

Vertex Environmental Inc.



**In-Situ Formaldehyde
and PHC Spill Response
(a Case Study)**

October 16, 2014

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Agenda



- What is Formaldehyde?
- The Spill
- Bench & Pilot Results
- Full Scale Clean-up
- Questions



Formaldehyde

- Both naturally occurring and produced by humans
- In 2012, the global production >42 million MT
- \$145 billion: 2003 formaldehyde & derivative products sales
 - 1.2% of the gross domestic product (GDP) in the USA & Canada
- Uses
 - Resins: pressed wood products - particle board, plywood paneling (furniture and cabinets)
 - Wallpaper, cardboard
 - Paints, adhesives, varnishes and floor finishes
 - Textile: resins used to make fabrics crease-resistant
- In 2011, the US National Toxicology Program described formaldehyde as "known to be a human carcinogen"



Formaldehyde

- 30 mL (1 oz) of a solution containing 37% formaldehyde has been reported to cause death in an adult human
- No established clean-up guideline
- Maximum Acceptable Concentration (MAC) for drinking water of 350 ug/L has been suggested
- Health Canada Guidelines (air):
 - 123 ug/m³ (100 ppb) for one hour
 - 50 ug/m³ (40 ppb) for eight hours
- What is the danger?
 - Formaldehyde quickly breaks down in air (UV light)
 - At low concentrations: human body can process
 - Danger exists at high concentrations





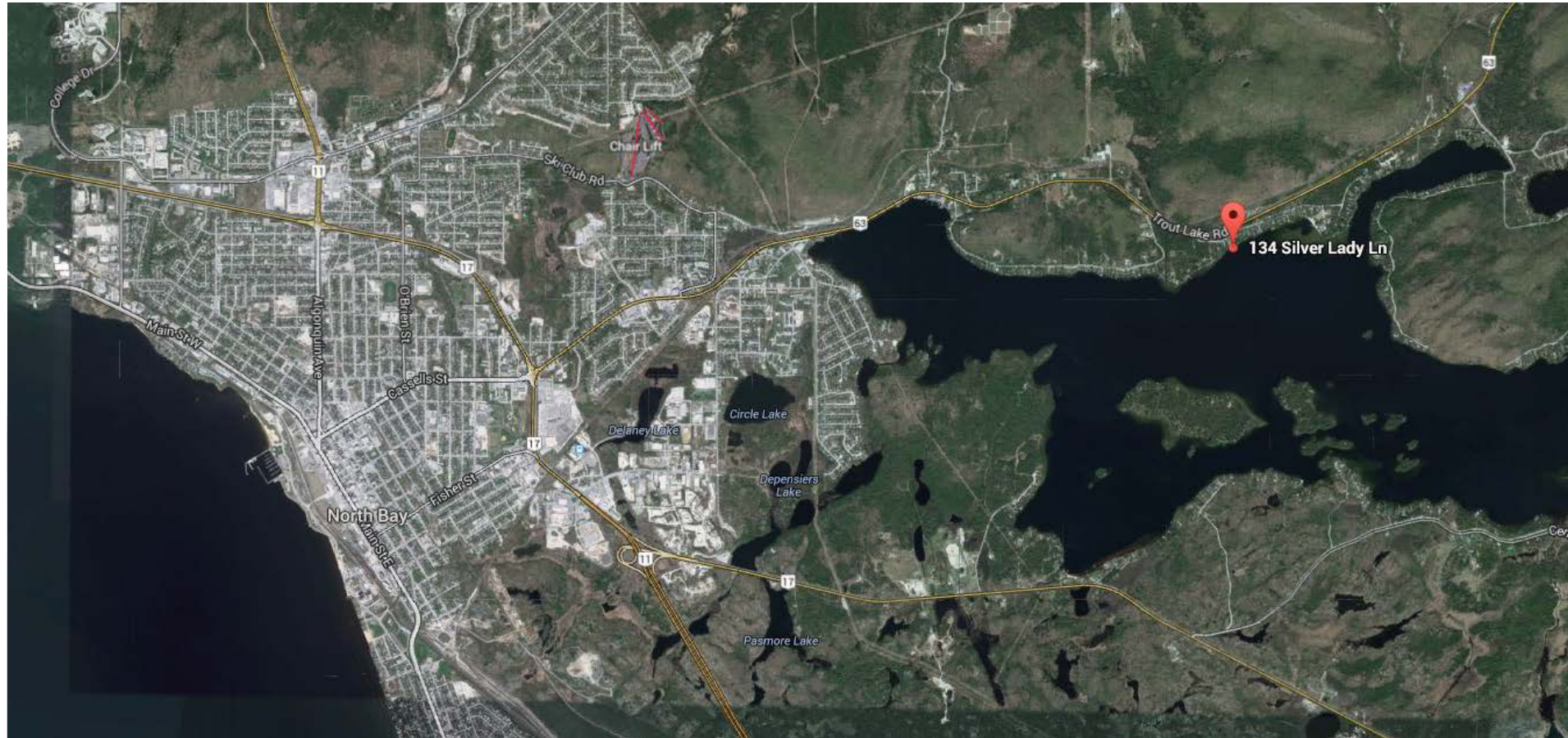
“Fifteen short seconds changed our lives”, local resident

Project History

- May 21, 2012, 8:30 am: Truck carrying ~35,000 L of heated waste formaldehyde overturned on hwy 63 in North Bay.
- Formaldehyde and diesel (fuel) released.
- Cascaded down embankment, along a secondary road, through a culvert, and down to Trout Lake.
 - Trout Lake supplies drinking water to North Bay
- Truck driver died. Cottagers who tried to stop the spill brought to the hospital.
- Residents from 30 properties were evacuated.
- Drinking water ban.



Project History



City of North Bay



Project History



Truck Overturned



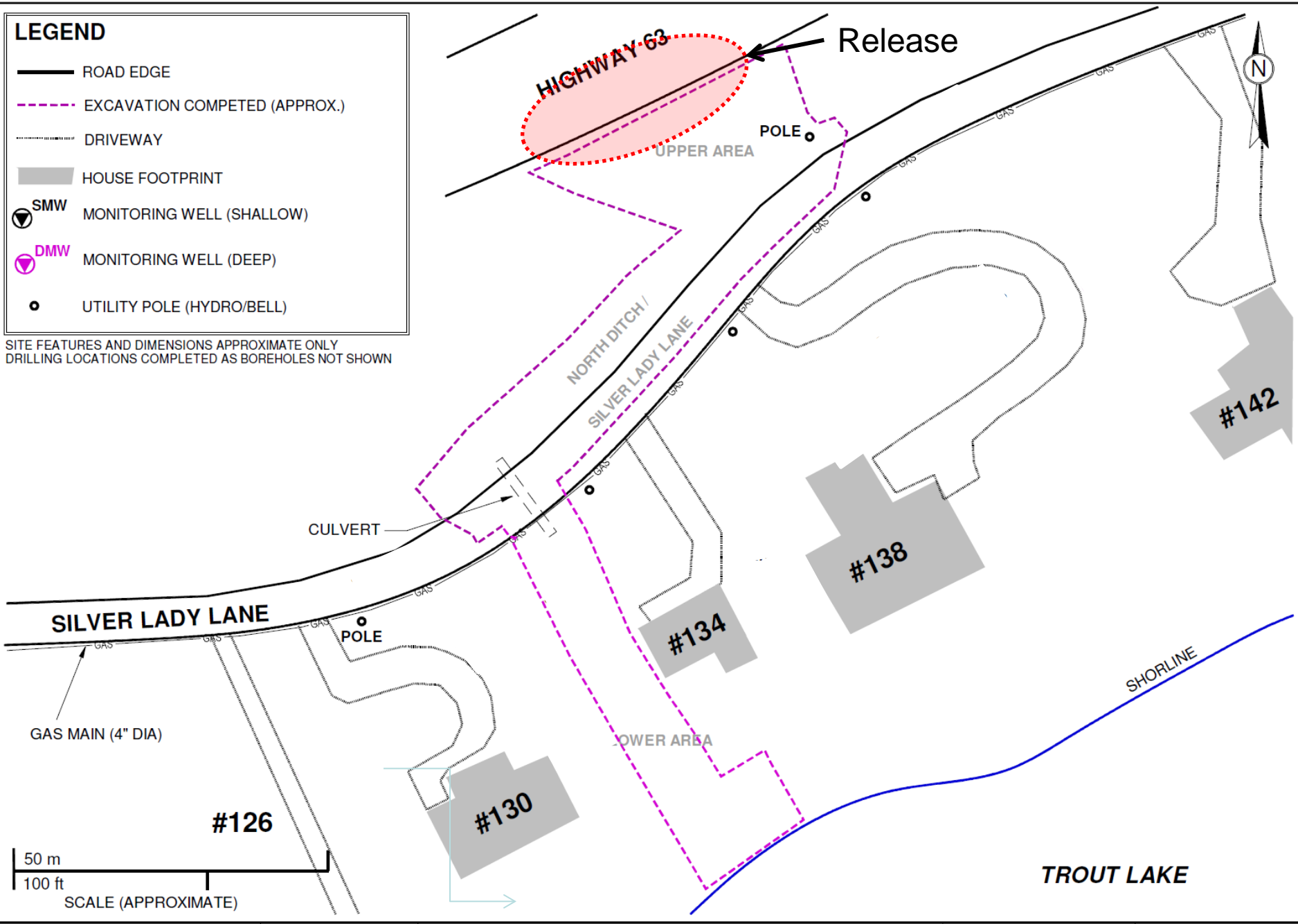
Silver Lady Ln



LEGEND

- ROAD EDGE
- EXCAVATION COMPETED (APPROX.)
- DRIVEWAY
- HOUSE FOOTPRINT
- SMW MONITORING WELL (SHALLOW)
- DMW MONITORING WELL (DEEP)
- UTILITY POLE (HYDRO/BELL)

SITE FEATURES AND DIMENSIONS APPROXIMATE ONLY
DRILLING LOCATIONS COMPLETED AS BOREHOLES NOT SHOWN





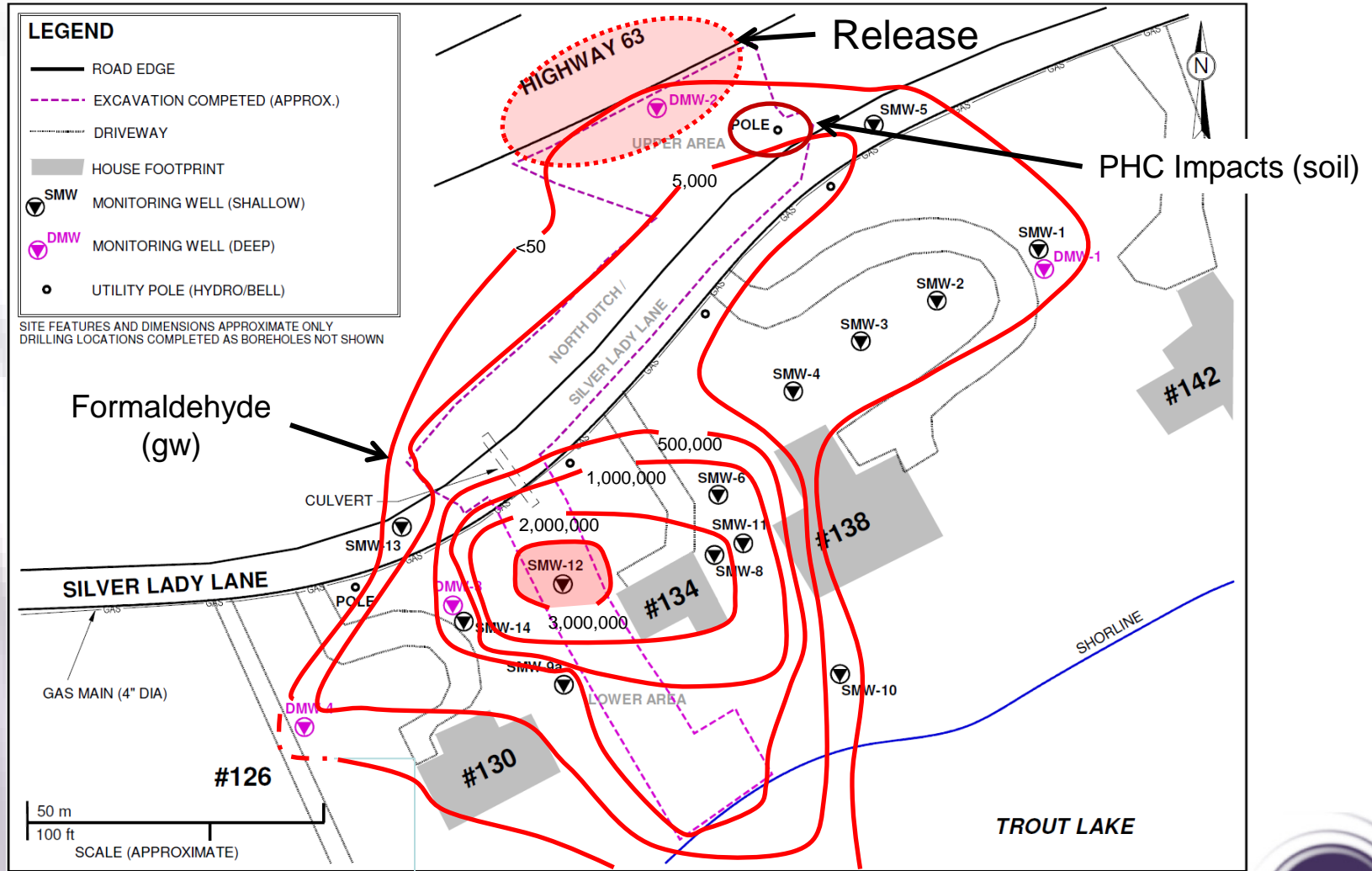


CAUTION





Post-Excavation Concentrations

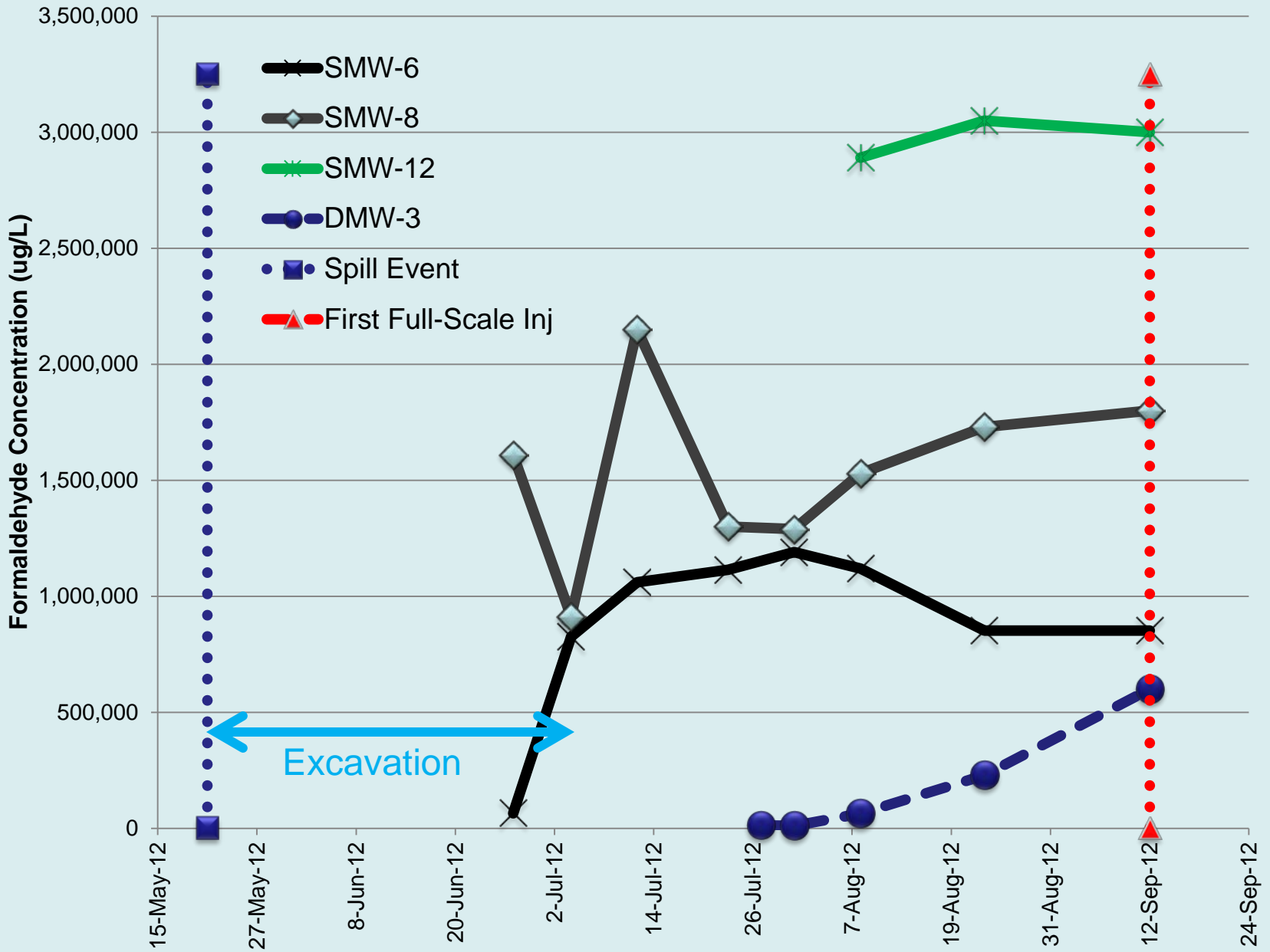




Post-Excavation Concentrations

	Concentration	Clean-up Goal	% Reduction
Formaldehyde (shallow gw)	3,050,000 ug/L	<10 ug/L	99.9997%
Formaldehyde (bedrock)	600,000 ug/L	<10 ug/L	99.998%
Formaldehyde (surface water)	487,000 ug/L	<10 ug/L	99.998%
PHC (F2)	~2,500 mg/kg	150 mg/kg	94.0%





Project Approach - Vertex

- Review project data to date
- Bench Scale Test
 - Purpose: confirm oxidant will destroy formaldehyde
- Pilot Scale Test
 - Field-based test
 - Verify the injection rate and oxidant distribution
- Full-Scale Remediation



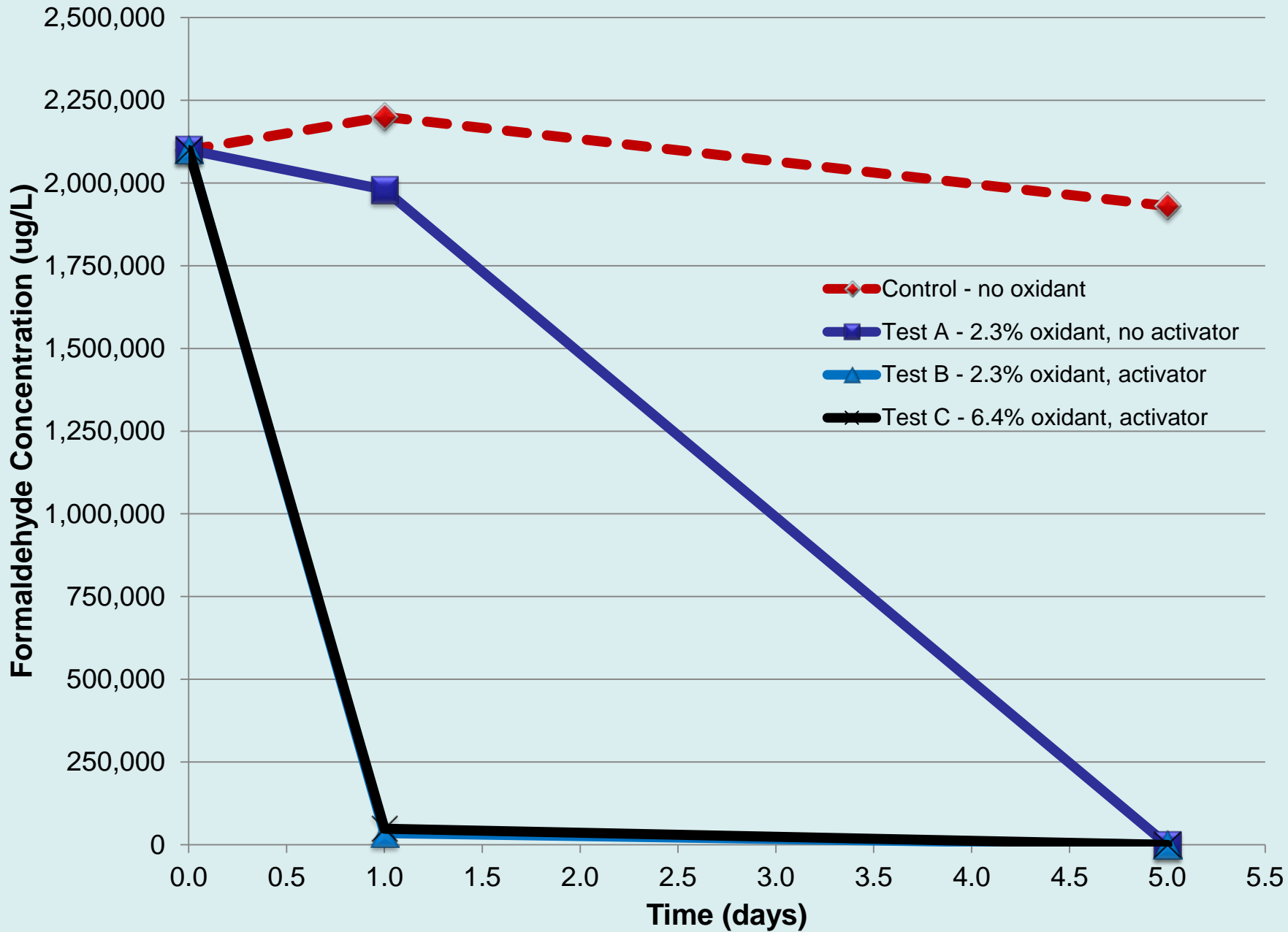
Bench Scale Results

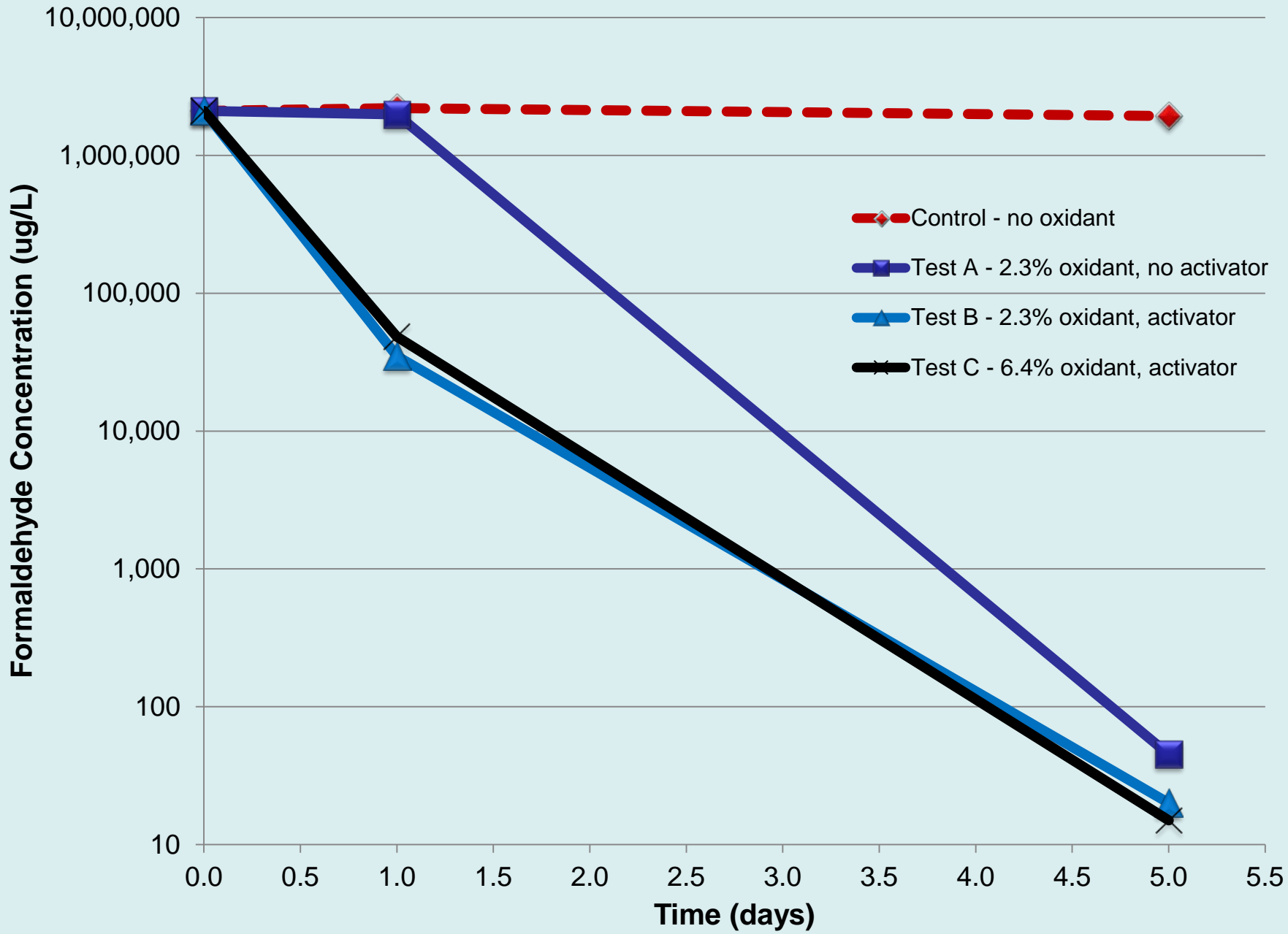


Bench Results

- Collected groundwater from Site wells
 - Transported to Vertex laboratory
- Set-up Bench Test
 - Control (groundwater sample, “worst case”)
 - 2.3% **Unactivated** Hydrogen Peroxide
 - 2.3% **Activated** Hydrogen Peroxide
 - 6.3% **Activated** Hydrogen Peroxide
- Sampling Times (Day 0 – dose groundwater samples)
 - Day 0
 - Day 1
 - Day 5







Pilot Scale

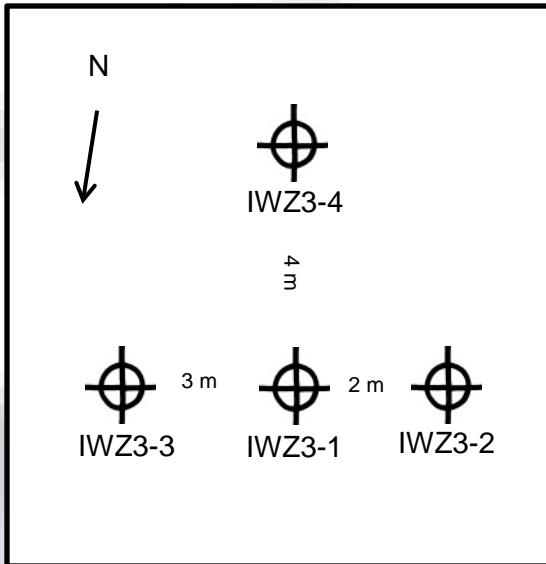
Purpose:

- Assess equipment access
- Test Injection Well design
- Measure injection flow rate and pressure
- Estimate Radius of Influence (ROI)



Pilot Scale

Injection Well Layout



Pilot Scale



Pilot Scale



08/29/2012

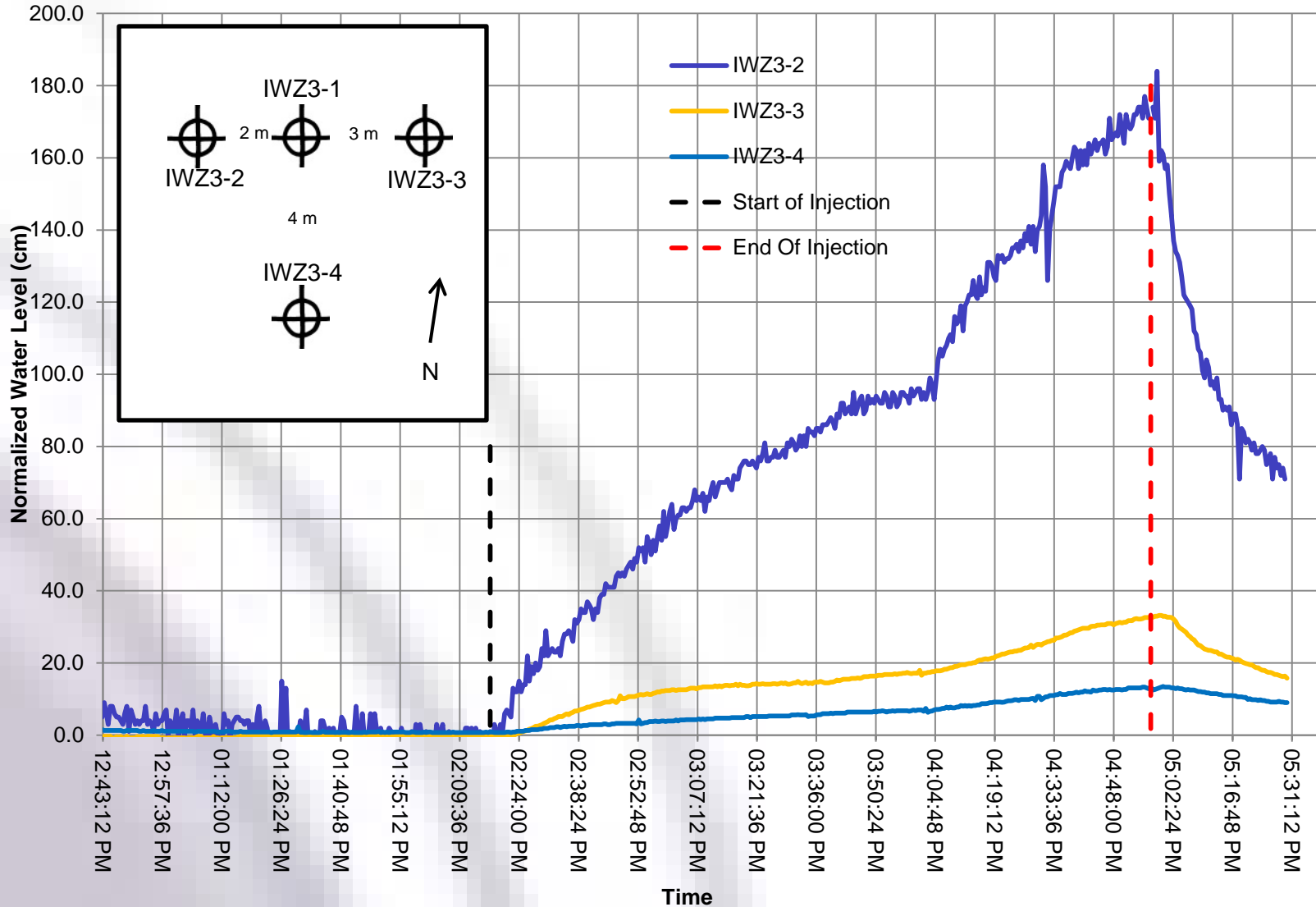
Pilot Scale

Results:

- 2 Pilot plots tested
- Injection Wells
 - installed successfully
 - some issues with cobbles
- Flow rate and pressures
 - Gravity Feed: 10 litres per minute
 - Pump: 30 litres per minute at 15 psi
- Radius of Influence (ROI)
 - see next slide



Pilot Scale – P134



Full Scale

Formaldehyde:

- Treatment of impacted groundwater
- Injection into wells and temporary injection points

PHCs:

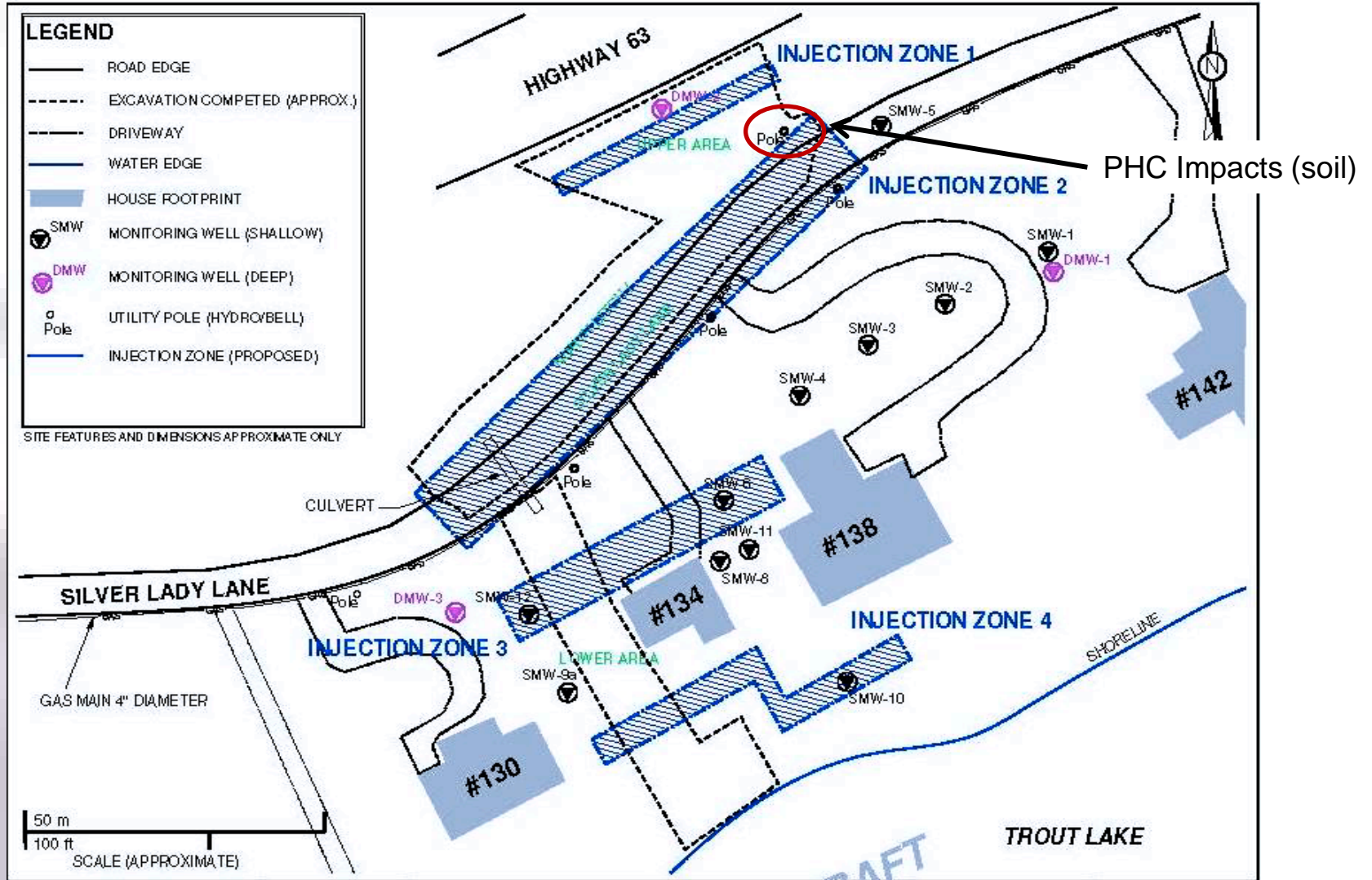
- Treatment of unsaturated soils
- Injection into temporary injection points

Approach

- Injection wells installed in stages
 - ~5 m spacing between Injection Wells within a Reactive Zone
 - ~20 m spacing between Reactive Zones
 - Fifty four (54) vertical wells installed in three (3) Reactive Zones
 - Eight (8) horizontal wells installed under roadway
- Injections every 3 to 4 weeks (peroxide)



Full Scale





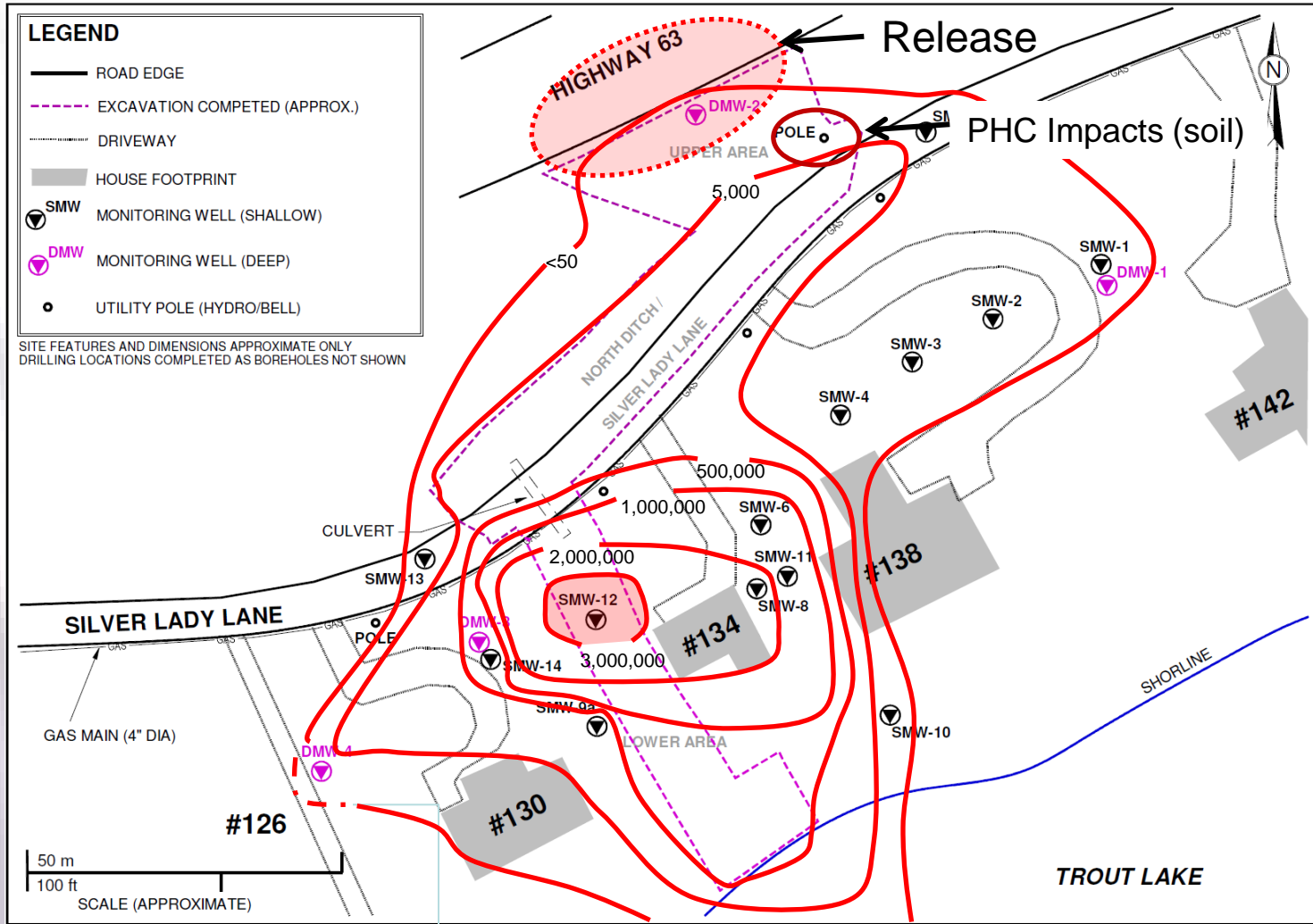
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Post-Excavation Concentrations



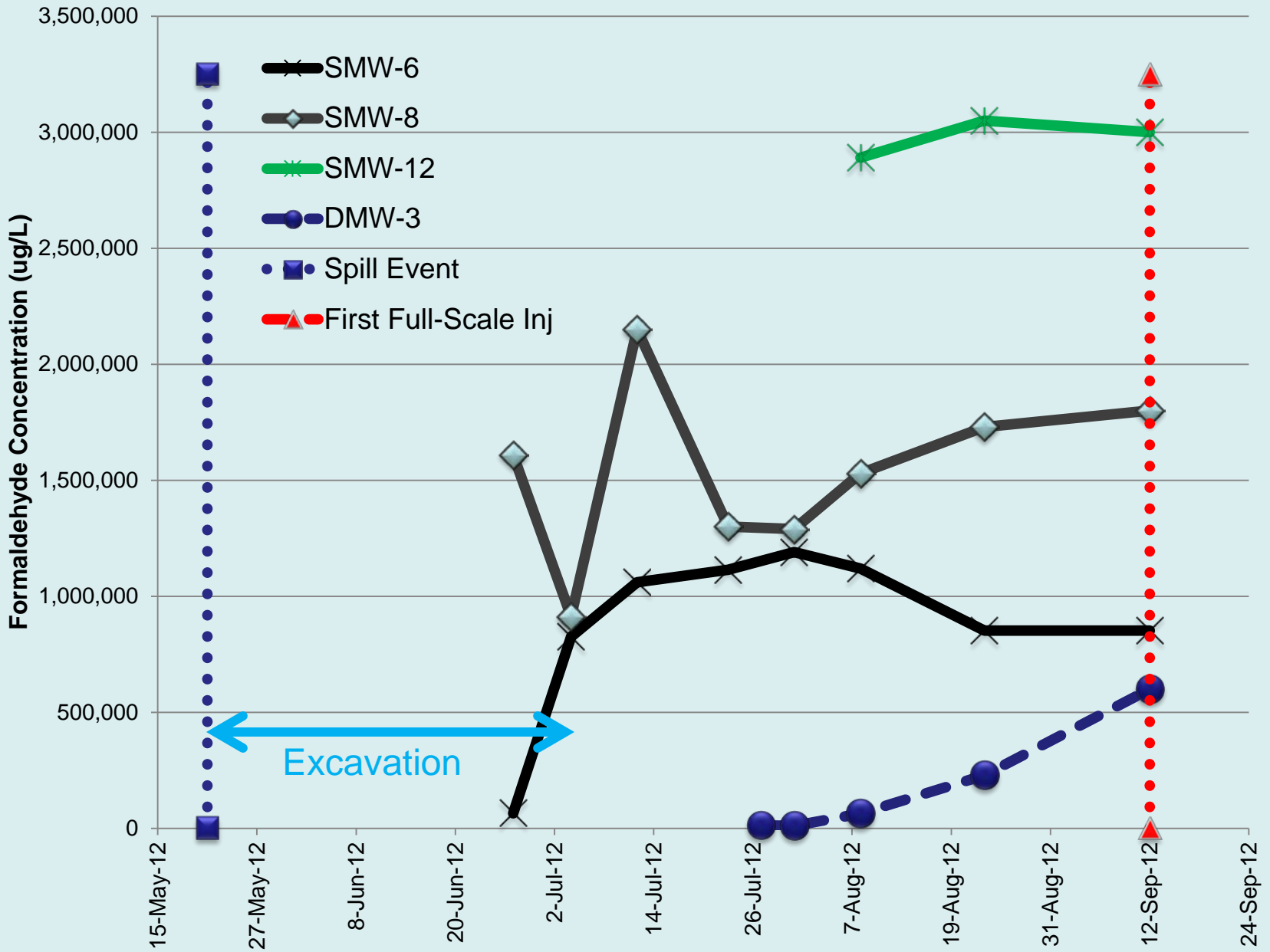
Full-Scale Results

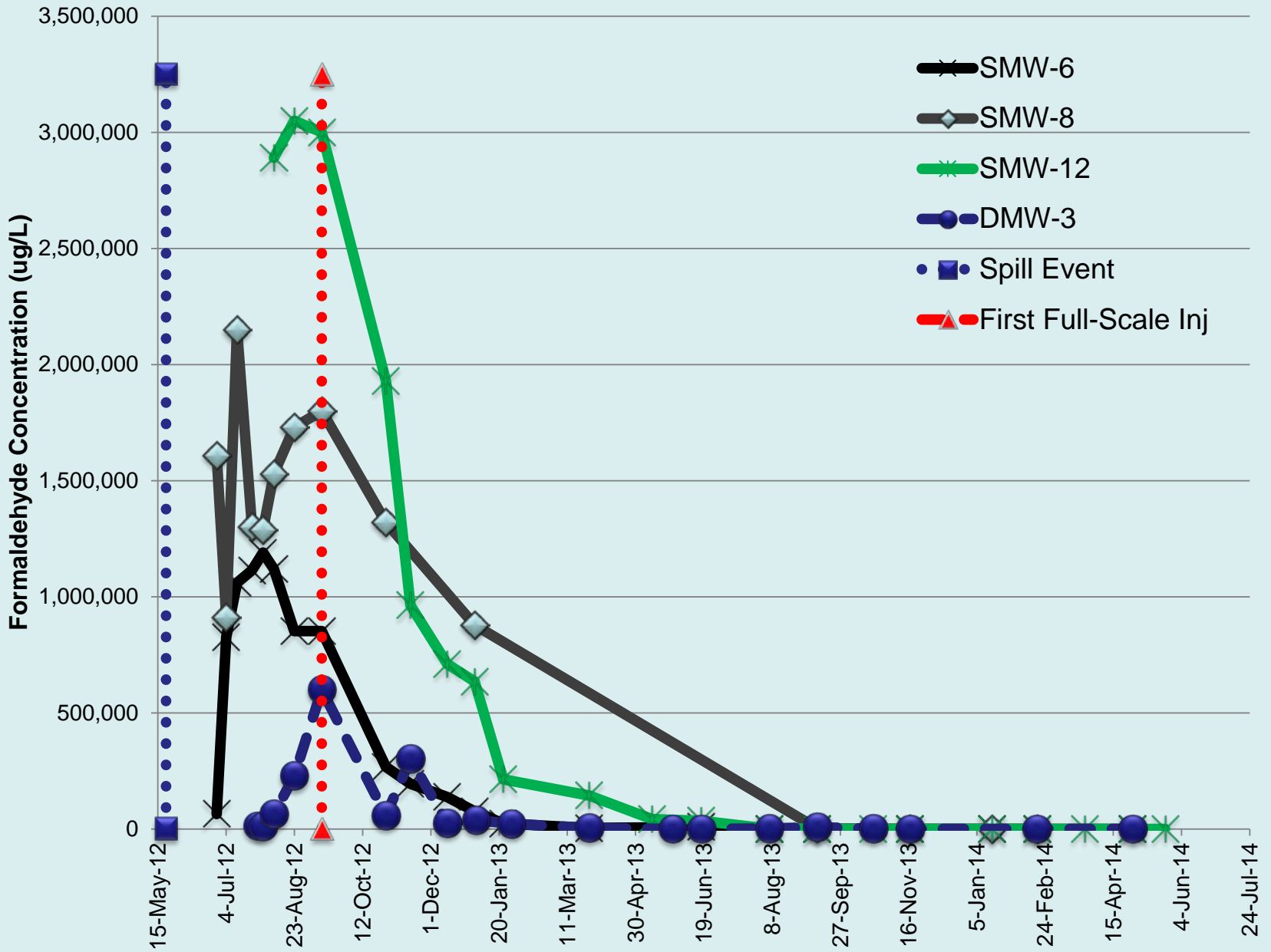


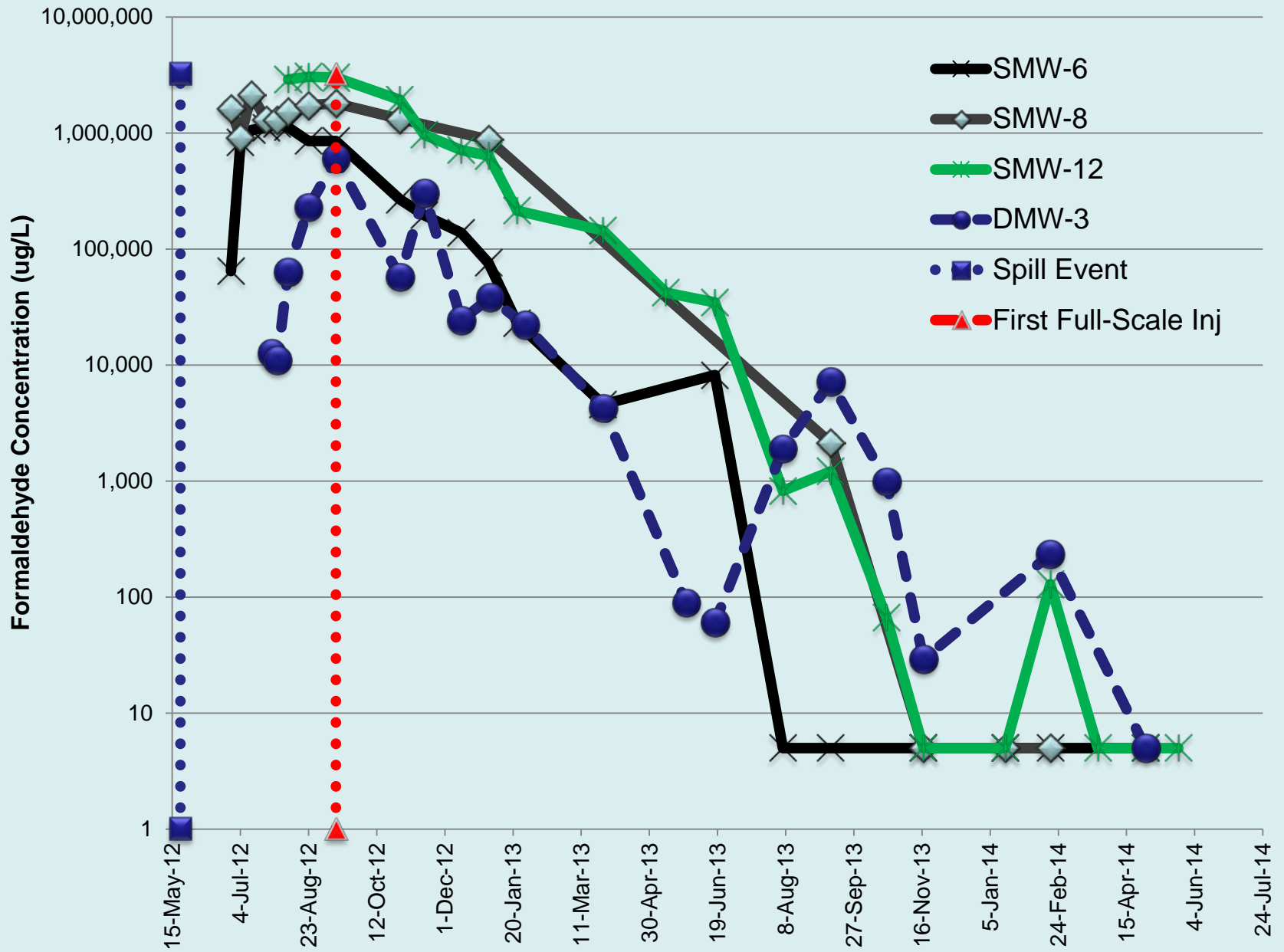
PHCs Treatment

- Percarbonate (RegenOx)
- 2 Applications
- PHCs <150 mg/kg
- Soils clean for PHCs

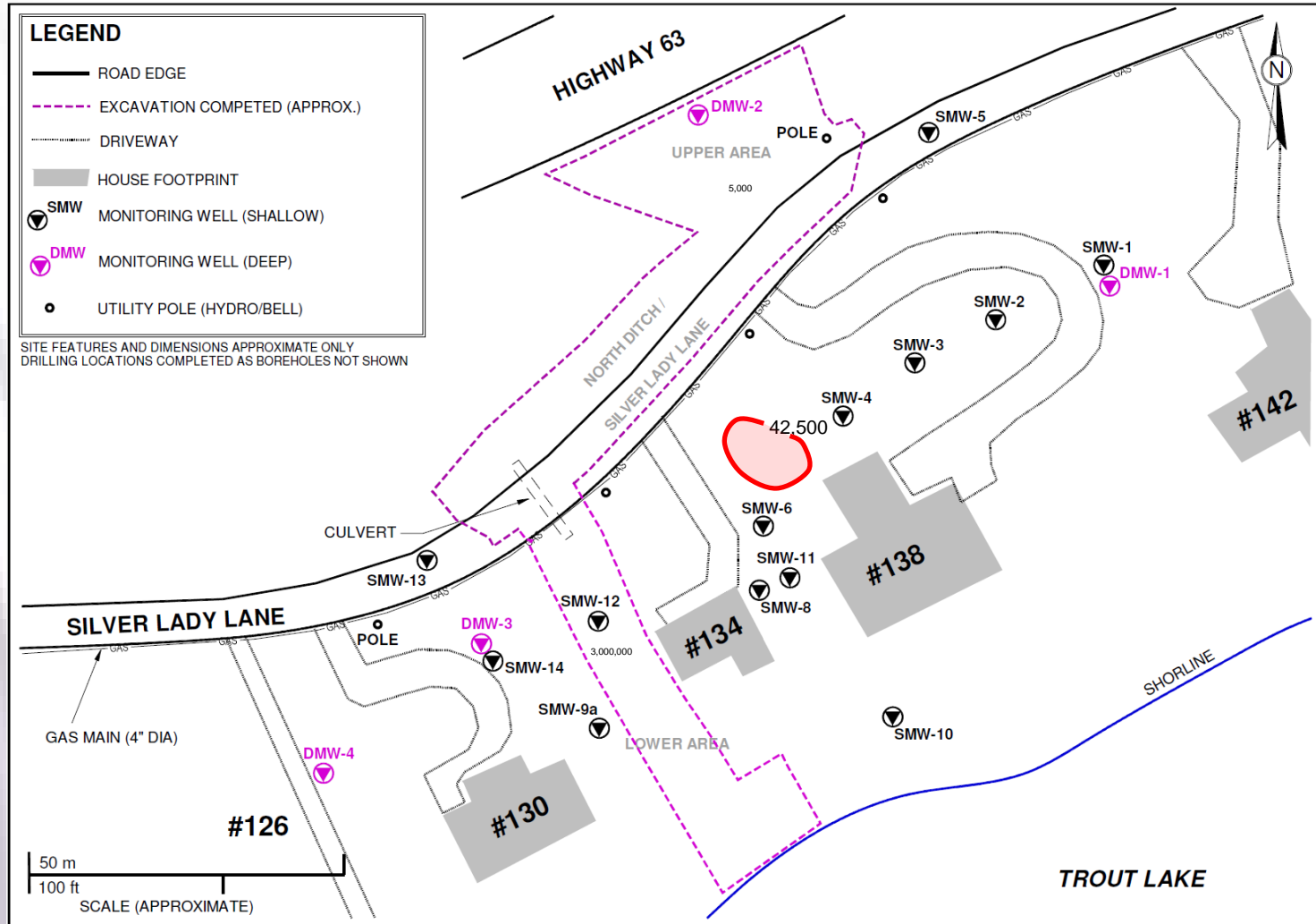








Post-ISCO Formaldehyde Conc.



Full Scale

Conclusions:

- Excavation
 - Very expensive, but excellent for soil removal
 - *in-situ* remediation was required for groundwater impacts
- In-situ injection completed under planned approach
 - Selection of appropriate oxidant
 - Testing at bench
 - Confirmation at pilot
 - Modifications during full-scale
- Results
 - Overall: >97% reduction in plume size
 - Overall: >99% reduction in concentration
 - SMW-12 gw conc 3,050,000 ug/L to <10 ug/L
 - Combined digging and ISCO works



Questions?



Thank You for
Your Time

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