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**THE LESS-THAN-IDEAL PATH
TO REMEDIATION OF A WASTE
SOLVENT RELEASE SITE**

Welcome

OVERVIEW

Challenges and Constraints

- Significant challenges to remediate high contaminant (toluene) concentrations
- need for adaptive, dynamic remediation strategies deviating from a standard step-wise approach.
- Restrictions on accessing portions of the site due to property owner restrictions



Adaptive Remediation Strategies

- The project utilized flexible and innovative techniques to address site-specific issues and achieve remediation goals despite constraints.





Contamination Details

- Groundwater contained dissolved toluene over 400 mg/L with likely residual LNAPL.

Hydrogeological Complexity

- Site featured deep groundwater impact and stratified subsurface with multiple soil layers and bedrock complicating remediation. fine-grained soil, consisting mainly of silt and clay with discontinuous sand seams to approximately 9.0 metres (m) below ground surface (bgs), underlain by fractured sandstone bedrock to 13 m bgs. Depth to water approximately 8 m bgs.

PROJECT CONTEXT

PROJECT CONTEXT (CONT'D)

Multiple Consultants/Remediation Approaches

- Various remediation activities have been undertaken -
1986 excavation to address impacts to soil and groundwater resulting from inadvertent loss of waste solvents.
- 1986 to 1992 - removal of LNAPL and operation of a vapour extraction system
- 1992 - installation of a recovery trench, with treatment of extracted liquids before disposal
- 1992 - limited injection of nutrients and hydrogen peroxide
- 1997 - removal of waste solvent UST and partial excavation remediation of solvent-impacted soil.



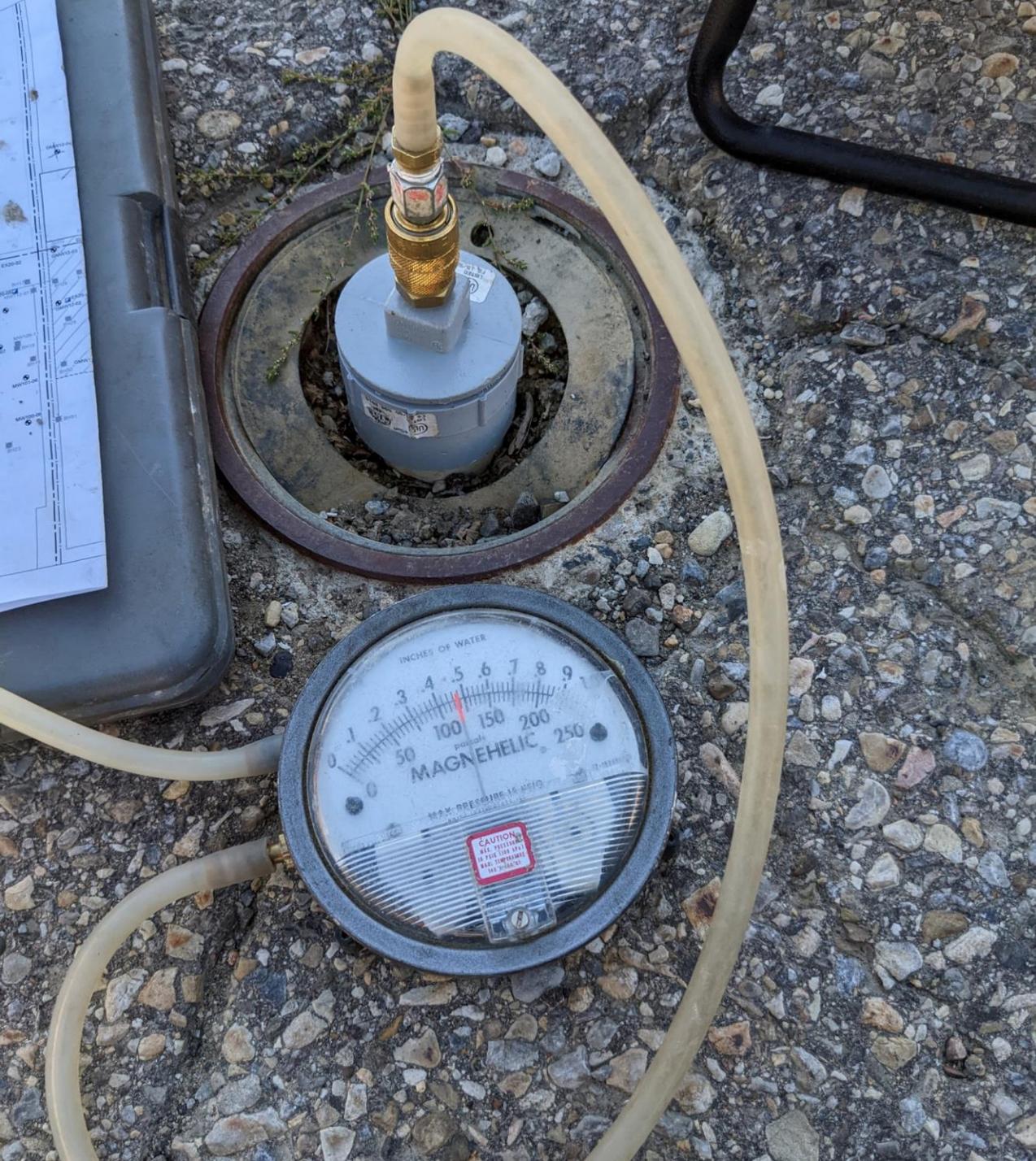
PROJECT CONTEXT (CONT'D)



- Multiple landowners and stakeholders complicated site access and remediation coordination
- Four legal parcels, three owners; monitoring and remediation access granted for 3 of 4 parcels.
- Residual groundwater impacts located:
 - Beneath northeast corner of Lot 3 building footprint
 - Beneath northeast portion of Lot 3
 - Beneath southeast portion of Lot 1
 - Beneath former excavated area on west-central portion of former source property (Lots 2 and 4)
- Initially, only historical information was available for one parcel
- Responsible client for remediation no longer owned/operated the site; client contact was internationally based

PROJECT CHALLENGES AND APPROACH

→ Ideal vs. Client-Driven Approach



TYPICAL APPROACH

- Evaluate historical sources and assessment
- Gain property access
- Complete hydrogeological and contamination characterization
- Evaluate receptors and exposure pathways
- Exclusion of non-completed exposure pathways
- Contamination assessment
- Delineate horizontally and vertically
- Evaluate residual mobile and non-mobile LNAPL
- Assess impact of unconsolidated and consolidated layers

- Remedial Action Plan and Objectives
- Remove residual sources
- Conduct bench scale / pilot study evaluations
- Design full-scale remediation system
- Fabricate and install full-scale system
- System Operation, Maintenance, and Optimization
- Long Term Monitoring (if required)

KEY CHALLENGES

Limited Site Understanding

- Starting remediation without horizontal and vertical delineation, complete contaminant and site characterization, limited knowledge of conditions, complicating planning

Access and Infrastructure Barriers

- Restricted access to some portions of the site due to landowner issues and existing infrastructure/buildings complicated equipment deployment and monitoring.

Regulatory and Seasonal Constraints

- Changing regulations impacted permitting, while seasonal factors limited operational time windows.
- Restrictions to remediation system prevented operation in winter months, requiring seasonal operation only

Site Security and Coordination

- Security concerns, vandalism, and the need for multi-stakeholder coordination required flexible strategies.

CLIENT-DRIVEN APPROACH



Client-Driven Immediate Action

- Client priorities shifted focus to immediate mass removal of dissolved phase impacts rather than using the typical remediation approach
- Previous remediation and assessment conducted by others used up client appetite for pursuing further assessment and delineation prior to starting remediation
- Opportunity to take over project from other consultants if we could show an Immediate Action approach instead of recommending more assessment first

Need for Flexible and Adaptive Strategy

- Engineering team developed a flexible plan with contingency to adjust actions based on existing data

Importance of Adaptability

- Adaptability is crucial when traditional methods are impractical due to client or external pressures

REMEDICATION STRATEGY AND IMPLEMENTATION

→ Adaptive Strategy, Implementation
Highlights

ADAPTIVE SYSTEM



Multi-Phase Extraction System

- Utilizes vapor phase, dissolved phase, and LNAPL extraction to remove residual hydrocarbons contaminants effectively.

Pneumatic Air-Lift Mechanism

- Efficiently transports fluids from deep subsurface layers, adapting to complex geological conditions, enhancing vacuum extraction and overcoming pipe friction and head losses.

Modular Equipment Design

- Infrastructure designed for modularity enables reconfiguration based on evolving site access and conditions.

Adaptive Operation Scheduling

- Incorporates seasonal operation and real-time feedback to optimize extraction rates and well placements.

EQUIPMENT / OPERATION MODIFICATIONS



Pilot study with seasonal operation and tank storage for treated effluent

Year-round operation

- Winterization of MPE/FAL system
- Placement of piping and well-head infrastructure to below ground
- Permitting for amended sewer discharge
- Directional drilling of discharge piping to sanitary sewer connection.

Stakeholder / Legal Issues

- Coordination with client and adjacent property owners.
- Reluctance to allow ease of property access

Vandalism

- 200 Amp. electrical wiring stolen, go underground to building

IMPLEMENTATION HIGHLIGHTS



Tailored Remediation Systems

- MPE and air-lift systems to optimize vacuum distribution and fluid lift efficiency in complex subsurface conditions

Pilot Study Equipment Usage - Extended

- Extended use of pilot-scale equipment provided valuable data, informing adjustments and refining wellfield priorities.

Stakeholder Engagement

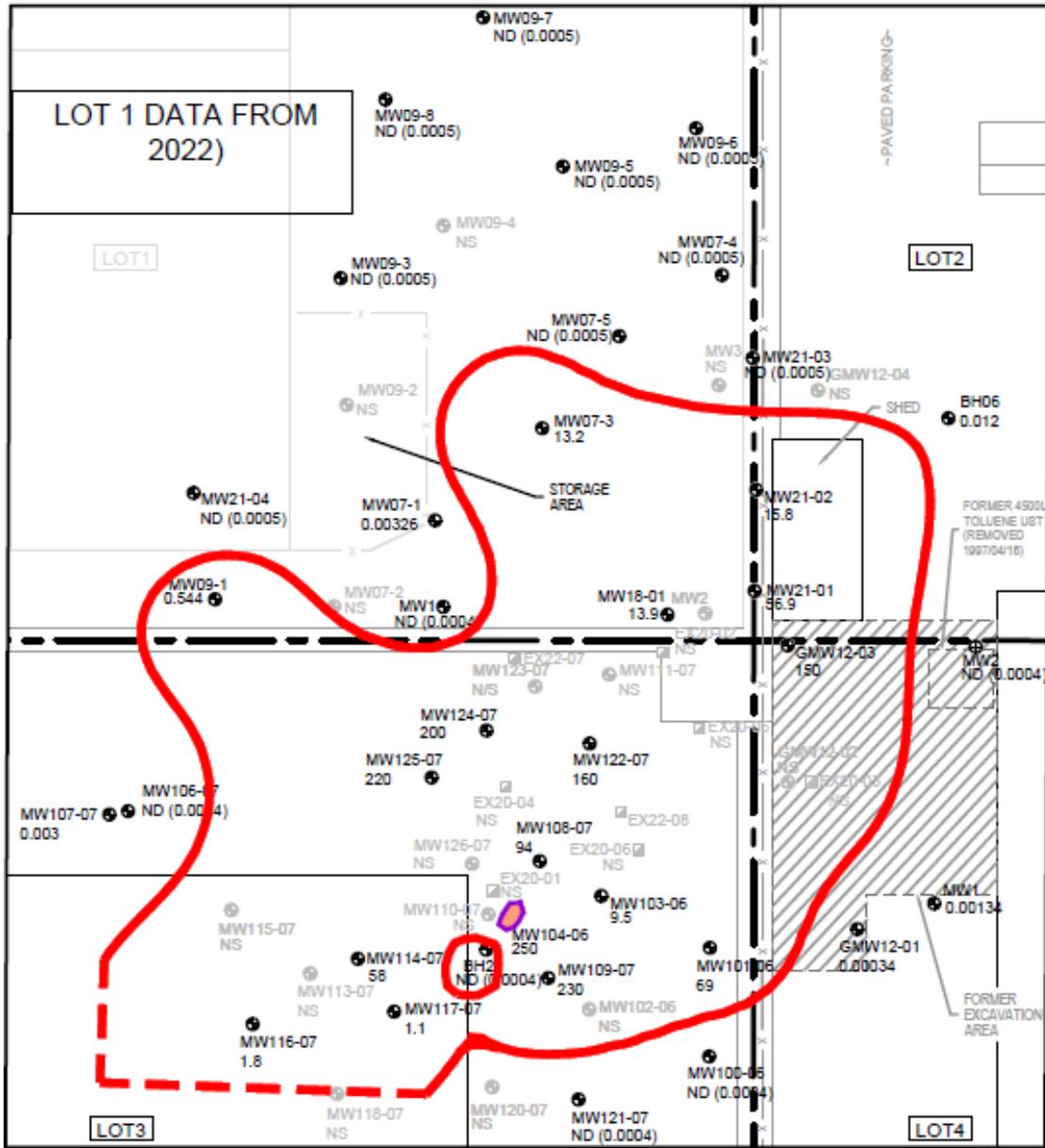
- Regular updates and transparent communication.
- Cooperation from most property owners
- Patience.

Iterative Improvement Approach

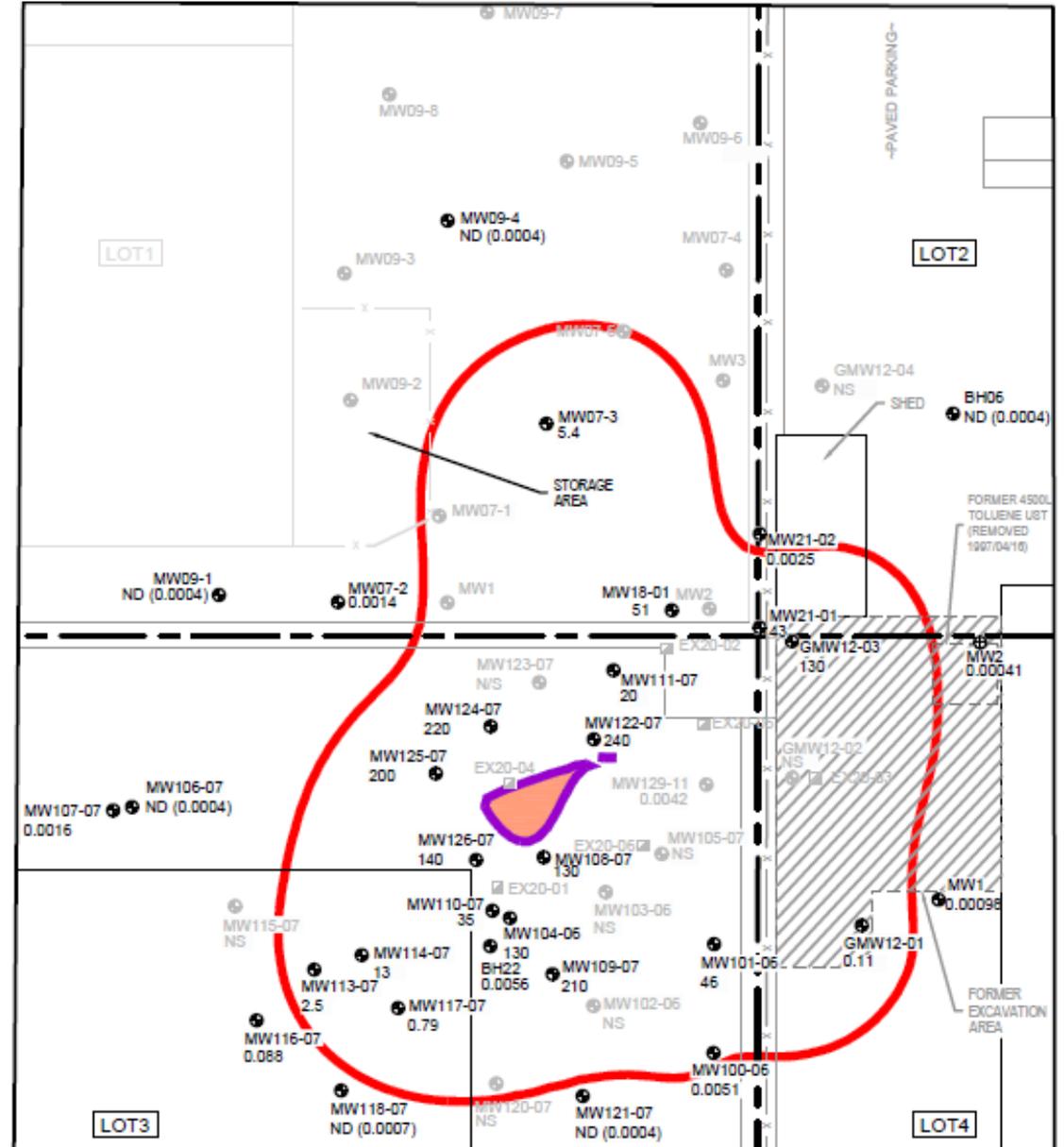
- refinement of system
- effective remediation strategies.

RESULTS AND OUTCOMES

→ Results & Footprint Reduction,
Outcomes & Takeaways



OCTOBER TO DECEMBER 2022



2024

RESULTS - FOOTPRINT REDUCTION

Contamination Footprint Reduction

- Remediation efforts reduced contaminated zones from multiple properties to minor areas on a single property.

Incremental Improvement Strategies

- Improvements in concentration levels, mass reduction, and hotspot consolidation led to effective cleanup.

Innovative Site-Specific Approach

- Creative, flexible methods adapted to site conditions enabled successful remediation under constraints.

RESULTS – STAKEHOLDER SATISFACTION

Stakeholder Interests Addressed

- The project met the clients, landowners, and regulators needs through responsible and cost-effective remediation methods.

Importance of Adaptability

- Adaptability, transparent communication, and modular design are vital when working under uncertain financial and regulatory pressures.

Risk Management and Success

- Maintaining flexibility and responsiveness allowed effective risk management, contamination removal, and achievement of remediation goals.

Practice-Driven Innovation

- This case highlights the importance of innovation driven by practical experience.



*** Thank you**