Technical Approaches for Developing the Site Management Strategy for the New Don River

Toronto Port Lands Project

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Outline

1. Background
2. Investigative Techniques
3. Risk Evaluation
4. Strategy Evaluation
5. Conclusions

Background

- 356-hectare area, formerly largest natural wetland in Lake Ontario
- Infilled in early 1900s to support industrial growth and shipping
- Currently underutilized, lacks municipal services
- Located in flood plain of Don River

Objective: flood protect and revitalize this valuable part of the city

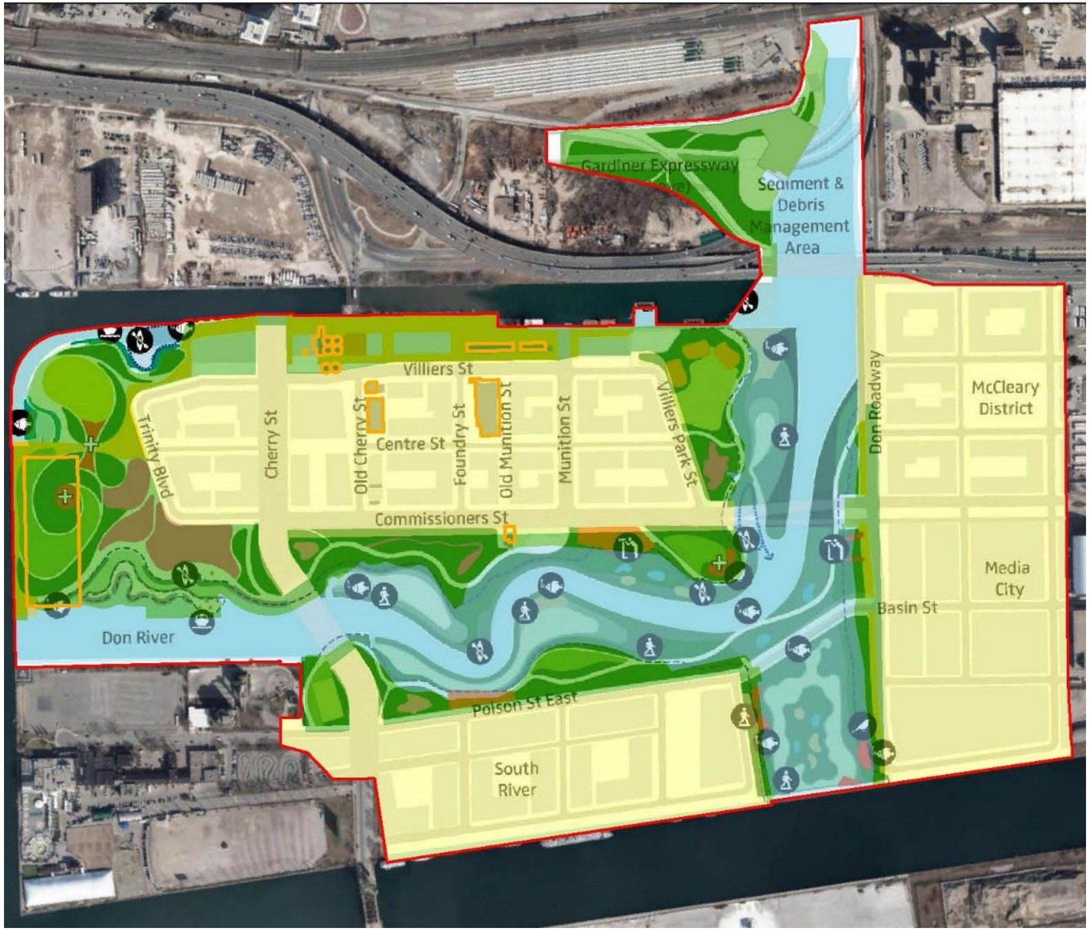
Background

Introducing the New Don River!

Background

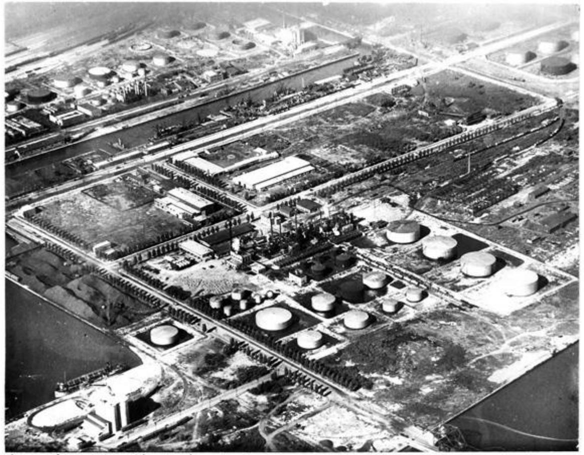
- Flood protection
- Updated infrastructure

Unlock development potential



Background

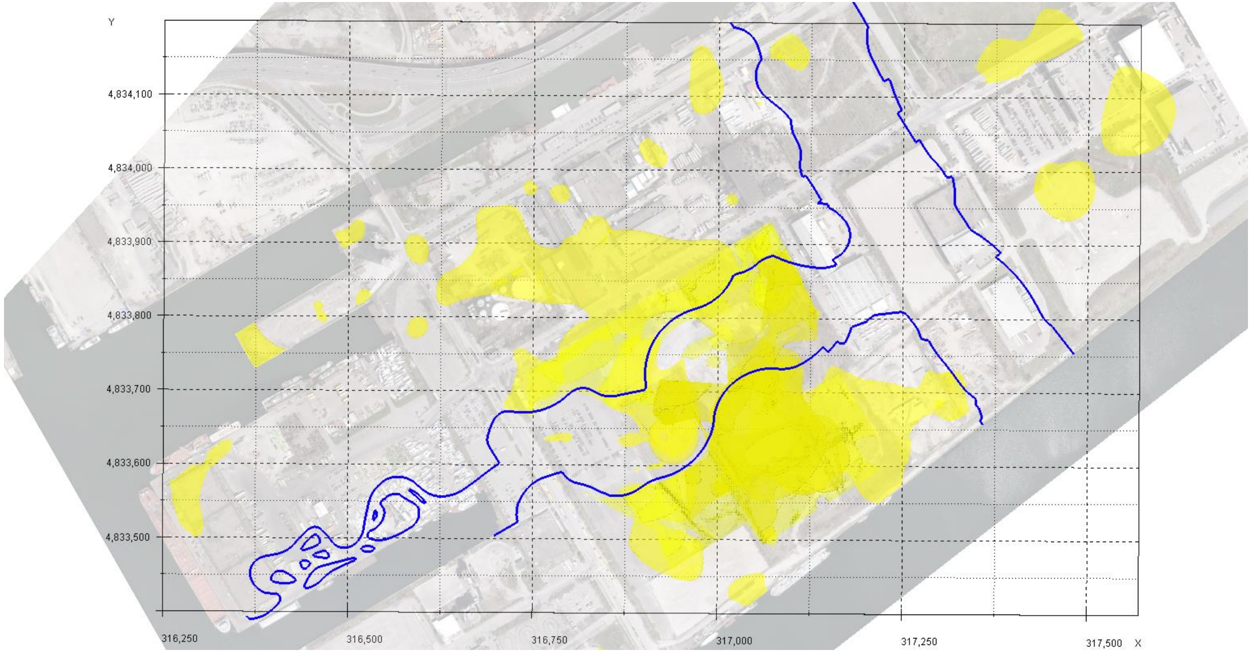
Images from http://www.blogto.com/city/2012/02/what_the_port_lands_used_to_look_like/



City of Toronto Archives, Series 1465, s1465_fl0154_id0027

Background

Projected Non-Aqueous Phase Liquid (NAPL) Distribution below Construction Grade



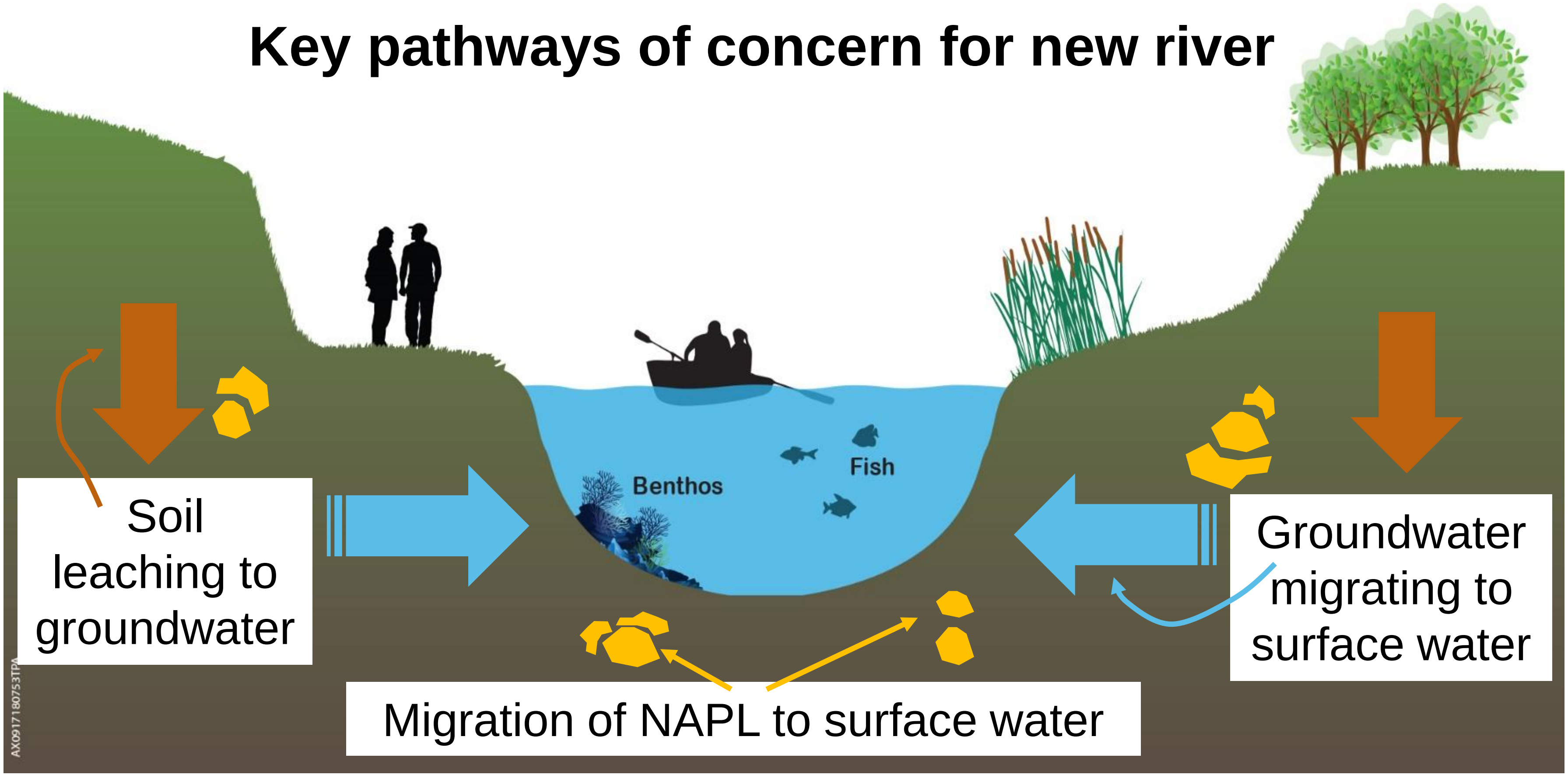
Boundary of Water Lot

Potential NAPL

Based on coarse model interpolation (+/- 25%) of total PHC >1,500 mg/kg (based on LIF and analytical data), and data set to April 2018.

Background

Key pathways of concern for new river



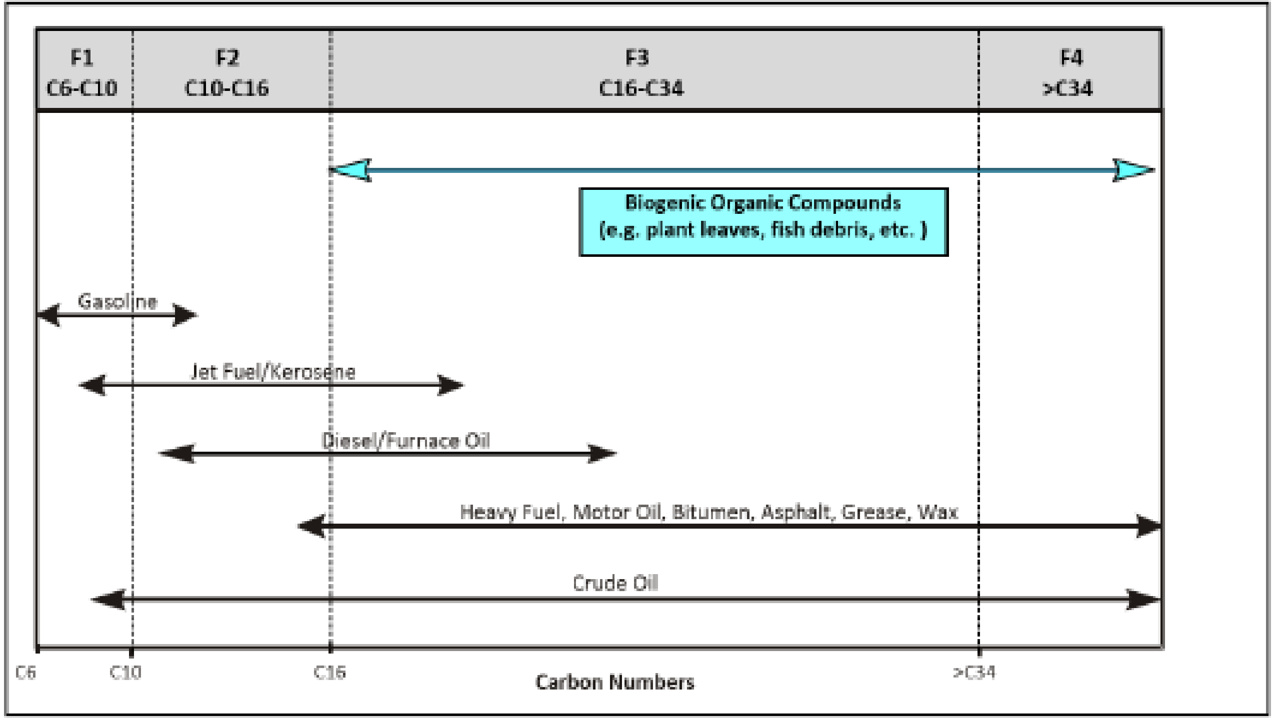
Investigative Techniques

Technique	Goal
Peat Interference and Product Evaluation	• Confirm anthropogenic impacts and potential source
Bioassay Assessment	• Confirm dissolved concentrations that could lead to elevated risks to new river
Laser-induced fluorescence (LIF) **Tar-specific Green Optical Screening Tool (TARGOST)** **Ultra Violet Optical Screening Tool (UVOST)**	• Confirm distribution of NAPL that will be left in place post-excavation
NAPL Mobility Coring	• Confirm potential mobility of NAPL left in place

Investigative Techniques – Peat, Product Source

- Highly organic peat soils could cause biogenic interference in Petroleum Hydrocarbon (PHC) analytical results
- Source of PHC can indicate potential mobility of impact

Figure 2. PHC Products Organized by F1, F2, F3, and F4 Carbon Number Ranges



Sources: Kelly-Hooper et al., 2013, 2014; CCME, 2008; Wang et al., 2007

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Investigative Techniques – Peat, Product Source

Biogenic Interference	Source
• GC-FID chromatograms • PHC F2 to F4 carbon range patterns	• PHC F1 to F4 percentage of total PHC concentrations • GC-FID chromatograms • Total PAH Percentages of Total F1 to F4 Concentrations

Peat not causing false exceedances of PHC soil standards

Light and medium fuel, coal tar, and asphalt observed; potentially mobile impacts in and along edge of new river

Investigative Techniques – Bioassay

Initial groundwater-to-surface water modeling (using Aquatic Protection Values) indicates potential risks to aquatic receptors:

Media	Parameters Indicating Elevated Risk
Surface Water	PHC F2
Porewater	PHC F1, PHC F2, ethylbenzene, toluene, and xylenes

Refine assessment via toxicity testing in two phases:

Phase	Duration; Purpose
1	Short; confirm GW concentrations collected within 30 m of new river produce viable results (static and rate of degradation tests)
2	Longer; account for adjustments in COC concentrations (static renewal tests, and other adjustments based on Phase 1 results)

Investigative Techniques – Bioassay

Mix of static, static renewal, and serial dilutions for:

Media	Receptors
Surface Water	Pelagic invertebrates, algae, aquatic plants, and fish
Porewater	Benthic invertebrates, demersal-oriented and spawning fish

Phase 1:

Step	Tests	Status
A	• Chemical degradation • Toxicity for larval Fathead Minnow (7-day)	Complete
B	• Toxicity for pelagic invertebrates (48 and 72 hours) • Toxicity for rainbow trout (96 hour test)	Results under review

post-confirmation of appropriate concentrations

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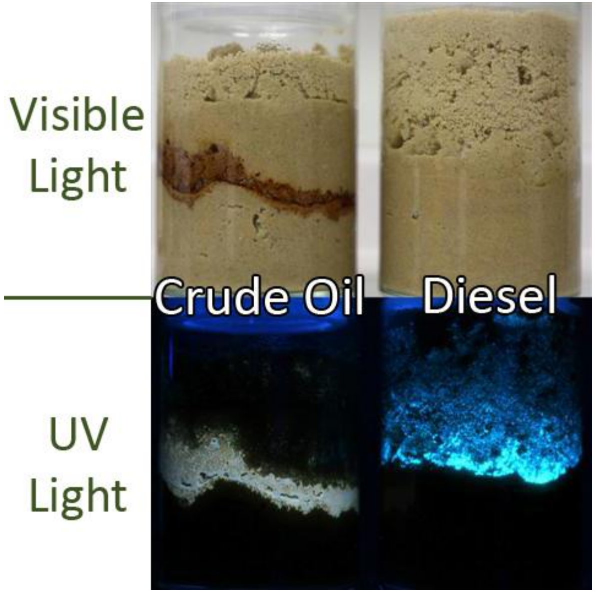
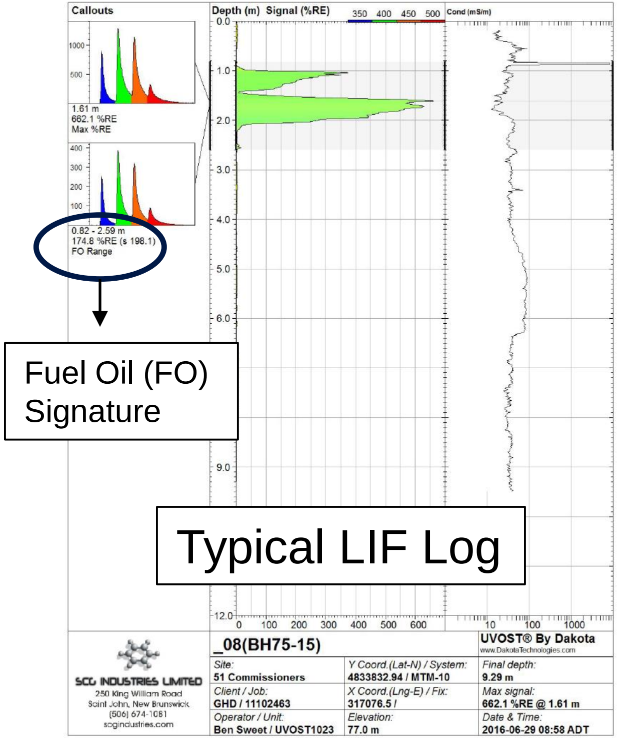
LIF Investigation for NAPL Delineation

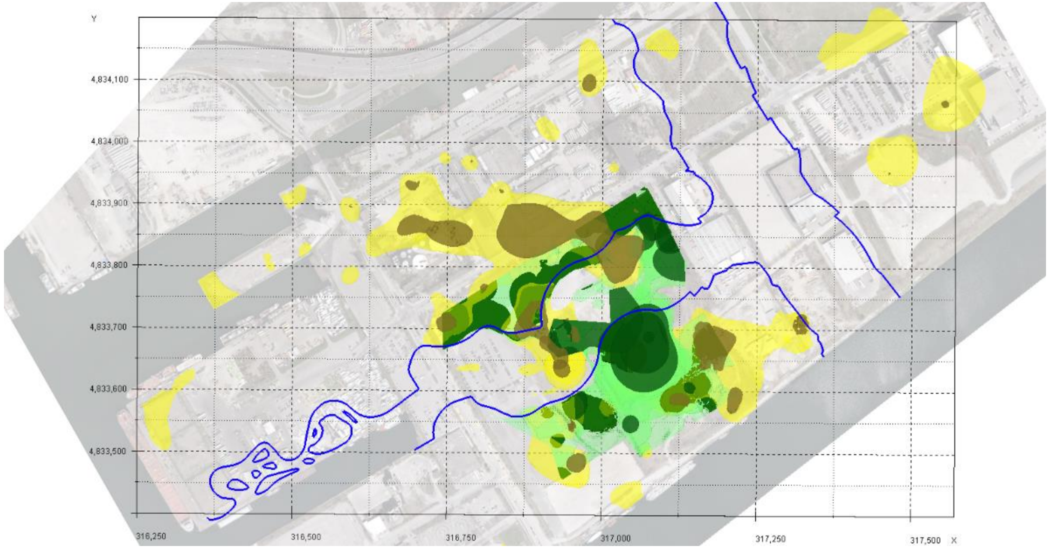
- Utilizes laser light to excite and detect polyaromatic hydrocarbons (PAHs) in NAPL
- Total PHC levels proportional to LIF signal
- LIF tooling coupled with direct push drilling provides vertical profiling of NAPL
  - **UVOST:** Targets lighter molecular weight NAPL (e.g., gasoline, diesel)
  - **TarGOST:** Targets heavier molecular weight NAPL (e.g., coal tars, creosotes)



Different NAPLs under Visible and UV light (Dakota Technologies)

LIF Investigation for NAPL Delineation





Total Petroleum Hydrocarbon (TPH) Plume Visualization

- 1,500 < TPH (analytical data) < 8,000 mg/kg
- 1,500 < TPH (LIF-inferred) < 8,000 mg/kg
- TPH (analytical data) > 8,000 mg/kg
- TPH (LIF-inferred) > 8,000 mg/kg

NAPL Mobility Assessment

- Undisturbed soil cores collected from river banks and river bottom
  - **Primary cores:** Targeted areas with most significant contamination
  - **Secondary Cores:** Greater focus on impacts near surface water

Primary cores

Secondary Cores

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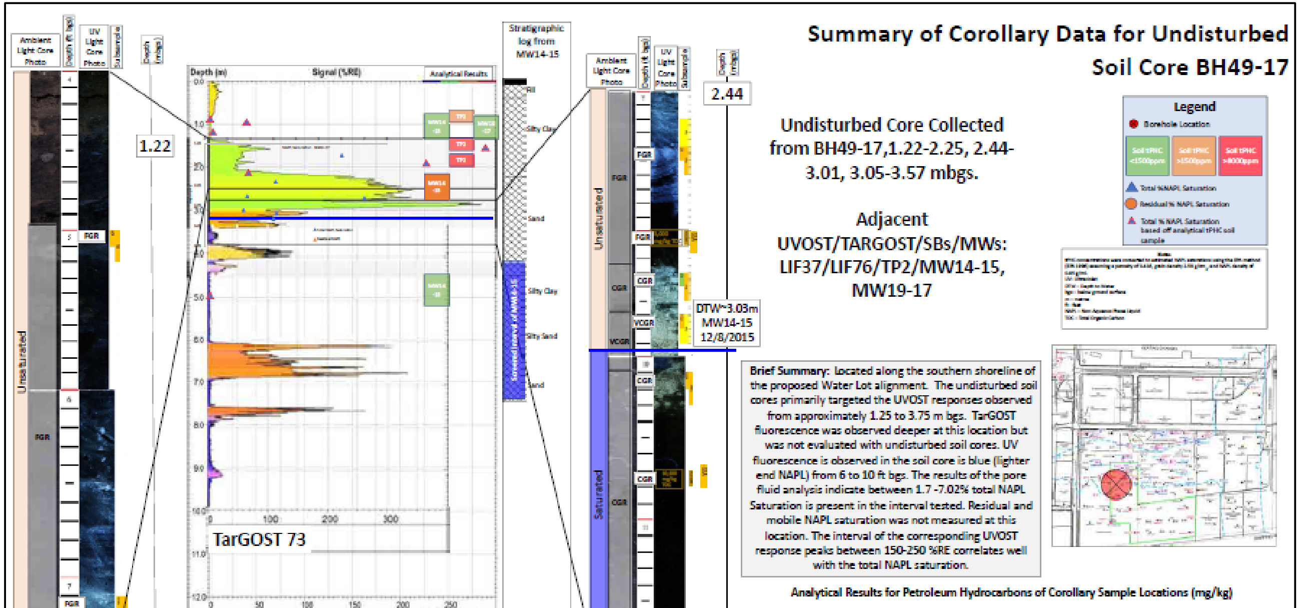
NAPL Mobility Assessment

- NAPL mobility interpreted from total and residual NAPL saturation
  - Pore Fluid Saturation Analysis: measures total NAPL saturation in soil cores
  - Centrifuge Test: quantifies residual saturation under extreme gradients
  - Water Drive Test: quantifies residual saturation under typical groundwater gradients
- Saturation greater than residual indicative of potential mobility
- Surface water sheening risk evaluated via Spontaneous Imbibition test
- NAPL saturation correlated to total PHC concentration for site-wide interpretation

NAPL Mobility Assessment

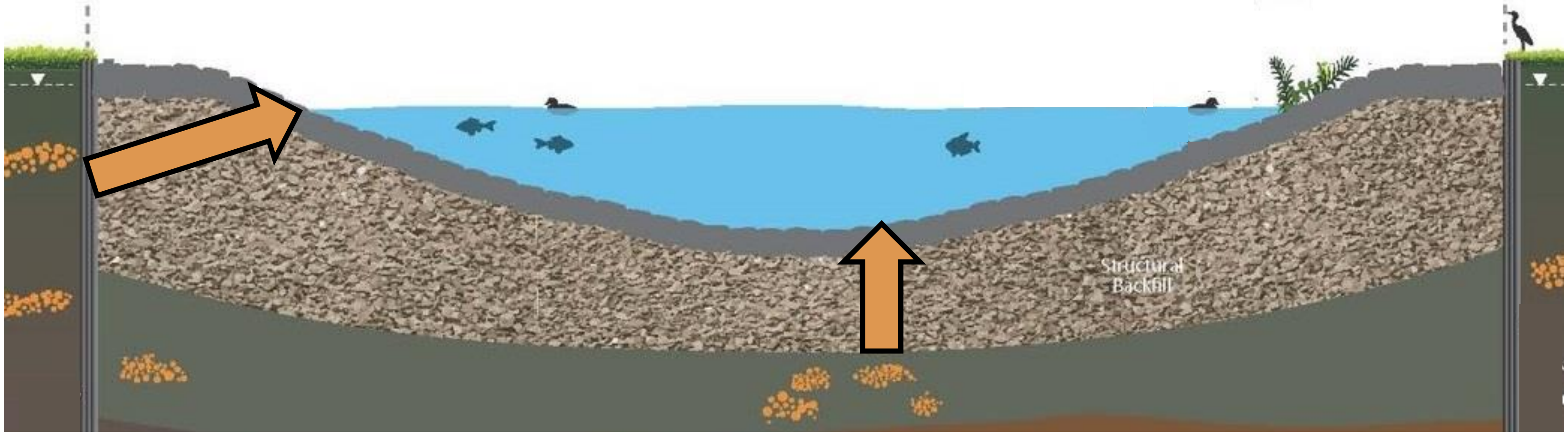


Associated boring(s)	Location Name	start depth (m)	end depth (m)	F1 (C6-C1)	F2 (C10-16)	F3 (C16-C34)	F4(C34-C50)	tPHC	NAPL Saturation (%)
BH49-17	MW14-15	0.76	1.37	67.9	77	357	216	717.9	0.31%
BH49-17	MW14-15	2.28	2.89	1780	4910	618	120	7428	3.24%
BH49-17	MW14-15	4.57	5.18	12	0	0	0	12	0.01%
BH49-17	TP2	0.71	0.91	1360	1360	1020	584	4324	1.88%
BH49-17	TP2	1.32	1.52	14700	14700	4130	1360	34890	15.20%
BH49-17	TP2	1.78	1.98	8770	8770	2890	930	21360	9.30%
BH49-17	MW19-17	0.75	1.5	41	150	250	0	441	0.19%

- Multiple lines of evidence used to characterize mobility
- Mobility varies due to site heterogeneity (gradient, NAPL type, and grain size)
- Criteria for mobile NAPL ranged from 8,000 to 16,500 mg/kg of total PHC

Risk Evaluation

Potential for impacts left in place to pose unacceptable risks to receptors in the new river?

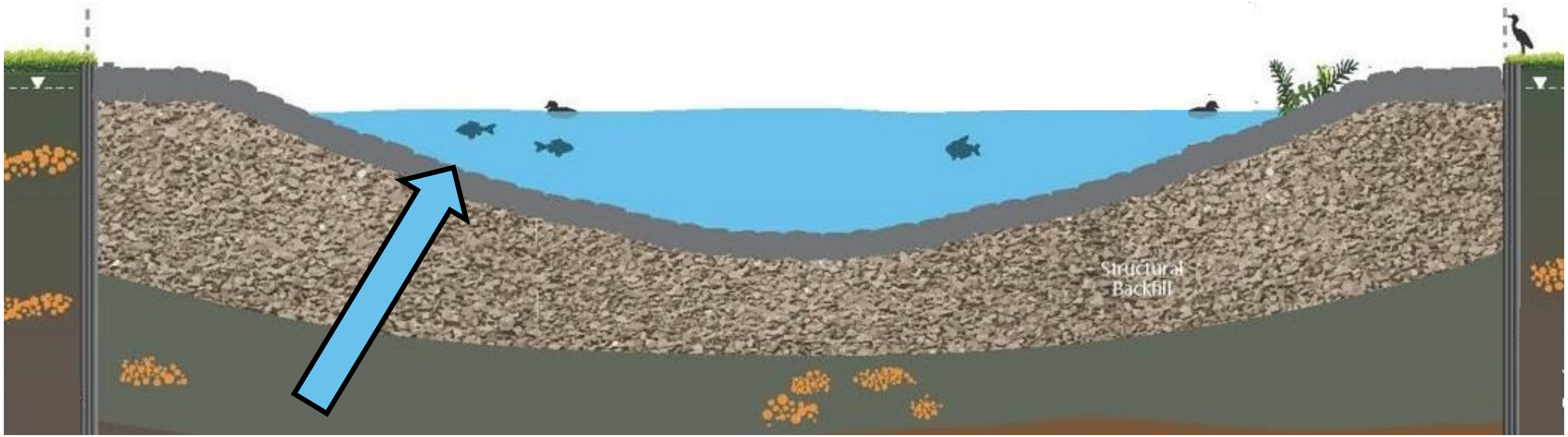


NAPL migration → Total PHC > 8,000 mg/kg

NAPL sheen → Total PHC > 1,500 mg/kg near water

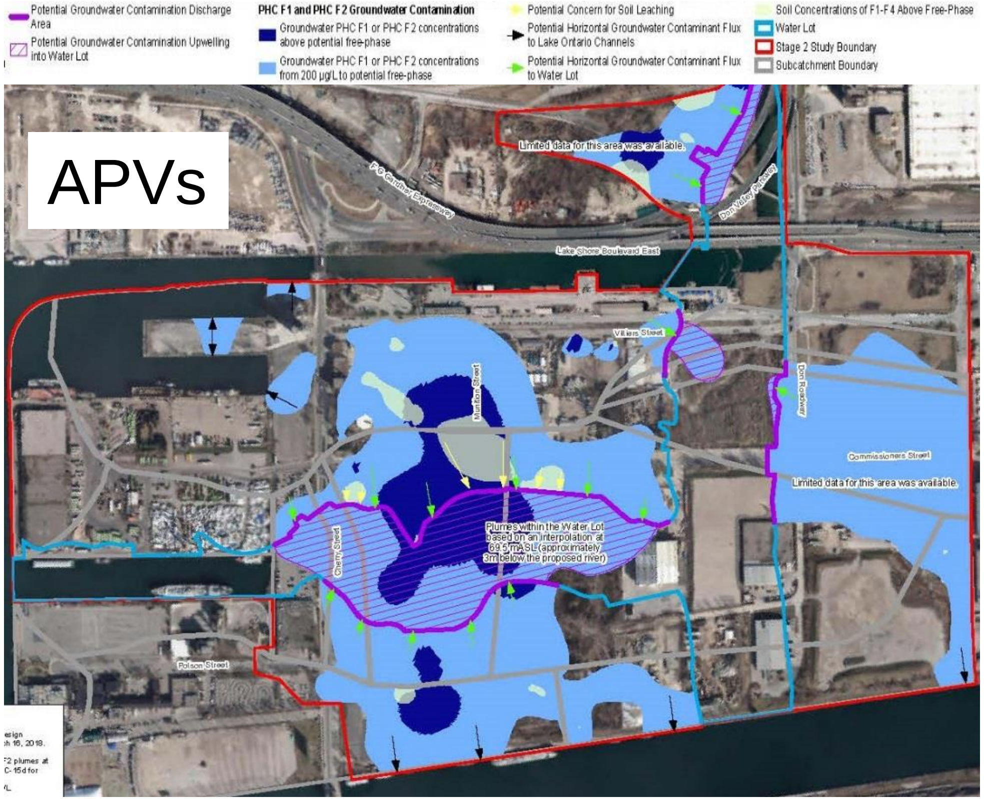
Risk Evaluation

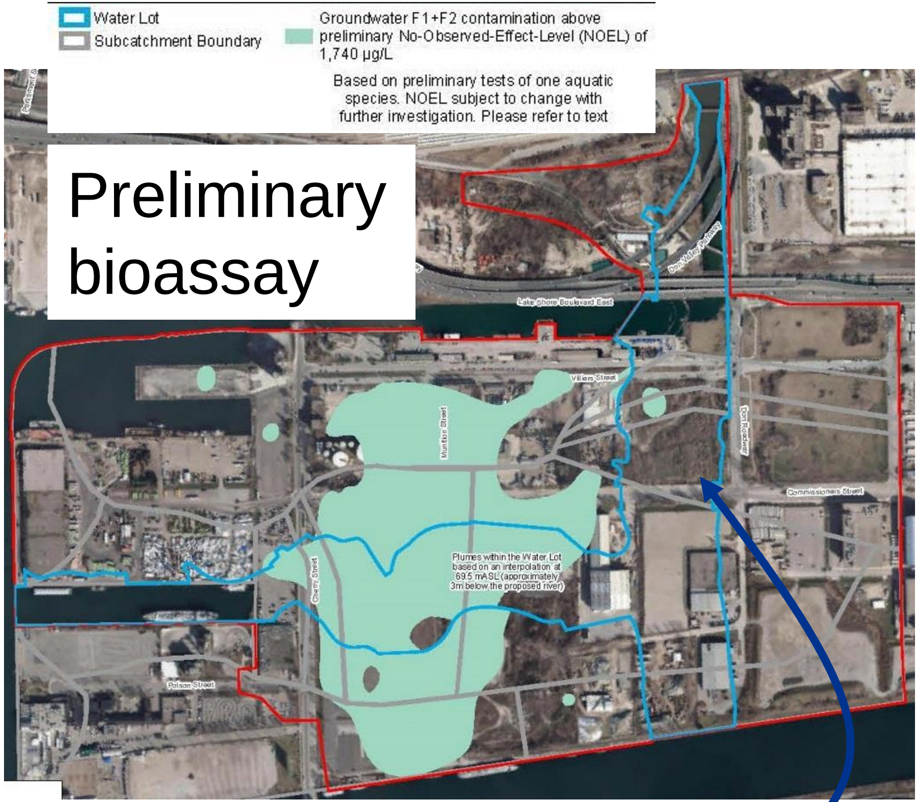
Potential for impacts left in place to pose unacceptable risks to receptors in the new river?



Dissolved GW concentrations → 1D contaminant transport/attenuation model indicates potential for elevated risks

Risk Evaluation – Toxicity Testing

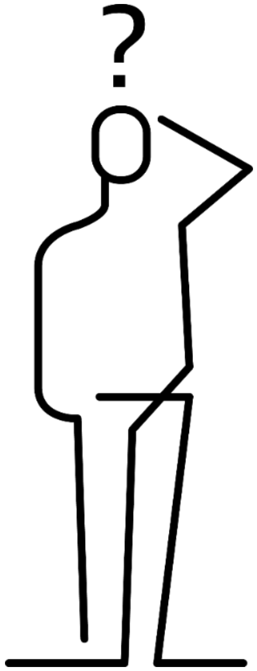




RMM required?

Strategy Evaluation

Optimal strategy to address remaining impacts that pose unacceptable risks to new river?



- Identify remedial and risk management options
- Compare technologies based on treatability, implementability, and lifecycle costs (with consideration of bench-scale and pilot-test results)
- Establish the conceptual plan to apply preferred technologies based on observed conditions and selected construction methods

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Strategy Evaluation

Primary options considered:

Remedial Options	RMM Options
• Excavation • Fluid recovery and enhanced LNAPL recovery • STAR and STARx • Air sparging and SVE • Biosparging and bioventing • ISCO • Enhanced anaerobic biodegradation • NSZD	• Activated carbon • Phytotechnology • Physical barrier • Hydraulic barrier • ISS • Administrative controls (e.g., HASPs)

Notes:

HASP = Health and Safety Plan

ISCO = in situ chemical oxidation

ISS = in situ stabilization

LNAPL = light nonaqueous phase liquid

NSZD = natural source zone depletion

STAR = in situ thermal remediation

STARx = ex situ thermal remediation

SVE = soil vapour extraction

Strategy Evaluation

Three core options identified:

- Option 1: Selective installation of ISS (cement and bentonite) with Oleophilic Bio Barrier (OBB) Mats
- Option 2: Selective installation of Impermeable Bentonite Barrier with Bentonite Horizontal Cap
- Option 3: Selective excavation and removal, followed by installation of OBB Mats

Aligns with preferred construction method

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Conclusions

- Complex redevelopment projects need innovative approaches
- Understanding impacts and risks is important for decisioning and site management
- Environmental planning needs to align with construction plans and help mitigate project risks

Thank you!

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