Building a Site Strategy via the Application of Specialized Investigation Tools and Models at NAPL Sites, Toronto Port Lands Project

JACOBS®
www.jacobs.com | worldwide

October 2019

Trevre Andrews (Jacobs) Minneapolis, MN
Tom Palaia (Jacobs) Denver, CO
Krista Barfoot (Stantech) Toronto, ON
https://portlandsto.ca/

Agenda

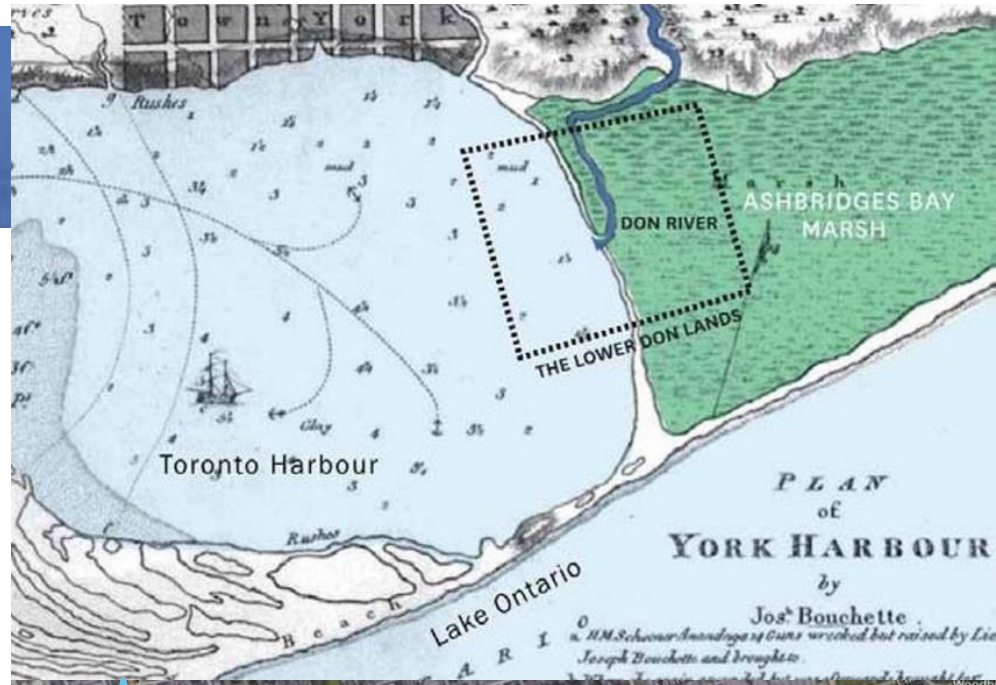
1. **Case Study Overview**
2. **Key Environmental Components**

   Remedy First, Investigation second…
3. **Defining LNAPL Mobility Criteria – Using Specialized data sets to determine site specific remedial/threshold metrics**

   Selecting Risk Management Measures (RMMs) Using Site Specific Risk Management Measures
4. **Improvements in contaminant extent by supplementing historical site data with updated high-resolution screening tools**
5. **Specific Remedial Cost/Benefit of Additional Strategic Investigation**
6. **Summary**

Overview – The Portlands, Toronto, ON

- 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

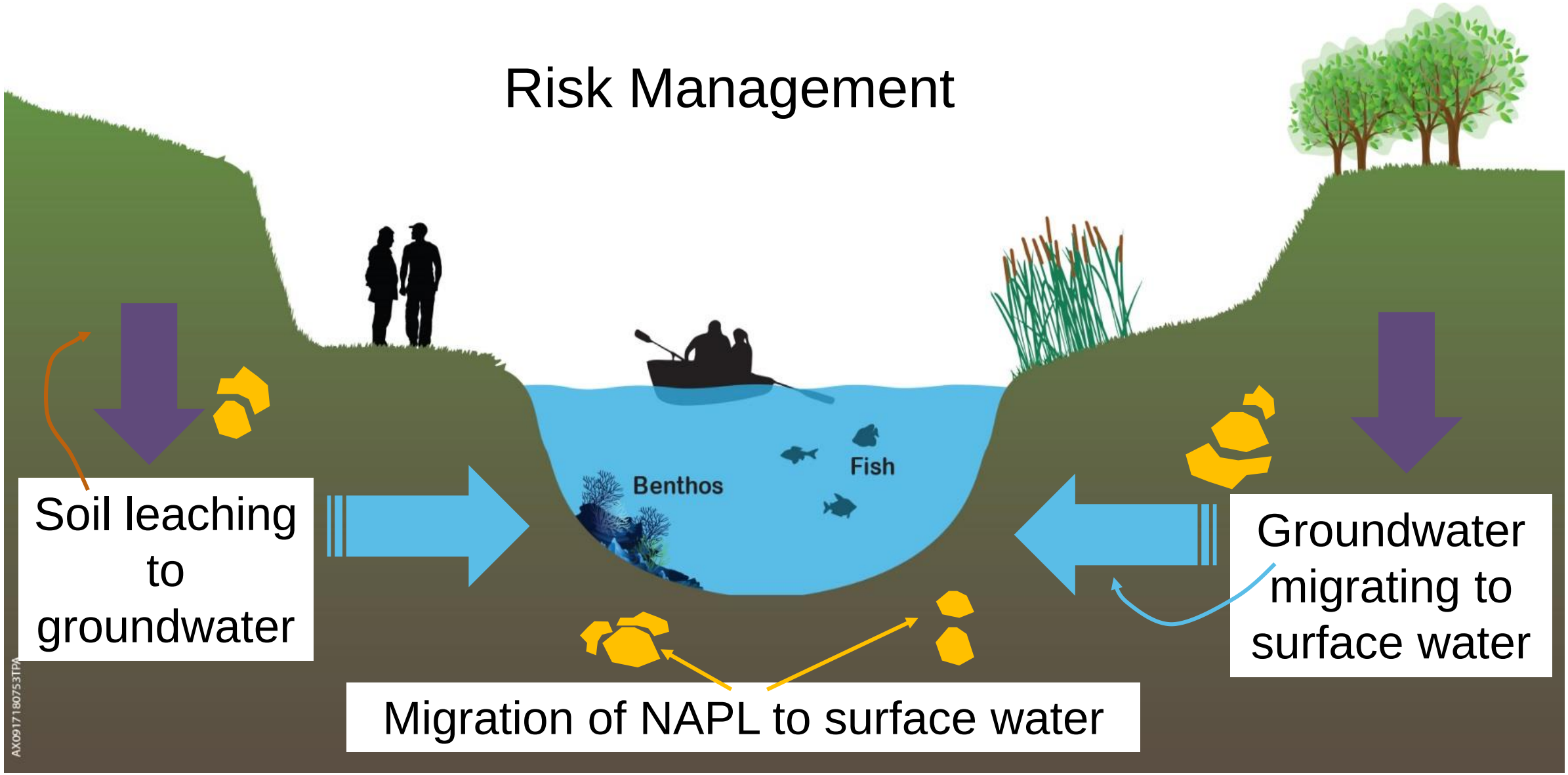


Overview - Drivers

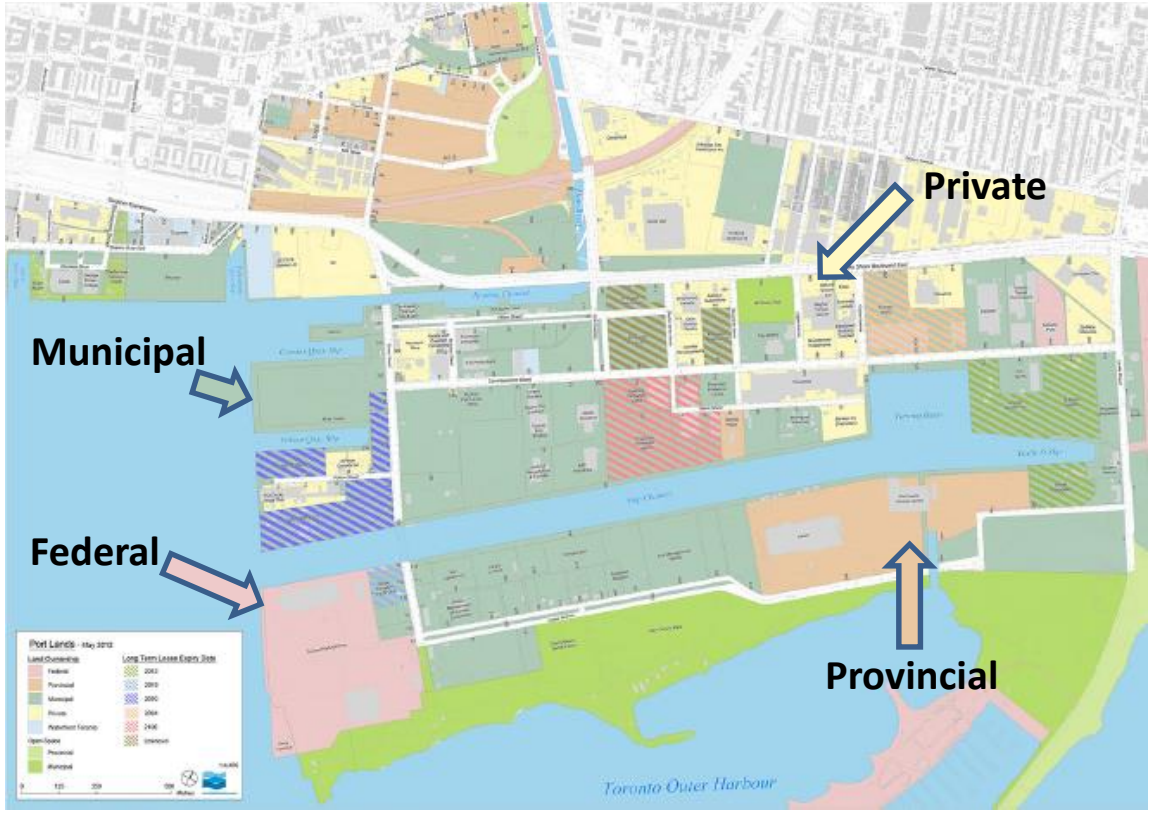
- Flood protection
- Updated infrastructure
- Mitigate former land use

Unlock development potential

Overview – Conceptual Model Receptors

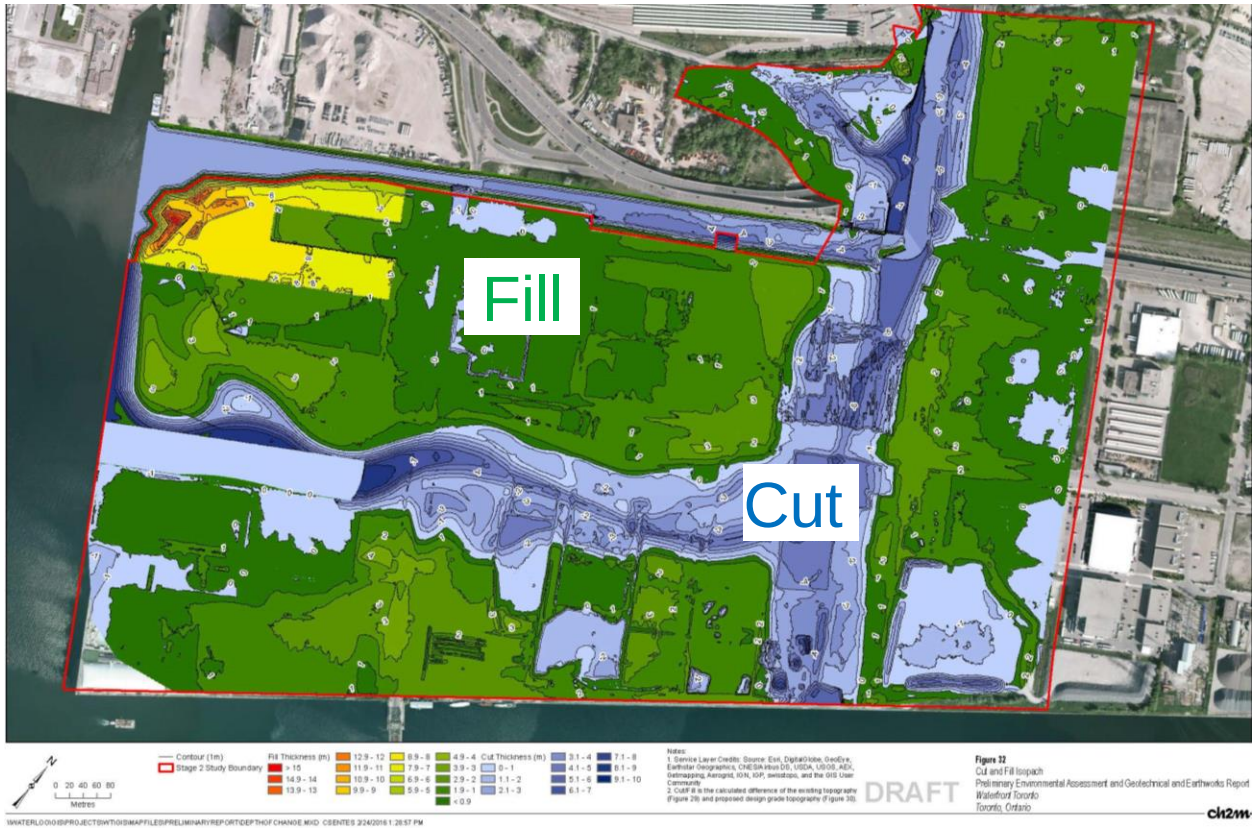


Overview – Stakeholder and Construction Challenges



Challenge: Many Stakeholders.

Approach: Committed Stakeholder teams, Stakeholder Consultation Planning, Public Information Centers, Risk Assessment pre-consultation



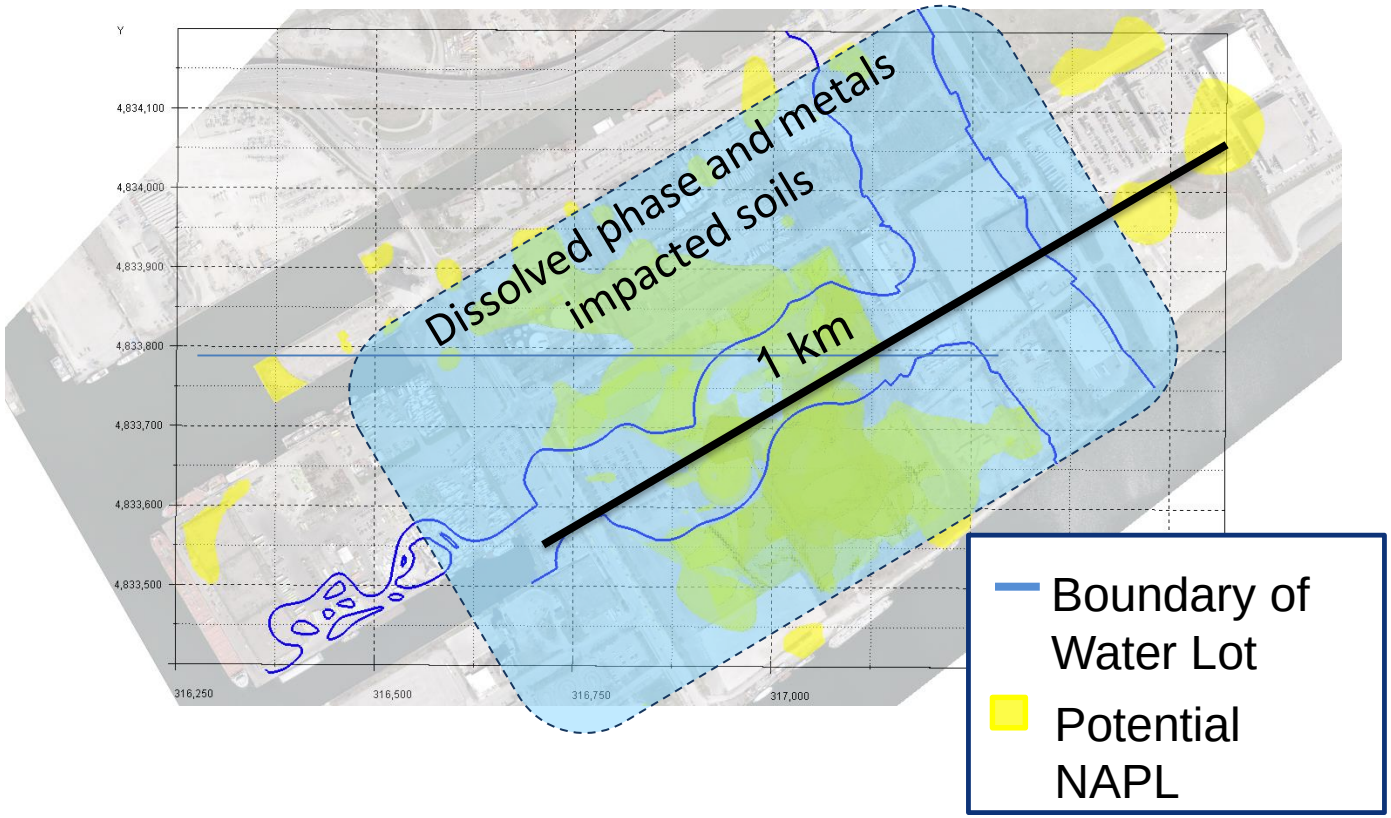
Challenge: More than 1,000,000 cubic meters of soil needed to be assessed, cut, and filled.

Approach: Comprehensive Soil Management Plan through iterative work packages

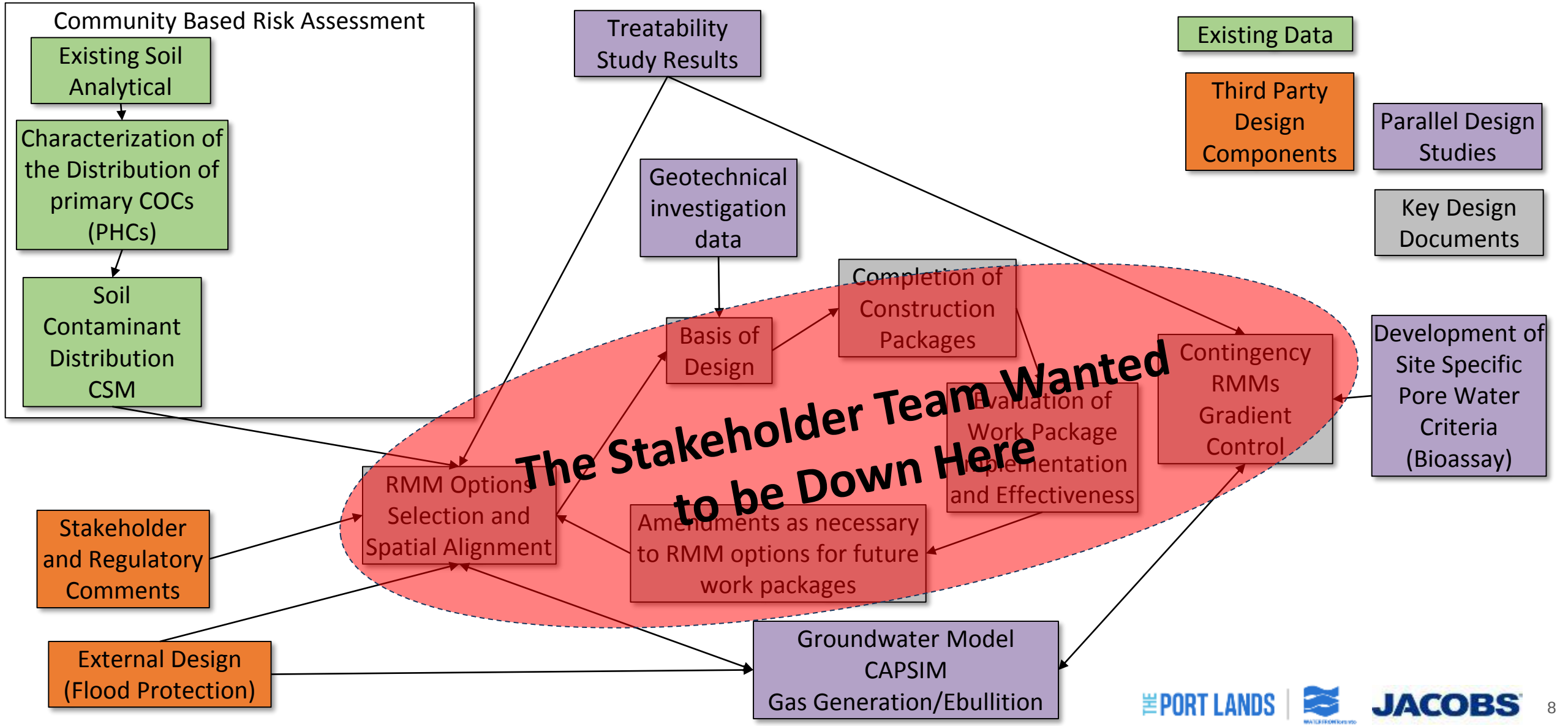
Overview – Challenges and Contaminant Distribution

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

- **Site size > 1km2**
- **Native geology present below water table, fill material (peat, silt, clay, sand) distributed across water table and primary contaminated zone**
- **Criteria for LNAPL impacted soils low (free phase threshold, ~1,500 mg/kg F2/DRO in soil) and 150 ppb F2 in groundwater**
- **Stakeholders design inserts sensitive receptor through center of NAPL mass**
- **Rapid design timeline <2 years**
- **NAPL types varied from light end gasoline to waste oils and creosote like material**
- **Historical data collected by different stakeholders, with different methodologies and quality**



Summary of Environmental/Engineering Workflow



First Remedy Option

- **Based on the concerns, criteria, and *current* CSM the best and only option is complete excavation.**
  - Excavation will include the removal and disposal of 1,000,000 m^3 of impact soil
  - Excavation in excess of 6 meters below the water table
  - 5 years
  - This will only cost $400,000,000

*Note these are fairly hypothetical/high level initial estimates

Nobody Likes the First Remedy Option…

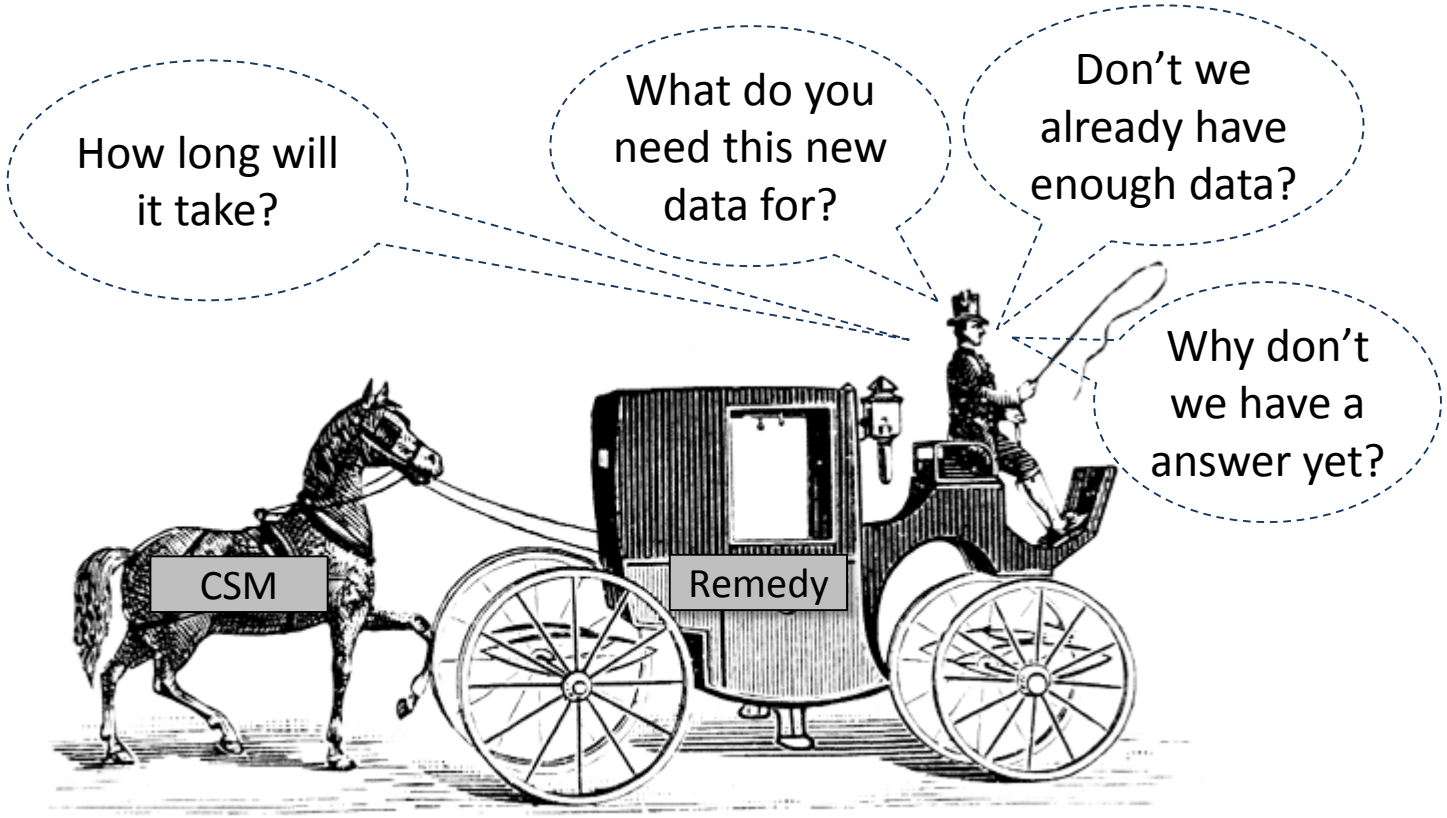
CSM → Identify Concerns → Set Objectives → Select Remedy → Define Metrics

The LNAPL Management process identifies data gaps and we need to revisit our CSM at the end.

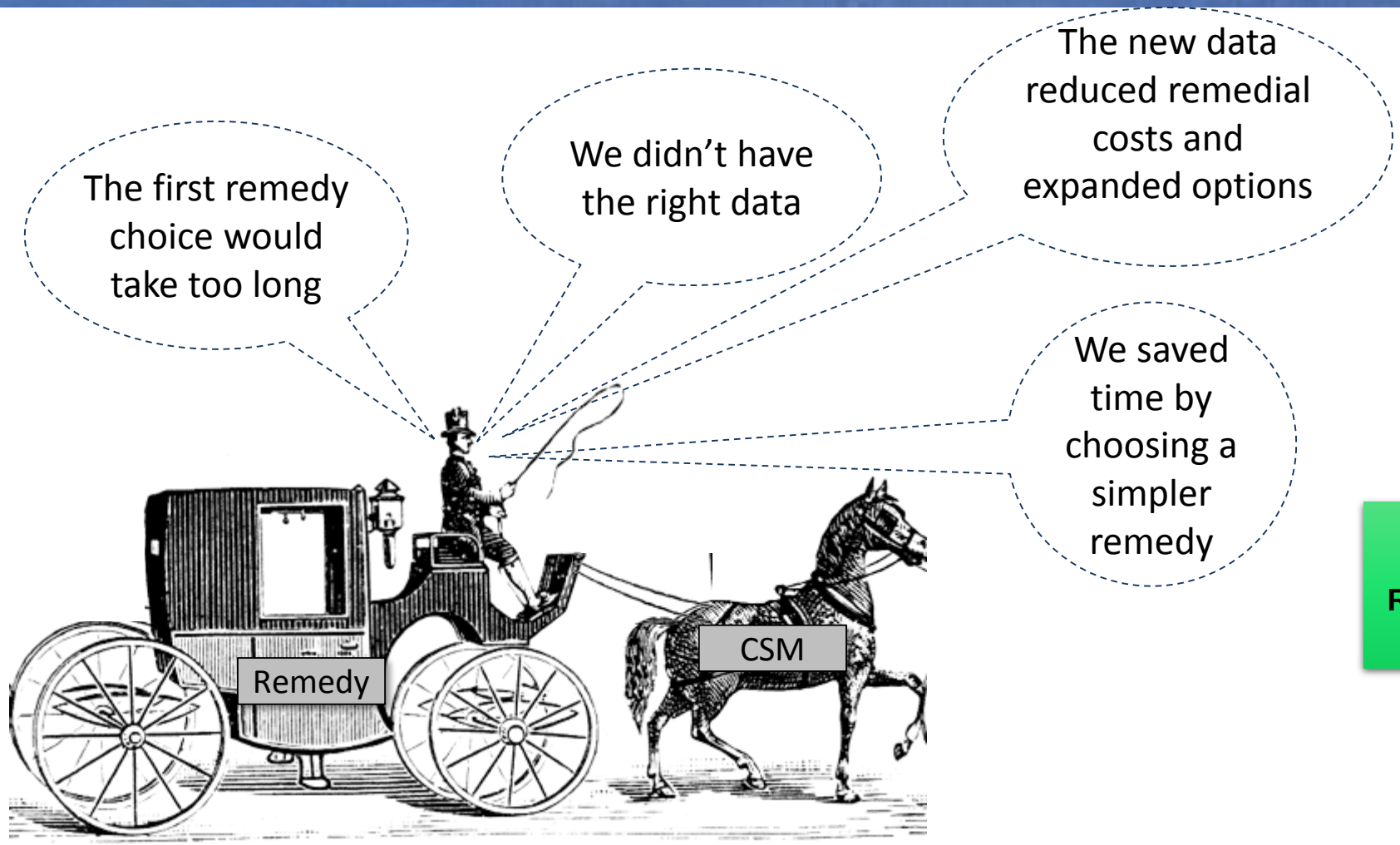
We need to:

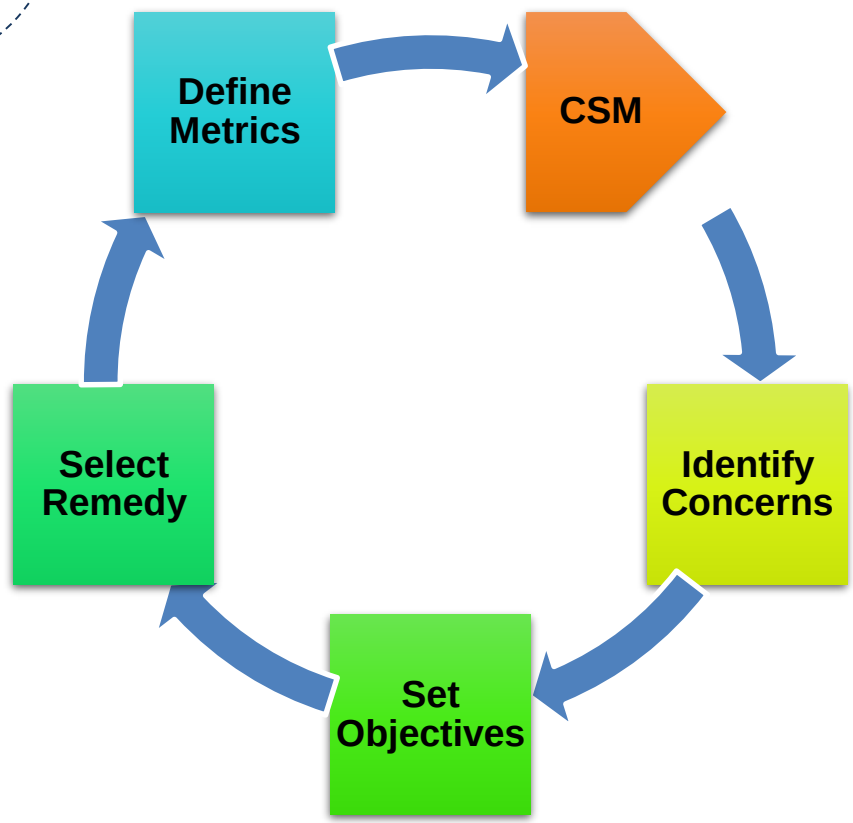
1) Utilize the existing data

2) Gather supplemental data

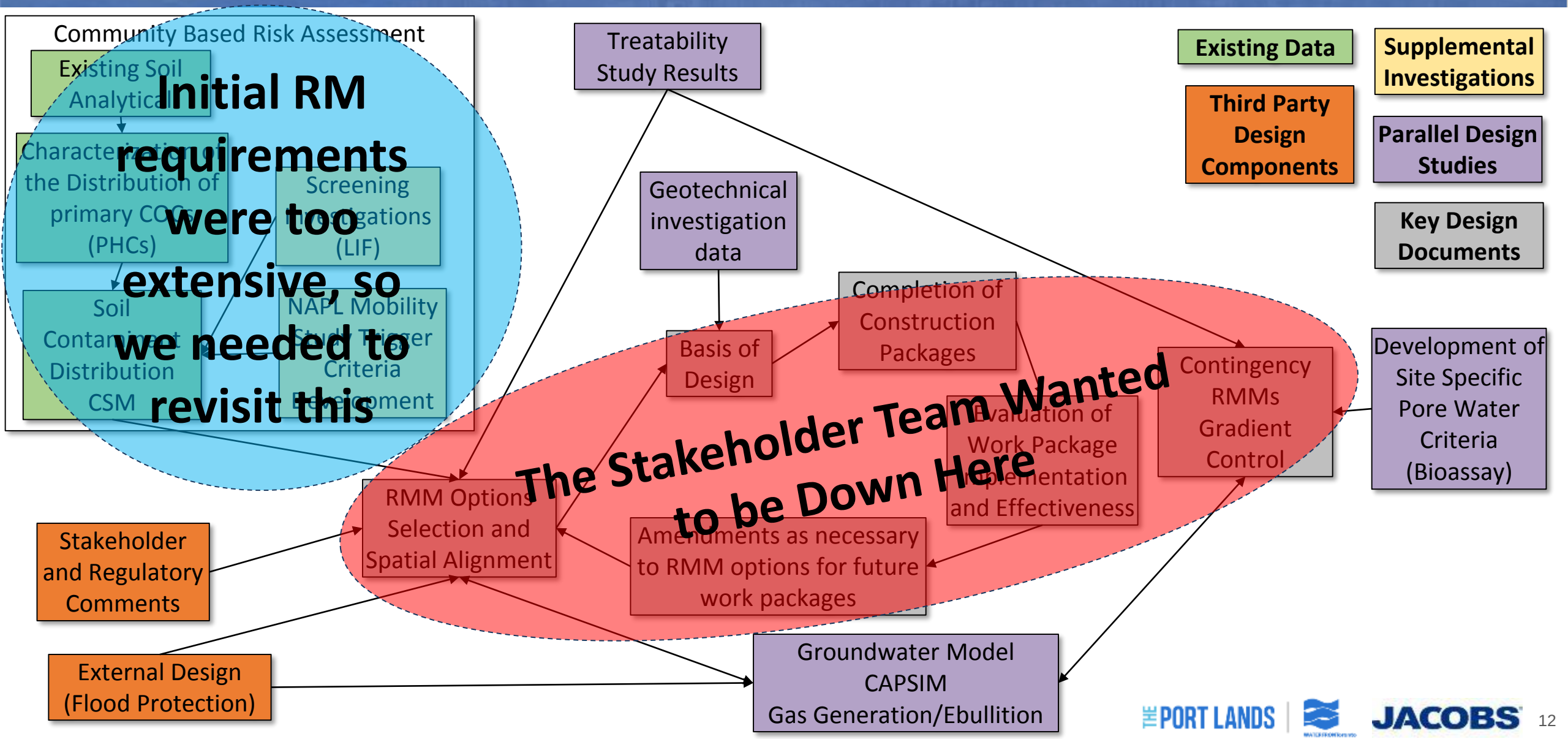


LNAPL Management is a Circular, Not Linear





Summary of Environmental/Engineering Workflow



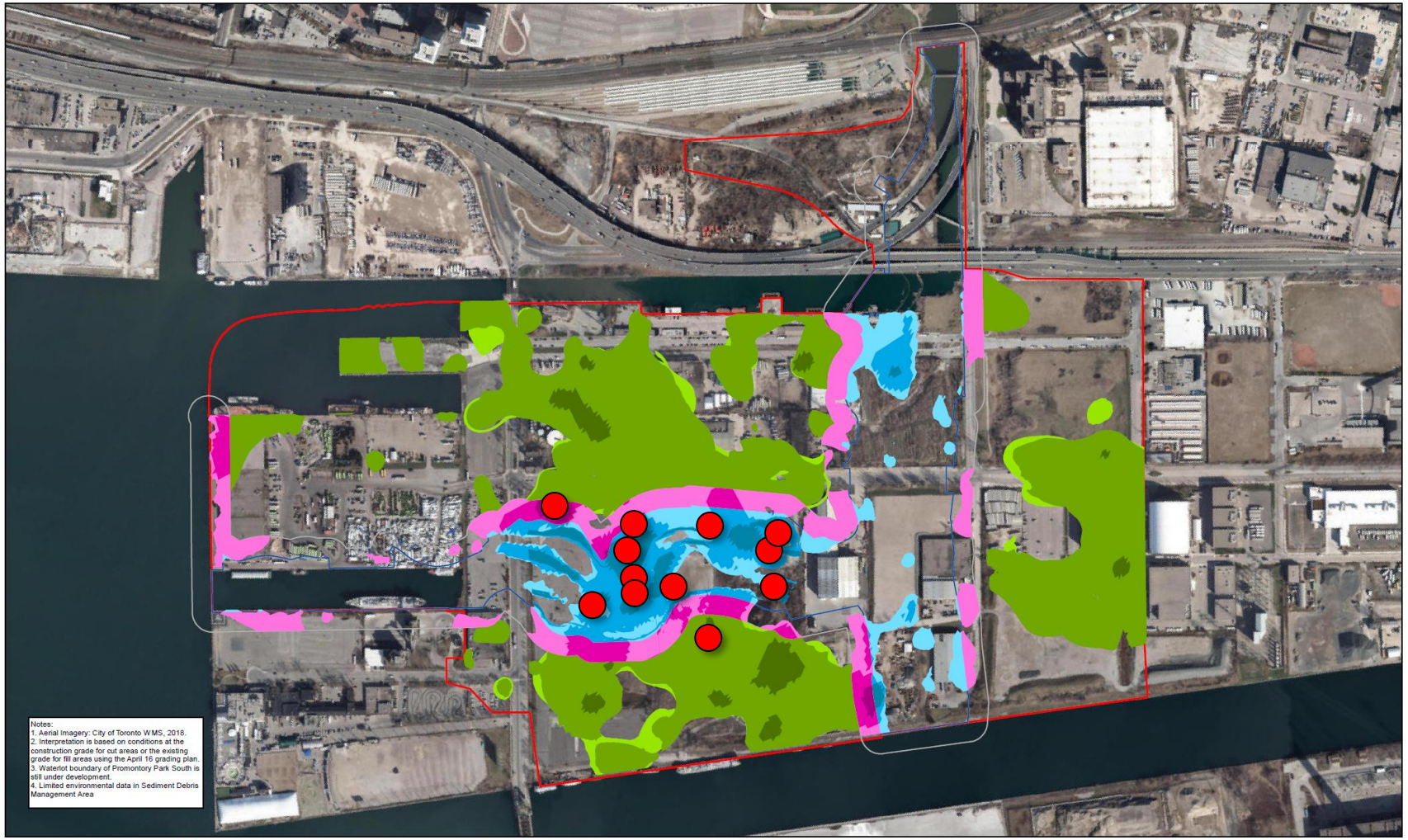
NAPL Mobility Criteria, Questions/Concerns

- **How must different types and concentrations of NAPL be managed?**
- **How do we establish the NAPL mobility criteria which can be used to inform remedial design?**
  - When is NAPL a migration risk in upland areas?
  - In shoreline areas?
  - Beneath water features?
  - At what concentrations would a sheen be produced?

If we don't answer these questions, 1,500 mg/kg needs to be managed the same as 15,000 mg/kg

Spatial Area	500 < tPHC < 1,500	1,500 < tPHC < ???	tPHC > ???? mg/kg
Primary Concern	Direct Contact		
Underneath Surface Water	Permeable Barrier		
Within 30 m of Surface Water	Impermeable Barrier	**REMOVAL/ACTIVE MANAGEMENT**	
Upland (greater than 30 m from Surface Water)	Direct Contact Barrier		

Mobility Samples (updated map)

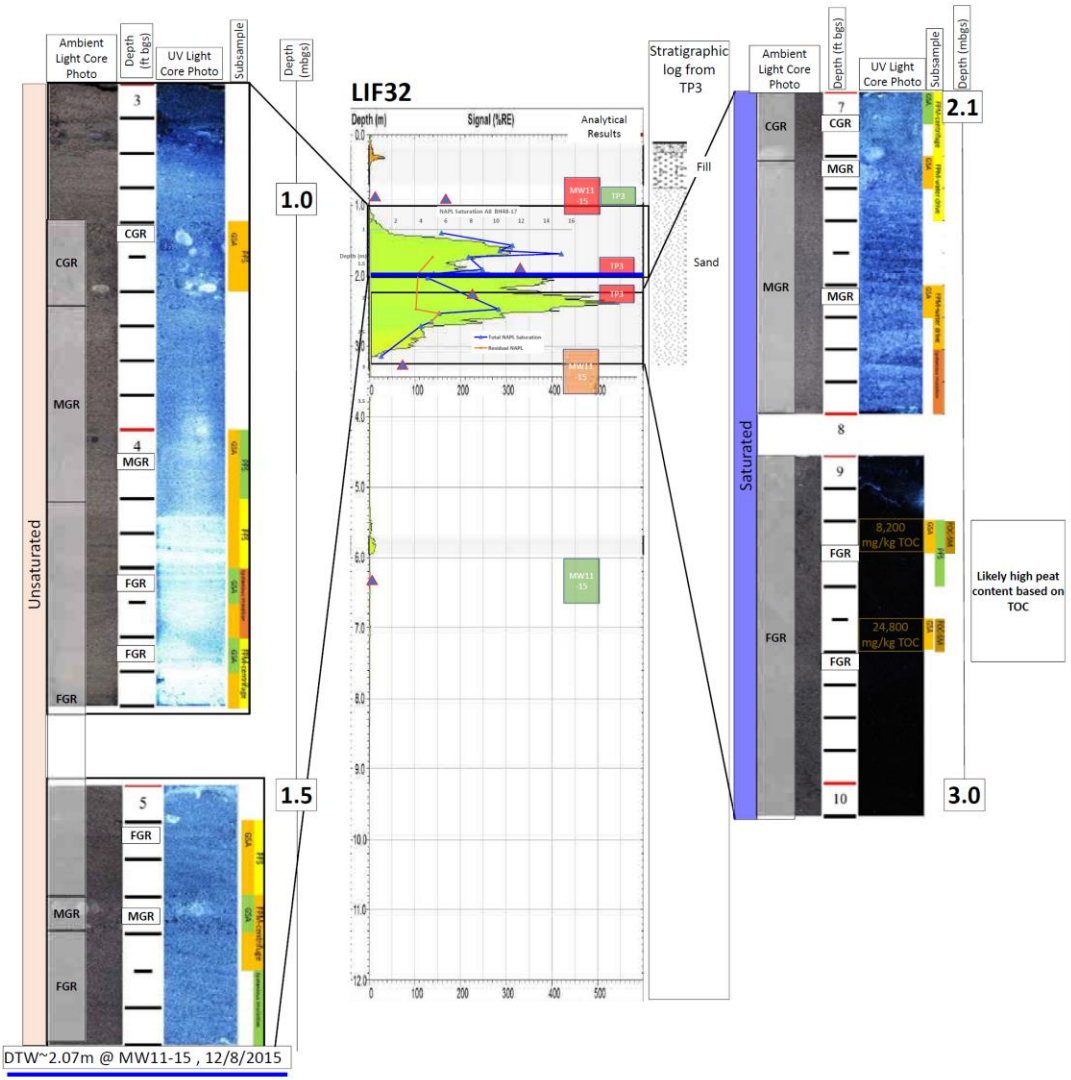


- **12 Representative Undisturbed NAPL Mobility Cores Were Collected Based on Improved LIF CSM**

Individual Conceptual Models Constructed for Each Location (Next Slide)

Rationale for Representative Nature of Locations Provided (i.e., All NAPL Types, Soil Types, and Distribution Types Represented)

Example Undisturbed Soil Core Location

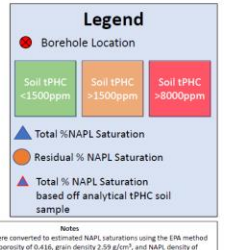


Summary of Corollary Data for Undisturbed Soil Core BH48-17

Undisturbed Core Collected from BH48-17,0.91-1.46, 1.52-1.74, 2.13-2.44, 2.74-3.05 mbgs.

Adjacent UVOST/TARGOST/SBs/MWs: LIF32/TP3/MW11-15

Brief Summary: Located along the northern shoreline of the proposed Waterlot alignment. The undisturbed soil cores targeted the UVOST responses observed from approximately 1 to 3 m bgs. UV fluorescence is observed in the soil core is blue (lighter end NAPL) from 3 to 8 ft bgs. The results of the pore fluid and NAPL mobility analysis indicate between 0.85-15.2% total NAPL Saturation is present in the interval tested. Residual NAPL saturation ranged from 3.62-5.47%. Mobile NAPL ranged from 0.0-6.58% The interval of the corresponding UVOST response which has two distinct peaks above 300-400 %RE correlates well with the total NAPL saturation. Spontaneous imbibition tests conducted at this location with total NAPL saturations ranging from 4.01 to 15.2 % did not produce any oil.



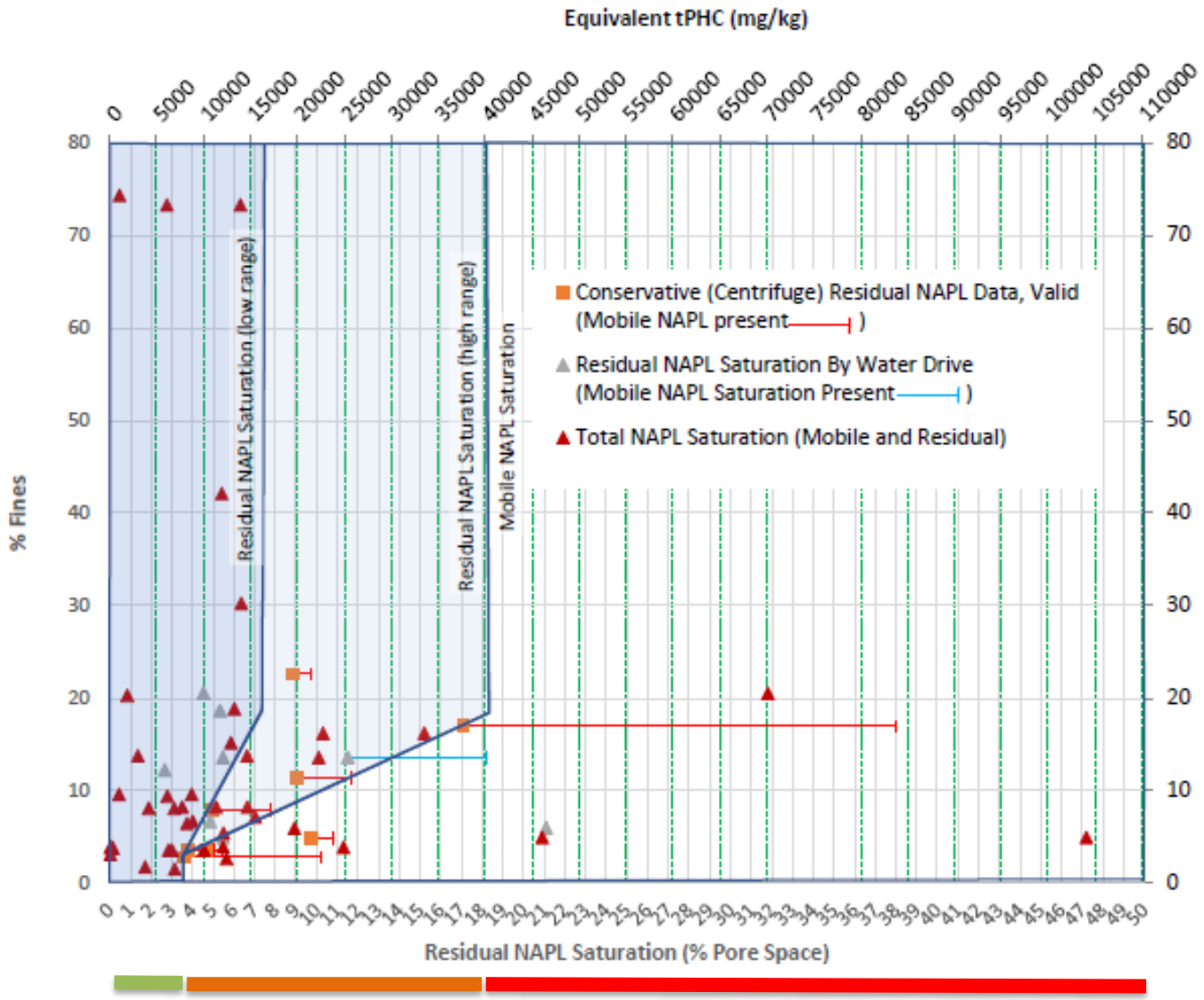
Analytical Results for Petroleum Hydrocarbons of Corollary Sample Locations (mg/kg)

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 (%)
BH48-17	MW11-15	0.76	1.37	1,290	9,390	2,460	123	13,263	5.78%
BH48-17	MW11-15	3.04	3.65	2,310	3,880	698	52	6,940	3.02%
BH48-17	MW11-15	6.09	6.7	0	0	0	0	0	0.00%
BH48-17	TP3	0.71	0.91	186	186	175	591	1,138	0.50%
BH48-17	TP3	1.78	1.98	11,800	11,800	2,830	0	26,430	11.51%
BH48-17	TP3	2.24	2.44	8,040	8,040	2,110	101	18,291	7.97%

Correlation of all types of site data (Visual, Analytical, and LIF Screening) provide a basis for estimating sitewide

Provides Relatively Straight Forward Correlation of Site Data Types (Visual, Analytical, and LIF)

Resulting Conservative NAPL Mobility Metrics



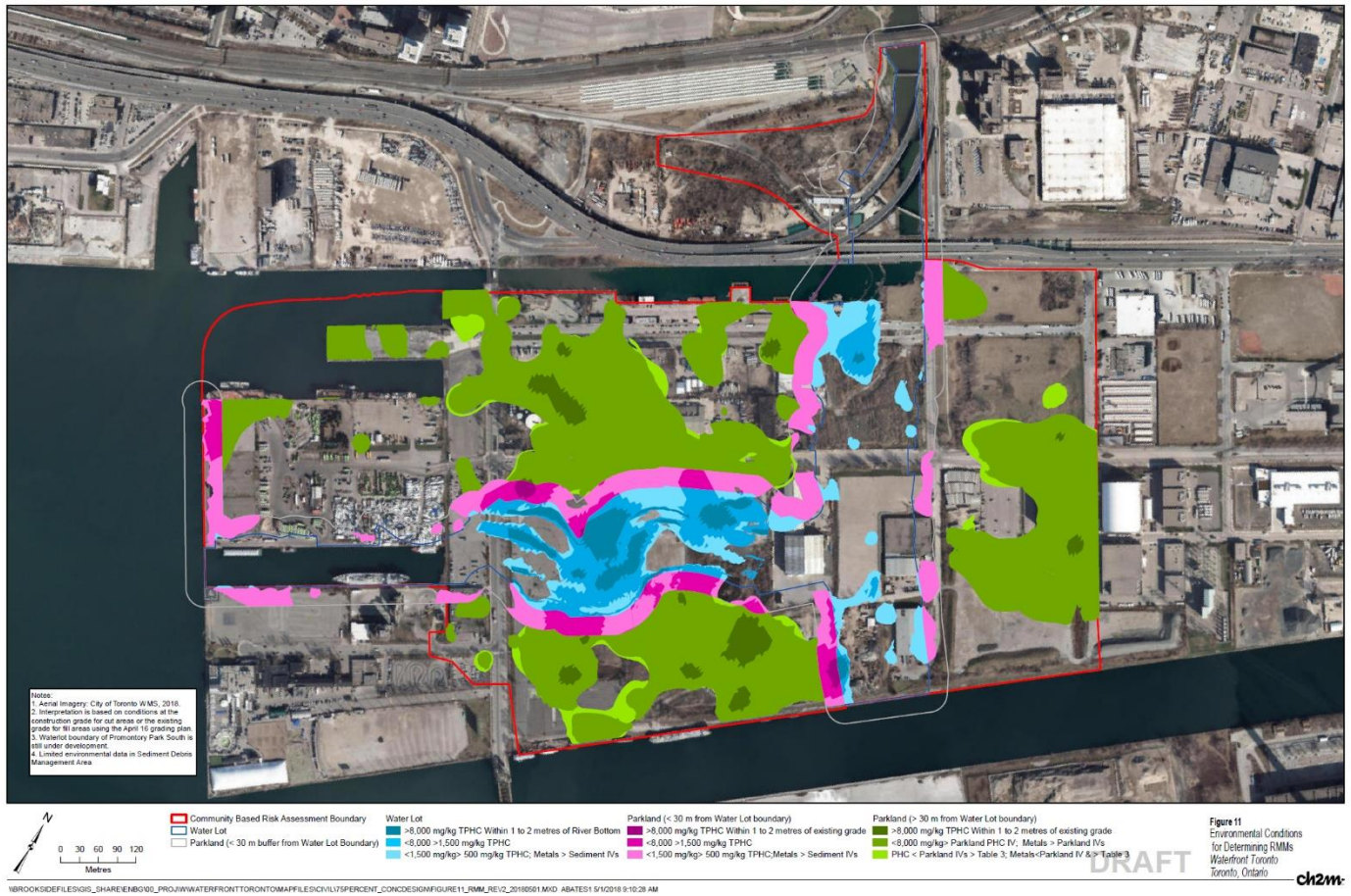
Based on this site specific data the following NAPL mobility criteria were established:

Conservatively, NAPL Saturations Below 4% (8,000 mg/kg) represent residual NAPL for and Soil type

NAPL Saturations between 4 and 18% may be residual, but it depends on soil type

NAPL Saturation above 18% are likely mobile for any soil type

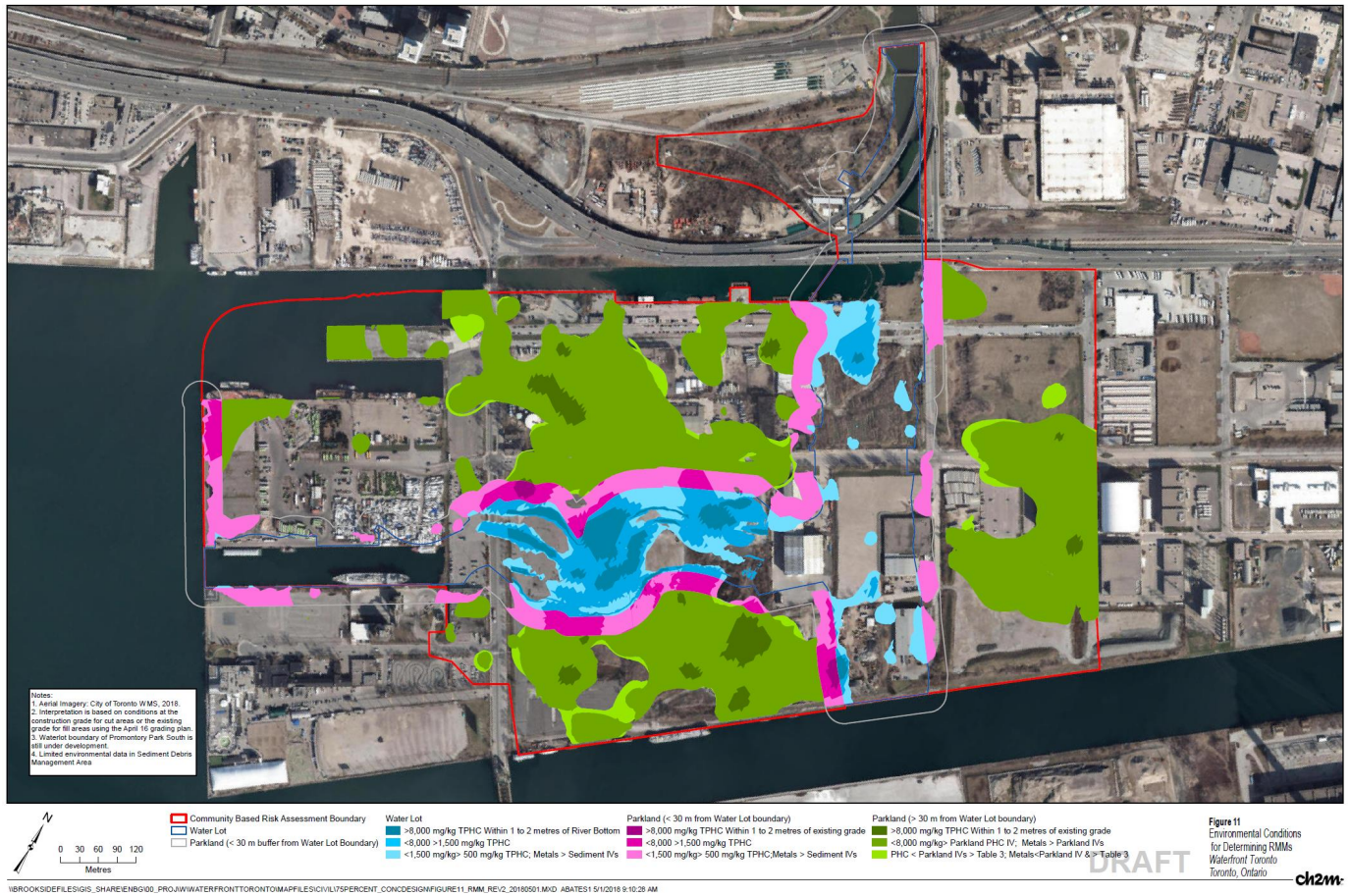
Remedy Implementation By NAPL Mobility Criteria (Prior to site specific evaluation)



Spatial Area	500 < tPHC < 1,500	1,500 < tPHC < ????	tPHC > ???? mg/kg
Primary Concern	Direct Contact		
Underneath Surface Water	Permeable Barrier	REMOVAL/ACTIVE MANAGEMENT	
Within 30 m of Surface Water	Impermeable Barrier		
Upland (greater than 30 m from Surface Water)	Direct Contact Barrier		

Based on the site specific NAPL mobility criteria the following general remedies were implement

Remedy Implementation By Revised NAPL Mobility Criteria

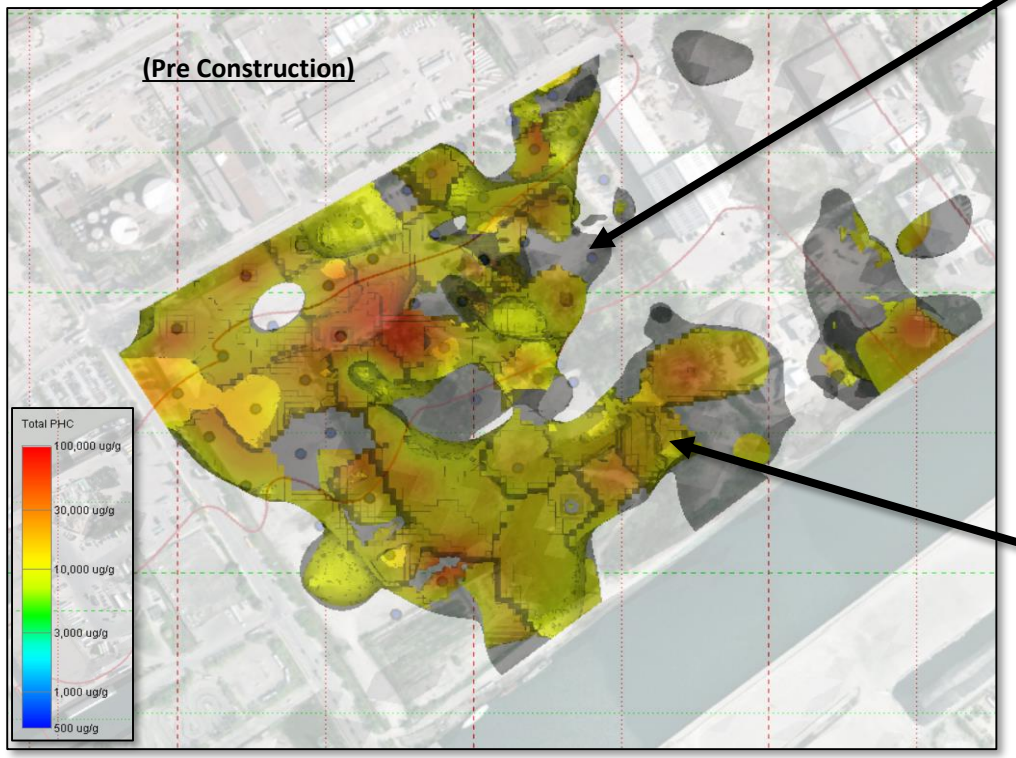


Spatial Area	500 < tPHC < 1,500	1,500 < tPHC < 8,000	tPHC > 8,000 mg/kg
Primary Concern	Direct Contact	Potential Sheen Generation	Potentially Mobile
Underneath Surface Water	Permeable Barrier	Impermeable Barrier	Overexcavation /Treatment
Within 30 m of Surface Water	Impermeable Barrier	Impermeable Barrier	Overexcavation /Treatment
Upland (greater than 30 m from Surface Water)	Direct Contact Barrier	Direct Contact Barrier	Direct Contact Barrier

Based on the site specific NAPL mobility criteria the following general remedies were implement

LIF and Traditional PHC Integration

- **Integrating these two data sets reduces the likely impacted soil volume (above 1,500 mg/kg tPHC) approximately 50%.**
- **Additional refinement will be made to the %RE contour which can be used for the cut and the inclusion of additional areas where LIF data is being collected.**
- **This may allow greater reuse of excavated soils with limited treatment and less extensive RMMs**



PHC Soil Volume above 1,500 mg/kg not cut with LIF data

PHC Soil Volume above 1,500 cut with volumes <5 %RE removed

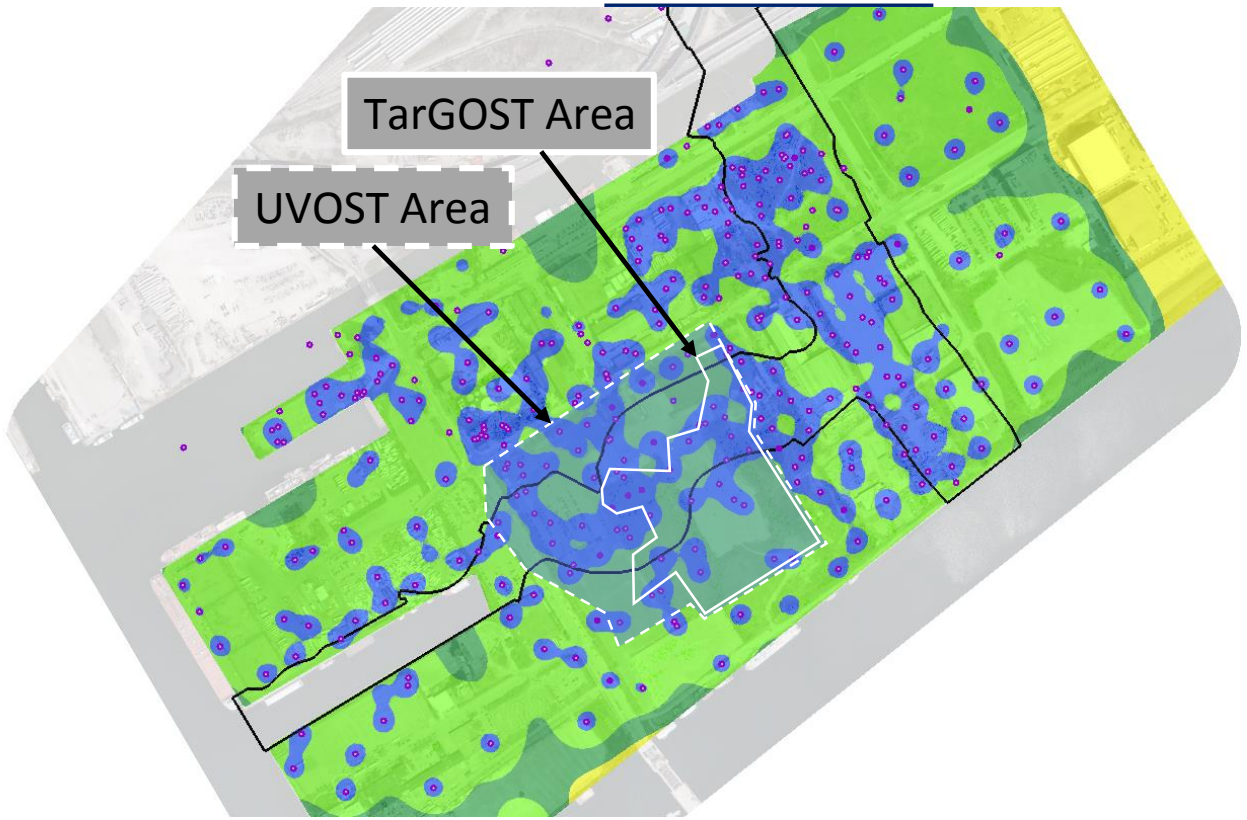
At many sites even rudimentary overlays of traditional sampling and LIF screening data will result in significant contaminated soil volumes (50% in this case)

Additional Screening, CSM Spatial Uncertainty, and Cost Benefit

Areas where UVOST and TarGOST have been completed are highlighted and have spacings of approximately 50 meters.

- For example if the cost to excavate/treat each m^3 of soil is $10, sample points spaced 25 meters apart use 3 sample locations with 3 samples each to decide on $30,000 worth of disposal/treatment. LIF borings or traditional borings cost roughly $1,000 each
- The data confidence can be further refined by exceedances and a cost benefit analysis of additional data offsetting excavation or remedy costs. ***Quantitative and Qualitatively the benefits of further investigation far outweigh the potential costs.***

Data Point Spacing (m)	CSM Resolution (m^2)	Certainty (estimated depth/thickness of impacts 5 m on average)	Borings/Samples/Cost of Soil Unit Excavated/treated
~25	600	6-9 data points being used to assess ~3,000 m^3 of soil	3/9/$30K
~100	10,000	6-9 data points being used to assess ~50,000 m^3 of soil	3/9/$500K
~130	20,000	6-9 data points being used to assess ~100,000 m^3 of soil	3/9/$1M



Summary

1. Large complex NAPL sites *require strong stakeholder engagement* to be *effective technically*
2. Don’t be afraid of revisiting your CSM, taking a new look at old data, and gathering data to fill data gaps. NAPL Management is a *Circular Process*
3. *Defining site specific NAPL mobility criteria* is important and can reframe your potential remedies
4. Representatively *extrapolate small scale detailed site data* sets to sitewide conclusions. This is helpful for getting buy in from stakeholders.
5. Perform at least *basic cost benefit analysis* of supplemental investigation data to reduce remedial costs
6. Questions/Discussion