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CREATING AND DELIVERING BETTER SOLUTIONS

In-Situ Chemical Oxidation of BTEX in Soil and Groundwater for the Redevelopment of a Brownfield

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Presentation Outline

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- Background and Site Conceptual Model
- Treatability Study and ISCO Design
- Pilot and Full-Scale Implementation
- Results
- Costs
- Conclusions

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Background and Chronology

- Former Highway Maintenance Yard (INFTRA) until early 1990s
- Purchased by municipality. Liability assessment.
- Phase II and Phase III in 2001
- Sold to private owners in late 2004
- Further site characterization site-specific RA/RMP in 2005 (salt impacts)
- Remediation in 2006/2007 (hydrocarbon impacts)

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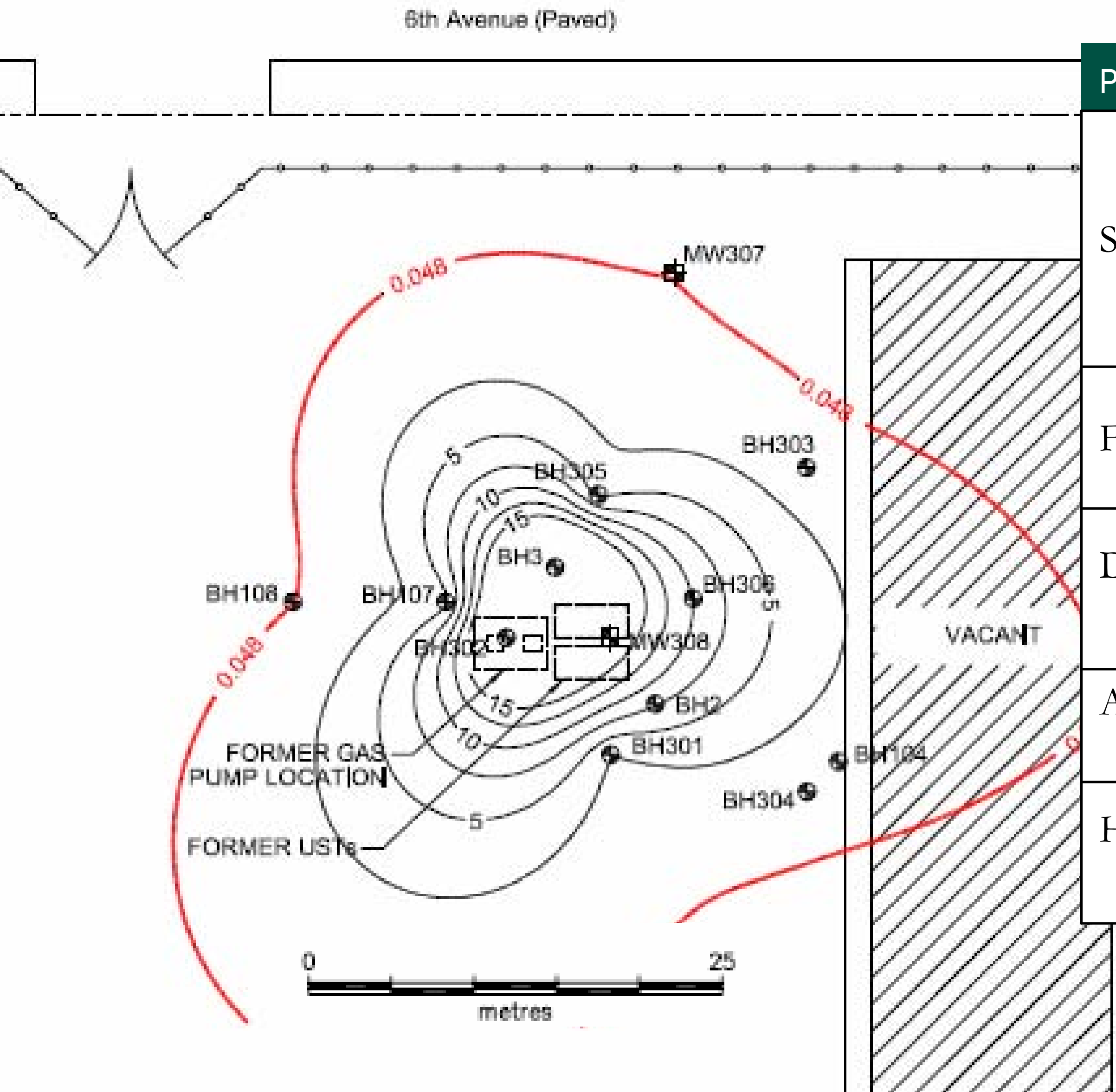
The Brownfields Deal

Site Conceptual Model

- Tanks installed in the 1970s, removed in 1997
- Duration/location of leak unknown
- Characterization indicates gasoline fuel release
- Residual saturation in soils acting as a source – groundwater impacts
- In 2001 – one well with separated-phase hydrocarbon
- COC is BTEX (benzene up to 30 mg/kg in soil, 23 mg/L in water; TPH 800-1500 in impacted zone)
- Impacted layer 3 to 6 m below ground surface
- Most sensitive receptors are protection of groundwater resources and soil vapour intrusion pathway (future development).

Site Conceptual Model – Contaminant Concentrations



PHYSICAL AND CHEMICAL CHARACTERISITCS	
Surficial sediments	Lacustrine silts and clays and alluvium and sand near the surface
Flow direction	North to northeast
Depth to groundwater	3.5 to 4 m below ground surface (seasonal)
Apparent horizontal gradient	0.005 m/m
Hydraulic conductivity	8 x 10^{-7} m/s

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Bench-Scale Study

- Treatability study on soil and groundwater
- Combined oxidants resulted in increased TPH removal
- No catalyst: reduction in TPH increased using higher oxidant concentrations
- With catalyst: high TPH removal at low oxidant concentration. TPH removal was not increased at high oxidant concentration
- Best results: persulphate + hydrogen peroxide + catalyst

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Design

Evaluate:

- Geology and hydrogeology
- Natural oxidant demand (natural organics, alkalinity, reduced metals)
- Potential for mobilization of redox-sensitive metals (Cr, As, Se, Hg)
- Transport mechanisms to ensure contact between oxidant and contaminant
- Sodium loading

Determine:

- Hydrocarbon mass in each phase
- Stoichiometry - contaminant and oxidant
- Mass oxidant required, delivery mechanism

Plan:

- Contingency
- Safety
- Logistics

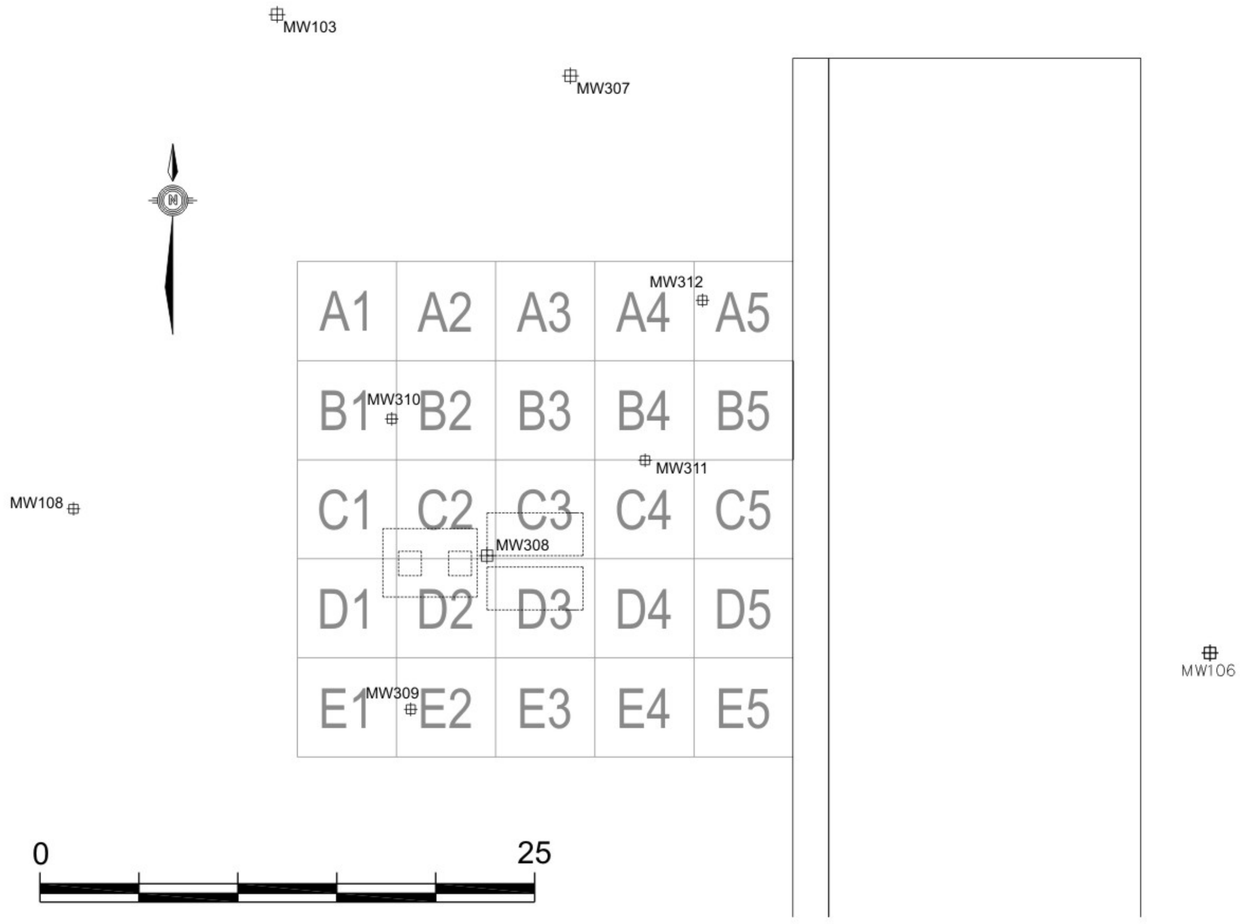
Pilot Study

- Sodium persulphate only
- Observe reaction in geomedia, handling, equipment
- Lessen soil oxidant demand for subsequent peroxide application
- Monitor water quality parameters

Pilot Study – Set Up and Equipment

Pilot Study

Pilot Study


MW103
MW307
MW312
A1
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A3
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B4
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MW311
MW108
C1
C2
C3
C4
C5
MW308
D1
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MW106
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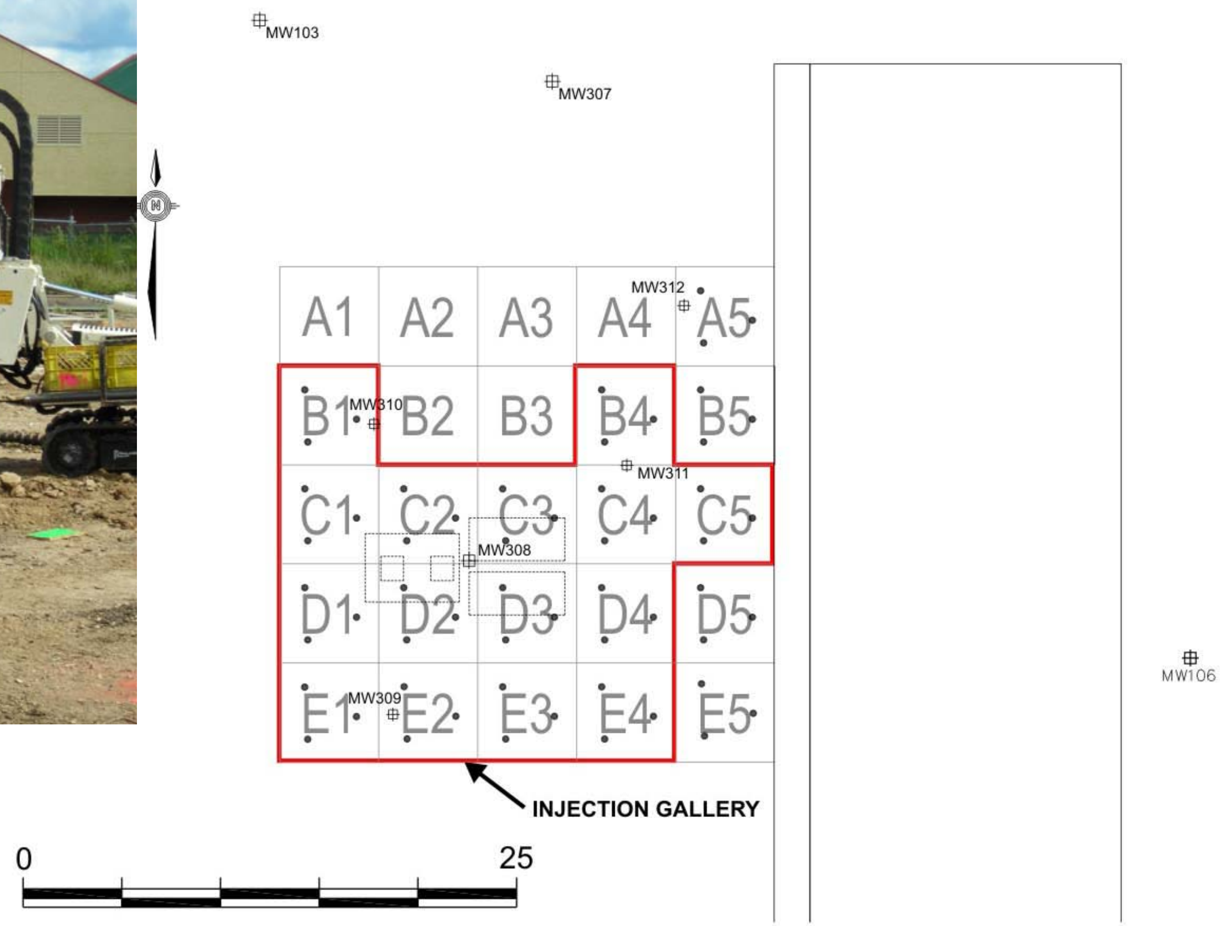
25

Injection Gallery

Injection Gallery



Full-Scale ISCO Implementation

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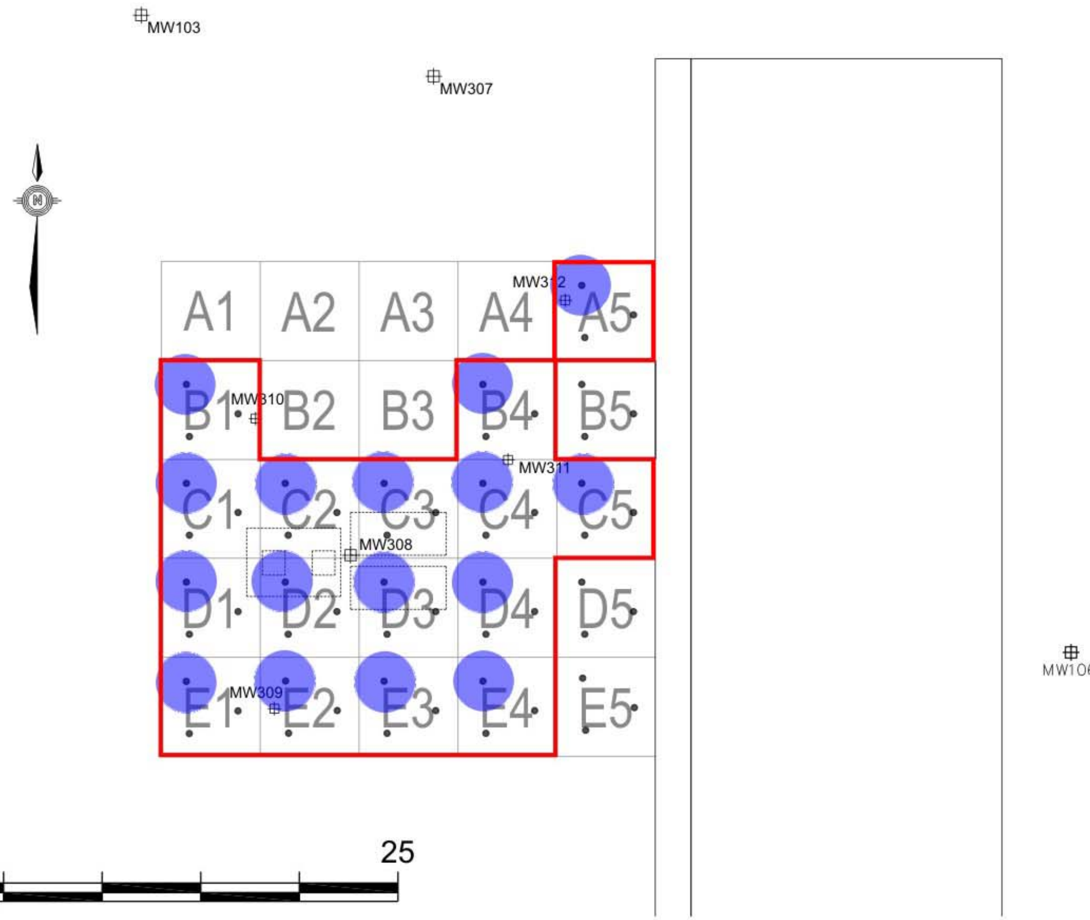
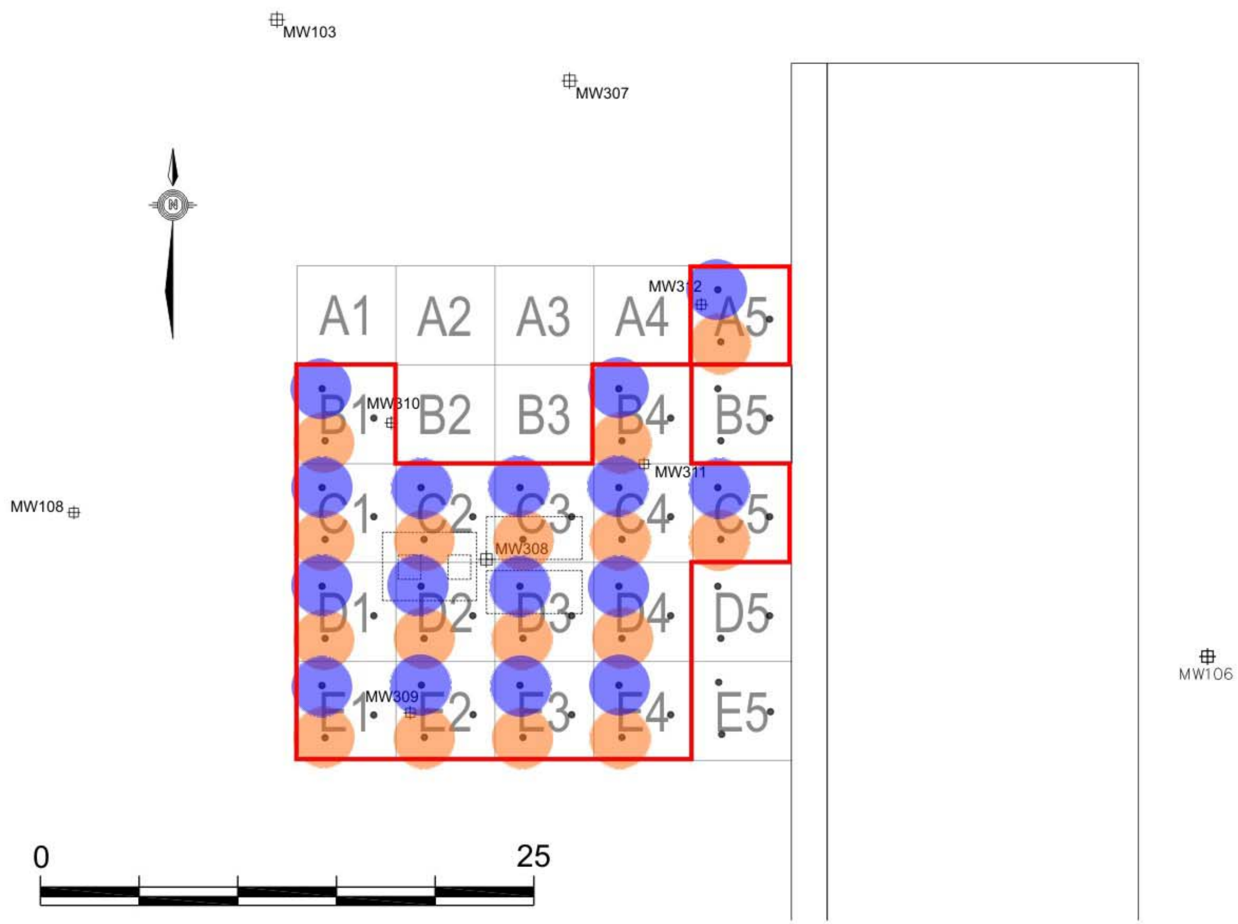
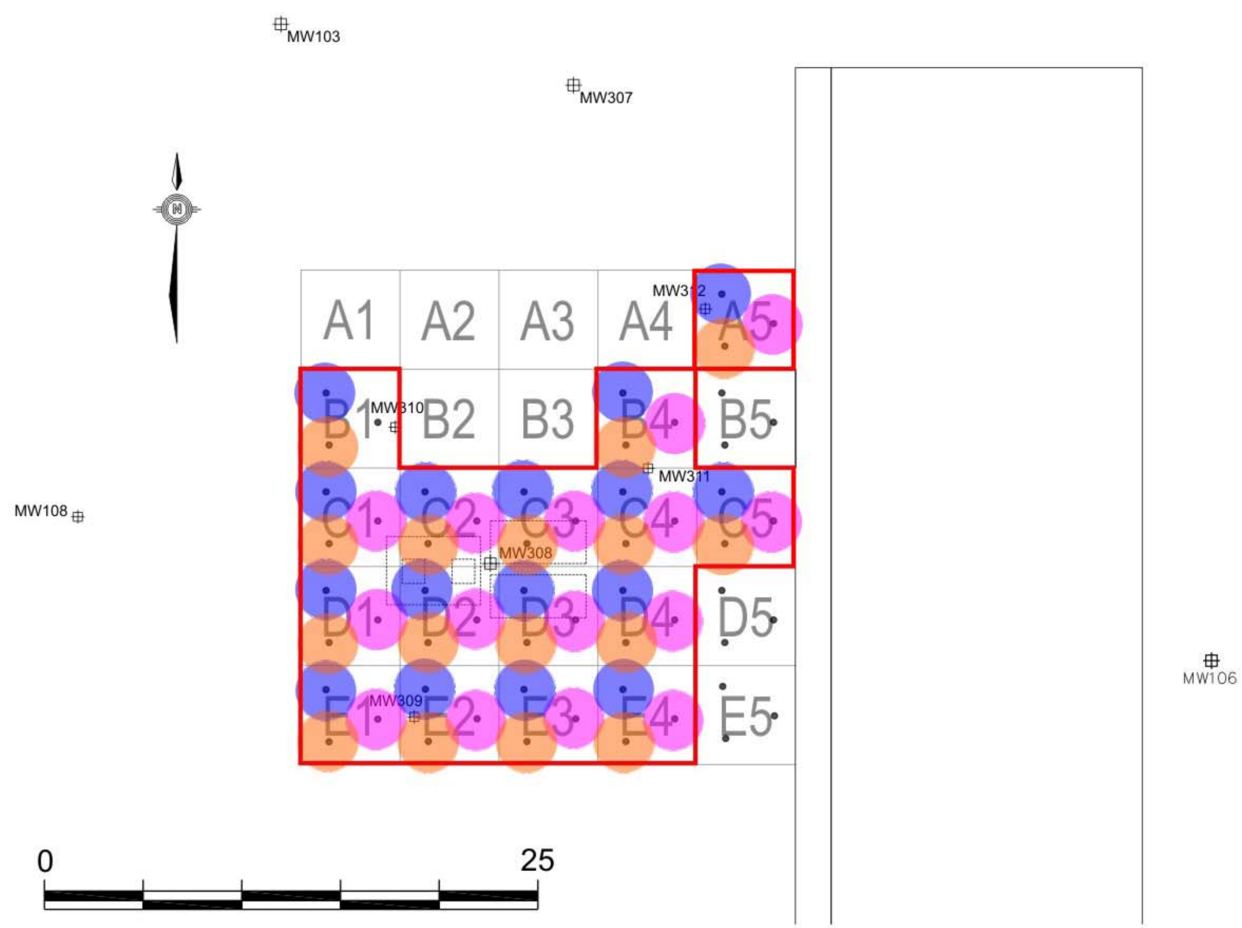


Full-Scale ISCO Implementation

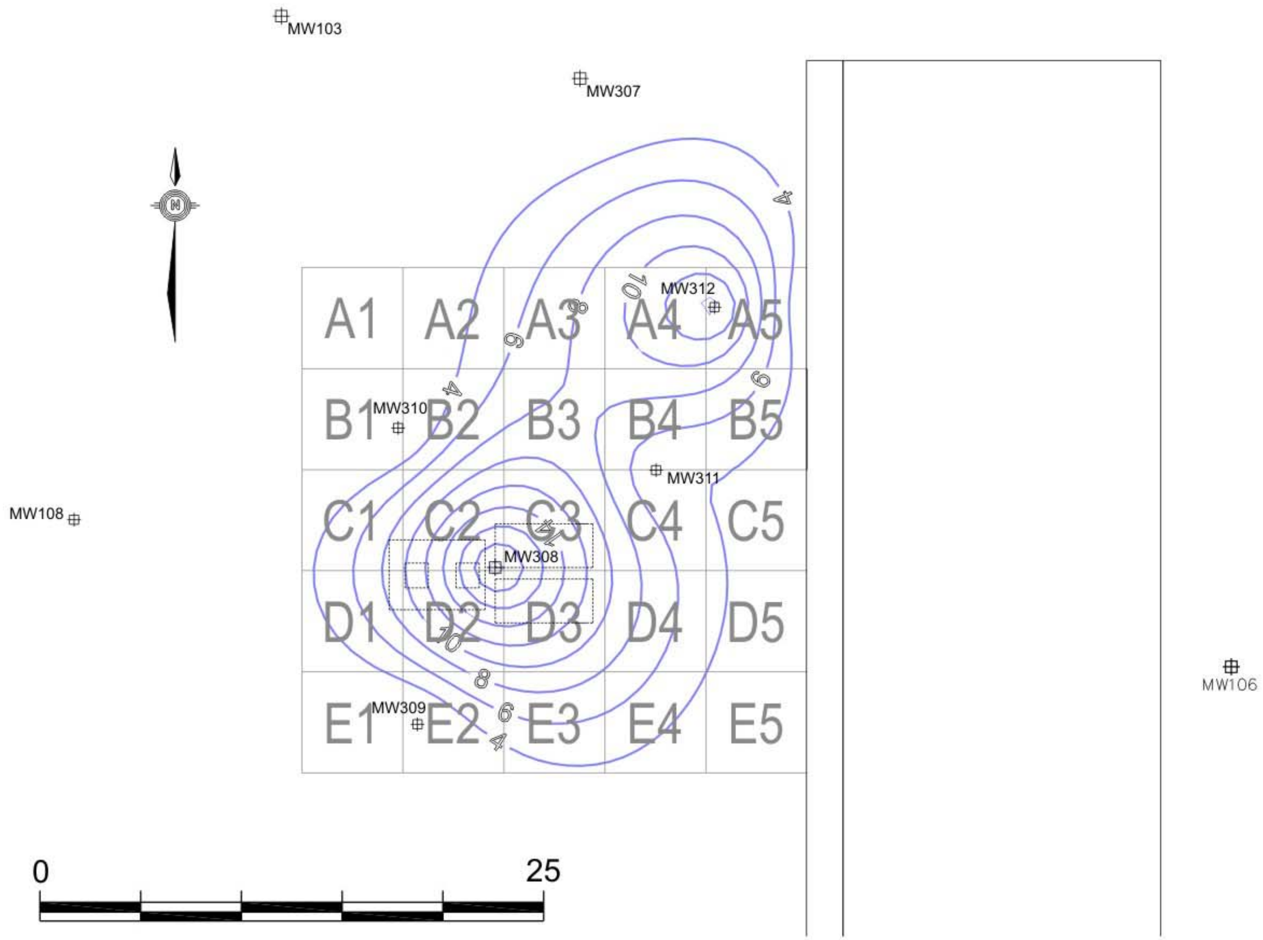


Full-Scale ISCO Implementation

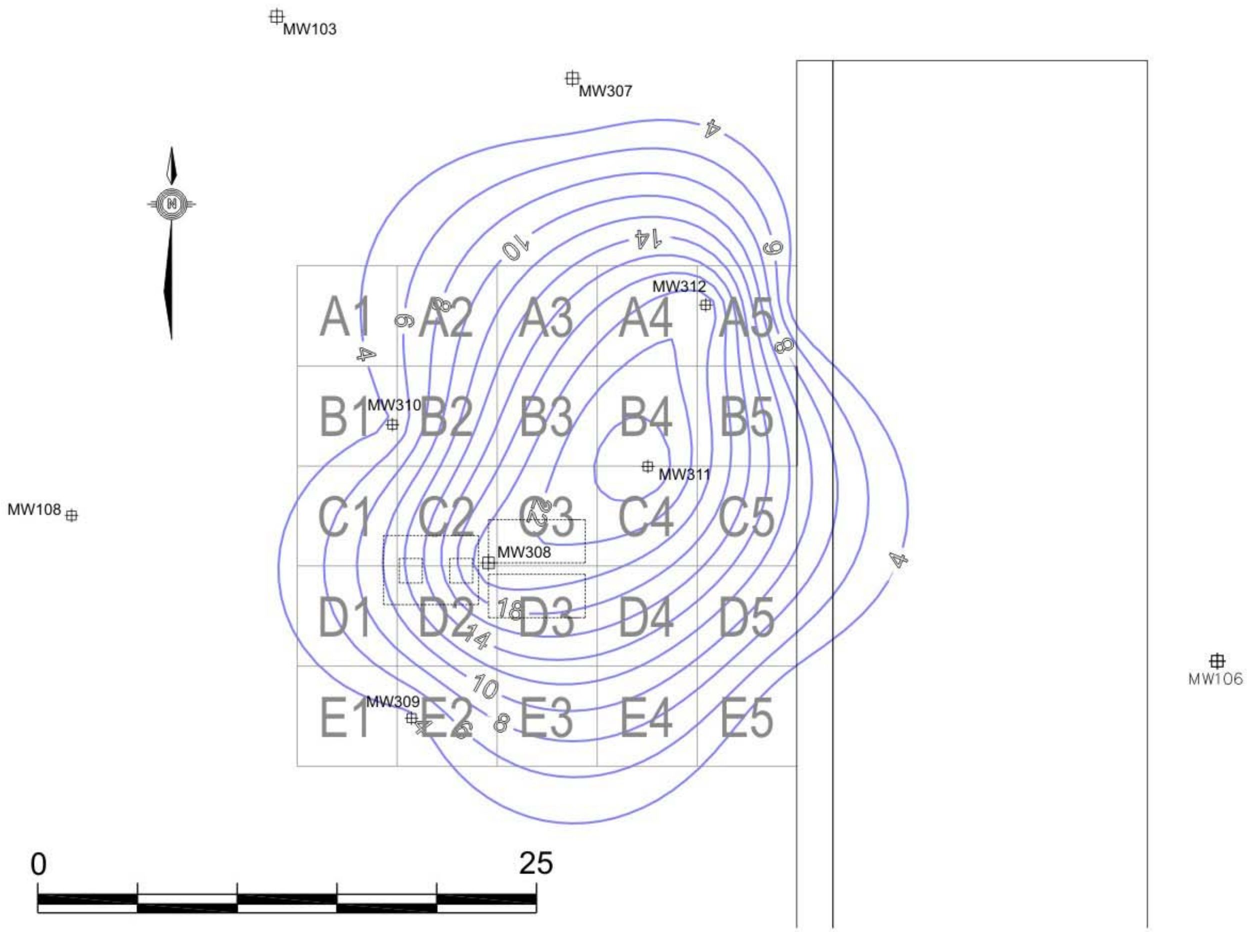


Full-Scale ISCO Implementation

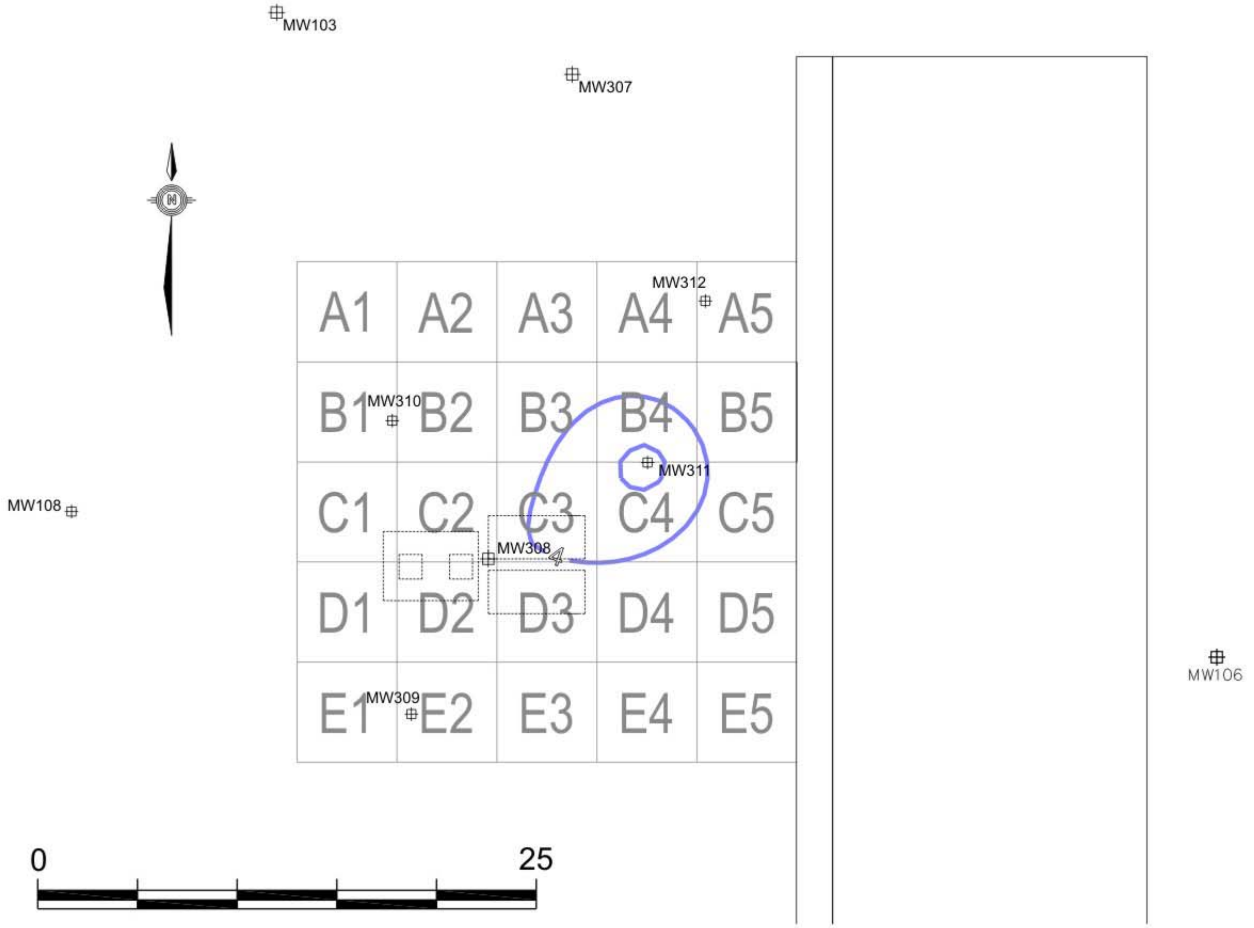
Groundwater Results – August 2 (Initial)



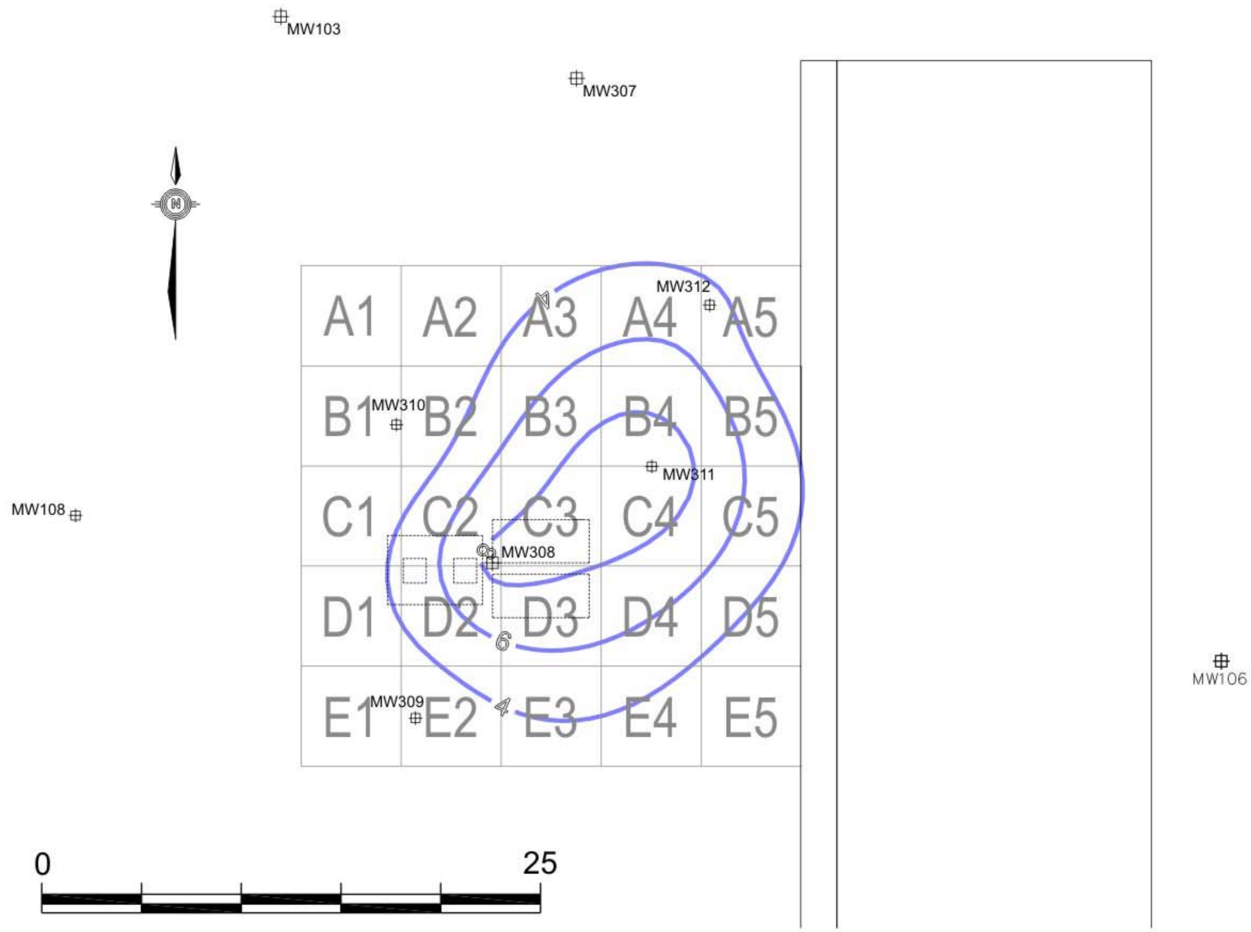
Groundwater Results – August 5 (After Pilot)



Groundwater Results – August 25 (Prior to ISCO)



Groundwater Results – August 26 (Post ISCO)



Remediation Costs

SUMMARY OF TYPICAL COSTS FOR HYDROCARBON REMEDIATION	
Item	Cost
Excavation and disposal	$80 – $150 /m3
Ground heating and vapour extraction	$150 – $300 /m3
Allu-Bucket process	$80 – 100/m3
Phytoremediation	$25 - $100/m3
Bioventing (no operational/monitoring costs)	$40,000 - $60,000
Pump and treat	$150,000 - $500,000
ISCO (persulphate)	$50-70/m3

Conclusions

- Easy and safe to handle
- Could safely mix oxidant solutions in-line prior to injection
- Higher concentrations of hydrogen peroxide caused moderate localized heat generation.
- Synergism observed in combination with hydrogen peroxide and catalyst
- Strong desorption of hydrocarbons from soil (staged approach, contingency planning)
- Persulphate is effective oxidant for mass removal of hydrocarbons (>99% removal of BTEX in groundwater observed in source area)

Partners

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and Chemicals Limited

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Solutions

Advanced Oxidation Technology, Inc.
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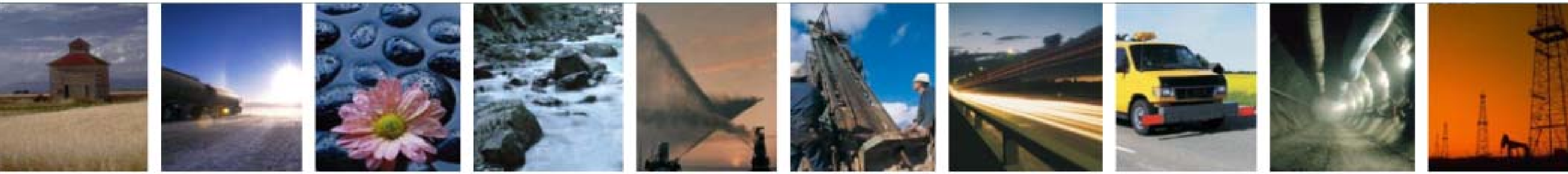
REMEDIATION

Thank you.

Questions?



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