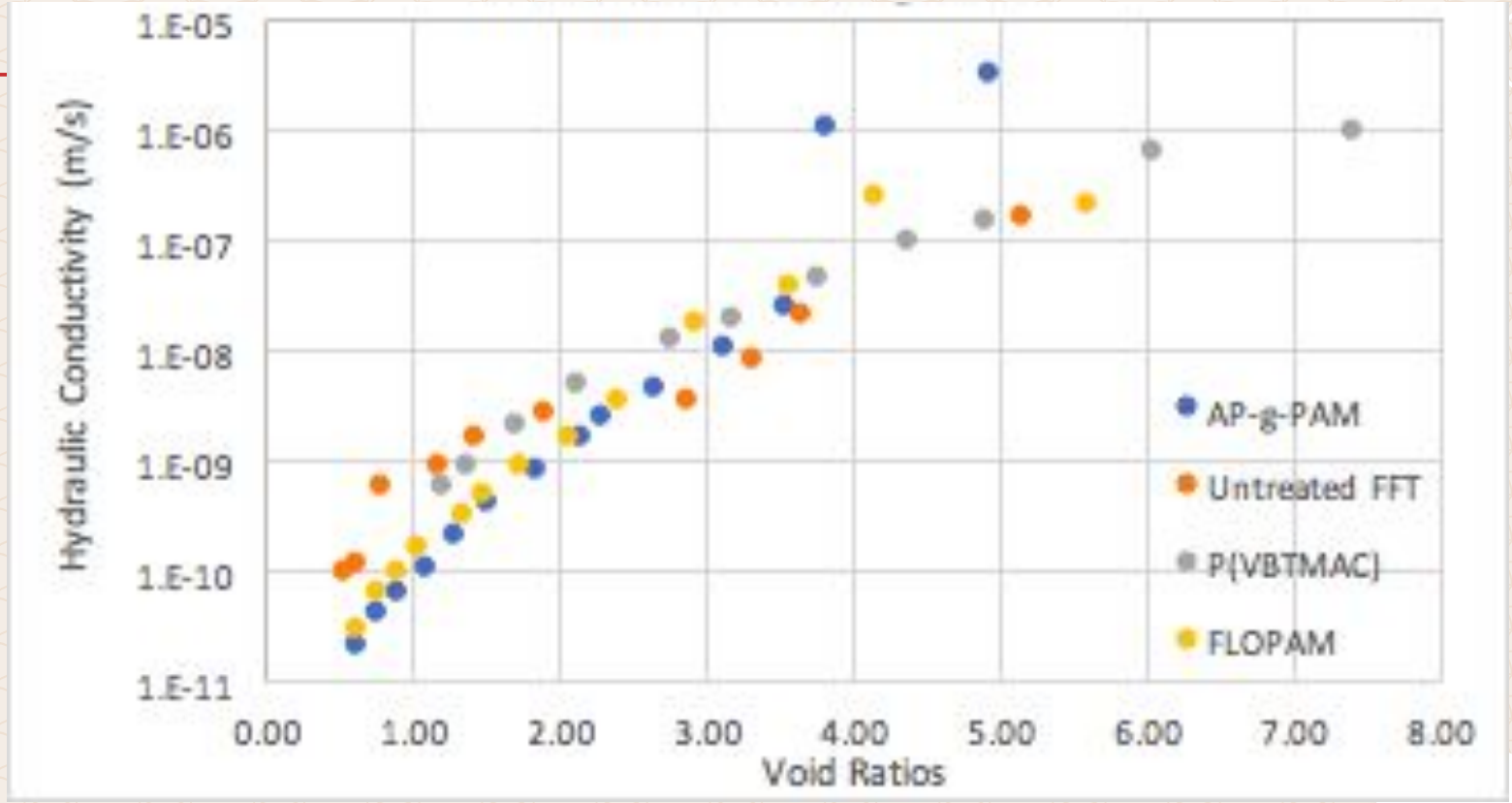
Roshani 2017 Figure 6.8



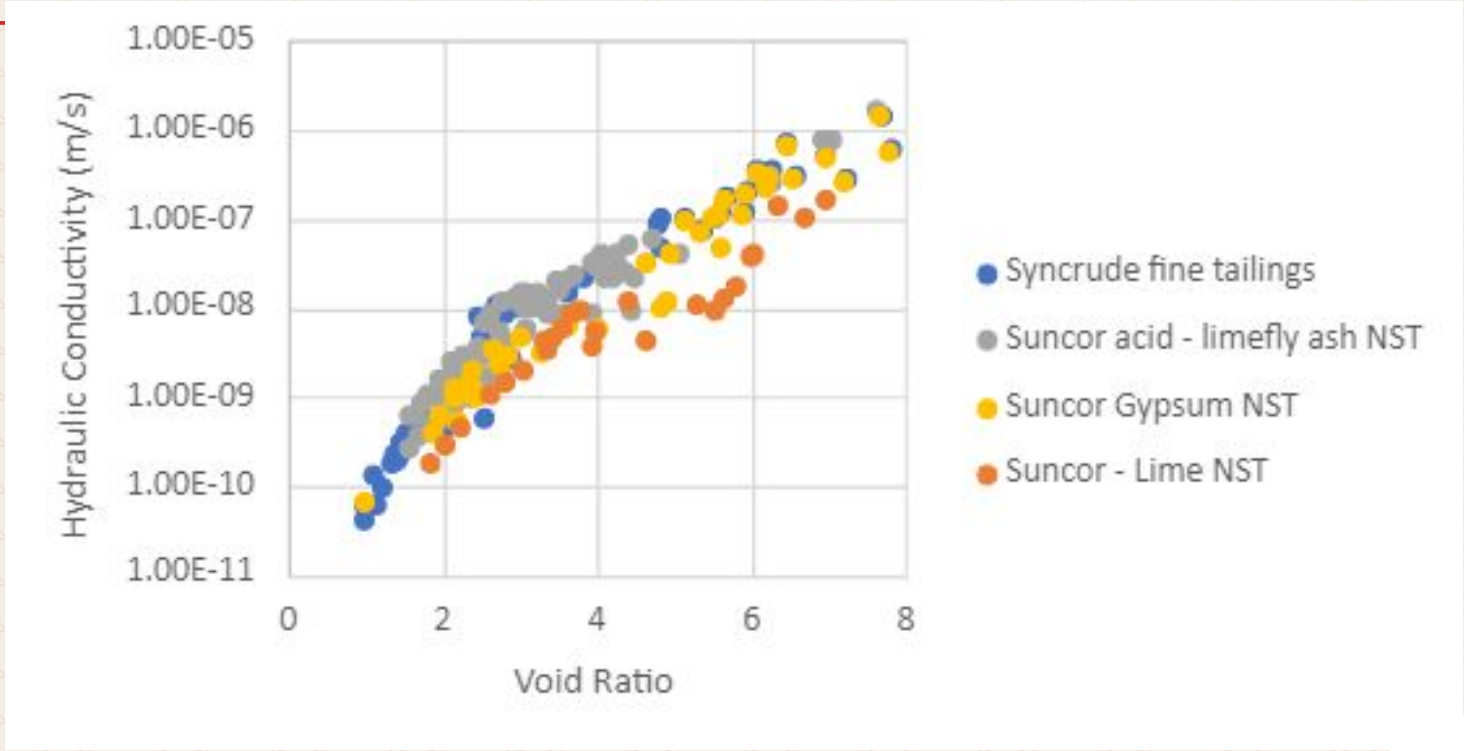
Elias and Beier 2017 - Figure 6



Abdulnabi et al. 2021 - Figures 5



Suthaker and Scott 1996 - Figures 15, 16, 17 (collated)



Hydraulic Conductivity and Void Ratio

At a given void ratio the treated material should have a higher hydraulic conductivity than the untreated material. This is because the higher the hydraulic conductivity the faster consolidation rates. The treatment was applied on the tailings to increase these consolidation rates. However, as time goes on, we are seeing a downward trend in the effectiveness of the treated material in increasing consolidation rates.

Lessons Learned

Through this project, I was able to see the importance of collecting data long term. You cannot truly gauge the effectiveness of a treatment on oil sand tailings if you do not look at what it actually does to the tailings over extended amounts of time. What in the beginning seems entirely positive can become something that behaves less effectively as time goes on. As we were able to witness in the graphs I created, polymer treatment on oil sand tailings is only effective for so long. If reclamation is our goal, other methods must be implemented in order to see positive result down the line.

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