ITRC Implementation Workshop

Integrated DNAPL Site Characterization

Michael B. Smith, Vermont
Naji Akladiss, Maine)

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Problem

- Traditional Characterization was largely based on inaccurate assumptions about the subsurface
- Solving CSM uncertainties by over engineering remediation programs has largely failed
- Advanced characterization tools are often unknown, unfamiliar, and unused

Solution

- Integrate newly understood DNAPL fate and transport considerations into site characterization
- Develop Conceptual Site Models with data resolution comparative to the scale of uncertainties in the subsurface
- Use data collection objectives that clearly target and test uncertainties in the subsurface.
- Provide a Tools Selection Matrix of all available characterization tools

Benefits

- Higher return on investigation (ROI)
- Improved selection of remedial measures
- Better performing remedies
- Reduced uncertainty in risk evaluations
- Decisions that are
  - More protective of HH&E
  - Focused necessity of source control
  - More predictability in outcomes

Tech-Reg Content

- Types of DNAPL and their properties
- Distribution of DNAPL, aqueous phase and vapor phase
- Integrated Site Characterization method of investigating a site
  - Define data gaps and resolution
  - Objectives-based data collection
  - Tools selection matrix

Investigation process

- **Plan Characterization**
- **Select applicable tools**
- **Manage and interpret data**

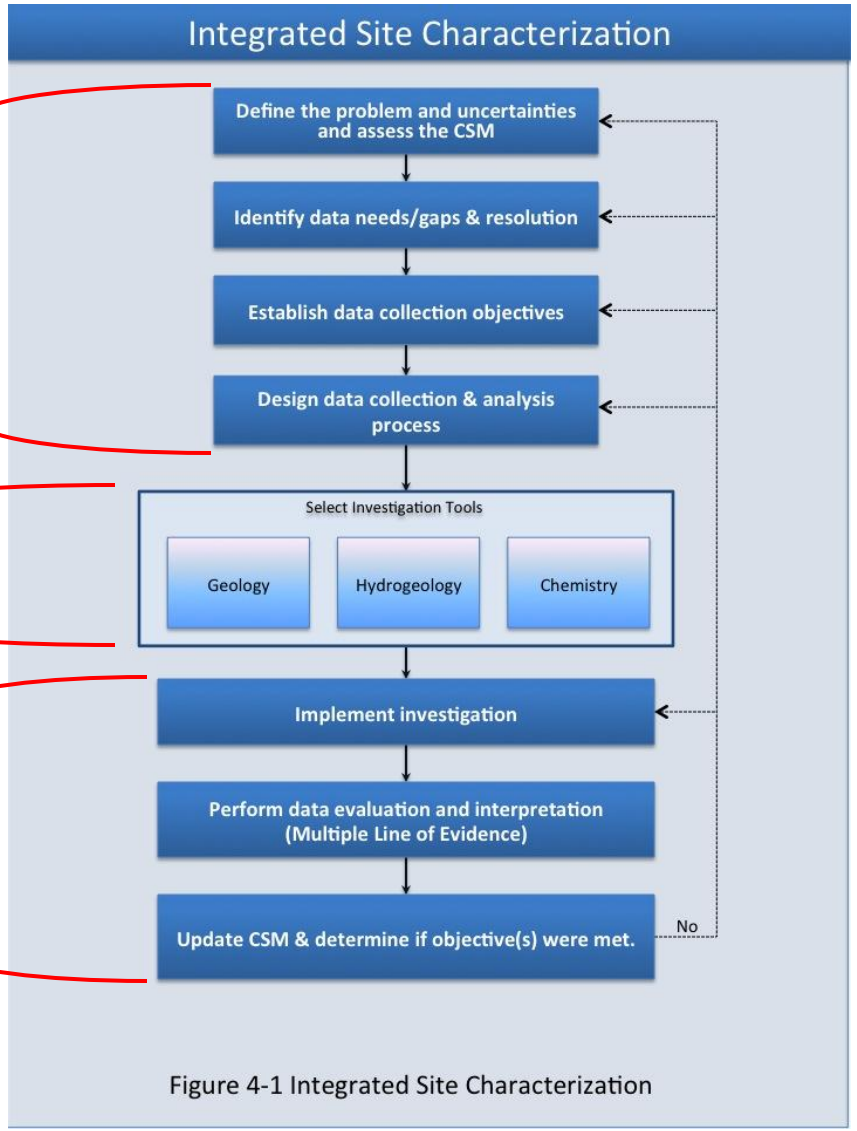
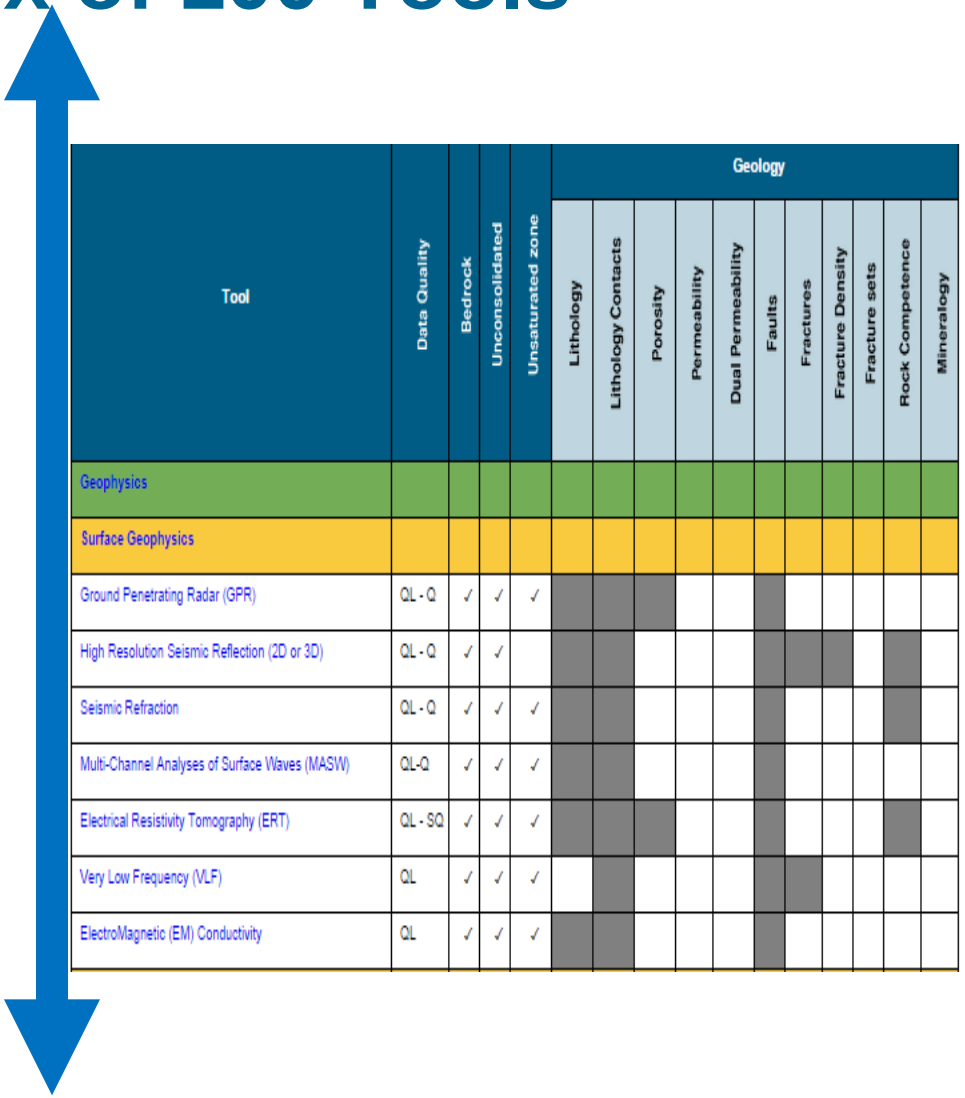


Figure 4-1 Integrated Site Characterization

Tools Matrix of 100 Tools

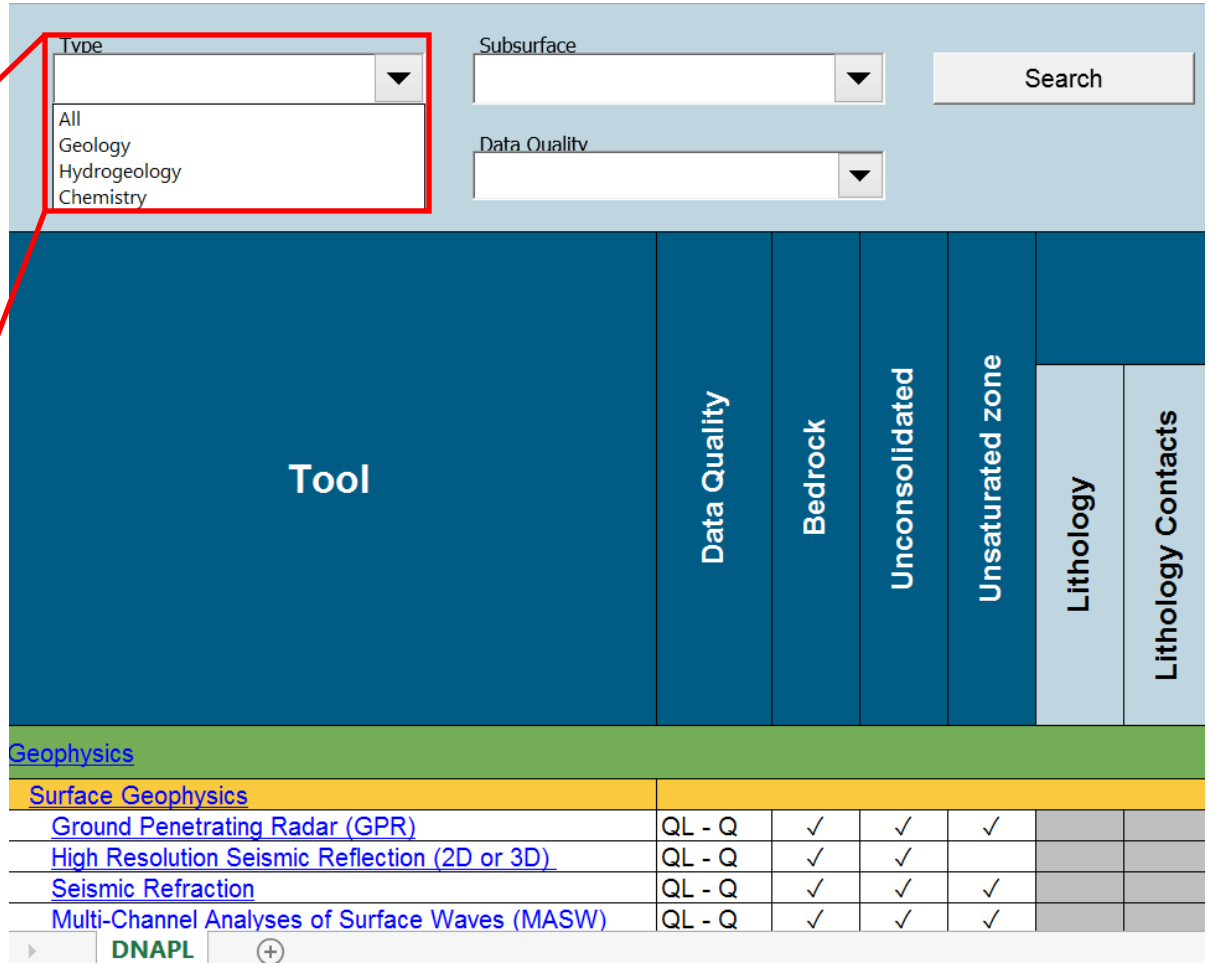
- Sorted by:
  - Type
    - Geology
    - Hydrogeology
    - Chemistry
  - Subsurface
    - Unconsolidated
    - Bedrock
  - Subsurface Zone
    - Saturated
    - Unsaturated
- Ranked by data quality
  - Quantitative
  - Semi-quantitative
  - Qualitative



Tool	Data Quality	Bedrock	Unconsolidated	Unsaturated zone	Geology										
					Lithology	Lithology Contacts	Porosity	Permeability	Dual Permeability	Faults	Fractures	Fracture Density	Fracture sets	Rock Competence	Mineralogy
Geophysics															
Surface Geophysics															
Ground Penetrating Radar (GPR)	QL - Q	✓	✓	✓	■	■	■			■					
High Resolution Seismic Reflection (2D or 3D)	QL - Q	✓	✓		■	■				■	■	■		■	
Seismic Refraction	QL - Q	✓	✓	✓	■	■				■				■	
Multi-Channel Analyses of Surface Waves (MASW)	QL-Q	✓	✓	✓	■	■				■					
Electrical Resistivity Tomography (ERT)	QL - SQ	✓	✓	✓	■	■	■			■				■	
Very Low Frequency (VLF)	QL	✓	✓	✓		■				■	■				
ElectroMagnetic (EM) Conductivity	QL	✓	✓	✓	■	■				■					

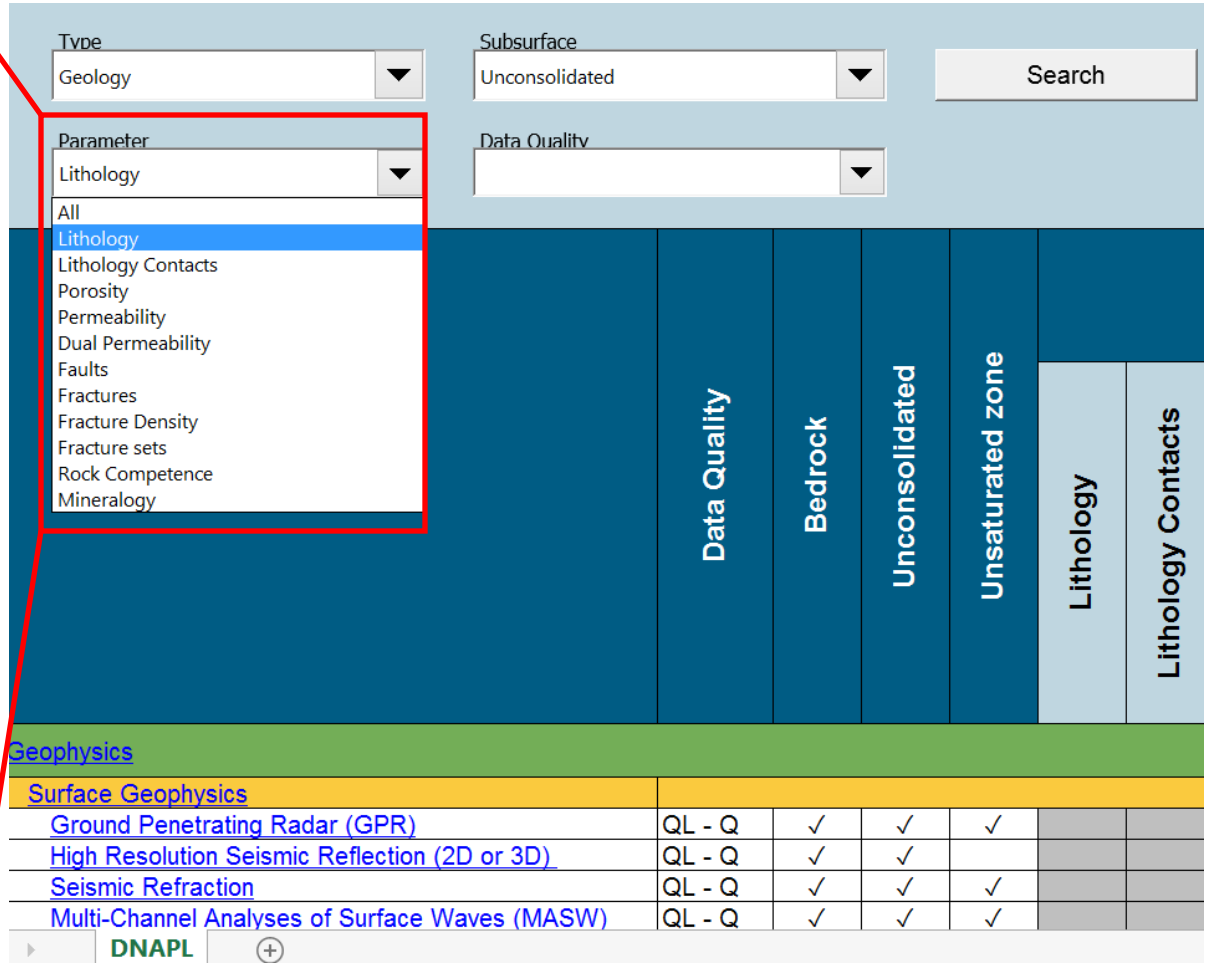
1. Select Category

All
Geology
Hydrogeology
Chemistry



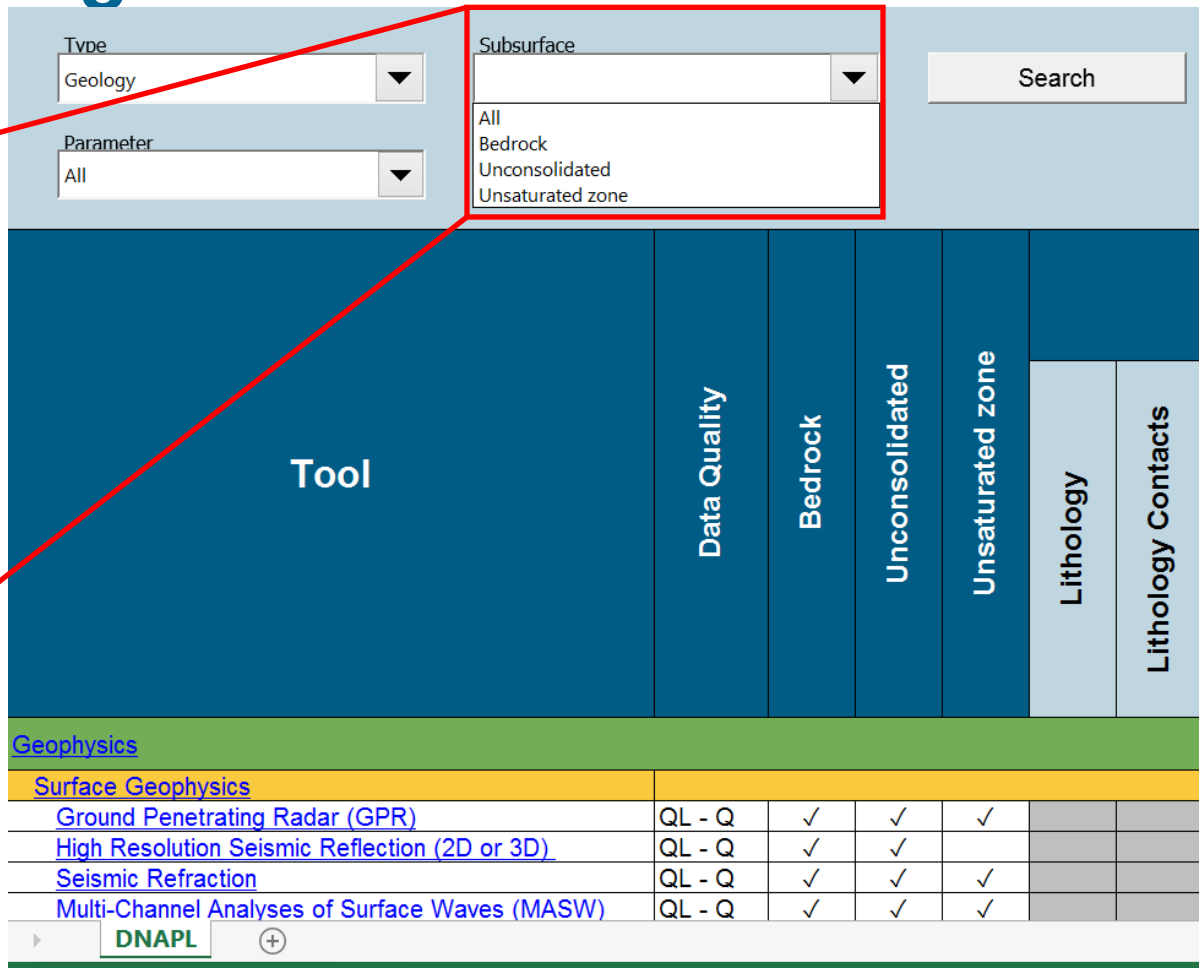
2. Select Parameters of Interest (Step 3)

All
Lithology
Contacts
Porosity
Permeability
Dual Permeability
Faults
Fractures
Fracture Density
Fracture Sets
Rock
Competence
Mineralogy



3. Identify Geologic Media

All
Bedrock
Unconsolidated
Unsaturated
Zone

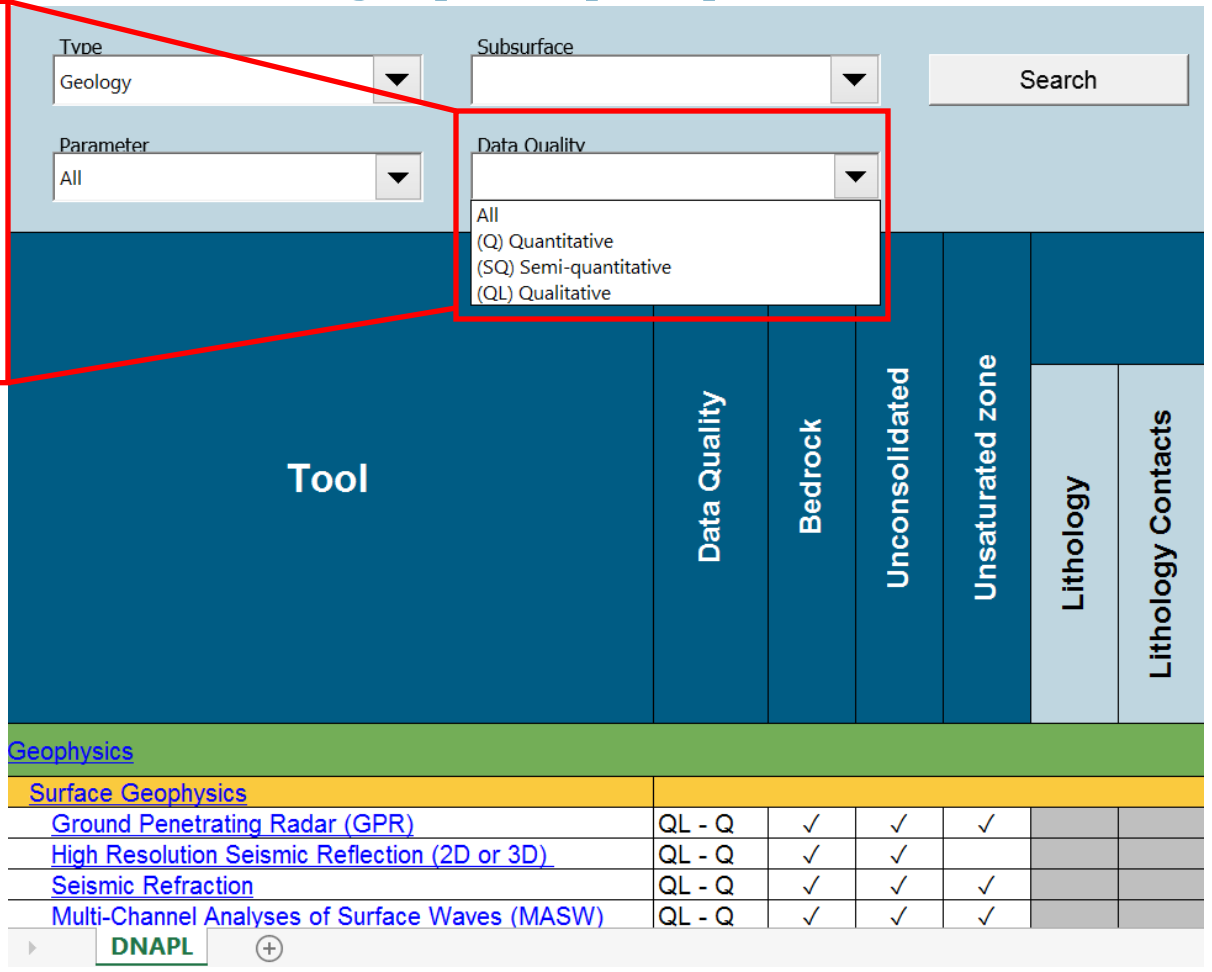


Tool	Data Quality	Bedrock	Unconsolidated	Unsaturated zone	Lithology	Lithology Contacts
Geophysics						
Surface Geophysics						
Ground Penetrating Radar (GPR)	QL - Q	✓	✓	✓		
High Resolution Seismic Reflection (2D or 3D)	QL - Q	✓	✓			
Seismic Refraction	QL - Q	✓	✓	✓		
Multi-Channel Analyses of Surface Waves (MASW)	QL - Q	✓	✓	✓		

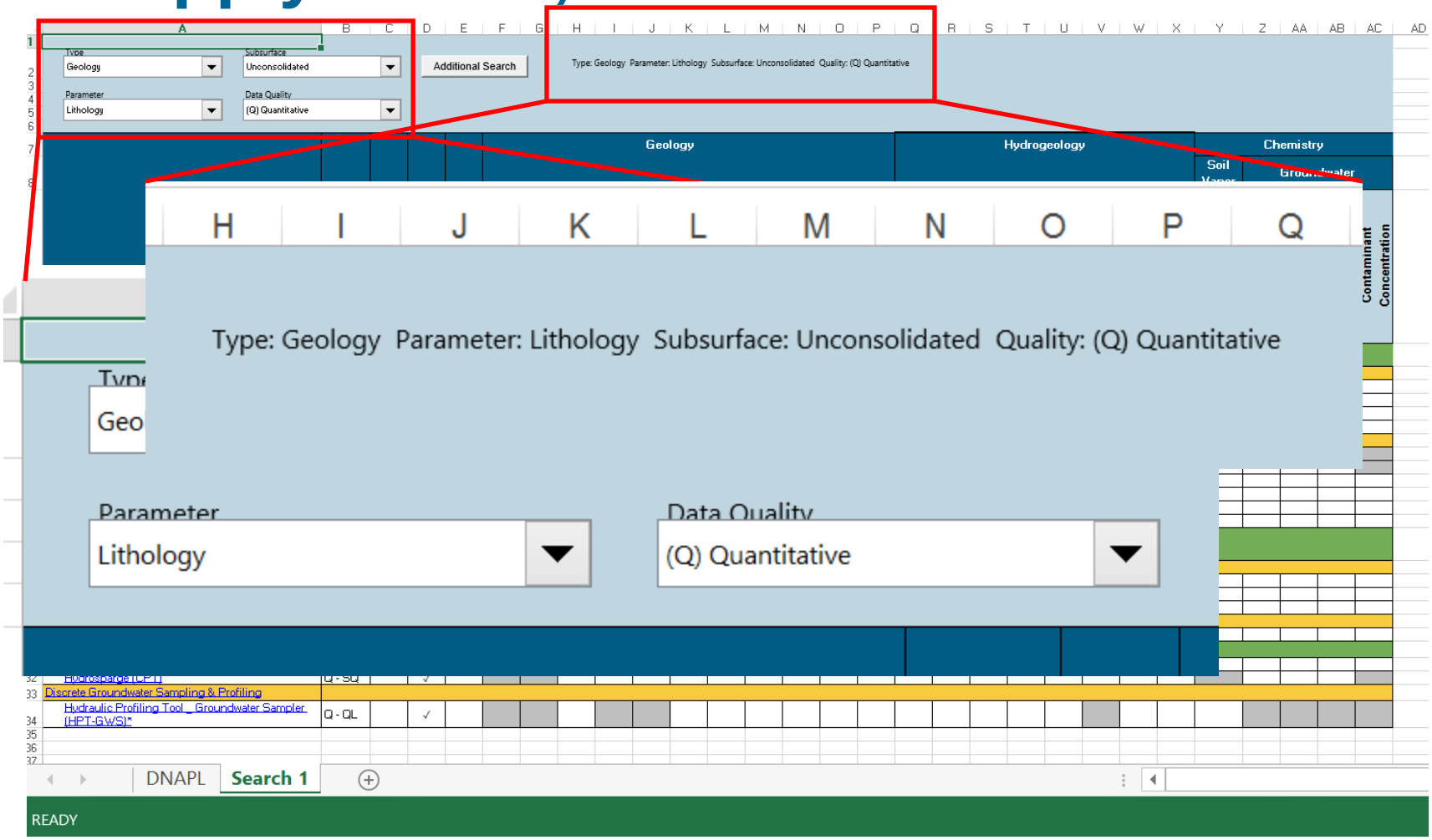
DNAPL

4. Choose Data Quality (Step 2)

(Q) quantitative
(SQ) semi-quantitative
(QL) qualitative

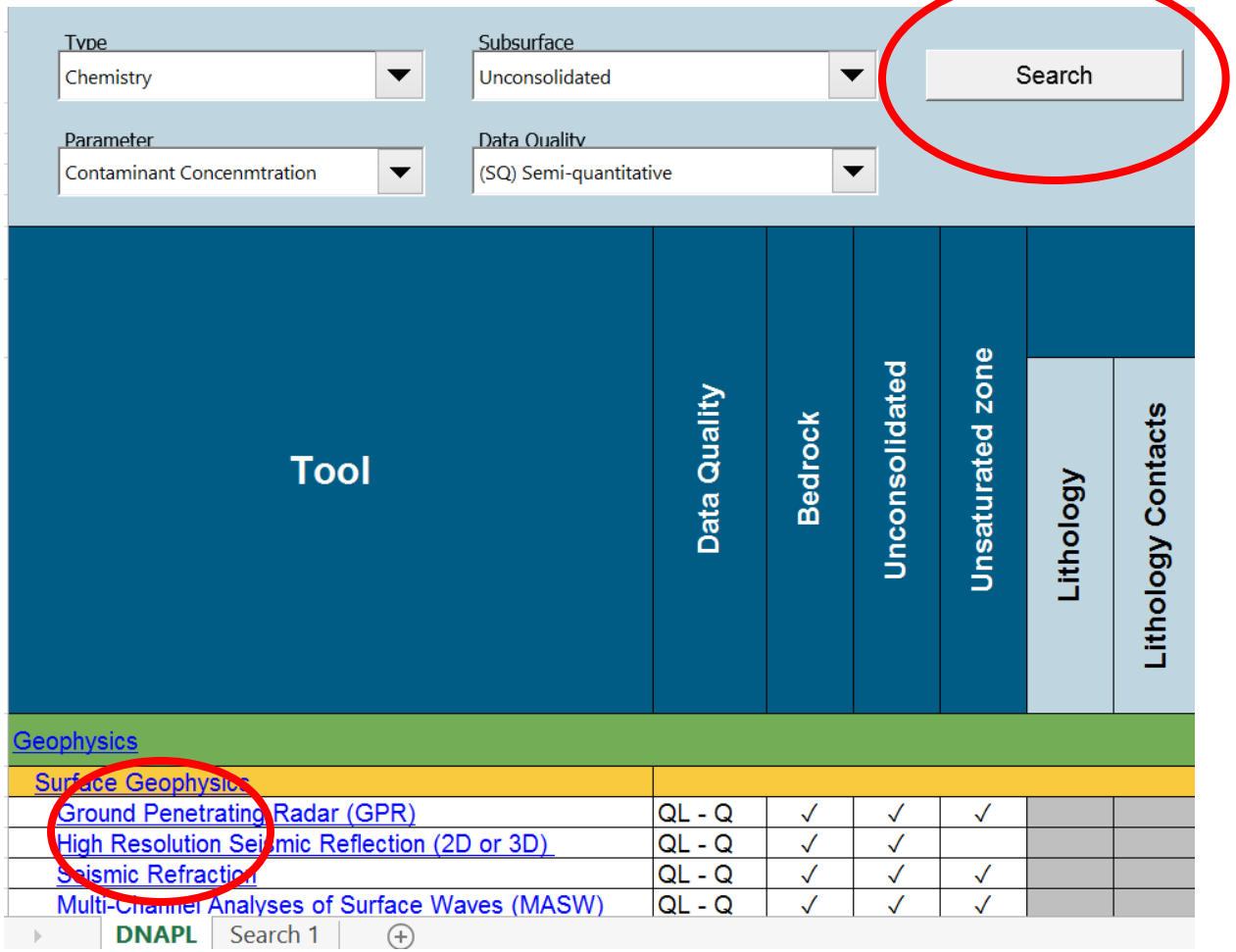


5. Apply Filters, Evaluate Tools

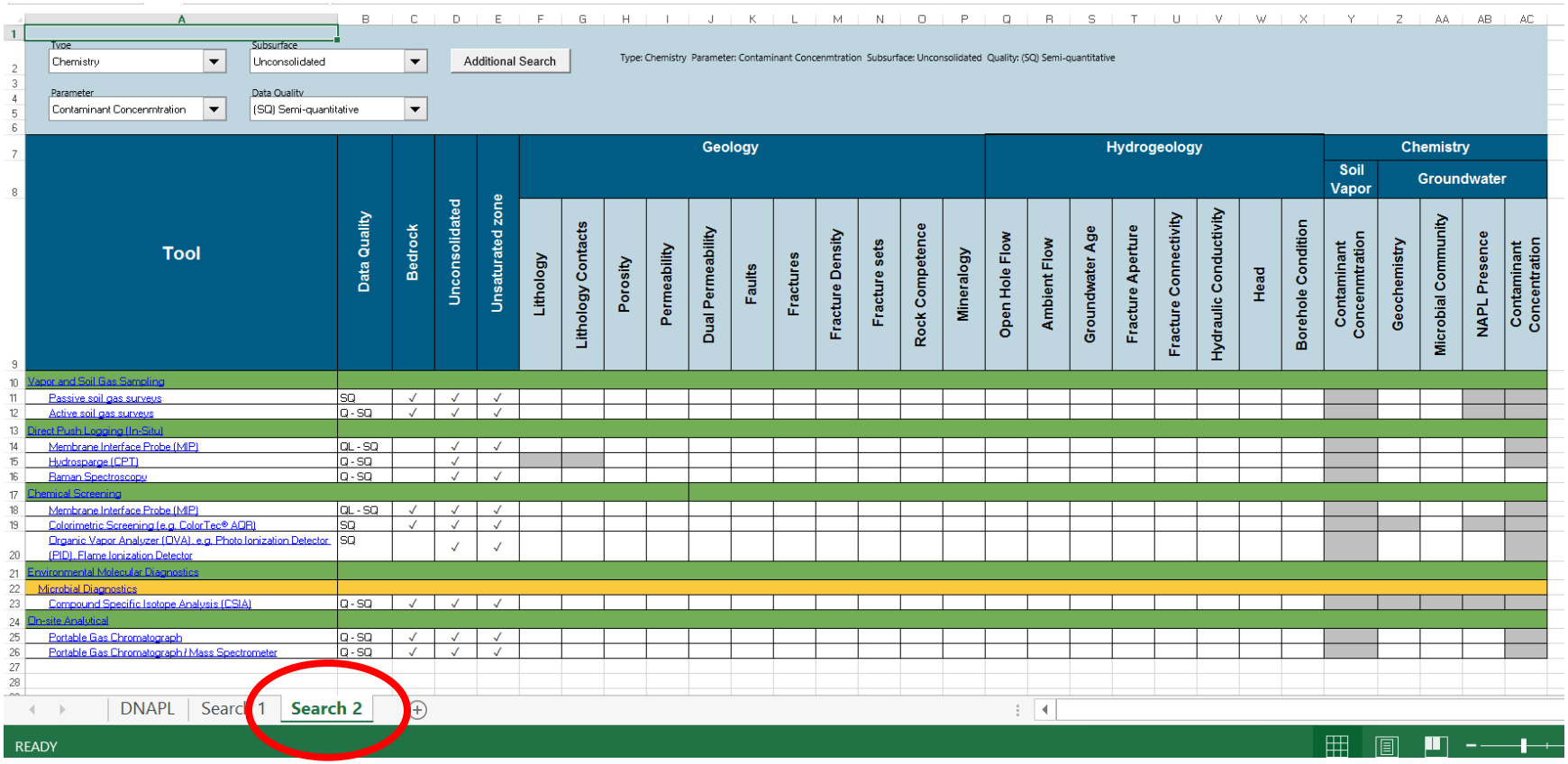


Perform additional searches to find more tools for different objectives

Search 2 – creates new, separate tool list from first search



Search 2 results



Type: Chemistry
Subsurface: Unconsolidated
Additional Search
Parameter: Contaminant Concenmtration
Data Quality: (SQ) Semi-quantitative
Type: Chemistry Parameter: Contaminant Concenmtration Subsurface: Unconsolidated Quality: (SQ) Semi-quantitative

Tool	Data Quality	Bedrock	Unconsolidated	Unsaturated zone	Geology: Lithology	Geology: Lithology Contacts	Geology: Porosity	Geology: Permeability	Geology: Dual Permeability	Geology: Faults	Geology: Fractures	Geology: Fracture Density	Geology: Fracture sets	Geology: Rock Competence	Geology: Mineralogy	Hydrogeology: Open Hole Flow	Hydrogeology: Ambient Flow	Hydrogeology: Groundwater Age	Hydrogeology: Fracture Aperture	Hydrogeology: Fracture Connectivity	Hydrogeology: Hydraulic Conductivity	Hydrogeology: Head	Hydrogeology: Borehole Condition	Chemistry: Soil Vapor: Contaminant Concenmtration	Chemistry: Groundwater: Geochemistry	Chemistry: Groundwater: Microbial Community	Chemistry: Groundwater: NAPL Presence	Chemistry: Groundwater: Contaminant Concentration
Vapor and Soil Gas Sampling																												
Passive soil gas surveys	SQ	✓	✓	✓																								
Active soil gas surveys	Q - SQ	✓	✓	✓																								
Direct Push Logging (In-Situ)																												
Membrane Interface Probe (MIP)	QL - SQ		✓	✓																								
Hydrosparge (CPT)	Q - SQ		✓																									
Raman Spectroscopy	Q - SQ		✓	✓																								
Chemical Screening																												
Membrane Interface Probe (MIP)	QL - SQ	✓	✓	✓																								
Colorimetric Screening (e.g. ColorTec® AQR)	SQ	✓	✓	✓																								
Organic Vapor Analyzer (OVA), e.g. Photo Ionization Detector (PID), Flame Ionization Detector	SQ		✓	✓																								
Environmental Molecular Diagnostics																												
Microbial Diagnostics																												
Compound Specific Isotope Analysis (CSIA)	Q - SQ	✓	✓	✓																								
On-site Analytical																												
Portable Gas Chromatograph	Q - SQ	✓	✓	✓																								
Portable Gas Chromatograph / Mass Spectrometer	Q - SQ	✓	✓	✓																								

DNAPL | Search 1 | Search 2

READY

Important Issues

- Understanding various DNAPL types and characteristics
  - Chemical characteristics
  - Physical characteristics
- DNAPL behavior in the subsurface
  - Age of the release
  - Contaminant phases
  - Geologic controls
- Familiarity with tools

Steps to Achieve Impact

- Practitioners need to do use better science to support engineering design
- Practitioners and regulators need to become more familiar with new characterization tools and their application

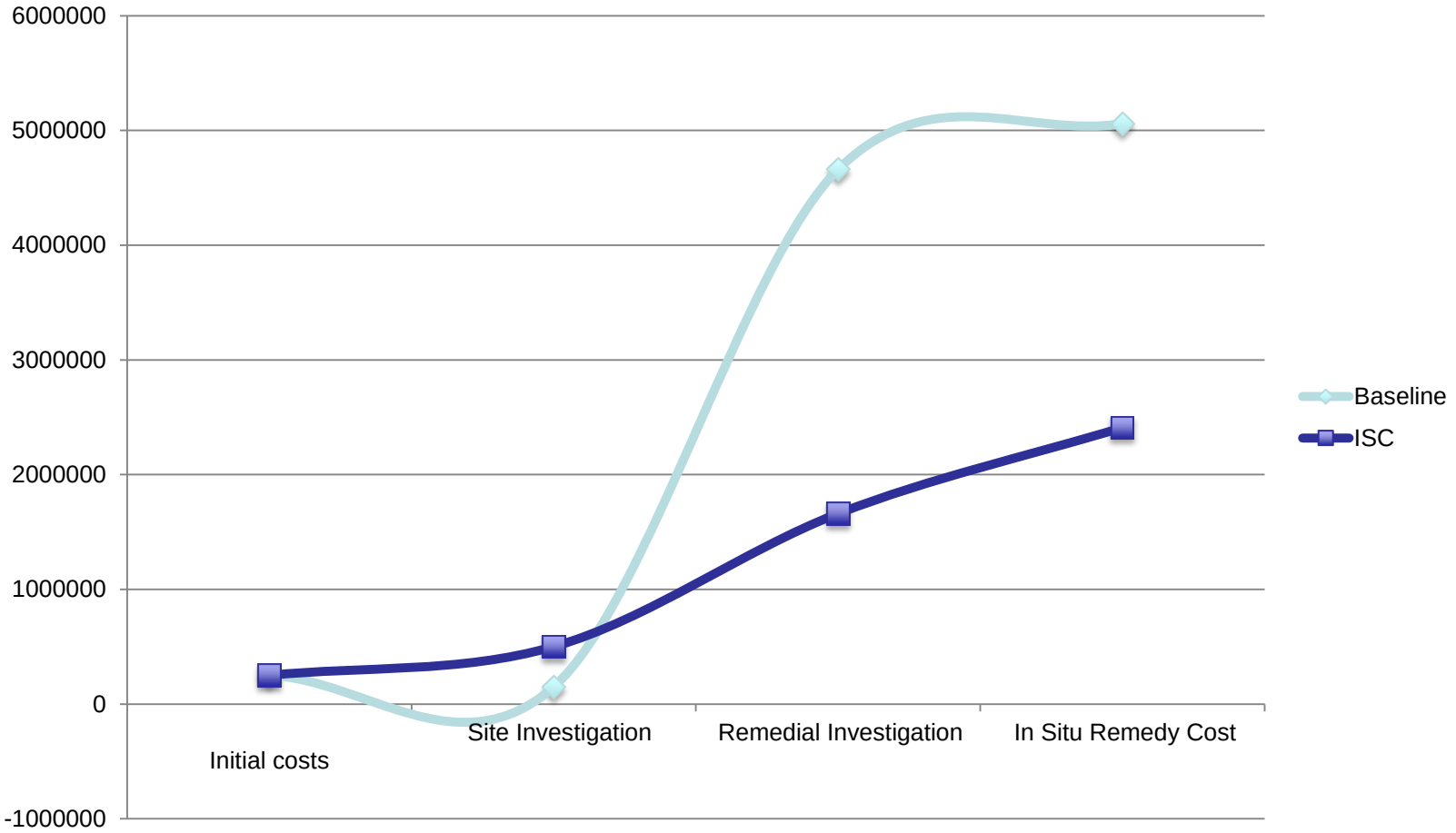
Where Tech-Reg Will Provide Impact

EXPECTED USER GROUP	INTENDED USE	BENEFIT TO BE RECEIVED BY USERS
State & Federal Regulators	Evaluate site life cycle	CSM may need updated
State & Federal Regulators	Evaluate DNAPL type considerations	Transport model may need to be updated
State & Federal Regulators	Evaluate DNAPL behavior in the subsurface	Unknown subsurface heterogeneities may be controlling transport
State & Federal Regulators	Re-evaluate remediation progress	Resolution of the subsurface characterization may not included adequate scale to identify matrix storage and diffusion

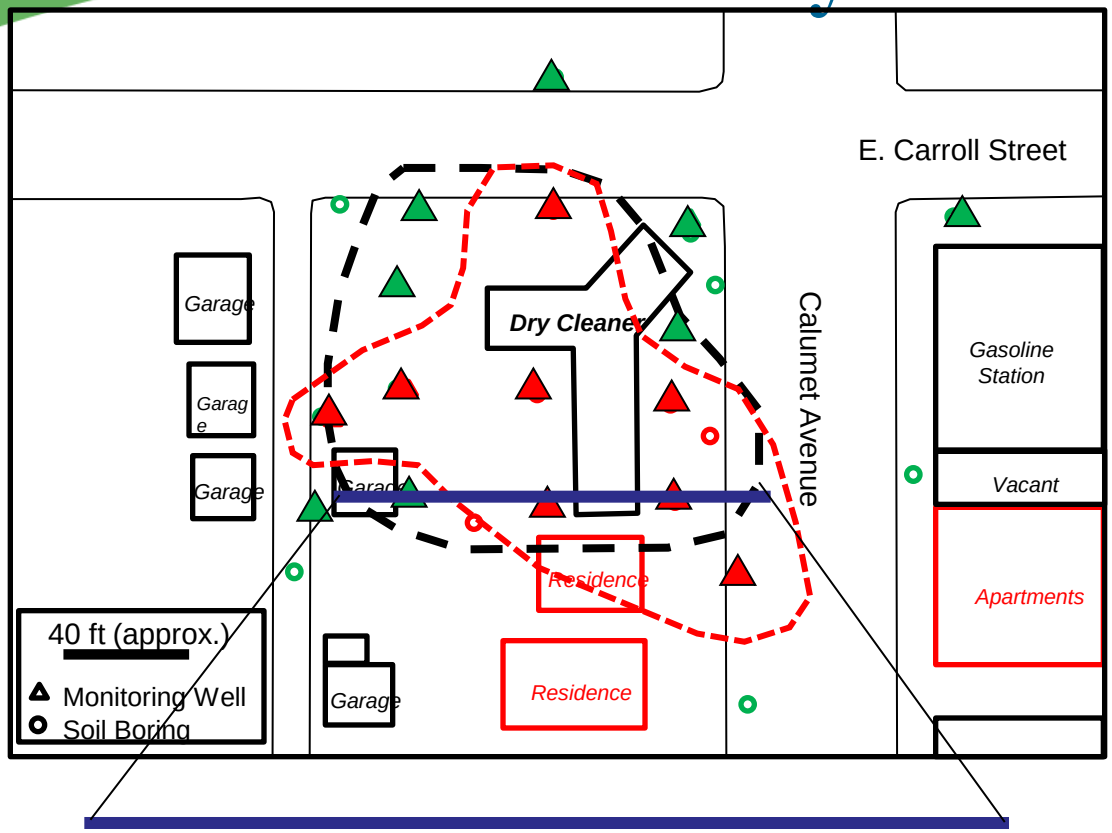
Where Tech-Reg Will Provide Impact

EXPECTED USER GROUP	INTENDED USE	BENEFIT TO BE RECEIVED BY USERS
Practitioners	Re-evaluate remediation progress	Resolution of the subsurface characterization may be inaccurate (Well 12A example)
Practitioners	Evaluate site life cycle	CSM may have overlooked a phase (DNAPL, aqueous, vapor). (Indiana dry cleaners example) & (14 compartment model spreadsheet)
Practitioners	Evaluate DNAPL type considerations	Transport model assumptions could be improved
Practitioners	Test DNAPL, aqueous, and vapor phase distribution	Remediation cost may be reduced (well 12A example)

Well 12A


6000000
5000000
4000000
3000000
2000000
1000000
0
-1000000
Initial costs
Site Investigation
Remedial Investigation
In Situ Remedy Cost
Baseline
ISC

Indiana Dry Cleaners



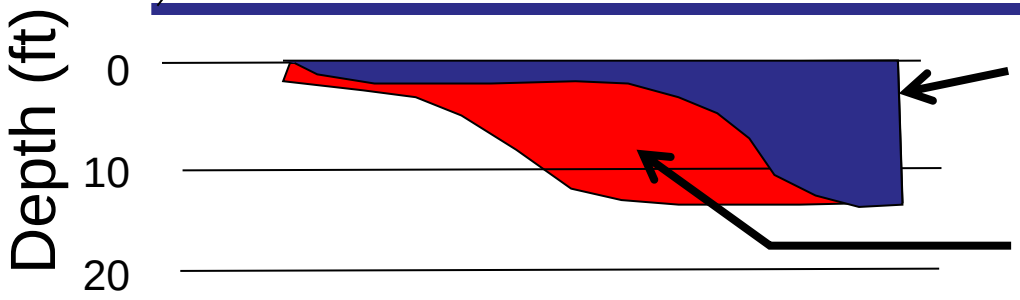
A. Define the problem

B. Identify data needs and resolution

C. Data collection

D. Data Collection

E. Data analysis



Original vertically-delineated plu

With additional data, the source area was found to extend west further than previously delineated