Lessons Learned Toronto Port Lands Contaminated Land Remediation and River Construction

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Agenda

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Overview of Lessons Learned on reducing uncertainty and/or reducing cost through:

1. Value in Data Collection
2. Value in Continuous Improvement
3. Value in Re-Engineering

Project Overview

- $1.25B Flood Protection Project near downtown Toronto creating a new 1km river valley to control flood waters
- Challenge: Contaminated soil and groundwater, infilled former wetland (soft soil), bedrock valley
- Solution: build river with environmental controls.

1) Value in late stage Data Collection

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- Optimizing Horizontal Barrier
- Balancing cost of Vertical Barrier with efficacy in function
- Supporting reuse of sediment dredgeate

Optimizing Horizontal Barrier

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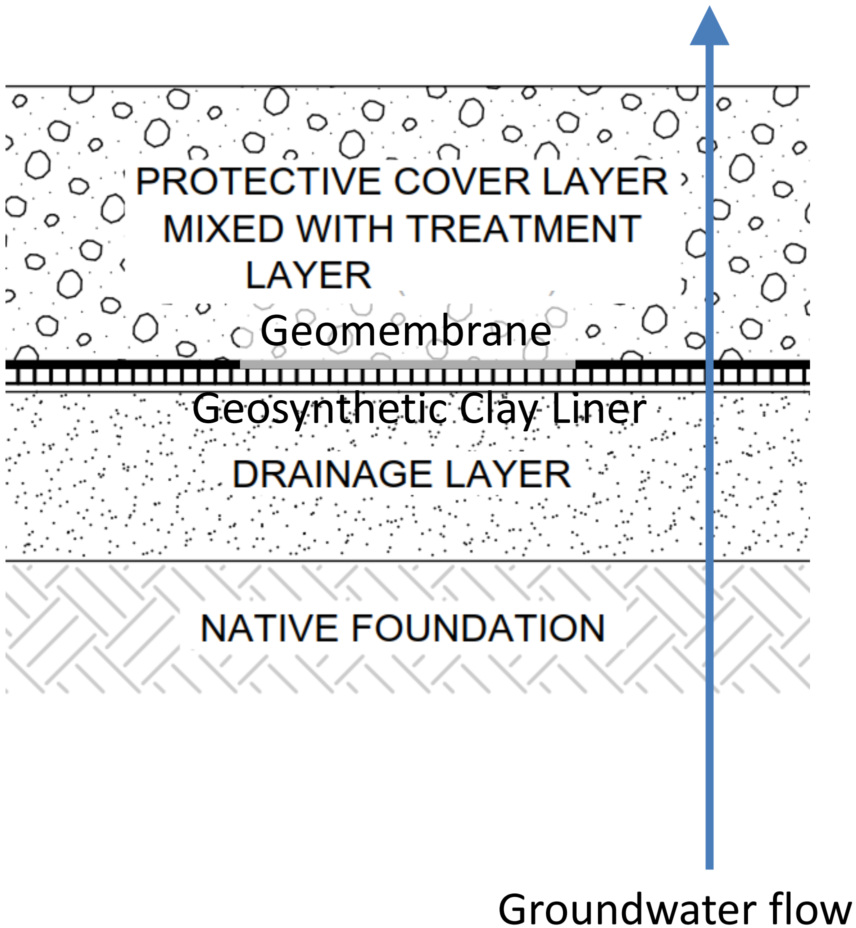
Barriers (vert/horiz) serves two functions: environmental protection and enabling dry excavation

Barrier a multicomposite barrier at the base of the river valley

Designed with Capsim/ Pollute Model for 100 year lifespan

Comprised of:

- Drainage Layer
- Impermeable Barrier
- Reactive Treatment Layer (GAC)



Despite Extensive Data Set….

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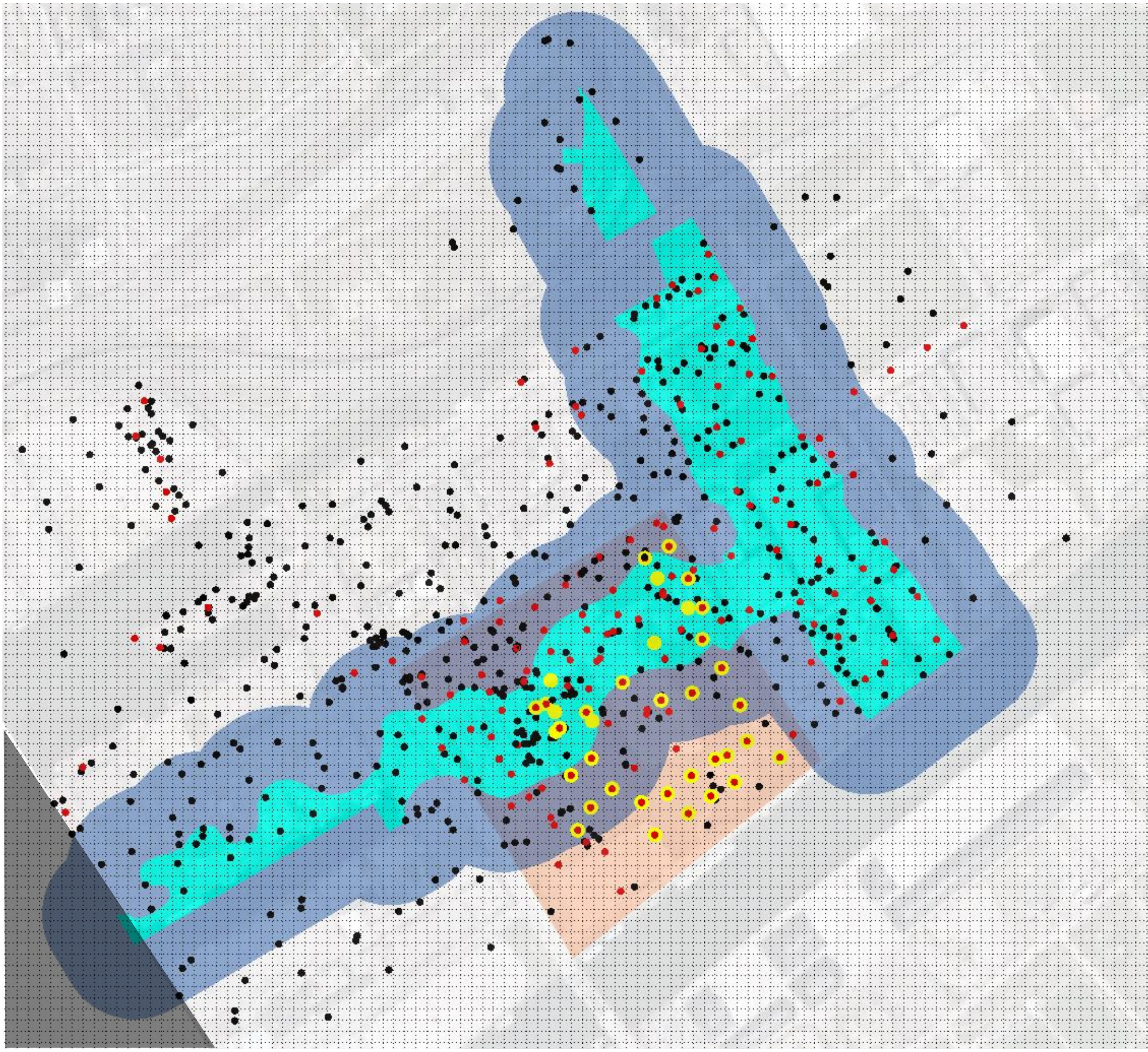
Current Sampled Locations

15m x 15 m Grid (~50 ft x 50 ft)

Waterlot
100m Buffer Zone from Waterlot
Work Package 3

TPHC Sampled Location
UVOST Location
TarGOST Location

Notes for All Slides:
STC – Sheening Threshold Criteria
MTC – Mobility Threshold Criteria



…There were Data Gaps in River Valley

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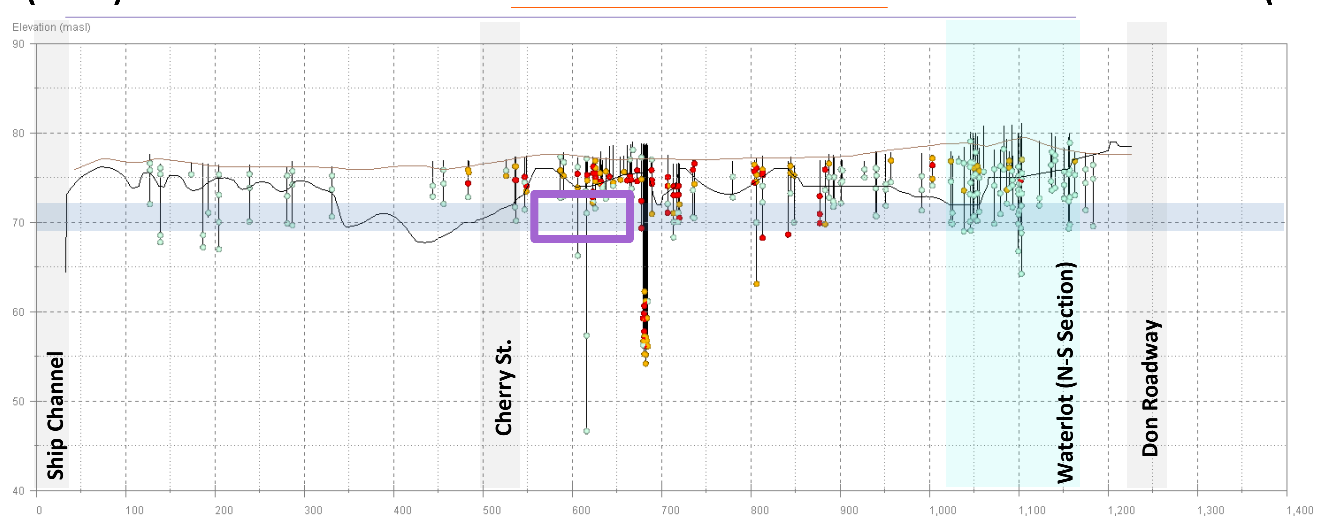
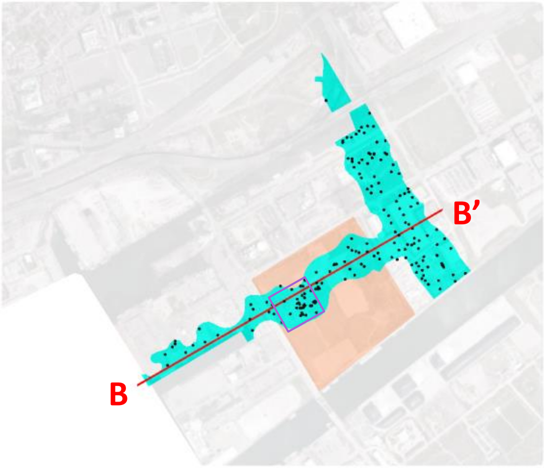
Analytical Data Within Waterlot (and <120 m from Cross-Section Line B-B')

B (West) **B' (East)**





Legend
- Cross-Section Line
- Waterlot
- Final Grade (Dec 2018)
- Ground Surface (March 2018)
- Work Package 3 Area

Analytical – TPHC
- Below TC
- Above STC and Below MTC
- Above MTC

- Streets/Roads/Highways (No Access?)
- ~73 to 69 masl interval
- Waterlot Section

- #1 – Additional Analytical

Data Collection Plan

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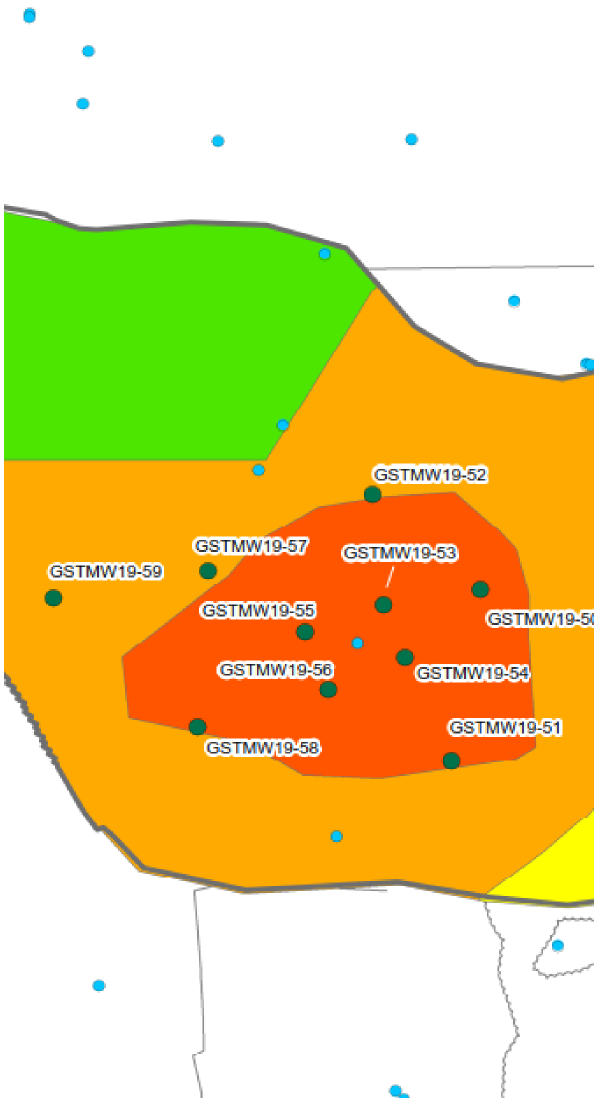
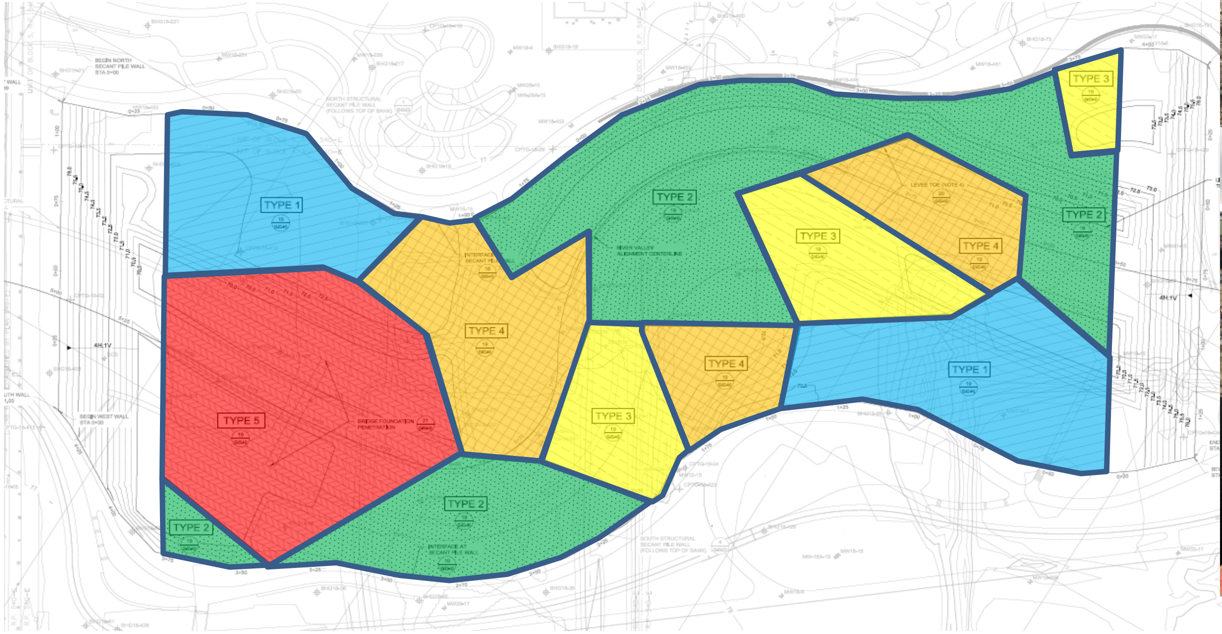
- The area with the most data gaps coincides with the area with the most costly barrier type (ie. with 17.8 kg of GAC/m^2)
- Additional investigation proposed ten temporary monitoring wells with focused screen intervals
- Investigation cost $100k



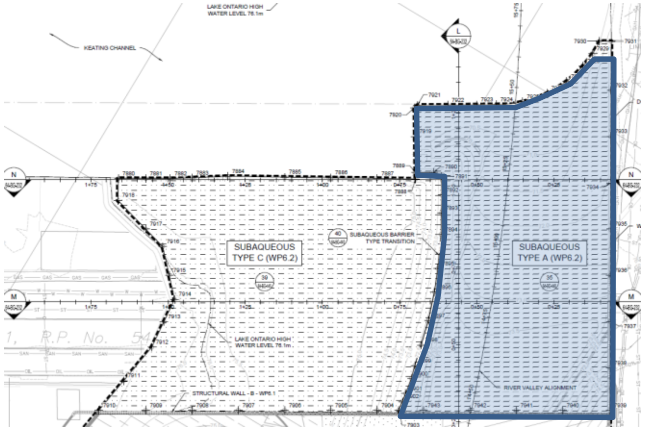
GCL/Barrier Optimization

- Between 60 and 90% Design
- Reduced GAC in cover layer
- $300k savings

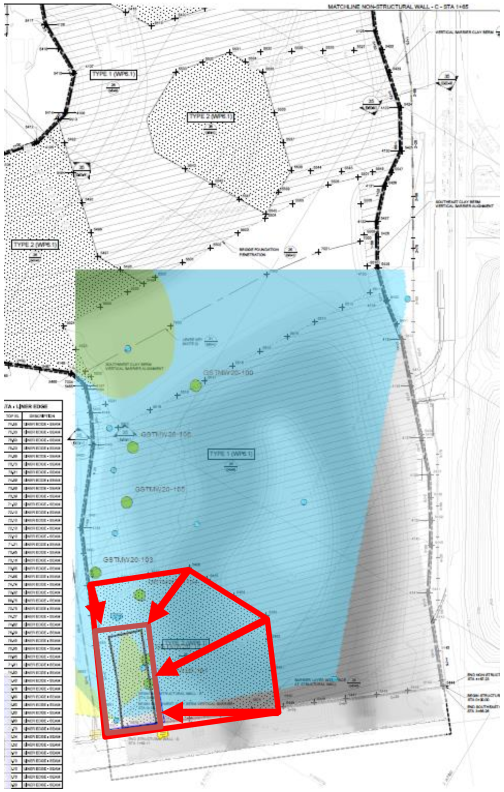


A few other examples:

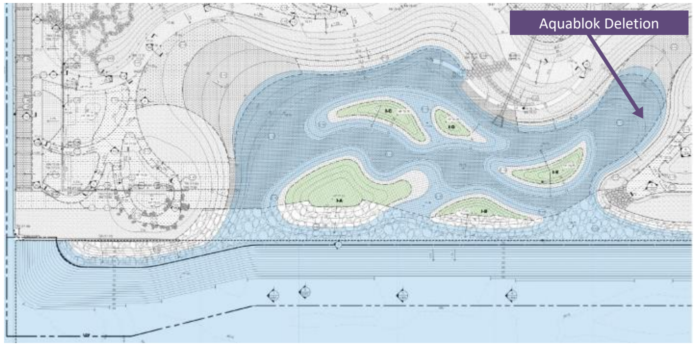
- Similar analysis led to barrier layer changes in other river sections (post 90% design)



$0.5M Savings



$1.3M Savings



$1.2M Savings

Balancing Barrier Costs

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- Dewatering controlled by Cut-off Walls on either side of river
  - Bentonite slurry walls
  - Secant pile walls

Cost-Benefit Analyses

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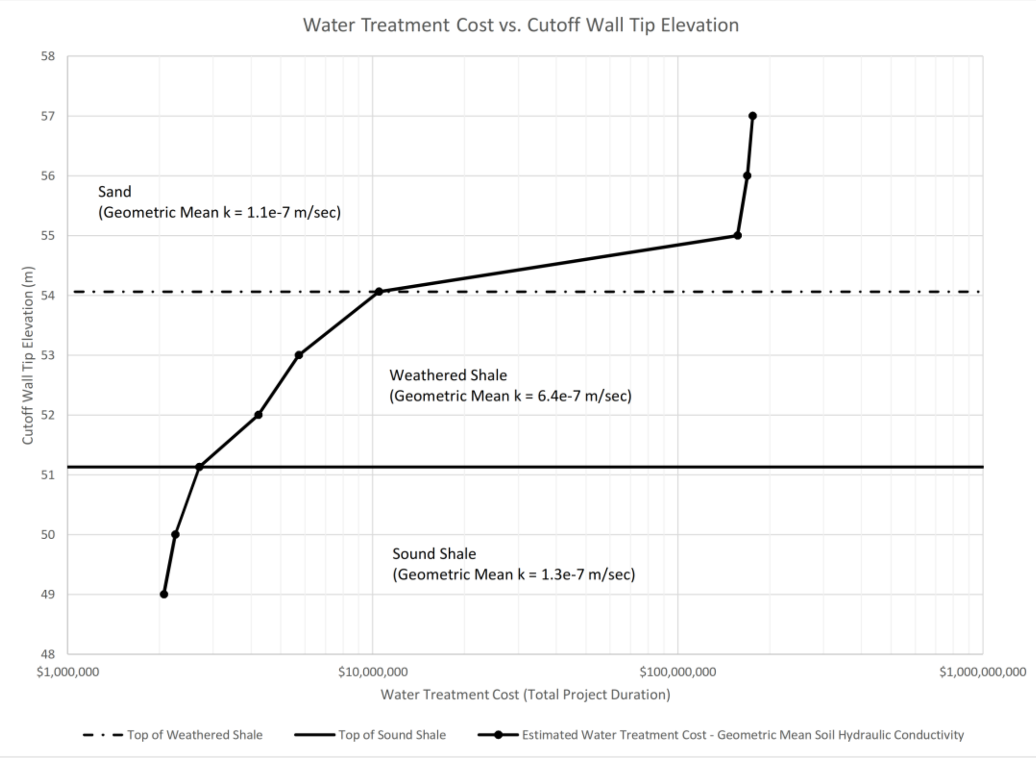
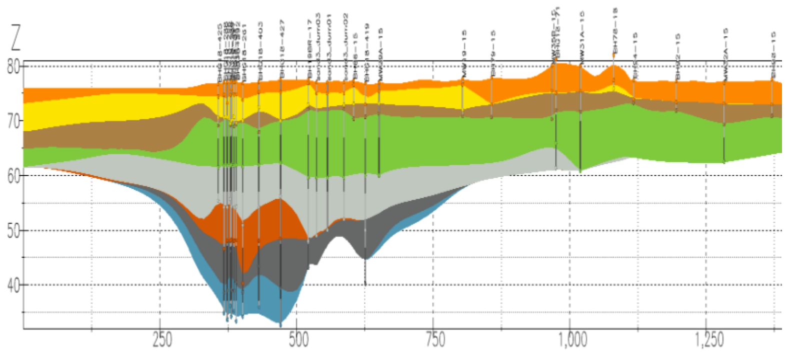
- Shale bedrock target cutoff unit; bedrock valley
- Using existing hydraulic parameters from groundwater modeling team, the dewatering cost of cut-off wall depths were assessed.
- Deeper the cutoff wall, the lower the dewatering cost
- Limited accuracy in data and sensitivity analysis showed high variability in cost estimates





Cutoff Wall Design Refinement

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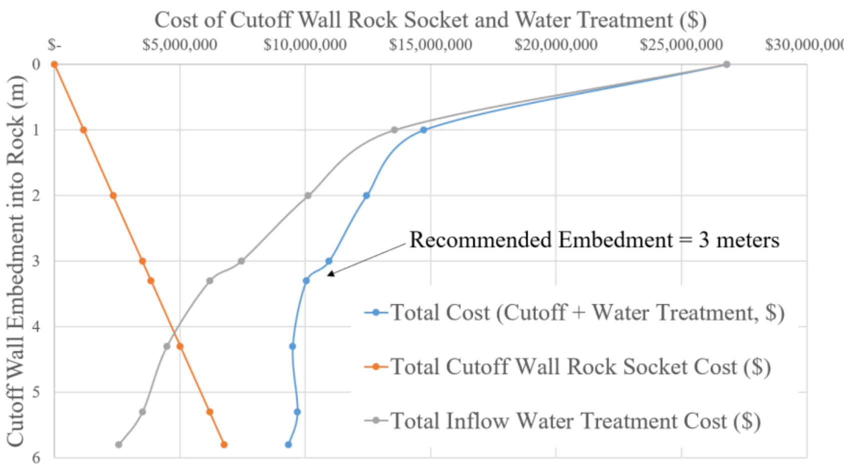
- Field Investigation ($300k)
  - Packer testing
  - Borehole geophysics
- Balanced dewatering cost uncertainty against deeper wall cost
- Optimum cutoff wall embedment found to be 3 metres below top of rock
  - Limited benefits in GW flow reduction after deepening cutoff wall beyond 3 m



Supporting Reuse of Dredge Sediment

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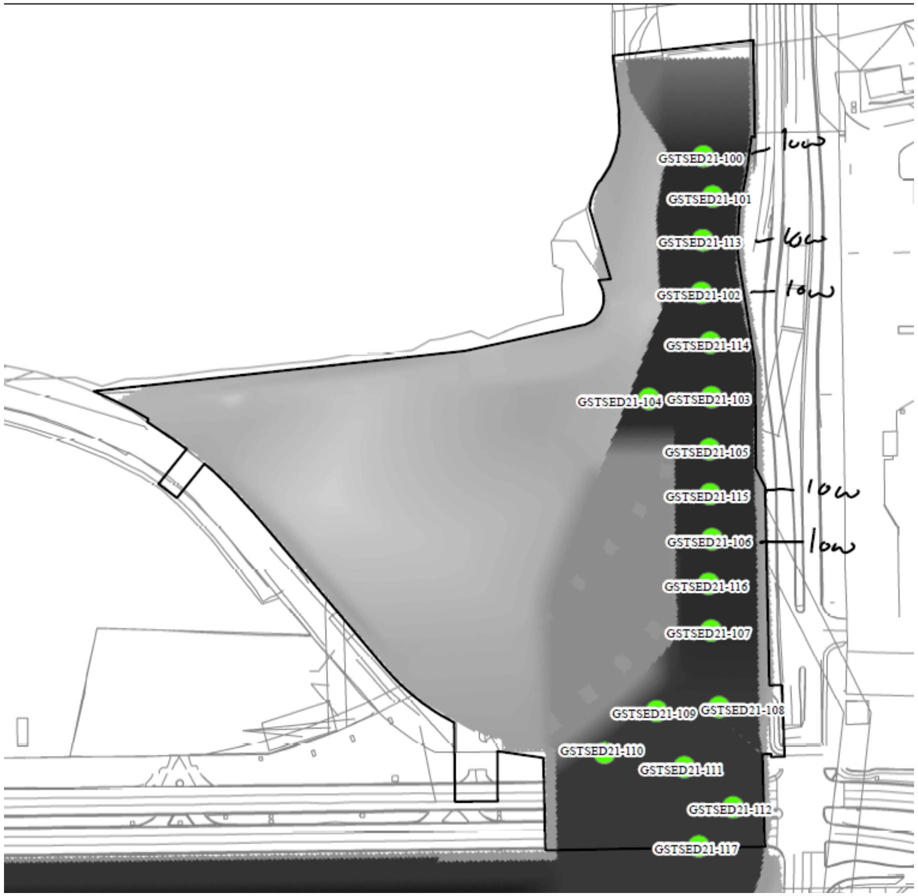
- 50,000 m^3 of sediment to be dredged from the river
- Initial 2019 shallow sampling not at depths or sampling frequency to validate sediment reuse
- 90% design; base cost assuming off-site disposal - $5M
- Field program $300k
- 33 Samples collected, supported sediment reuse within the Port Lands
- Cost Savings: $3.5M



2) Continuous Improvement

- Odour Monitoring and Control
- Updated Design To Lake Level

Odour Management Good Intentions

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- Lessons Learned from other large soil remediation projects that each received over 100 odour complaints; community protests; stopped work and reset odour management
- For those lessons learned, a rigorous Odour Management Plan was established for the river project.
- But…… spring, 2019…


Oily pipes

Continuous Improvement

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- Review of odour and VOC mitigation equipment and mitigation procedures.
- Analyzed existing data trends and recommend areas for improvement
  - Predicting odours
  - Mitigating odours at source
  - Odour complaint response protocols
  - Training on Odour Mitigation
  - Roles and Responsibilities (Odour Champion)
  - Greater feedback loop, response time and direction from the Air Quality Consultant to the Subcontractors.
- Resulted in team approach in mitigation; and greatly diminished subsequent odour complaints

Increased Definition on Monitoring and Mitigation

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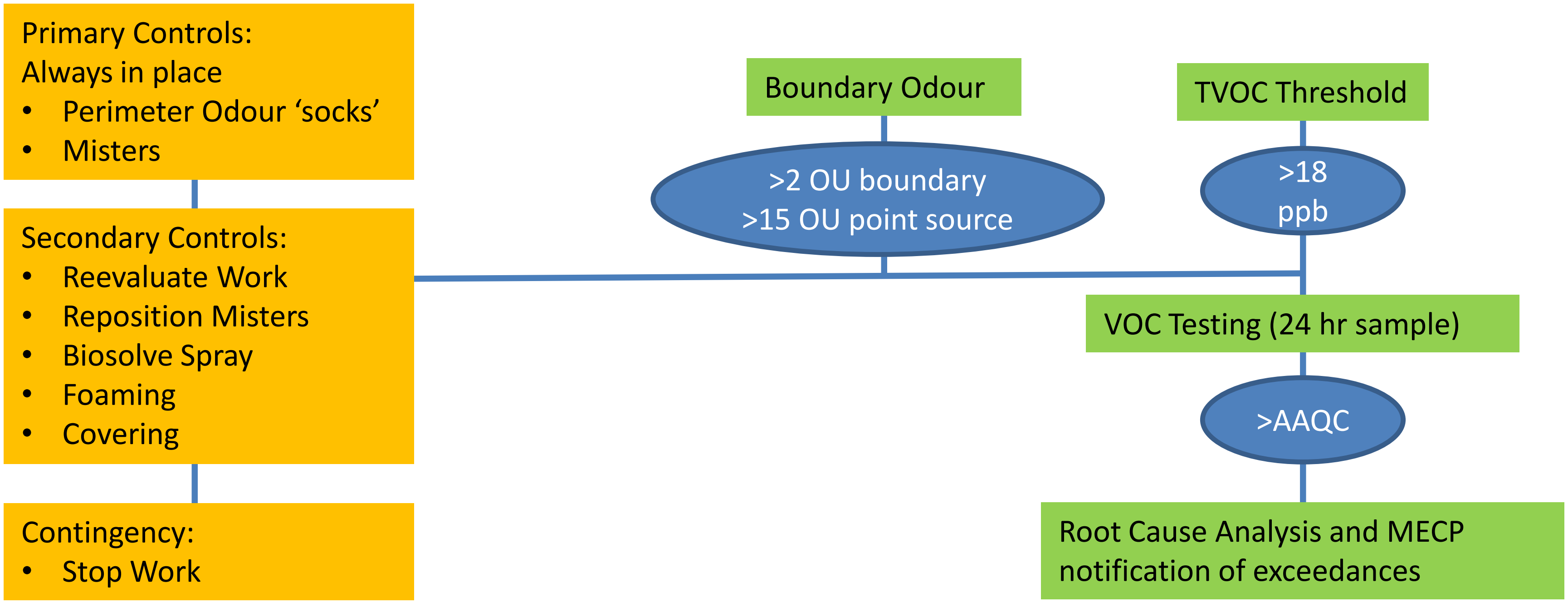

❖ Odour mitigation is a team effort and all parties need to be aware of the available tools and the stop work potential

Odour Monitoring Dashboard

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- Dashboard for odour, noise, turbidity, dust, VOCs, vibration and surface water chemistry
- Odour dashboard below

Updated Design-To Lake Level

Reevaluation of design based on new high lake levels.

- 2017, 2019 gave new record Lake Ontario lake levels, extensive waterfront flooding and beach erosion
- Ran hydrogeological model at multiple high lake levels
  - Toronto 2017 record lake levels
  - Toronto 2019 record lake levels
  - High lake level changed twice during project
- Assessed sensitivity of model to changing recharge conditions due to Port Lands redevelopment
- Assess interaction of groundwater with vertical cut off walls

Criteria	Lake Level (masl)
Original Lake Level Design Criteria	75.8
May 2019 Design Change	76.05
November 2019 Design change	76.2

Hydrogeological Model

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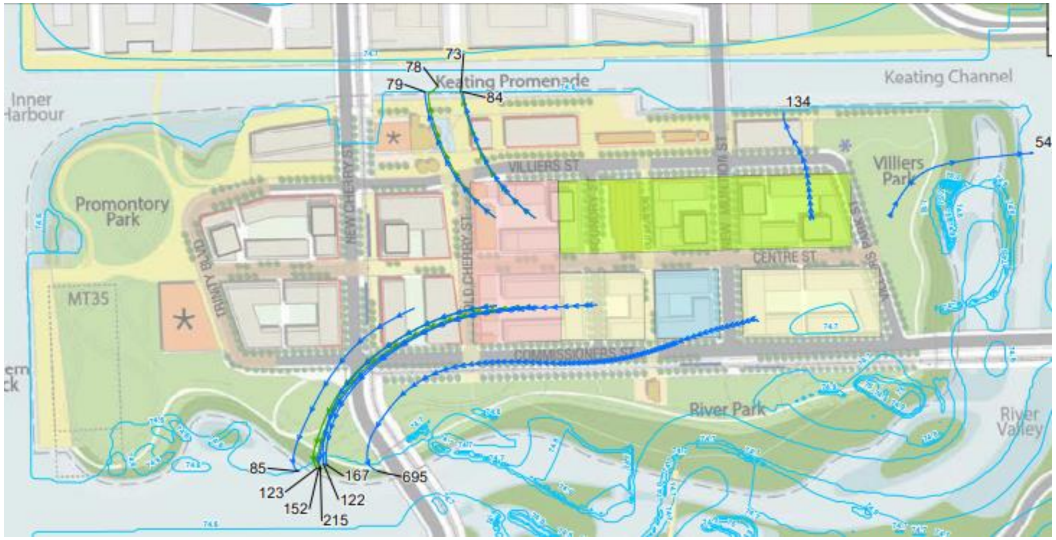
Before and after boundary control using a site wide groundwater model to demonstrate efficacy to regulators

- Demonstration of containment of groundwater and lengthening the flow paths
- But….sensitivity to lake levels?



Outcome

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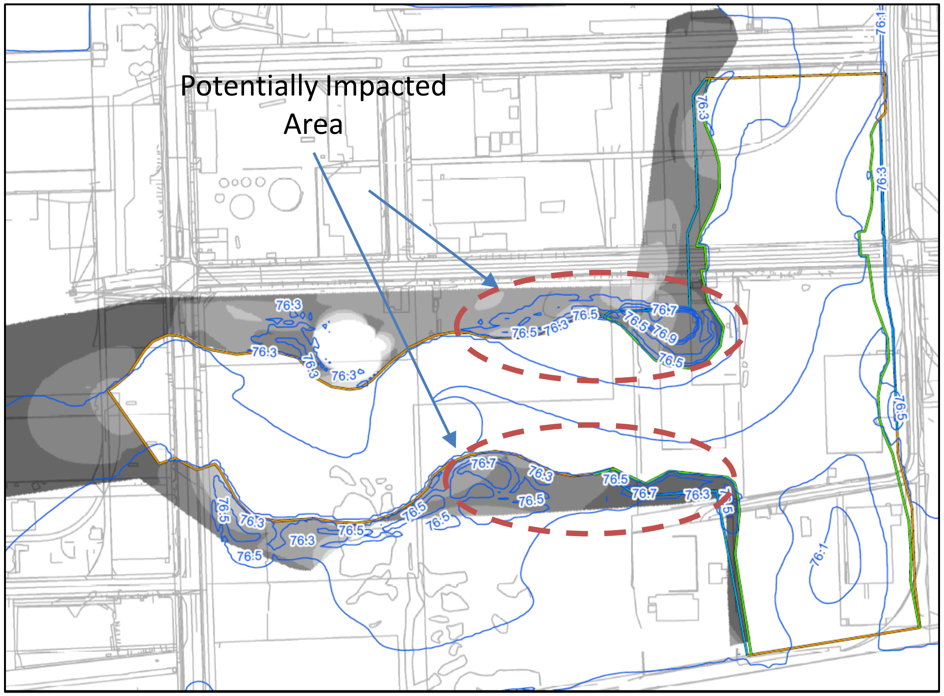
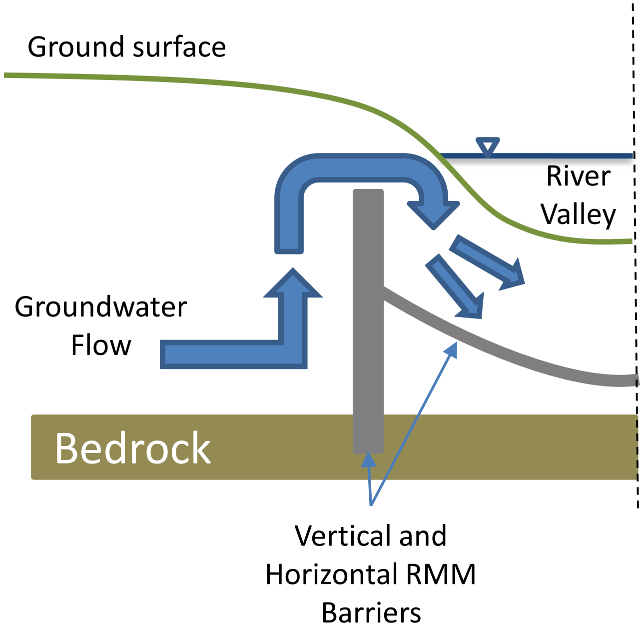
Areas Potentially Impacted by Groundwater Mounding Behind Vertical cutoff walls



Mounding Can Result in Flow Over the Vertical cut off walls



Final elevation of cut off wall kept at higher elevation = No modeled flow over Vertical Walls

Re-Engineering

1) Cutoff wall – post construction re-engineering
2) Cutoff Wall – change in type

Cut off Wall – Post Construction Reengineering

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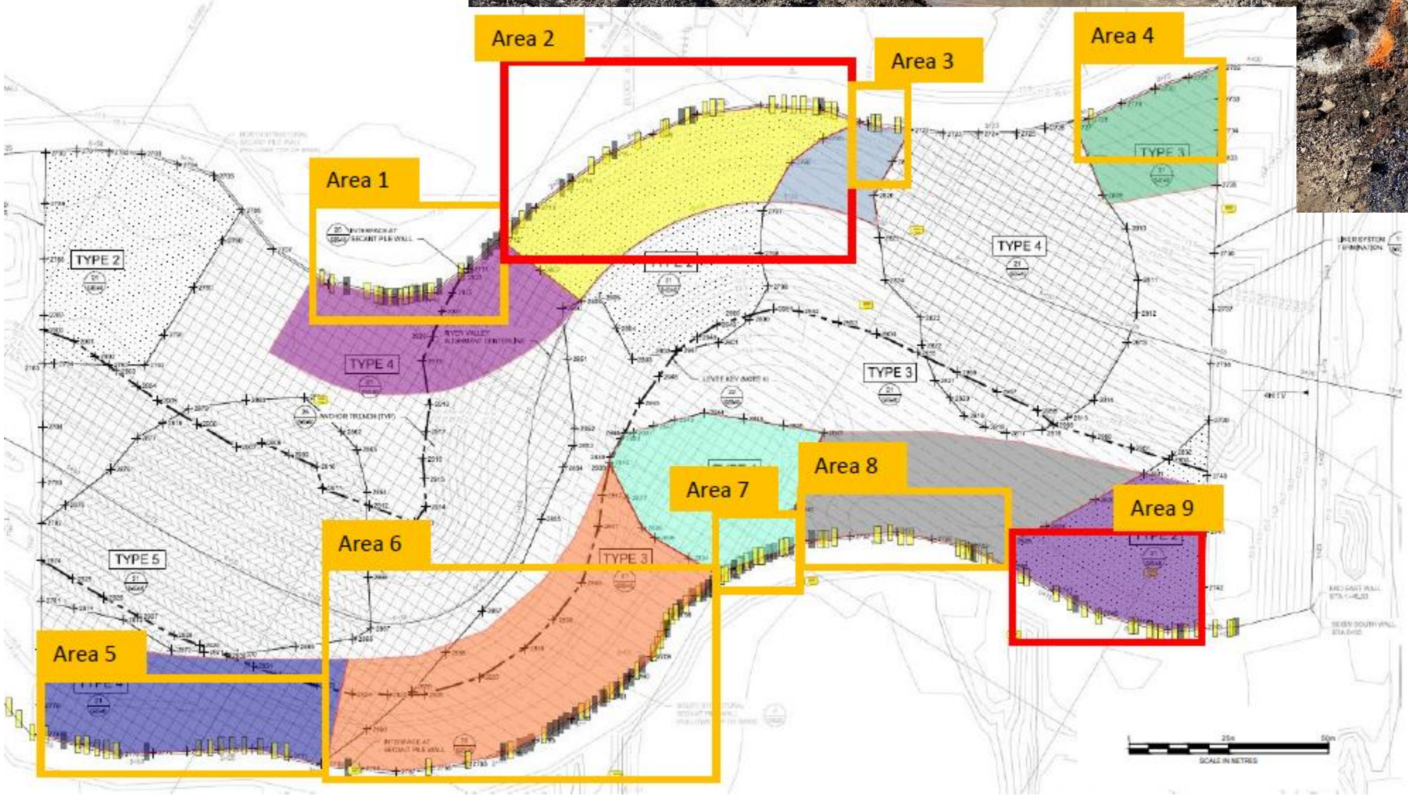

Reengineered Horizontal Barrier Edge

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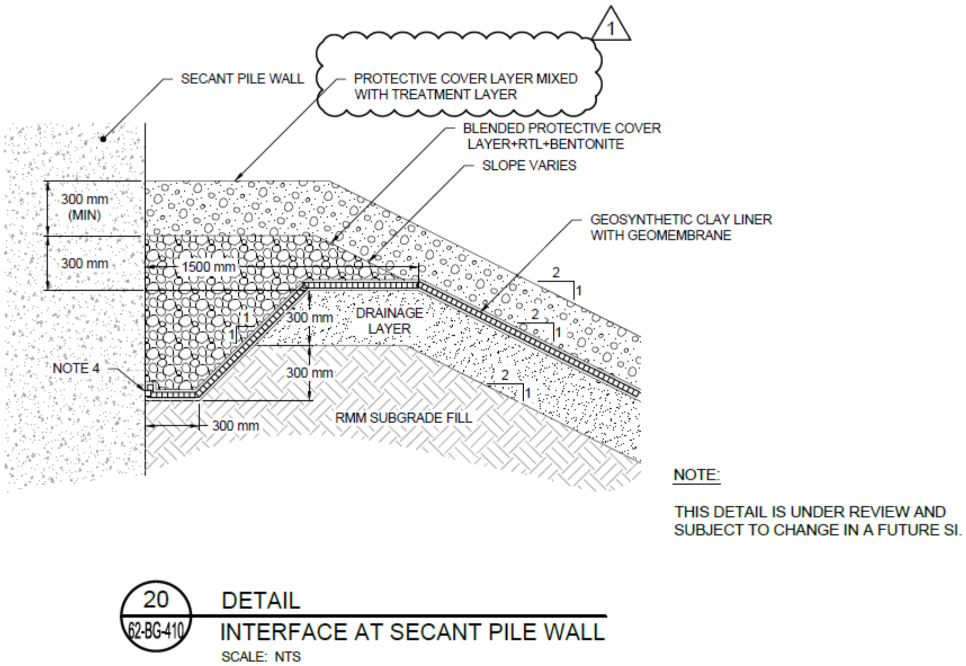
- Each seepage was evaluated and modelled (seepage rates, solubility limits, elevation)
- Seeps are being sealed, but regardless:
  - Majority of seeps will be below the horizontal barrier
  - In one location, the design was modified to bring the horizontal barrier higher up the secant pile wall

Modified Design



Mid-Construction - Reengineering

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- Cutoff wall constructed with overlapping secant piles and slurry walls
- Secant Pile productivity – 1 linear metre per day
- Slurry Wall productivity – 15 linear metre per day




Conversion to Slurry Wall Barrier

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- Replaced 192 m of planned secant pile wall with slurry wall in areas where excavation setback was possible (slurry walls are inset upland from the river whereas in areas with cutoff walls, excavation occurs up to the cutoff wall)
- Still able to maintain embedment into rock
- $1.35M cost savings

Closing

- Value analysis is a team effort requiring contributions from the entire team and engagement with stakeholders
- Value Add can be done at various stages of the project
- Evaluation of potential savings can help rationalize additional design/field investigation cost
  - logic test, is the savings worth it? Is the reduction in uncertainty needed?
- Build in procurement flexibility for value-add change

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Discussion?

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