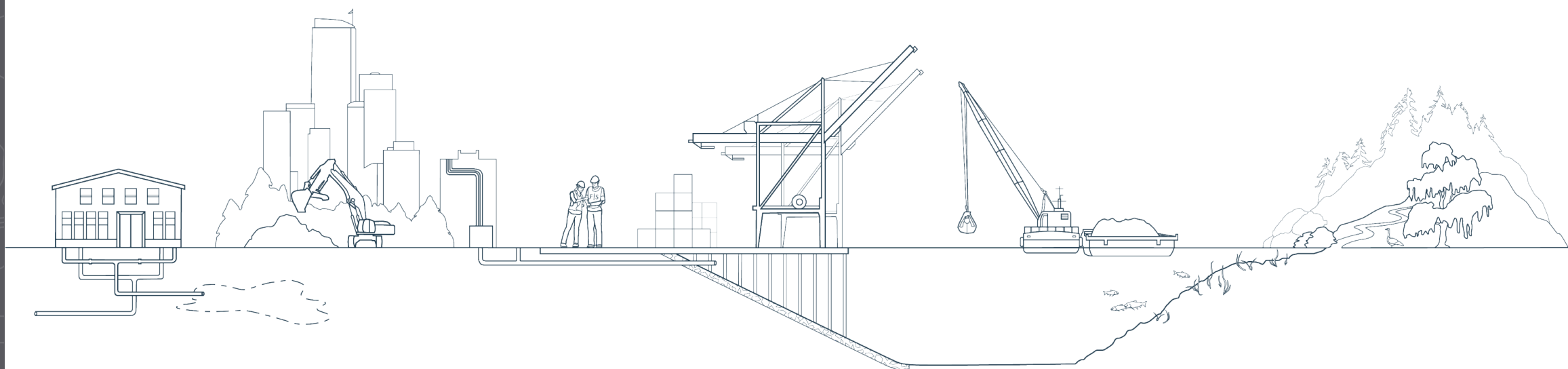


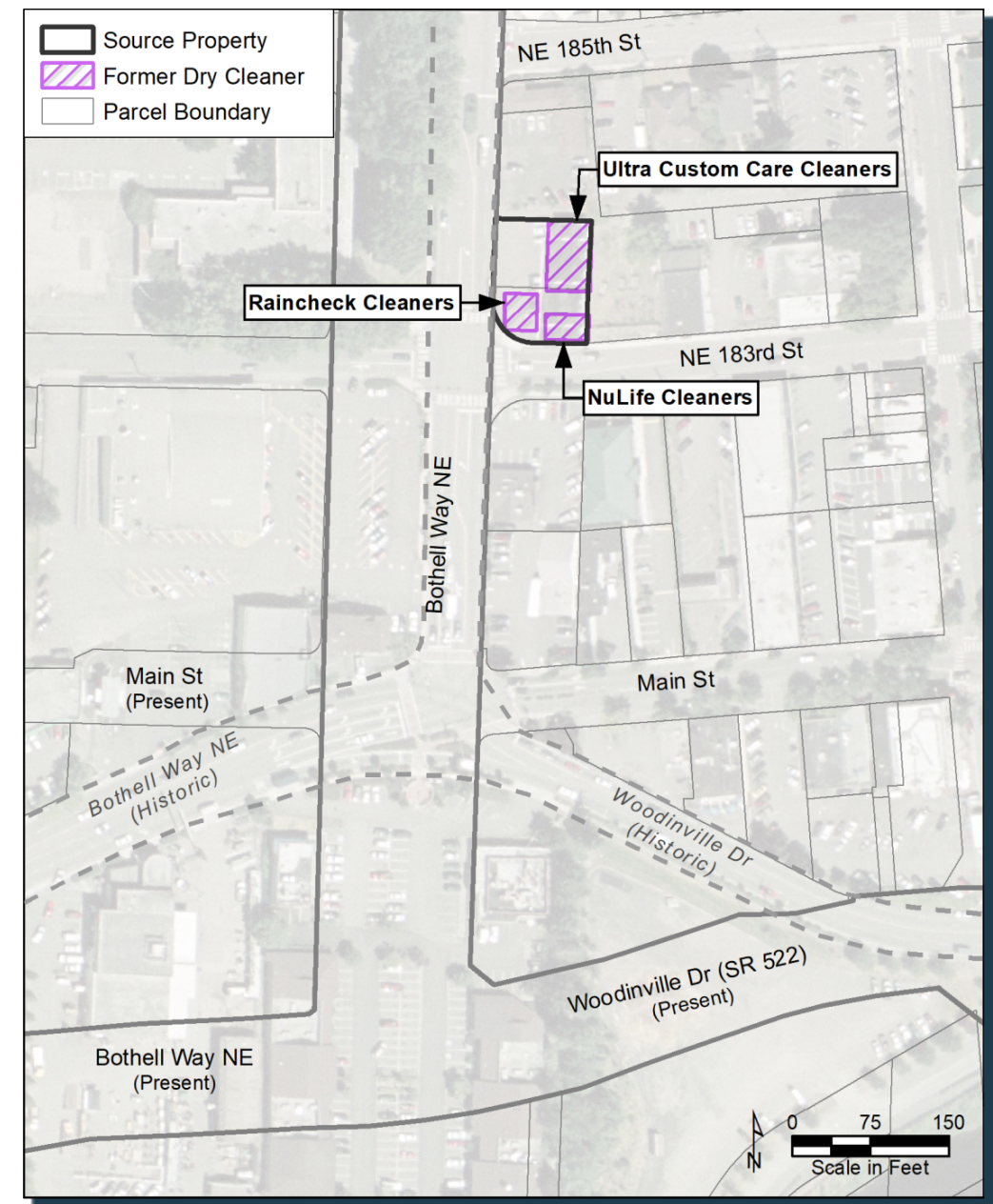
Use of Dynamic Visualization Tools to Improve Remediation Outcomes at Well-Studied Sites

Emily Jones and Henry Bates



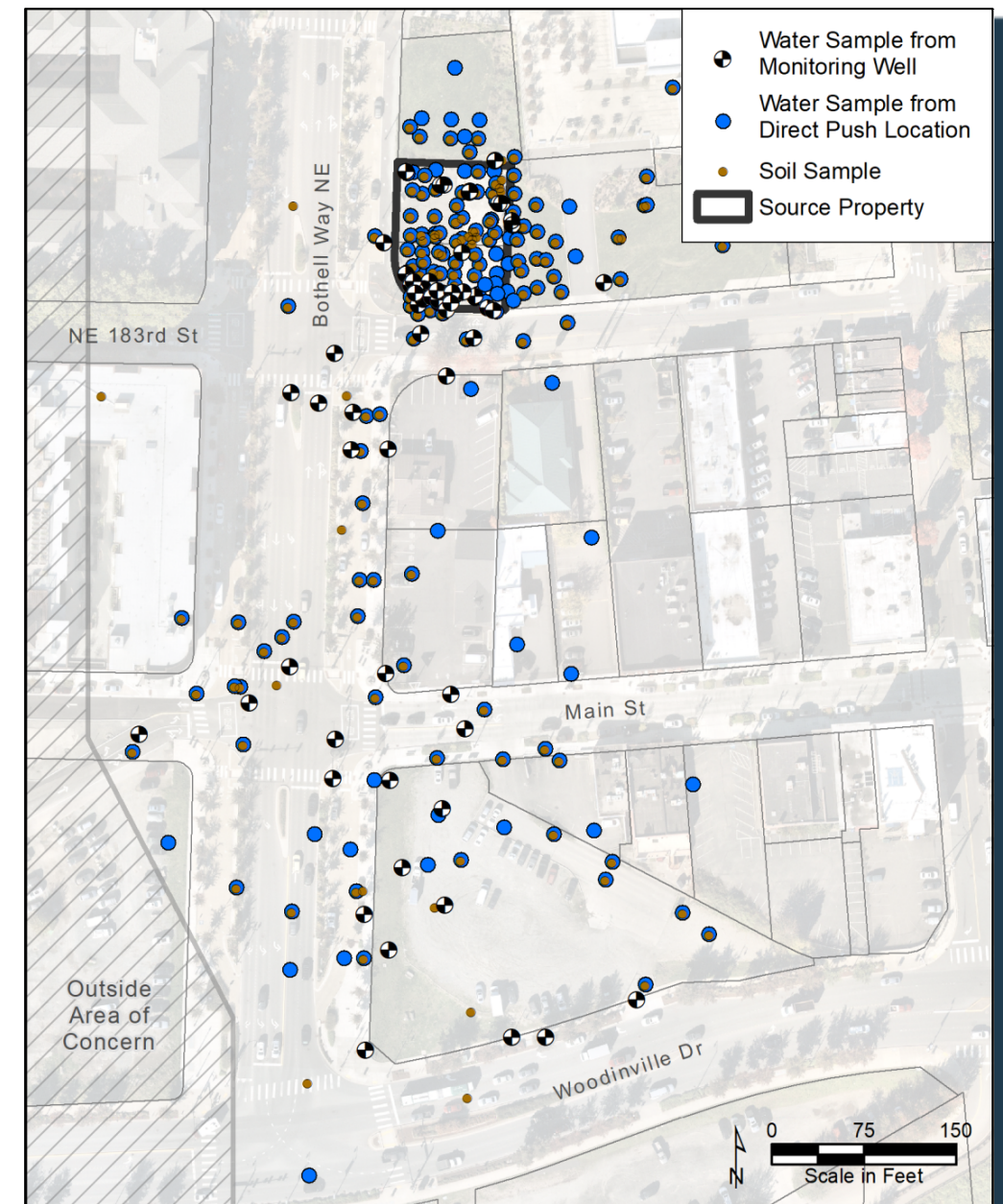
Site Background

- Chlorinated Volatile Organic Compound (CVOC) Site with complex release history and Site setting
 - Owned by local municipality
 - 4.5-acre Site spanning three City blocks
 - New roadway alignment and utility corridor
- Floyd|Snider began working on the Site in 2019



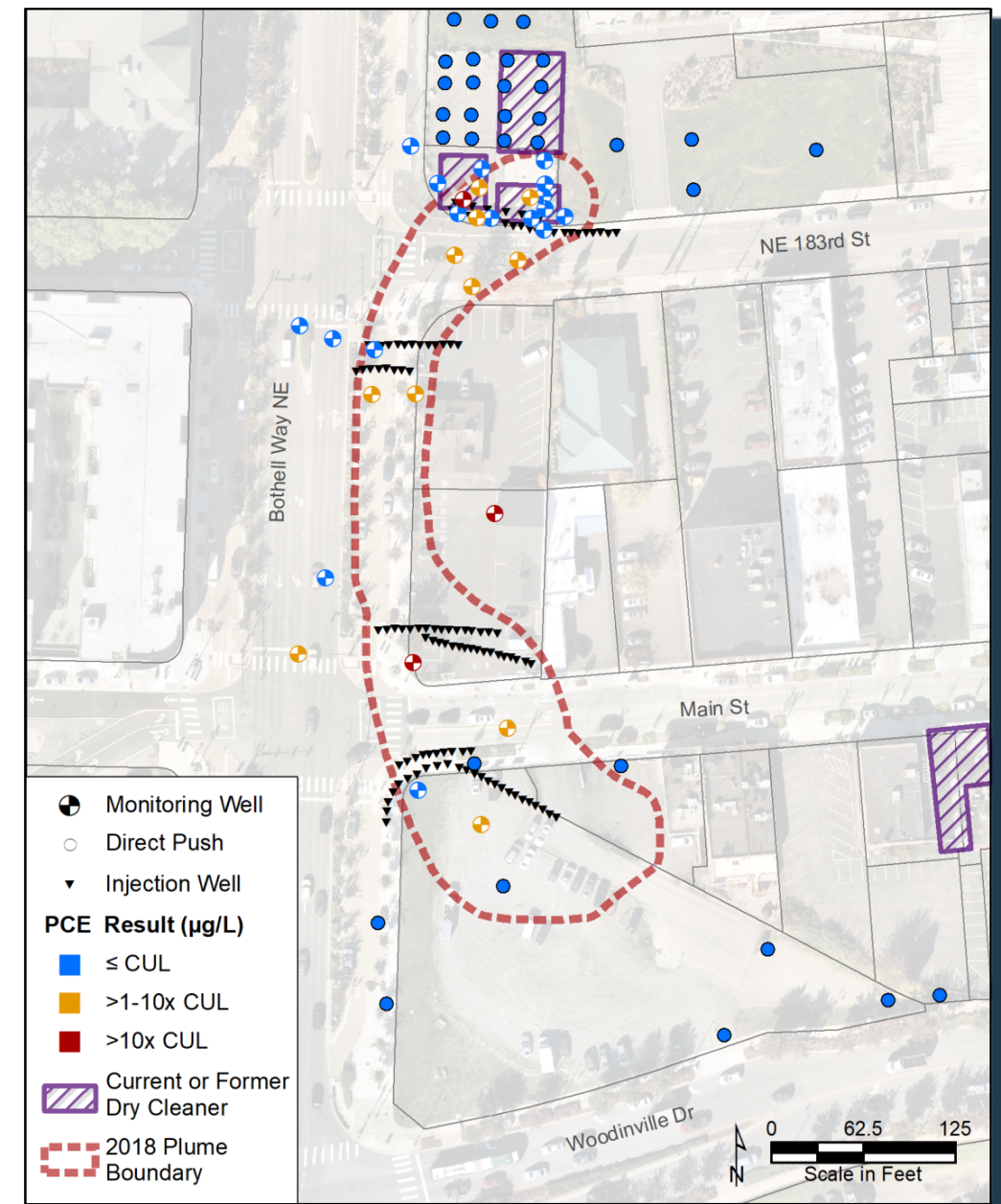
Well-Studied Site

- Approximately 50 prior investigations completed at and near the Site between 2007-2018 by various consultants at different Sites
 - 250 groundwater wells/probes
 - 175 soil borings
- Comprehensive Site database was not available



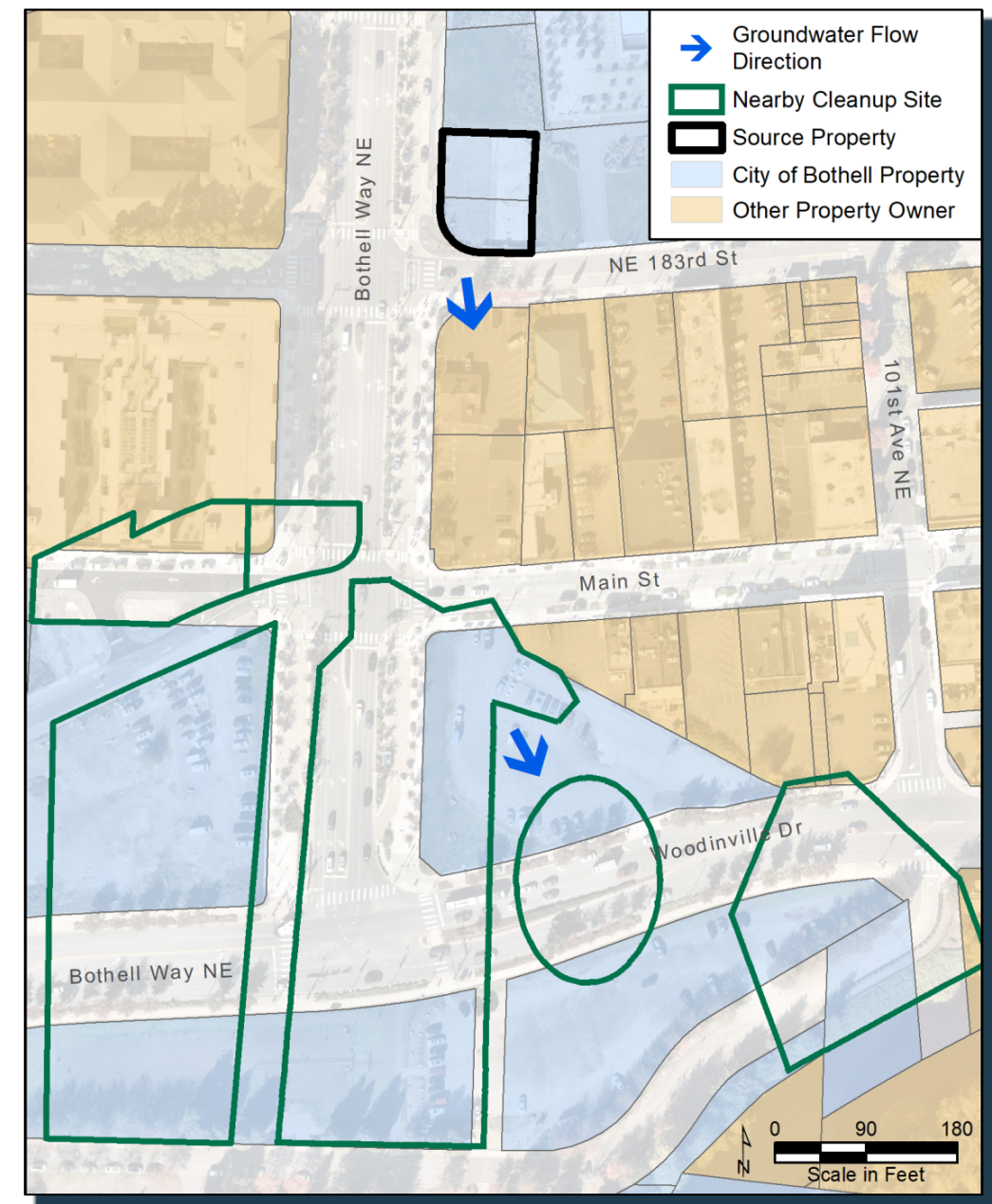
History of Interim Actions with Limited Success

- Interim actions:
 - 2014: Chemical Oxidation
 - 2015-2016: In Situ Bioinjections
 - 2009-2016: Targeted Excavations
- CVOC concentrations in several wells did not respond to interim actions
- Agency did not have confidence in the conceptual site model and prior data evaluation

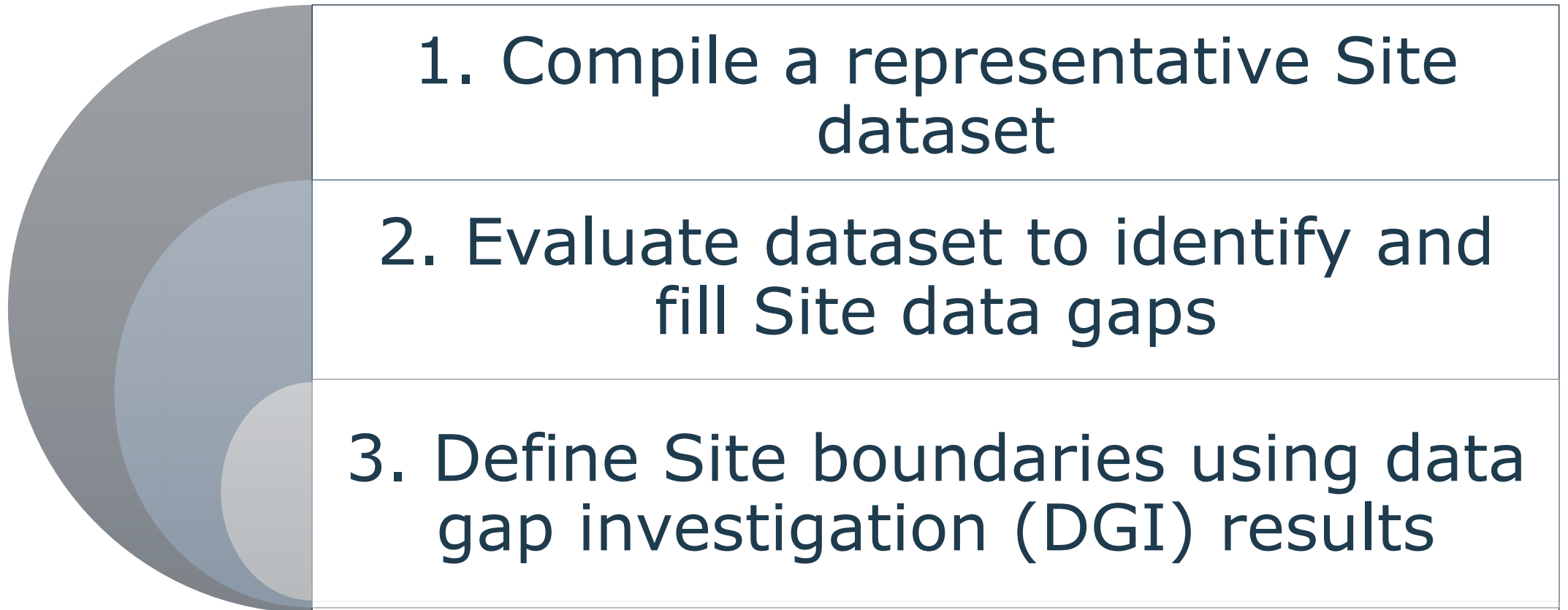


Data Evaluation Goals

- Bound Site CVOC contamination
 - Delineate the Site relative to surrounding Cleanup Sites
- Rule out other chemicals as Site COCs
- Understand interim action progress and aquifer properties



How Were Data Visualization Tools Used?



Step 1: Compile a Representative Site Dataset

- Identify and compile relevant data
 - Within the Site's area of interest
 - Analyzed for CVOCs or other relevant parameters
 - Analyzed using appropriately sensitive methods
 - i.e., with reporting limits less than Site cleanup levels (CULs)
 - For groundwater, collected after interim actions
 - For soil, not within excavation extent
- Use custom, interactive Tableau dashboards to standardize and QA/QC dataset

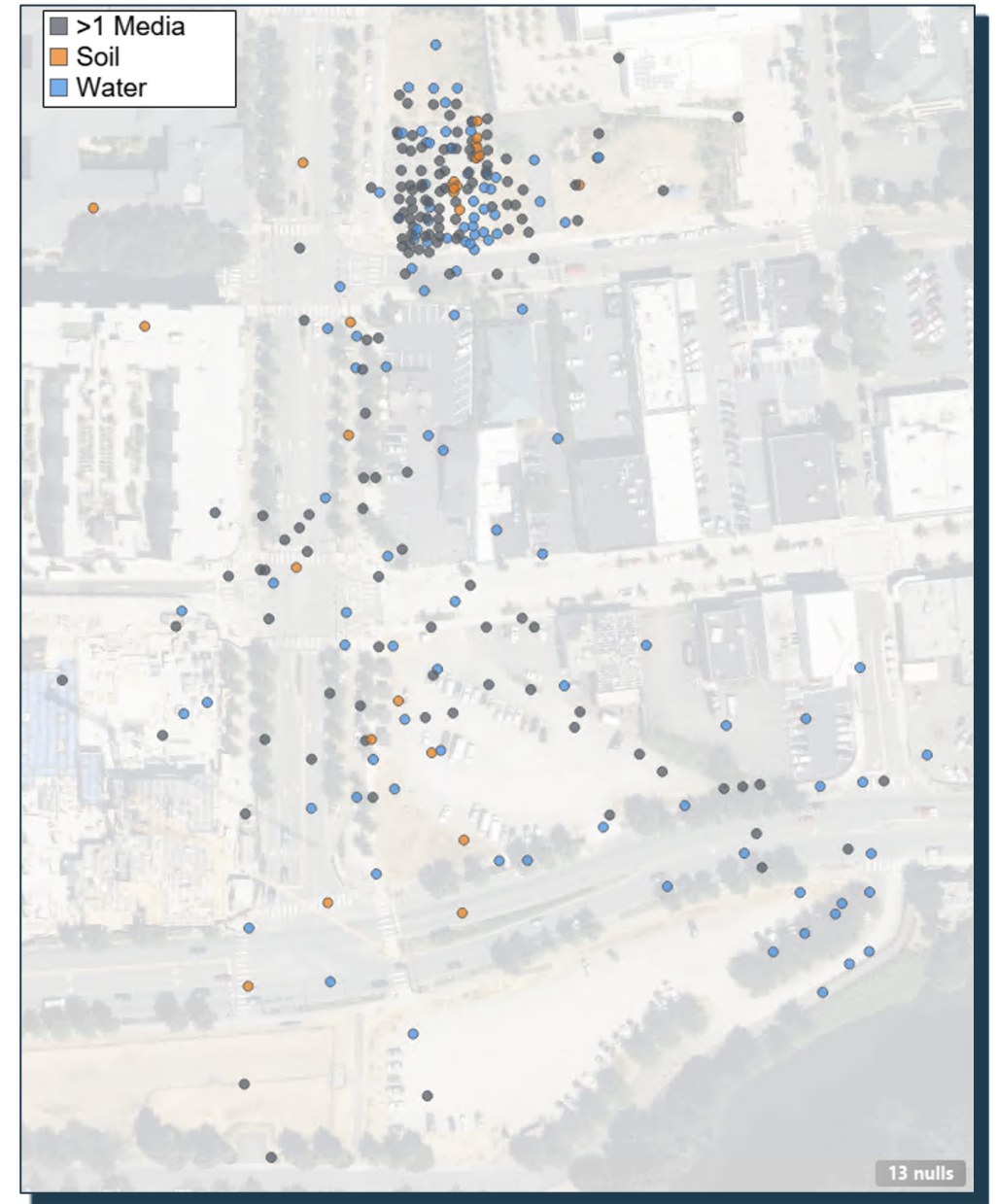
Assure Completeness and Accuracy of Dataset

- Completeness Checks

- Missing coordinates or datum
- Missing elevation or datum
- Missing sample depth or well screen depth

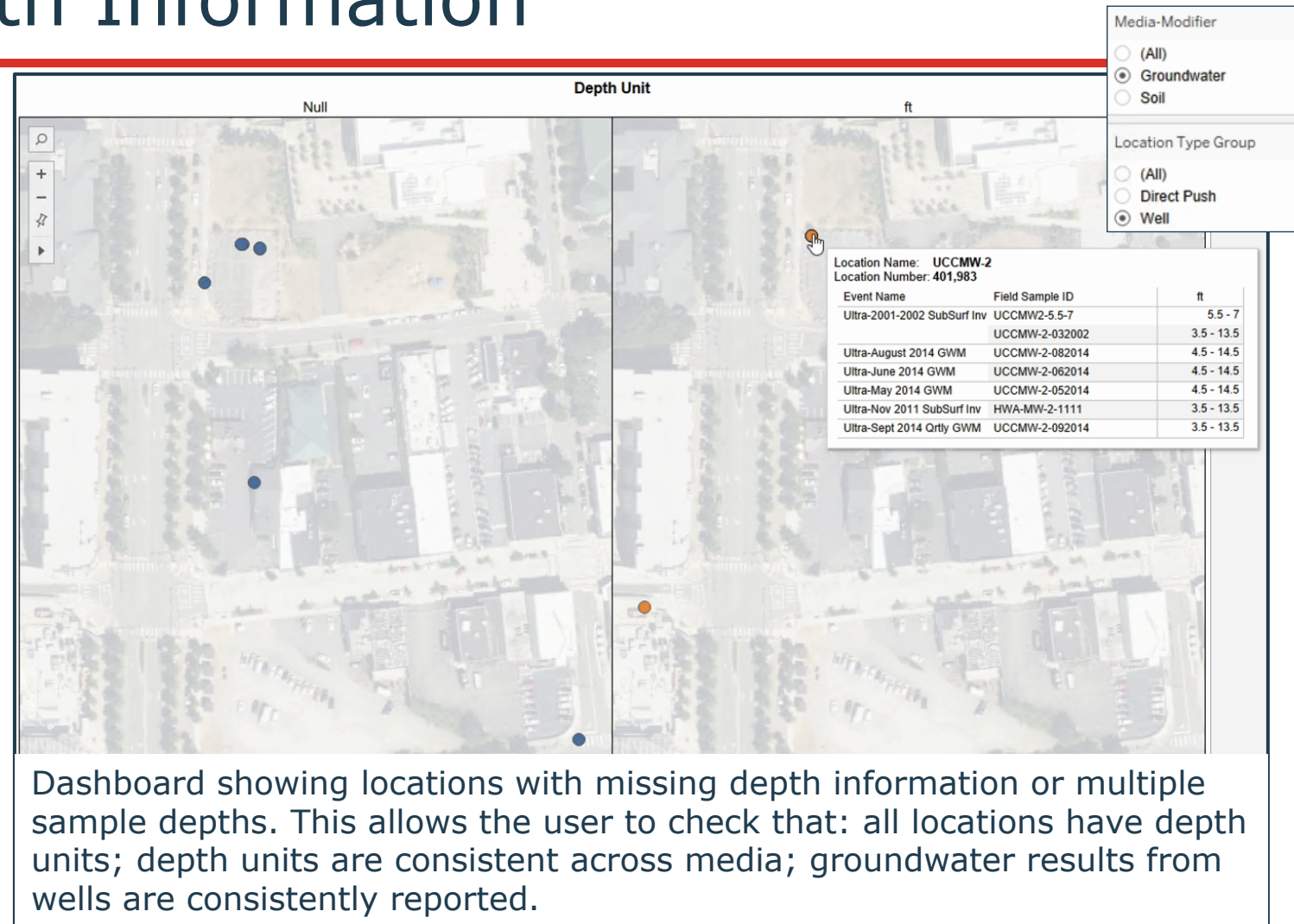
- Accuracy Checks

- Unique and accurate location coordinates
- Consistent groundwater well screen depth
- Excavated soil excluded



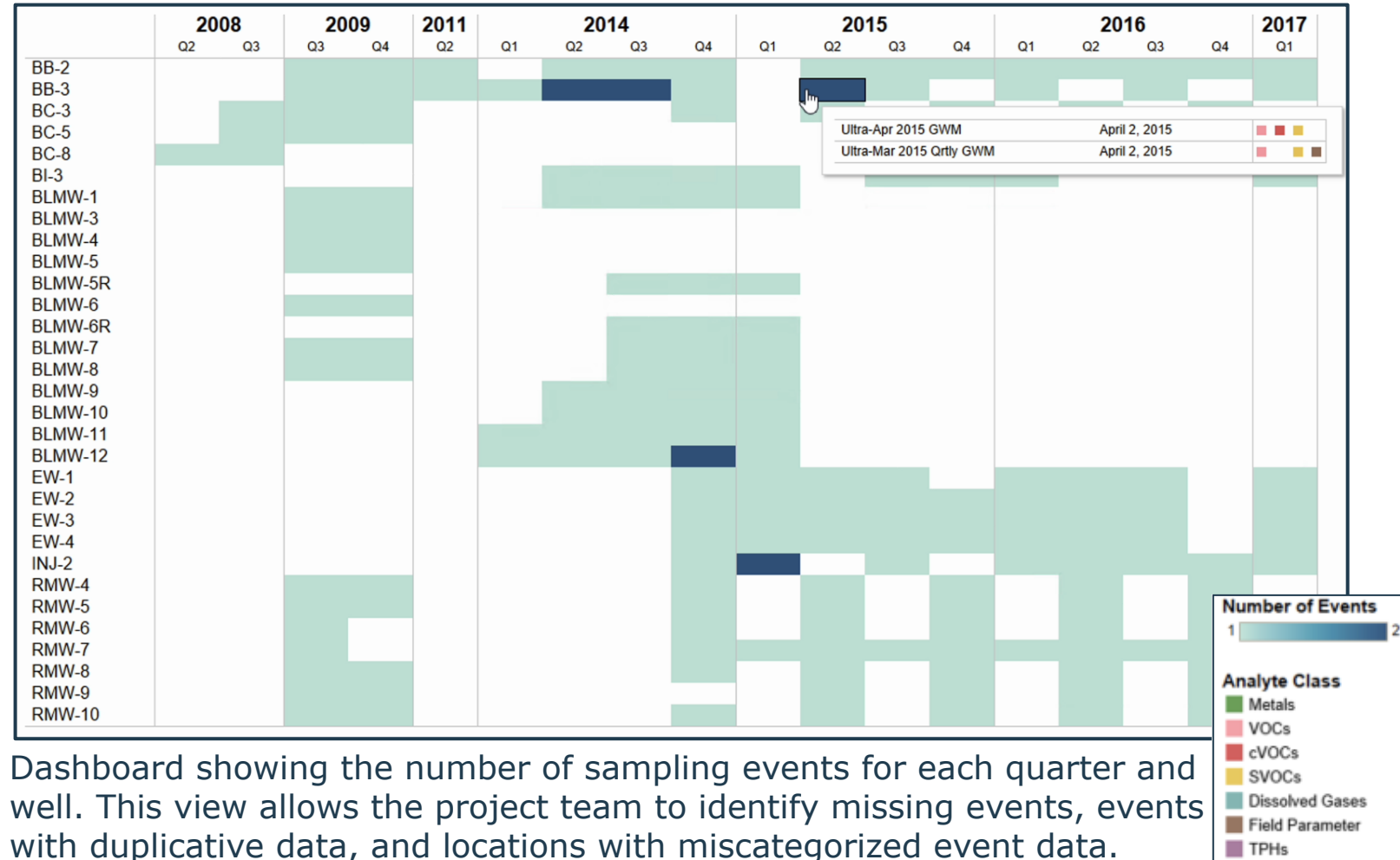
Example: QC Depth Information

- Depths are complete and consistent across each medium
- Identify groundwater probes installed as monitoring wells
- Standardize sample depth reporting in monitoring wells



Example: QC Groundwater Events

- Data for all events: wells sampled on different schedules and under multiple programs
- Field parameters stored with analytical data
- Data from same event reported in separate reports consolidated into a single record
- Event description matches sampling dates



Assure Completeness and Accuracy of Results

- Completeness
 - Missing reporting limits
 - Missing method
 - Missing sums
- Accuracy
 - Use results analyzed by more sensitive methods
 - Unit conversion errors

Location Name	Field Sample ID	cVOCs				µg/L	TPHs	VOCs		
		cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	Vinyl chloride	SVOCs Hexachlorobutadiene	Gasoline Range Organics	1,2,4-Trichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene
BI-3	BI-3-122014	2	2	2	2					
CDM-B18	CDM-B18-W						2			
UCCMW-1	UCCMW-1-122014	2	2	2	2					
UCCMW-8	UCCMW-8-032015					2		2		
	UCCMW-8-072015									2
	UCCMW-8-092014									2

Location Name: UCCMW-1
Field Sample ID: UCCMW-1-122014

Tetrachloroethene results by each method:

EPA 8260C	UNK
4.3	80

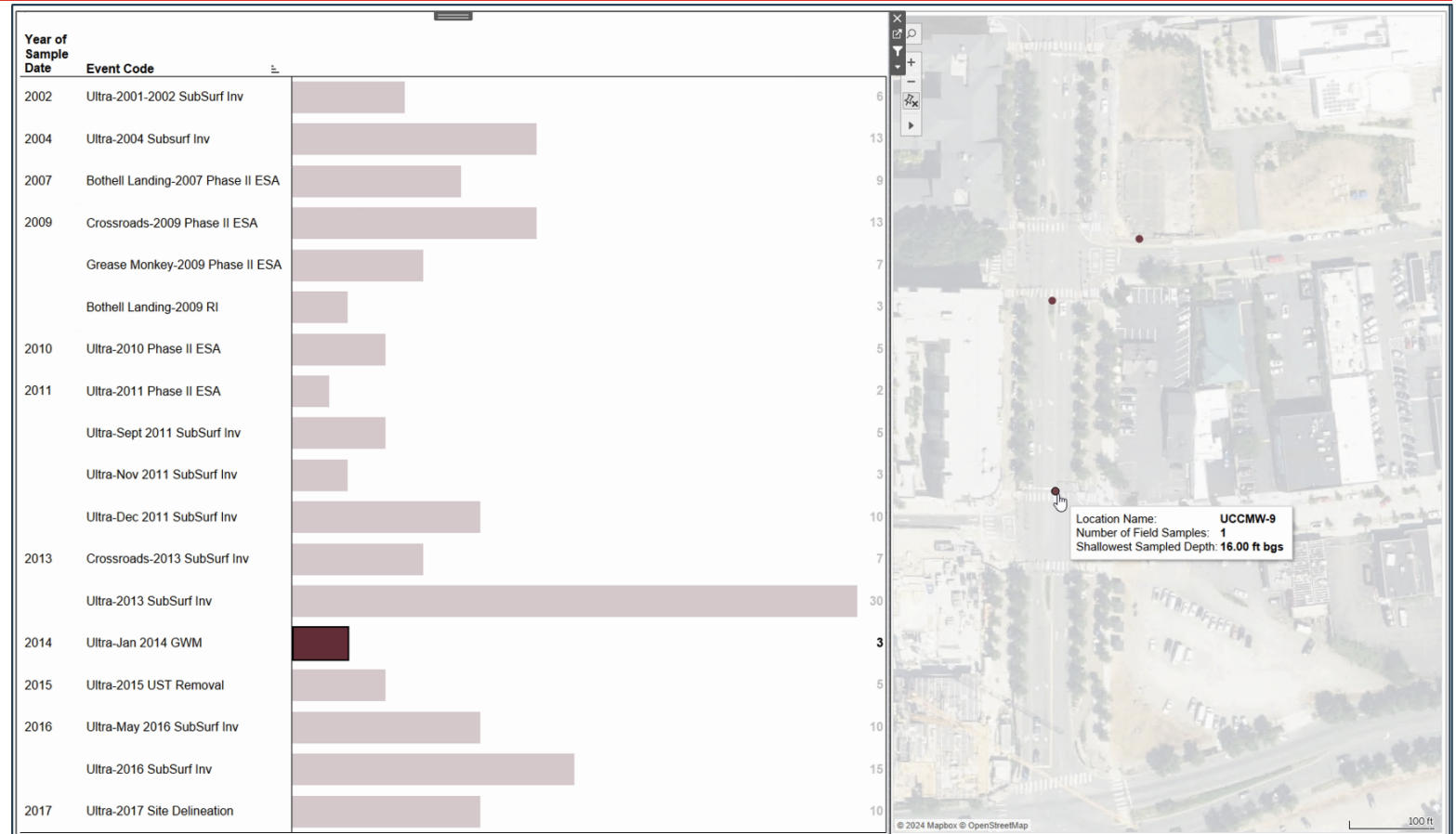
Dashboard showing samples with chemicals analyzed by more than one method. This view allows the project team to flag and preferentially use the method yielding more representative results.

Benefits of Programmatic Data Standardization

- QA/QC tool provides:
 - Greater transparency
 - Improved understanding of data
 - Improved communication between project team and database manager
 - Greater reproducibility
 - Forms standard operating procedure for QA/QC
 - Customization
 - The level of QA/QC can be tailored to specific project needs
- After QA/QC, data were stored in centralized database to ensure data integrity and ease of use

Step 2: Identify and Fill Data Gaps

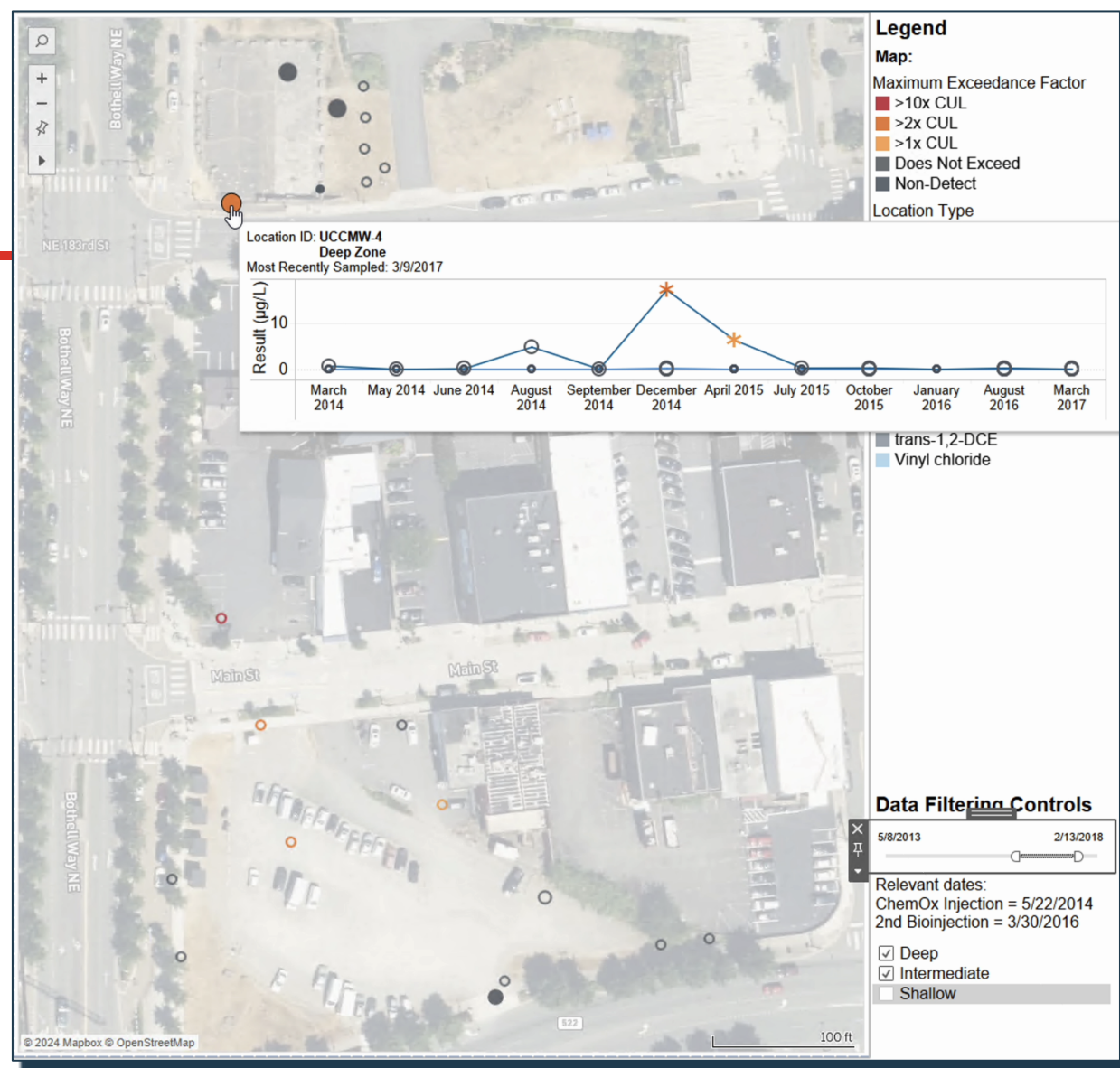
- Data evaluated and shared interactively
 - Improved Agency confidence in the conceptual site model
 - Questions answered in real-time during meetings



Interactive soil data event viewer allowed Agency to confirm relevant samples included in dataset, supporting conclusion that there were no soil data gaps.

Groundwater Data Gaps

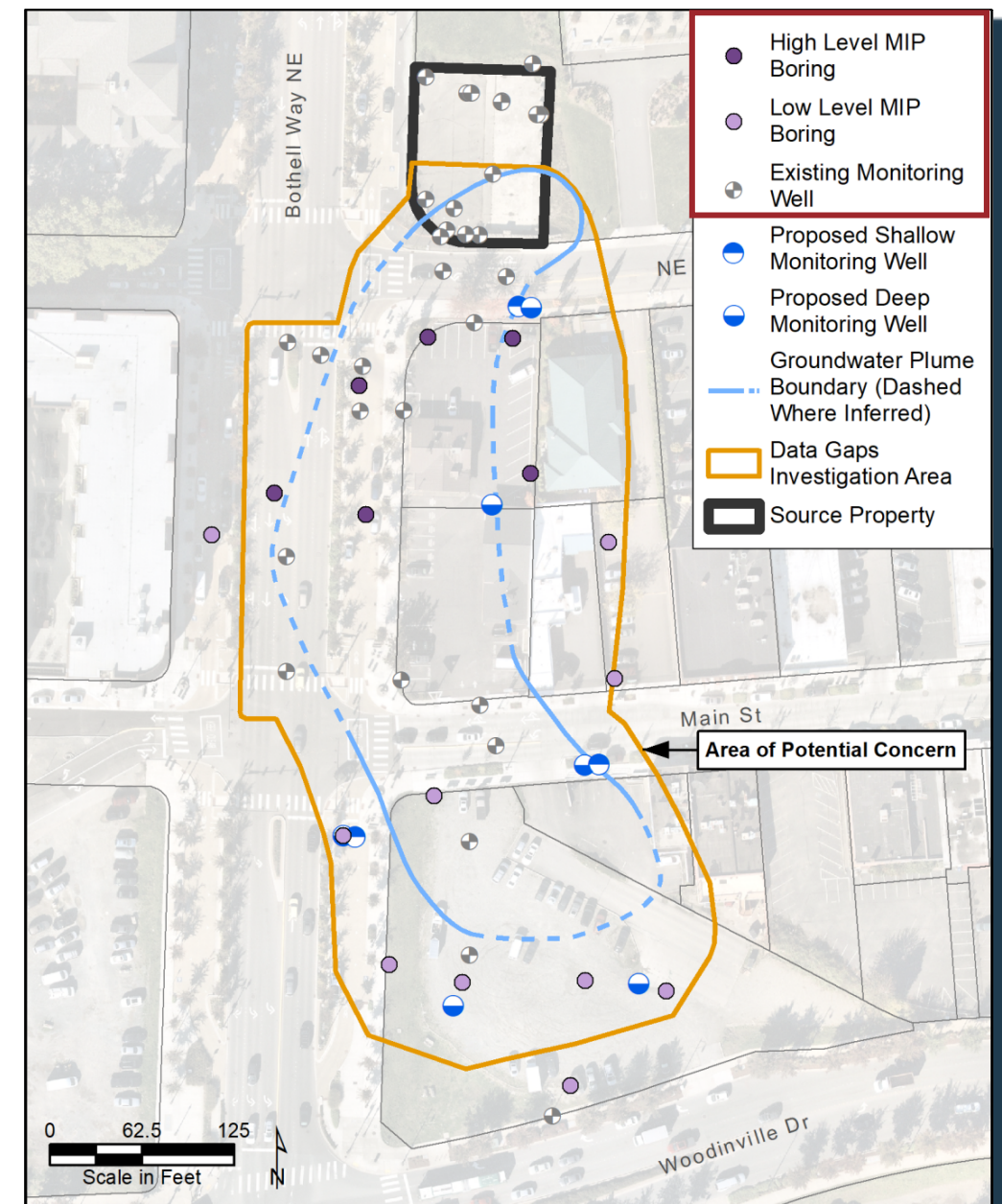
- Data evaluated spatially and temporally
 - Contamination extended deeper than targeted by interim actions
 - Little data in deeper aquifer zones; downgradient edge not delineated
 - Eastern and western extent of plume not well bounded in shallow zone



Interactive groundwater data event viewer show Site releases contaminated deeper groundwater zone, requiring further study.

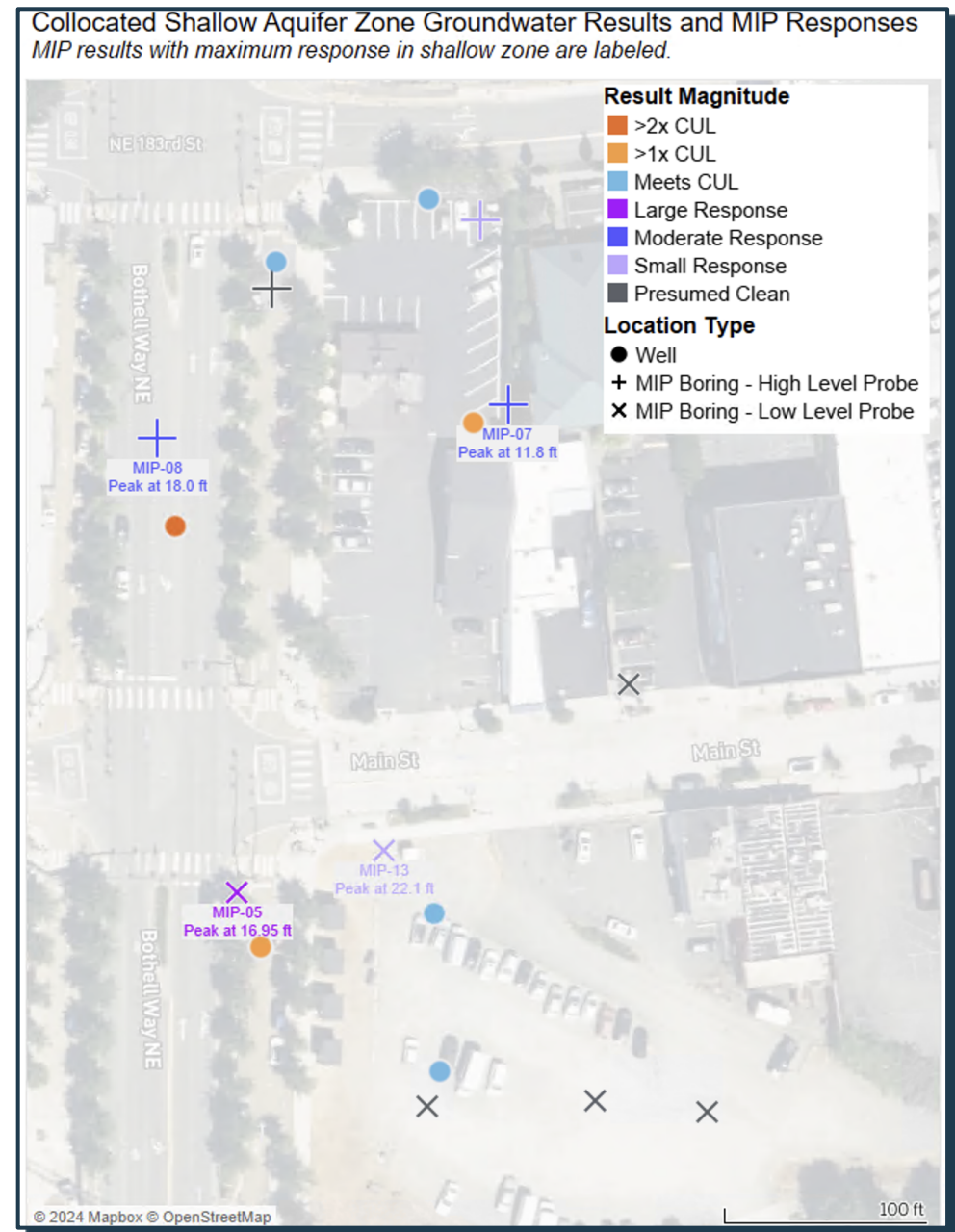
2020 DGI: Phase 1

- Collect data from existing wells
- Use Membrane Interface Probe (MIP) borings to characterize current groundwater conditions
 - High Level MIP for source zone
 - Low Level MIP for downgradient edges of plume



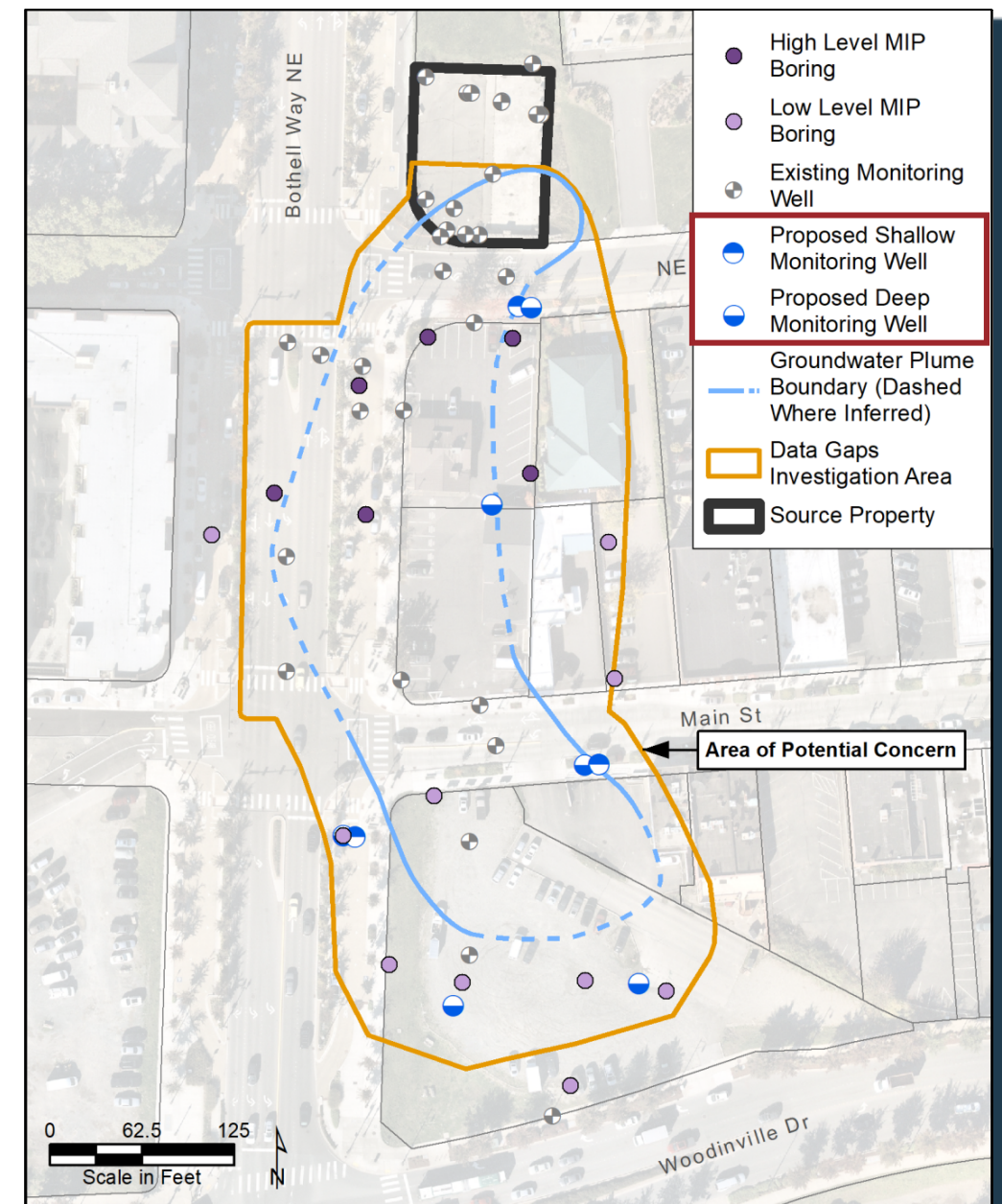
Step 3: Define Site Boundaries Using DGI Results

- MIP data were used to bound the plume in each zone
 - MIP responses compared to paired groundwater results to correlate response magnitude on each probe to a corresponding groundwater concentration range



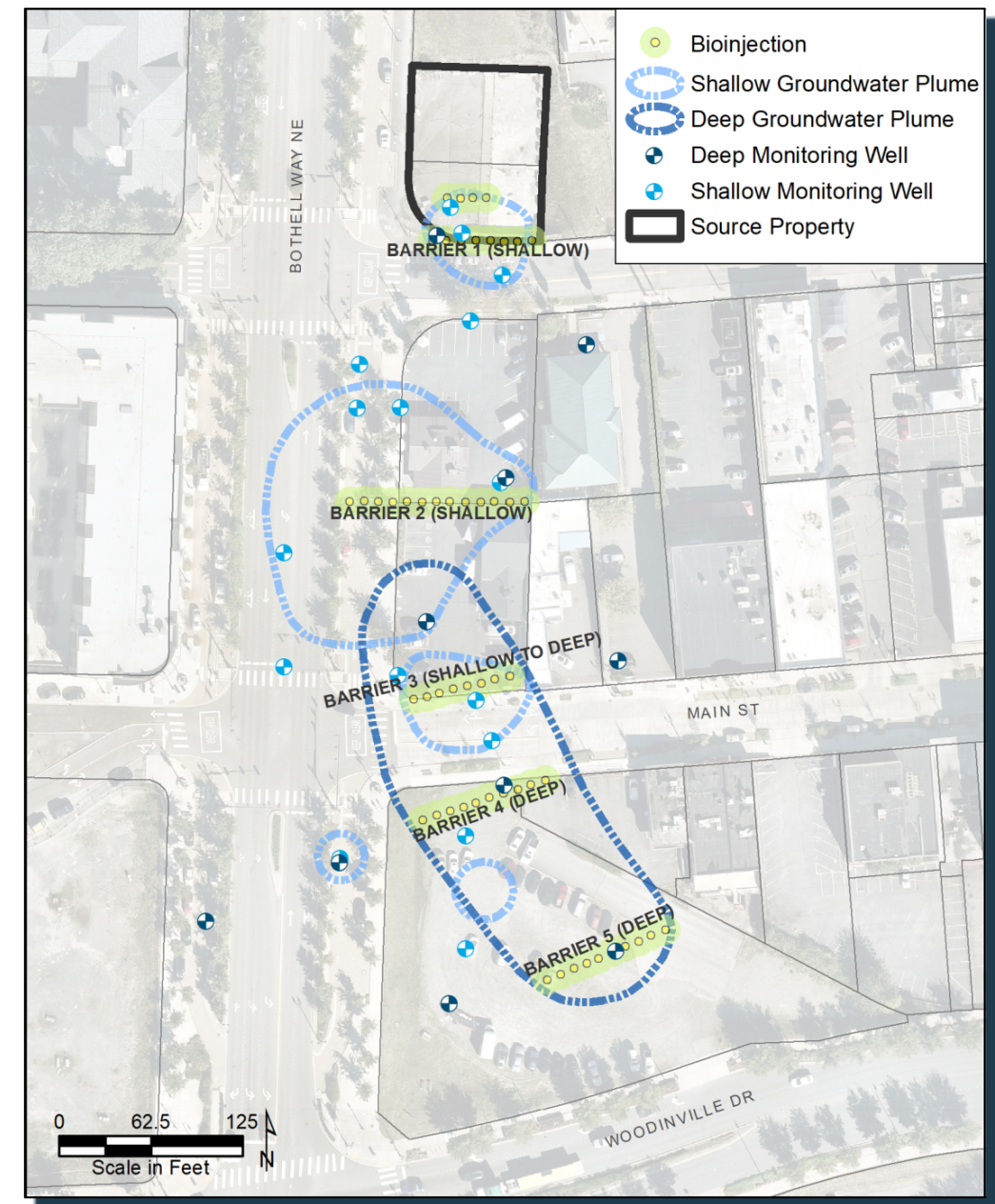
2020 DGI: Phase 2

- Phase 2: Install targeted wells to bound the plume
 - Shallow and deep zones
 - 11 wells installed to delineate Site contamination and support compliance monitoring and remedy design



Successful Outcome

- Agency approved RI/FS and Cleanup Action Plan:
 - Source soil excavation (completed)
 - In situ groundwater treatment injection (near future)



Acknowledgements

Thank you to our former (Nduta Mbutia) and current (Scott Adamek) City of Bothell – Public Works Project Managers

