

MDEQ PROJECT UPDATE

(2015 4Q PROGRESS REPORT)

RACER Lansing, Plants 2, 3 & 6

January 26, 2016

Agenda

- Tracer Study / ISCO Pilot Test Results
- Lower 1,4-Dioxane Toe Investigation
- Fourth Quarter Groundwater Sampling Summary
- Plant 6 Excavations
- 2016 Schedule

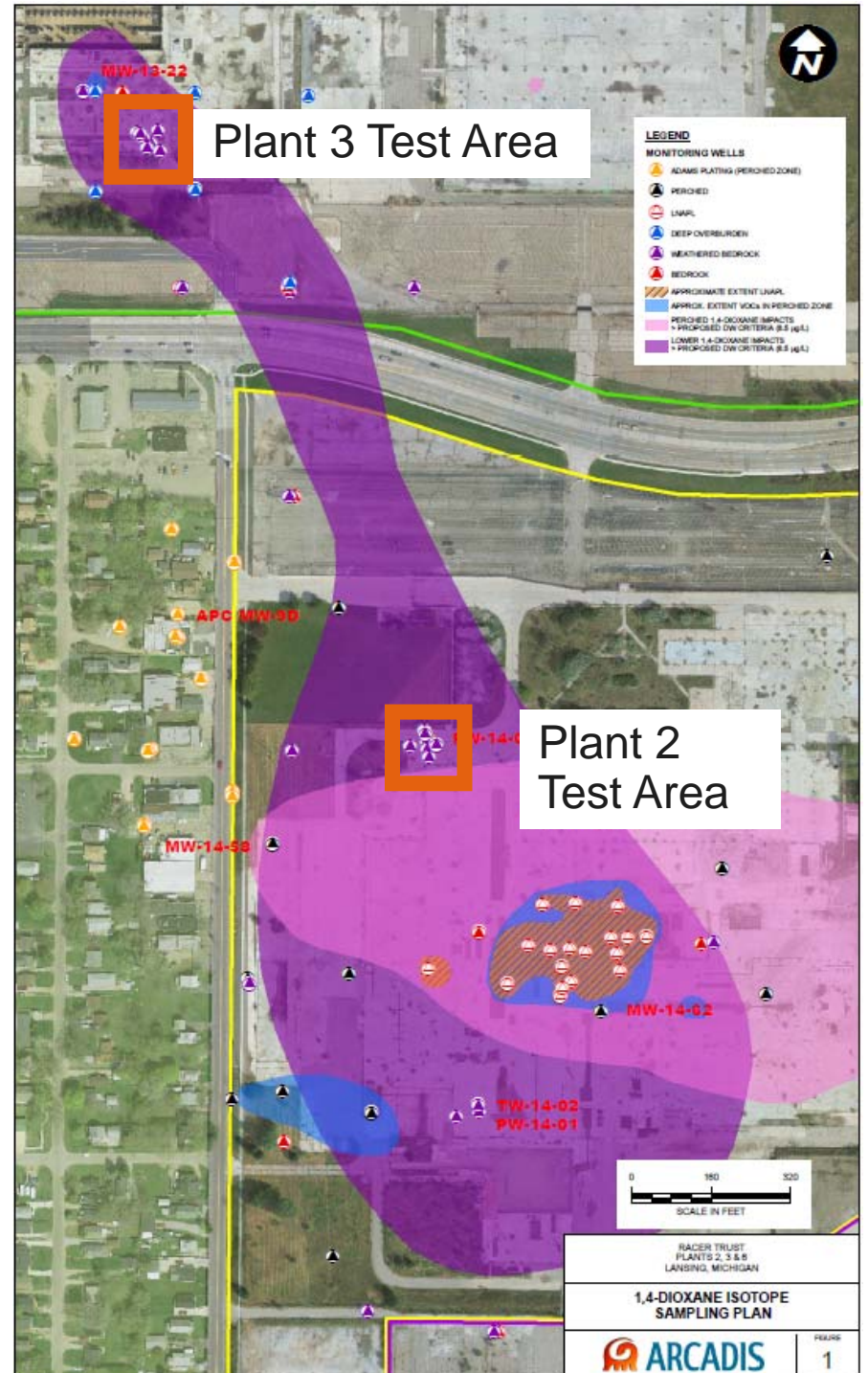
Tracer Study / ISCO Pilot Results

Objectives

- Hydraulics
 - Evaluate reagent distribution
 - Determine mobile porosity
 - Determine localized groundwater flow direction
- Oxidation
 - Evaluate reduction of groundwater concentrations
 - Evaluate the potential of the temporary generation of oxidation by products and/or metals mobilization
 - Assess rebound of groundwater concentrations



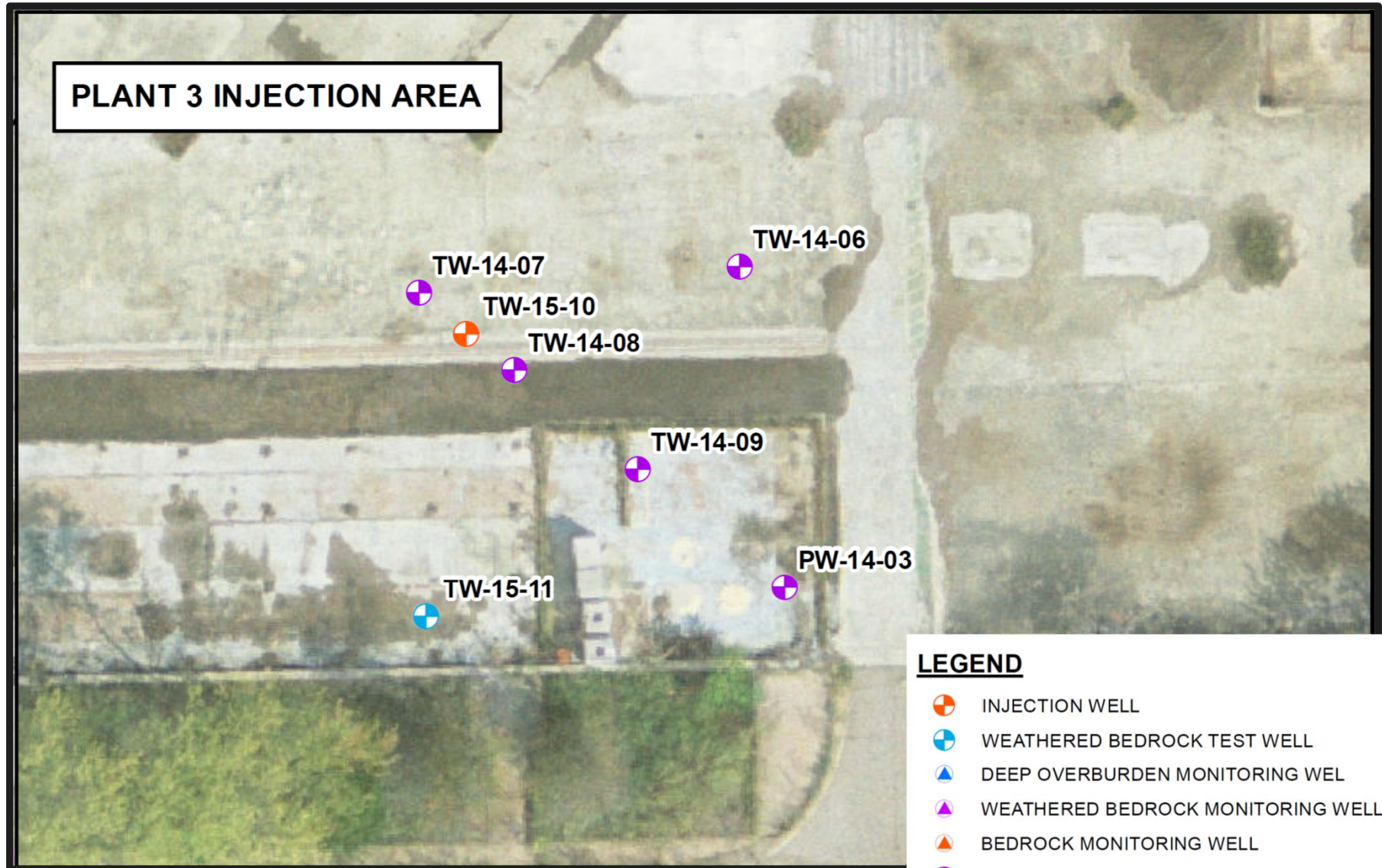
Injection Areas









Field Injection Summary

	Plant 3	Plant 2
Days of injection (Sept. 2015)	15 th – 16 th	17 th – 18 th
Volume injected (gallons)	3900	2970
Concentration of sodium persulfate (g/L)	60/45	60/70
Total mass of sodium persulfate injected (pounds)	1960	1621
Concentration of D2O (g/L)	2.5	2.5
Average injection rate	5.8-6.1 gpm	3.9-4.1 gpm
Average Injection Pressure (gauge/hydrostatic)	0 psi / 34 psi	0 psi / 28 psi

Injection Area – Plant 3

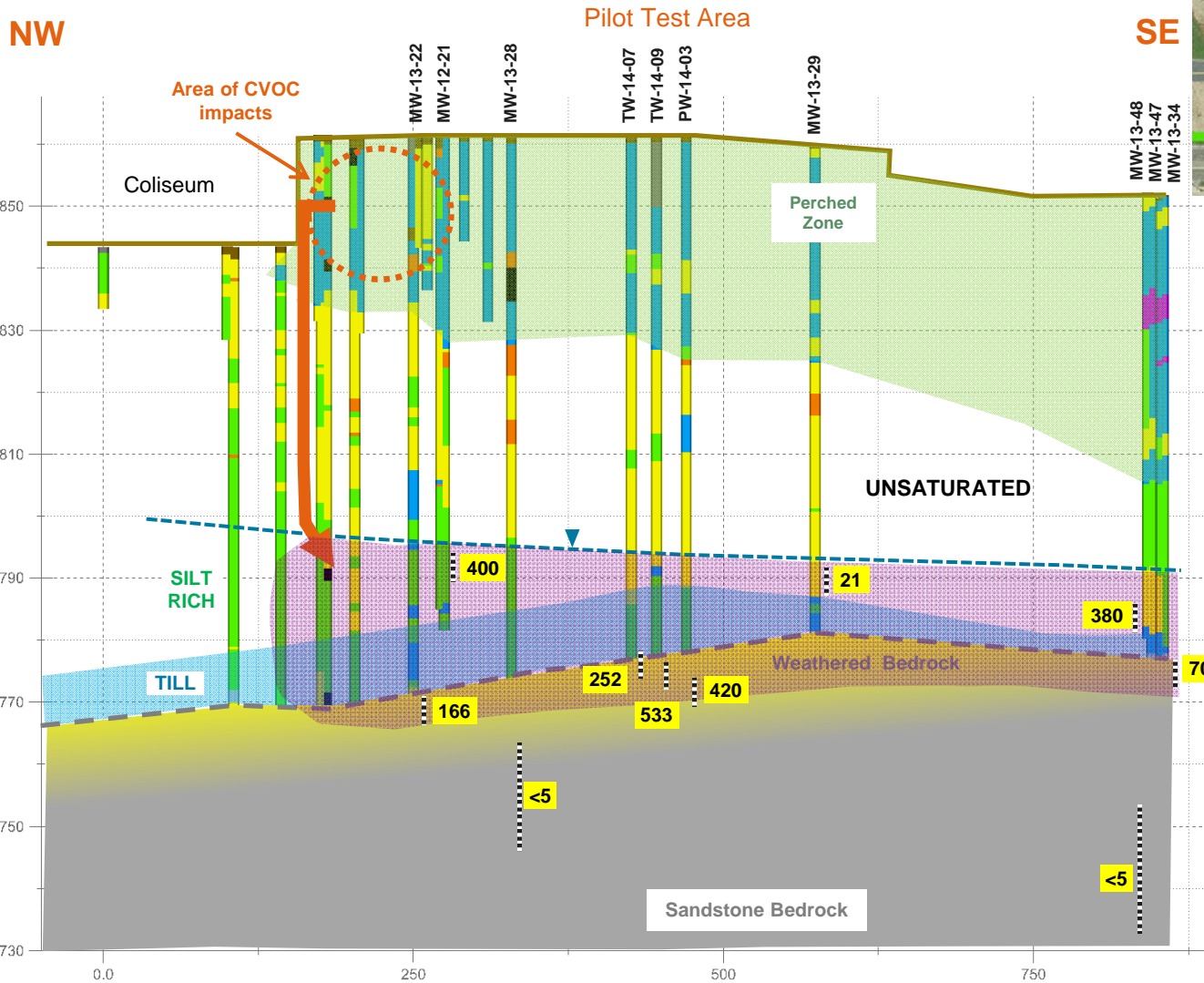


LEGEND

-  INJECTION WELL
-  WEATHERED BEDROCK TEST WELL
-  DEEP OVERBURDEN MONITORING WELL
-  WEATHERED BEDROCK MONITORING WELL
-  BEDROCK MONITORING WELL
-  WEATHERED BEDROCK TEST WELL

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Lower 1,4-Dioxane Source Area Conceptual Model



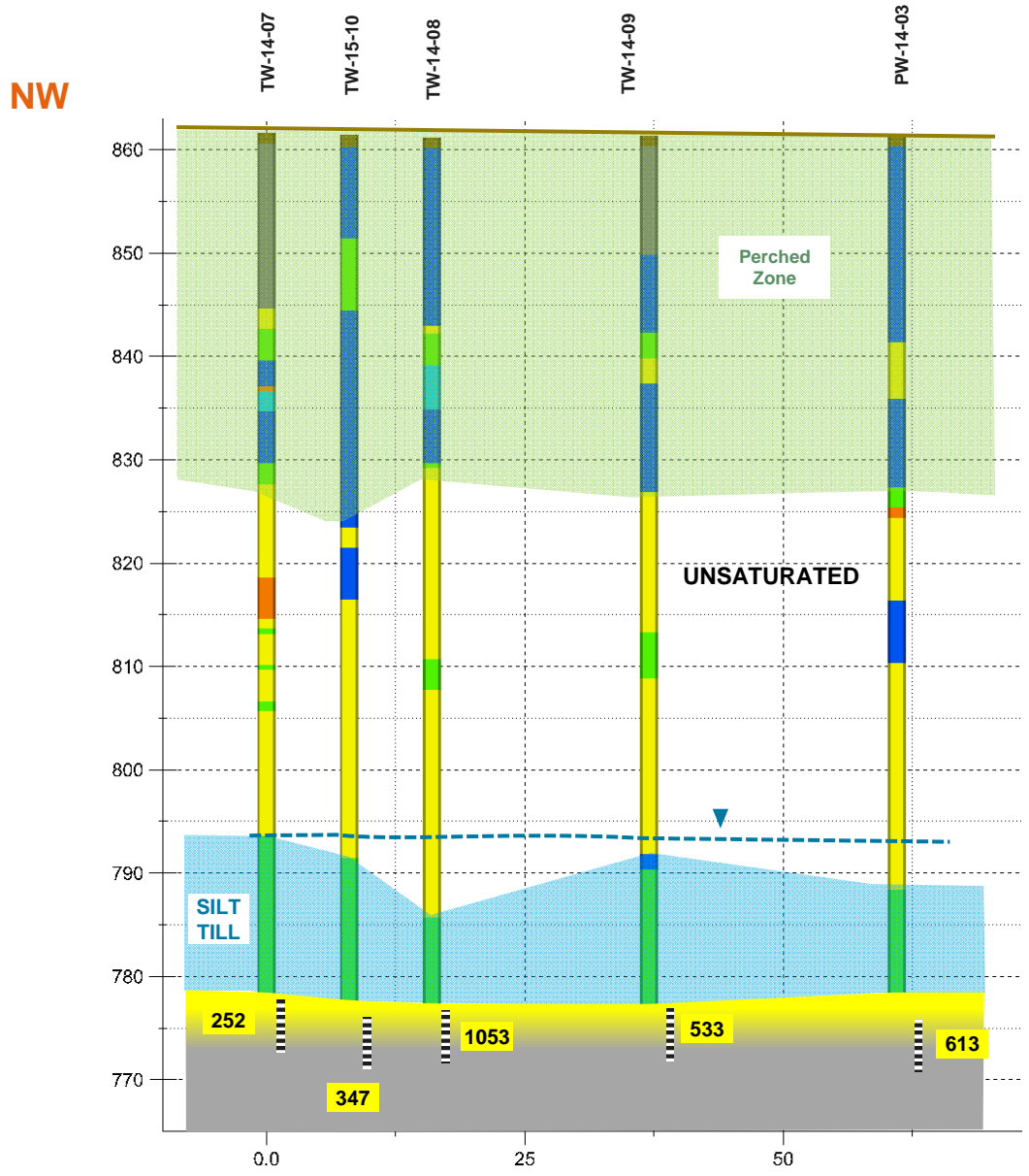
34 1,4-dioxane in GW (µg/L)
(December 2015)

- STRATIGRAPHIC UNIT**
- CONCRETE/ASPHALT/TOPSOIL
 - FILL
 - GRAVELLY_SAND
 - SAND
 - SANDY_SILT/SILT
 - SILTY/SANDY/GRAVELLY_CLAY
 - CLAY
 - PEAT
 - BEDROCK-SANDSTONE
 - BEDROCK-SHALE
 - NO_RECOVERY

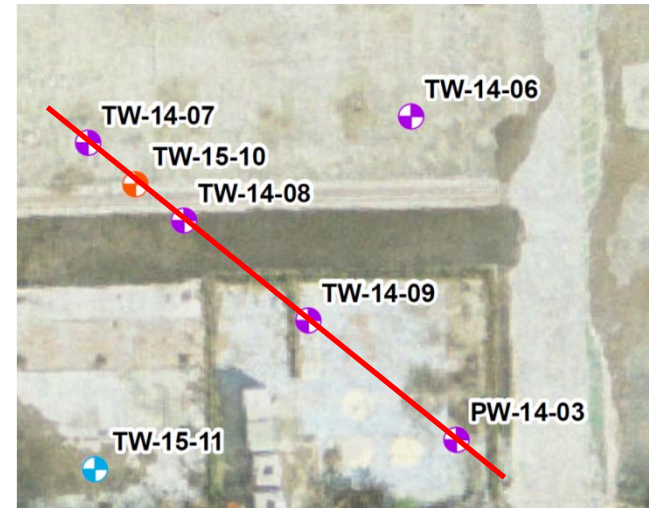
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Plant 3 Pilot Test Area



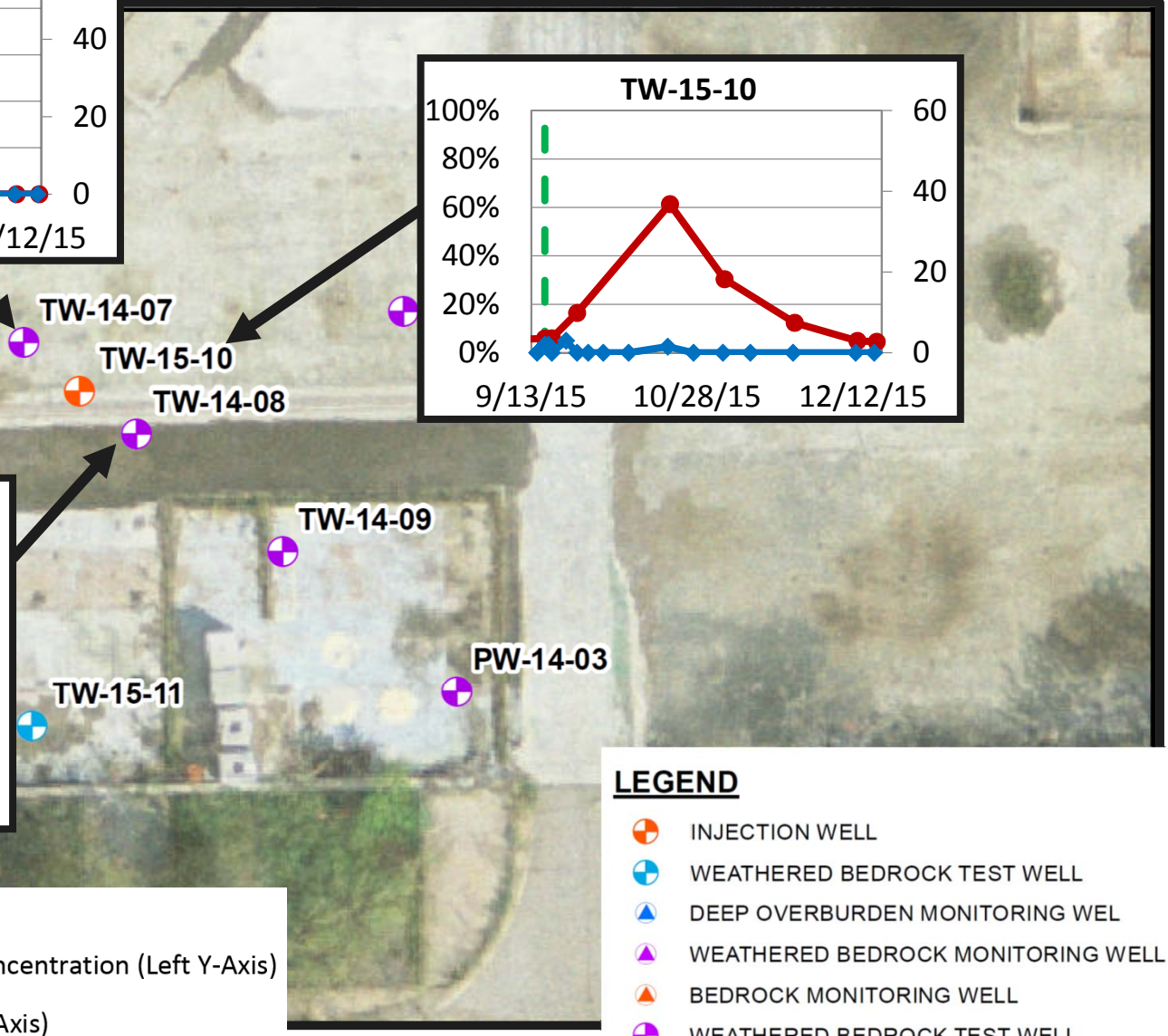
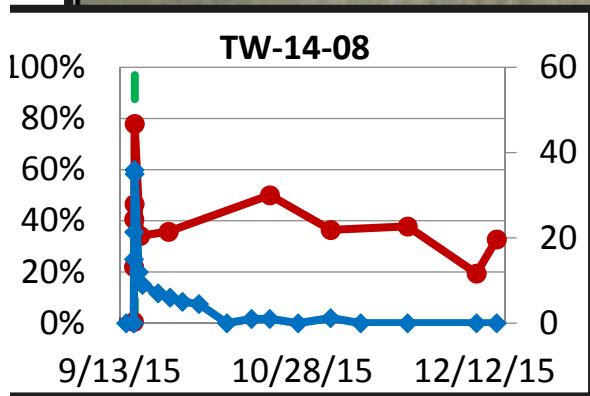
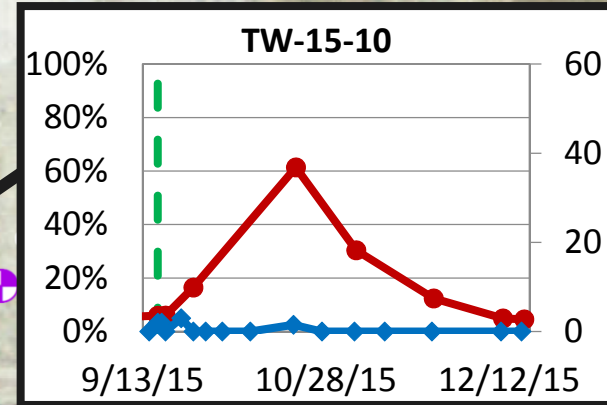
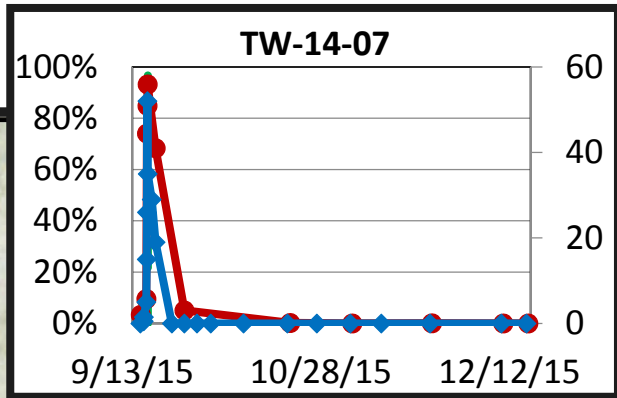
SE









34 1,4-dioxane in GW (µg/L)
(December 2015)

- STRATIGRAPHY
- TOPSOIL/CONCRETE/ASPHALT
 - FILL
 - GRAVELLY SAND
 - SAND
 - SANDY SILT/SILT
 - SILTY/SANDY/GRAVELLY CLAY
 - CLAY
 - PEAT
 - BEDROCK (PRIMARY SANDSTONE)
 - BEDROCK (SHALE)
 - NO RECOVERY

Tracer and Oxidant – Plant 3



- End of TW-15-10 Injection
- Normalized Deuterium Oxide Concentration (Left Y-Axis)
- ◆— Sodium Persulfate (g/L) (Right Y-Axis)

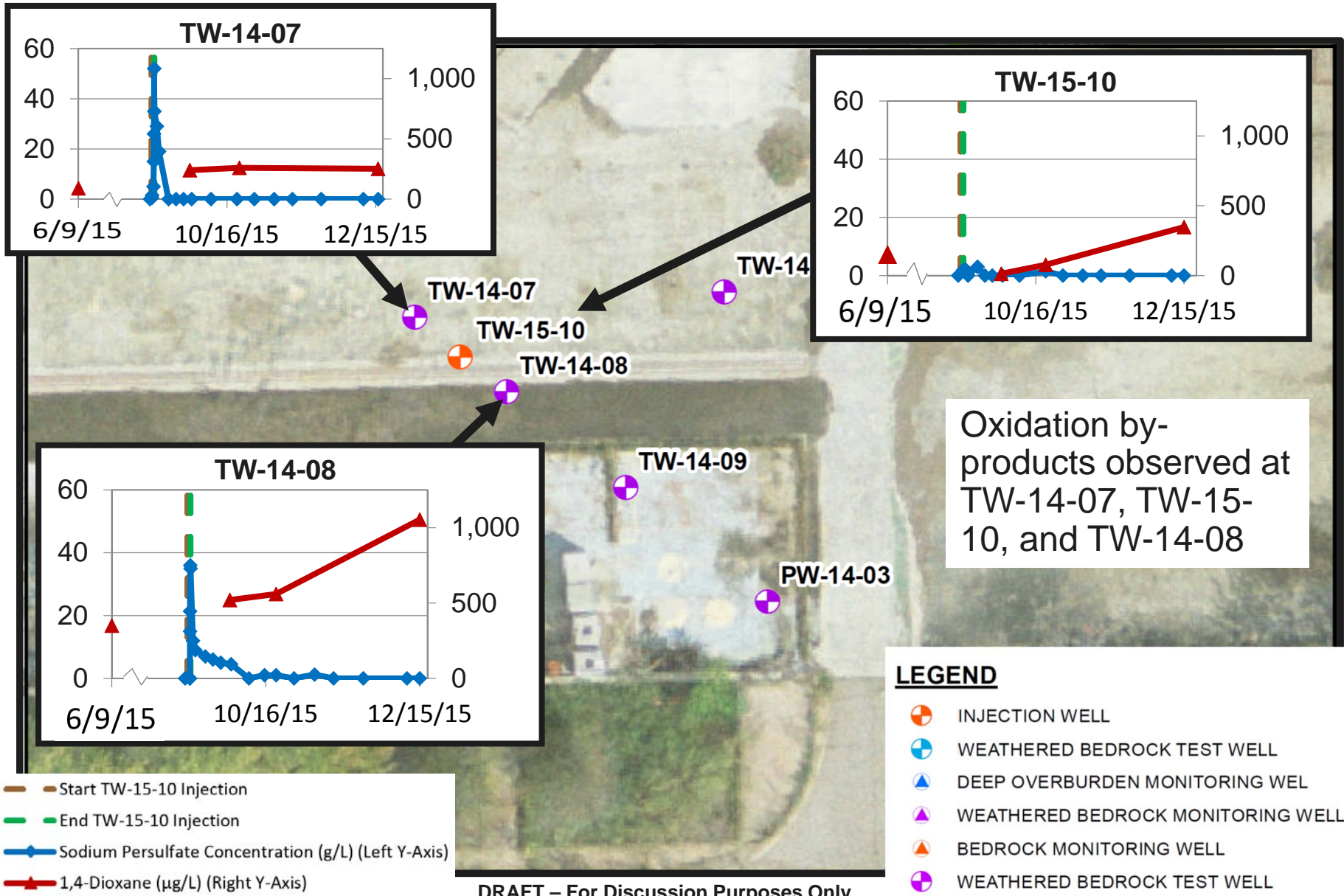
- LEGEND**
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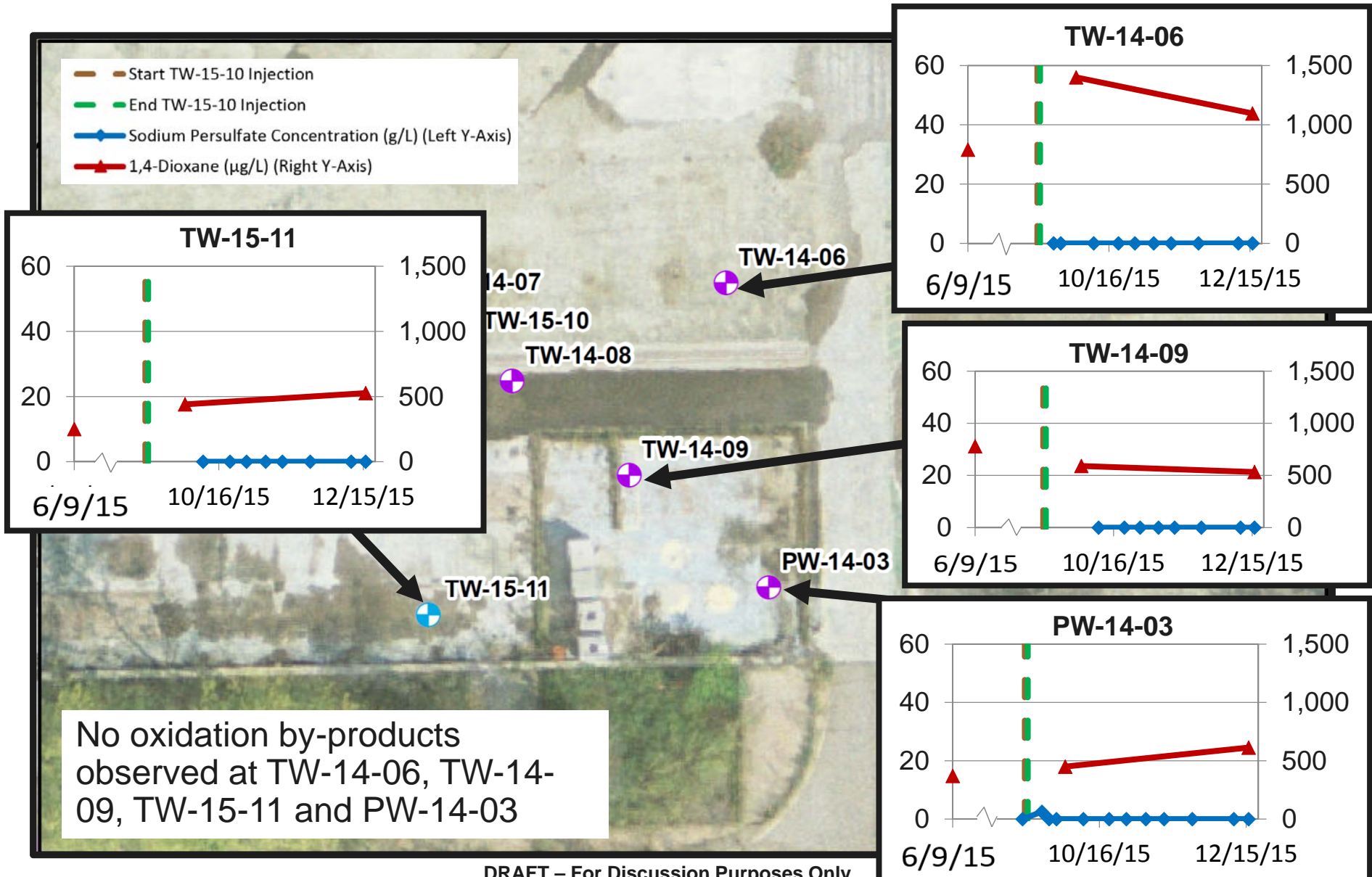
Plant 3 – Tracer Results

- Washout in DR wells indicates south easterly flow direction
- Mobile porosity ~19%
 - Calculated based on volume to reach 50% of max concentrations
 - Assumption for thickness of weathered rock
- Groundwater velocity based on washout ranges from 0.1 to 10 ft/day
- Sustained tracer concentrations:
 - Pushed tracer into storage fraction of weathered bedrock, slowing moving out
 - Mounding into overlaying till, slowly dissipating

1,4 Dioxane Results – Plant 3



1,4 Dioxane Results – Plant 3



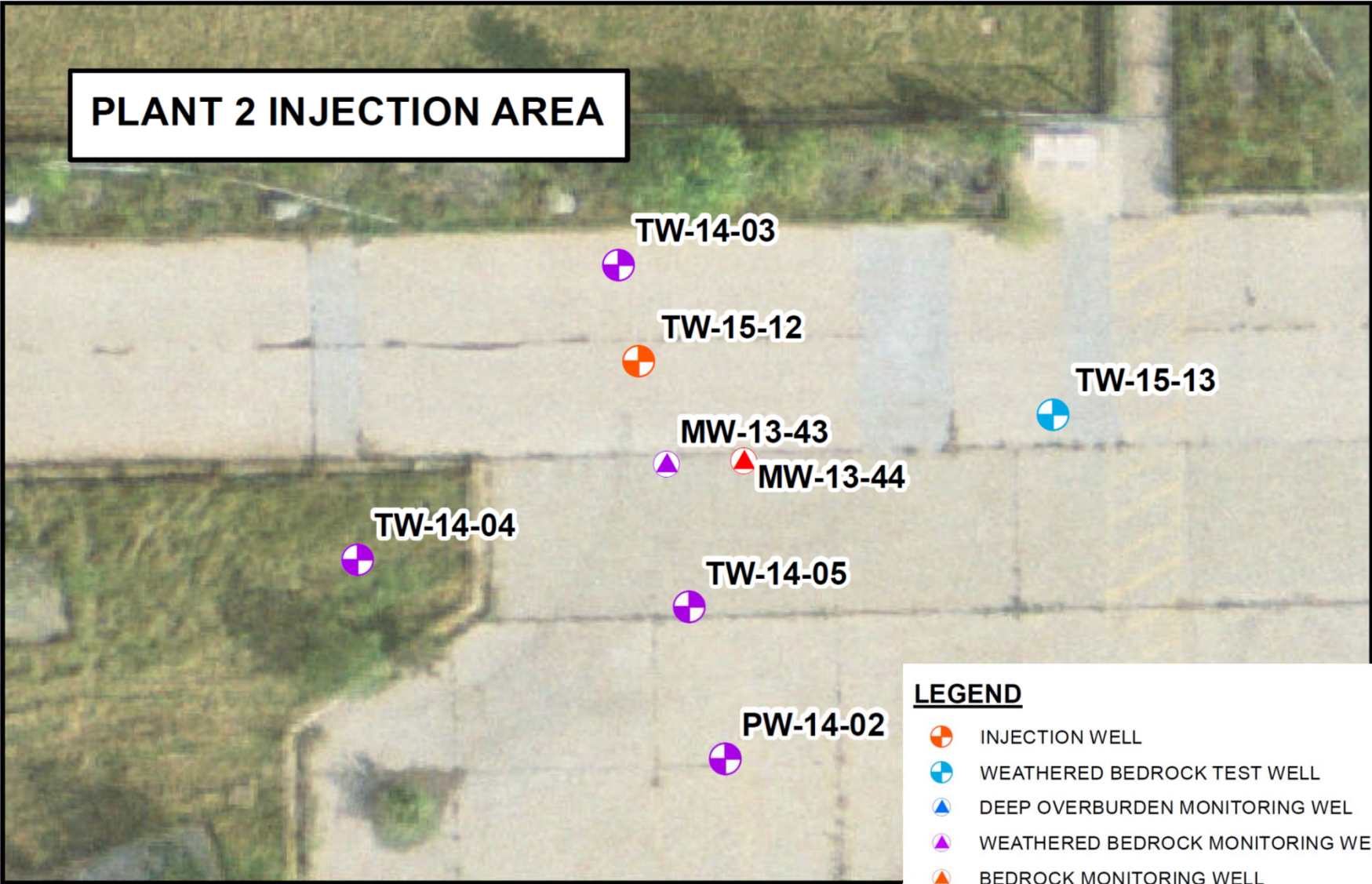
Plant 3 – ISCO Results

- Ambient activated sodium persulfate can reduce 1,4-D concentrations with adequate oxidant strength and persistence
- Working strength oxidant not observed in dose response or drift wells
- Increases in 1,4-dioxane:
 - Displaced from storage fraction by injection
 - Potentially in till mobilized by mounding







Plant 3 – ISCO Results

- Oxidation by-products were generated where oxidant was present
 - Methylene chloride exceeded DW criteria in December (8 ug/L vs 5 ug/L) @ TW-14-08
- Arsenic, chromium, and lead exceed DW
 - Based on experience, expected to return to pre-injection levels after geochemical conditions return to baseline within a year post injection
 - Most downgradient well (PW-14-03) does not exceed DW
 - Will continue to monitor metals in the treatment area during routine monitoring events

Injection Area – Plant 2

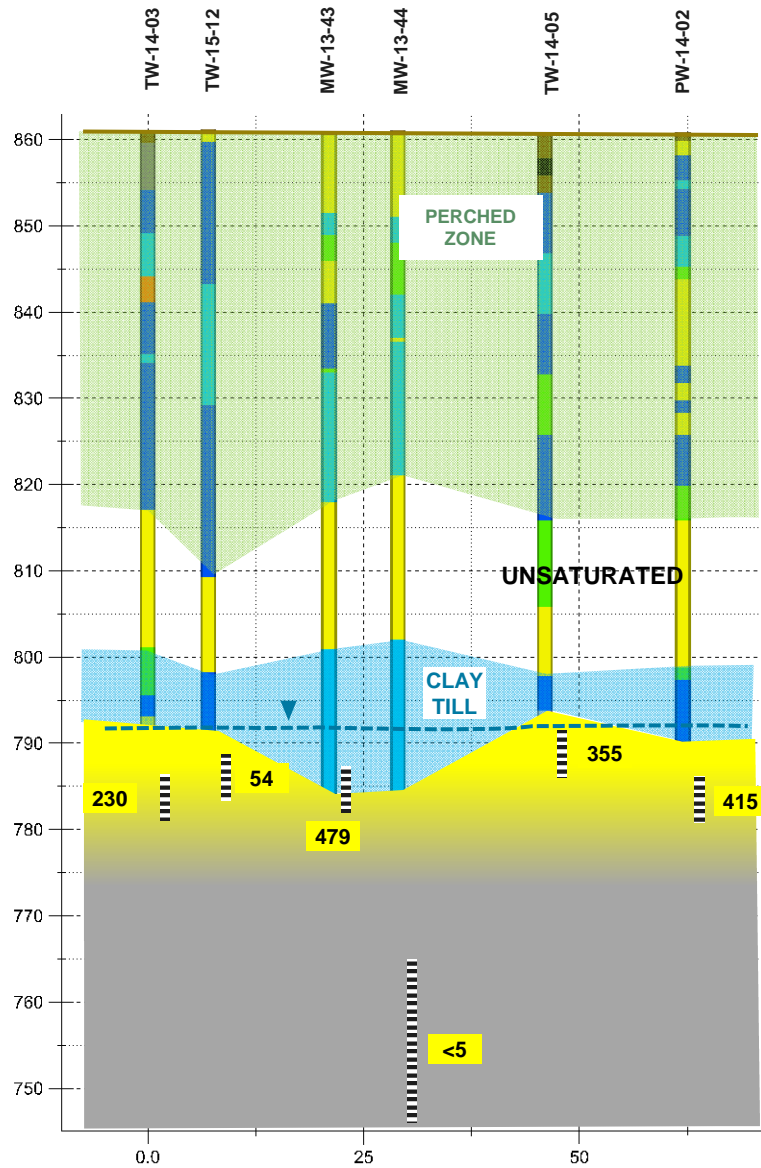


LEGEND

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-  BEDROCK MONITORING WELL
-  WEATHERED BEDROCK TEST WELL

Plant 2 Pilot Test Area

NW

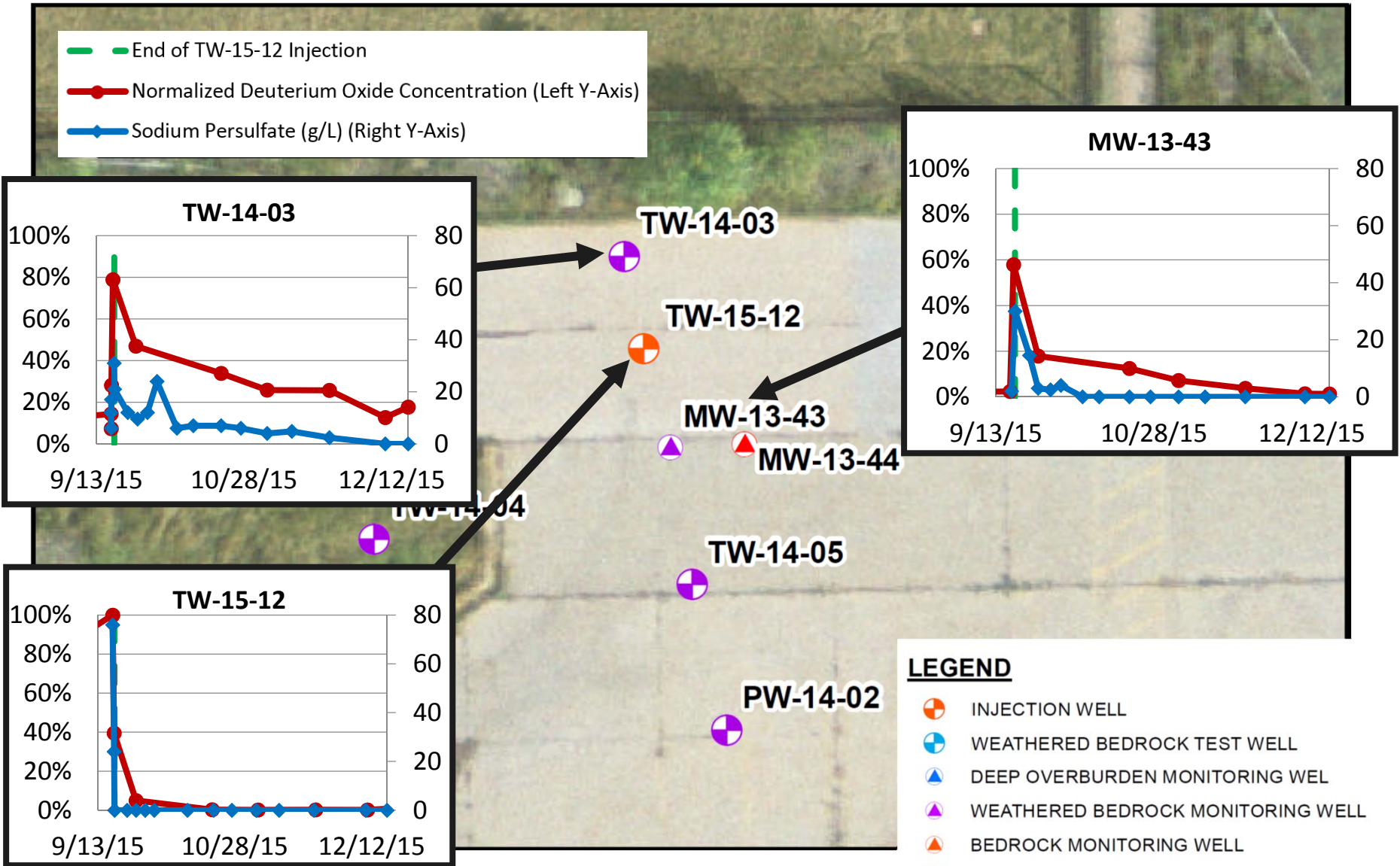


34 1,4-dioxane in GW ($\mu\text{g/L}$)
(December 2015)

STRATIGRAPHY

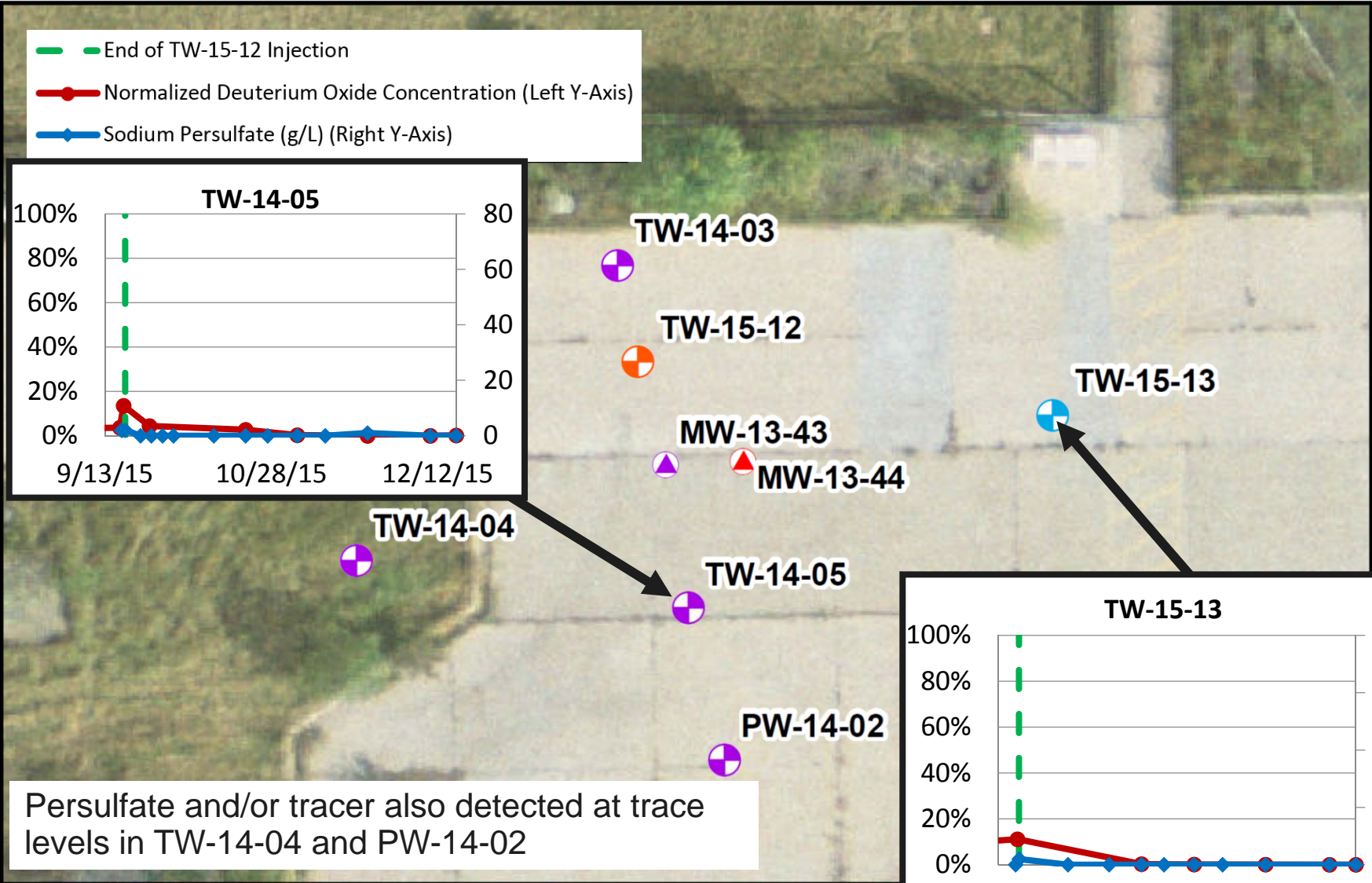
- TOPSOIL/CONCRETE/ASPHALT
- FILL
- GRAVELLY SAND
- SAND
- SANDY SILT/SILT
- SILTY/SANDY/GRAVELLY CLAY
- CLAY
- PEAT
- BEDROCK (PRIMARY SANDSTONE)
- BEDROCK (SHALE)
- NO RECOVERY

Tracer and Oxidant – Plant 2



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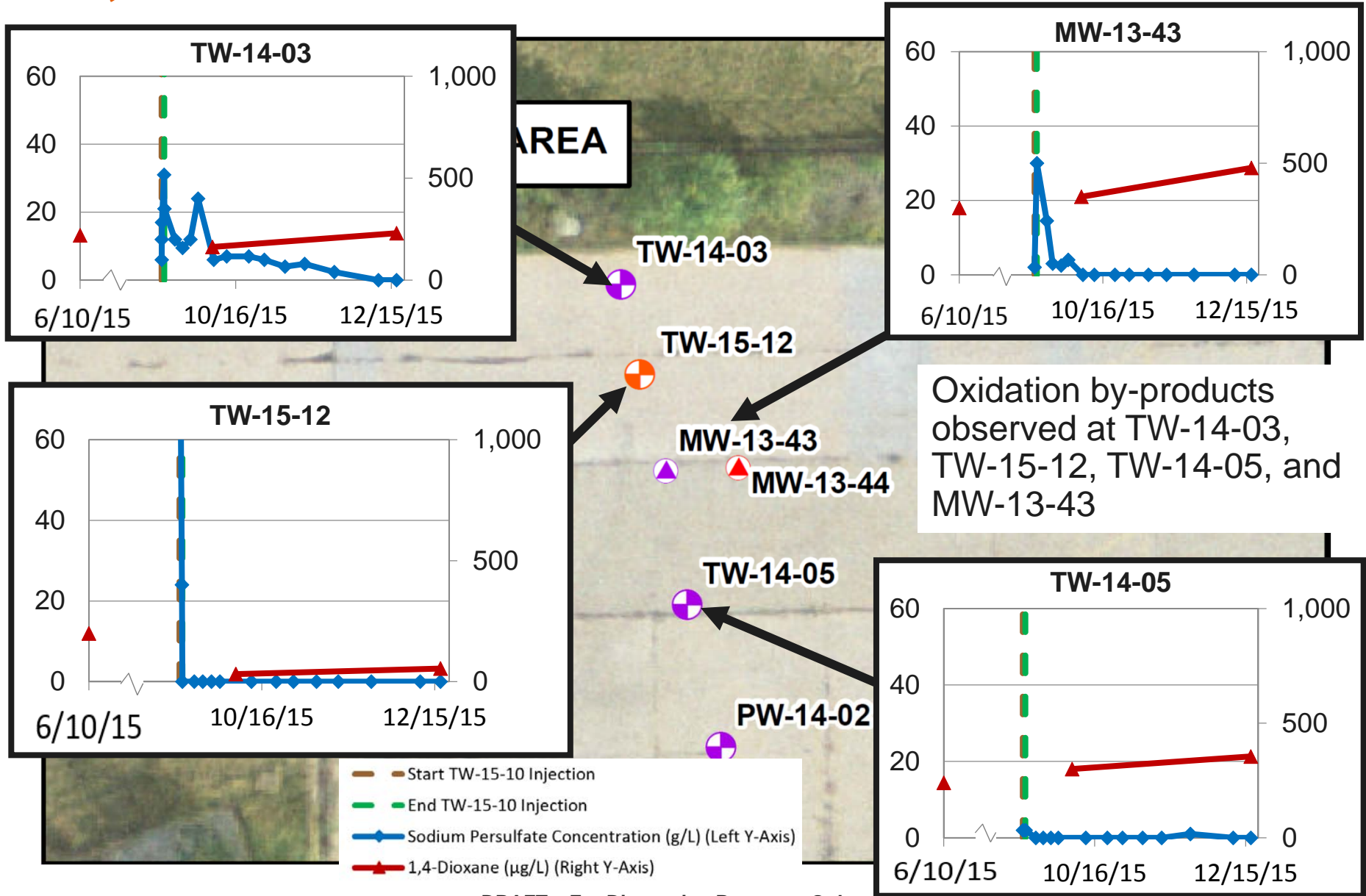
Tracer and Oxidant – Plant 2



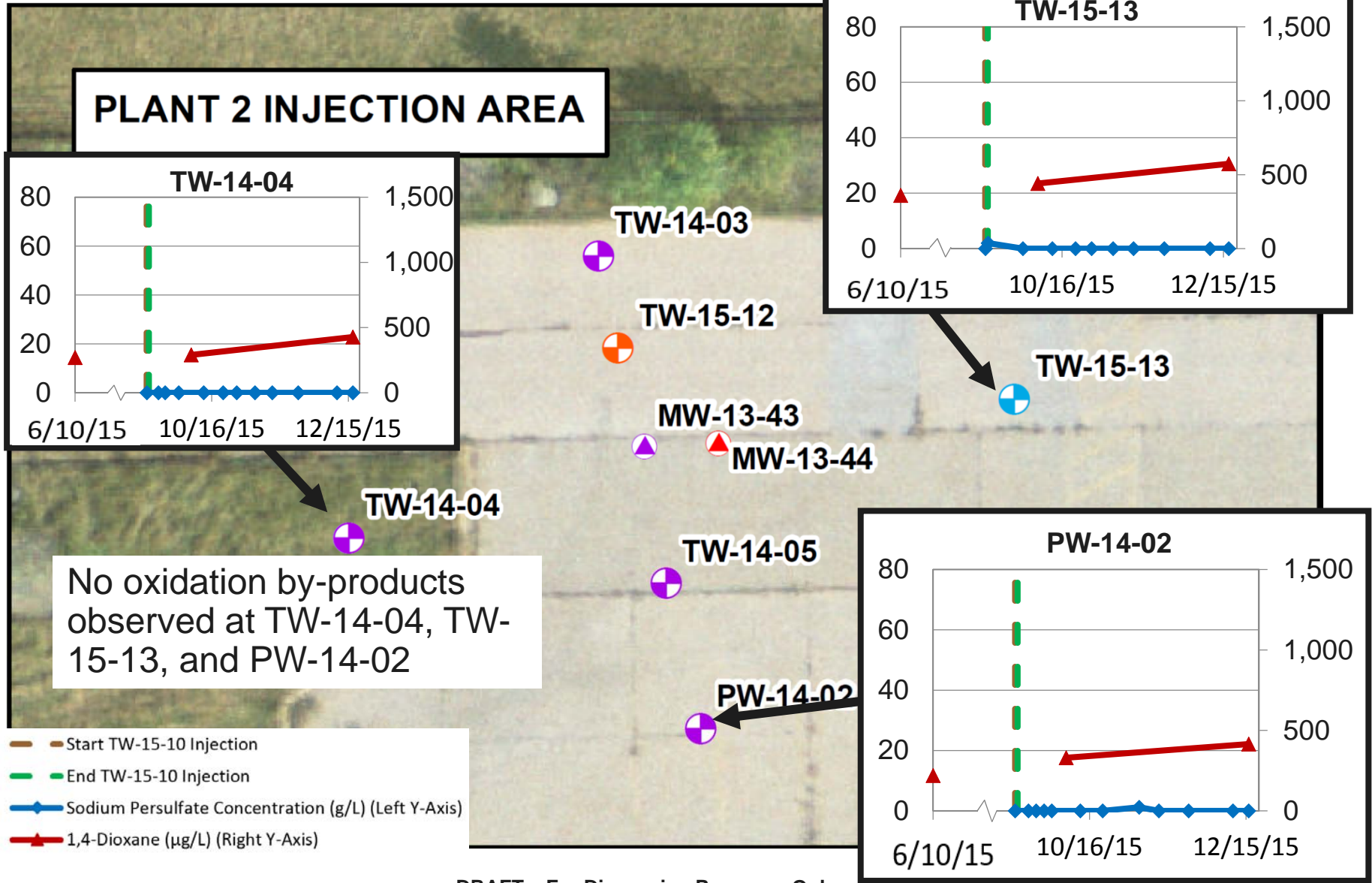
Plant 2 – Tracer Results

- Distribution and drift indicates southern component to flow
- Mobile porosity ~5.6%
 - Calculated based on volume to reach 50% of max concentrations
 - Assumption for thickness of weathered rock
- Groundwater velocity based on washout ranges from 0.5 to 2 ft/day
- Sustained tracer concentrations:
 - Pushed tracer into storage fraction of weathered bedrock, slowing moving out
 - Mounding into overlaying till, slowly dissipating

1,4 Dioxane Results – Plant 2



1,4- Dioxane Results – Plant 2



Plant 2 – ISCO Results

- Ambient activated sodium persulfate can reduce 1,4-D concentrations with adequate oxidant strength and persistence
- Working strength oxidant in injection and dose response well, not observed in drift wells
- Increases in 1,4-dioxane not as substantial as in Plant 3:
 - Further from the source?
 - Less saturated till?
 - Less storage in shale vs. sandstone?
- Oxidation by-products were generated where oxidant was present
 - No exceedances of DW

Plant 2 – ISCO Results

- TW-15-12 (injection well)
 - Chloroethane (1 ug/L) and 1,1-DCA (9 ug/L) in baseline sample
 - 1,1- DCE (11 ug/L, exceeds DW standard), 1,1,1-TCA (5 ug/L), and TCE (3 ug/L) present post injection
 - Displaced from storage fraction by injection
 - Mobilized by mounding
- Arsenic, chromium, and lead exceed DW
 - Based on experience, expected to return to pre-injection levels after geochemical conditions return to baseline within a year post injection
 - Most downgradient well (PW-14-02) does not exceed DW
 - Will continue to monitor metals in the treatment area during routine monitoring events

Full Scale Remedy Implications

- Define remedial objectives
- High concentration of oxidant to ensure contact and persistence required to treat mobile and stored mass
- Tightly spaced injection wells
- Injection pressures need to align with objectives:
 - Plume management
 - Source treatment
- Multiple injections for rebound

Lower 1,4-Dioxane Toe Investigation

Scope of Work

Additional work was completed to evaluate the 1,4-dioxane concentration detected at TW-14-02.

Objectives:

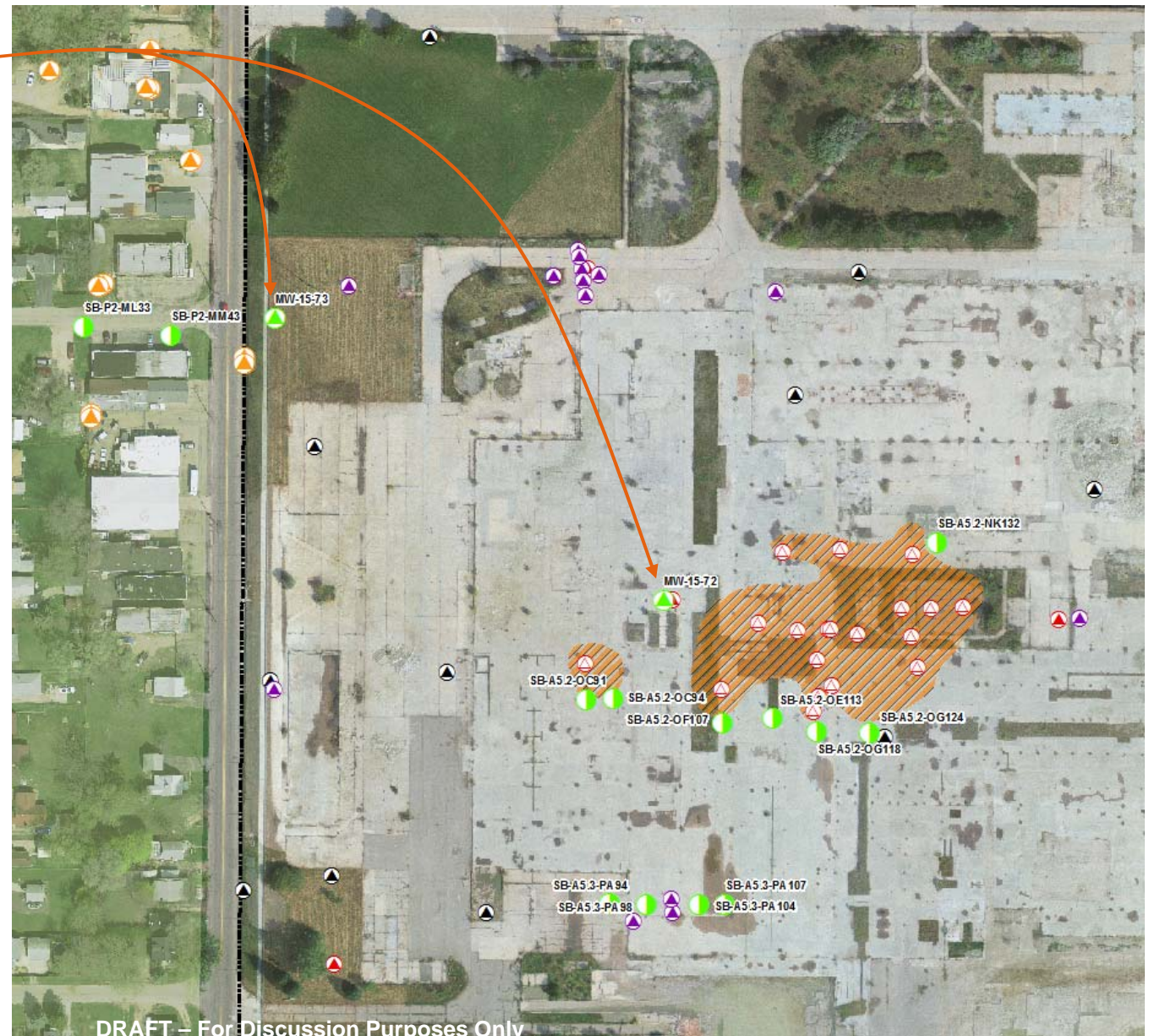
1. Further characterize the variability of 1,4-dioxane concentrations within the core of the lower 1,4-dioxane plume near TW-14-02
2. Evaluate if an off-site source or the on-site perched plume is contributing to the lower plume
3. Delineate the extent of 1,4-dioxane west of MW-13-42, and potential deep impacts associated with the former APC
4. Verify continuity of the plume from north to south across Plant 2 between PW-14-02 and PW-14-01

Scope of Work cont.

Installed 2 deep weathered bedrock monitoring wells

Completed 13 deep sonic borings:

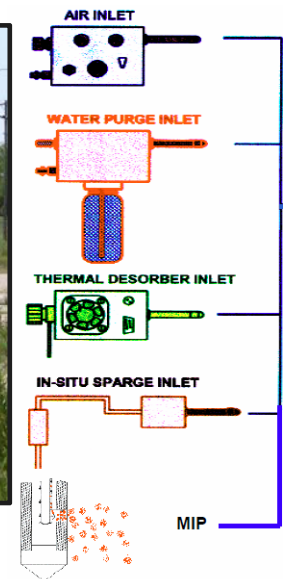
- WCSS at 3' intervals
- VAP sampling in weathered bedrock at 2 intervals
- On-site evaluation of 1,4-dioxane using DSITMS Method 8265
- ~5% samples split to Merit for 1,4-dioxane using Method 8260



On-Site Lab Results

On-site Laboratory (Triad ES):

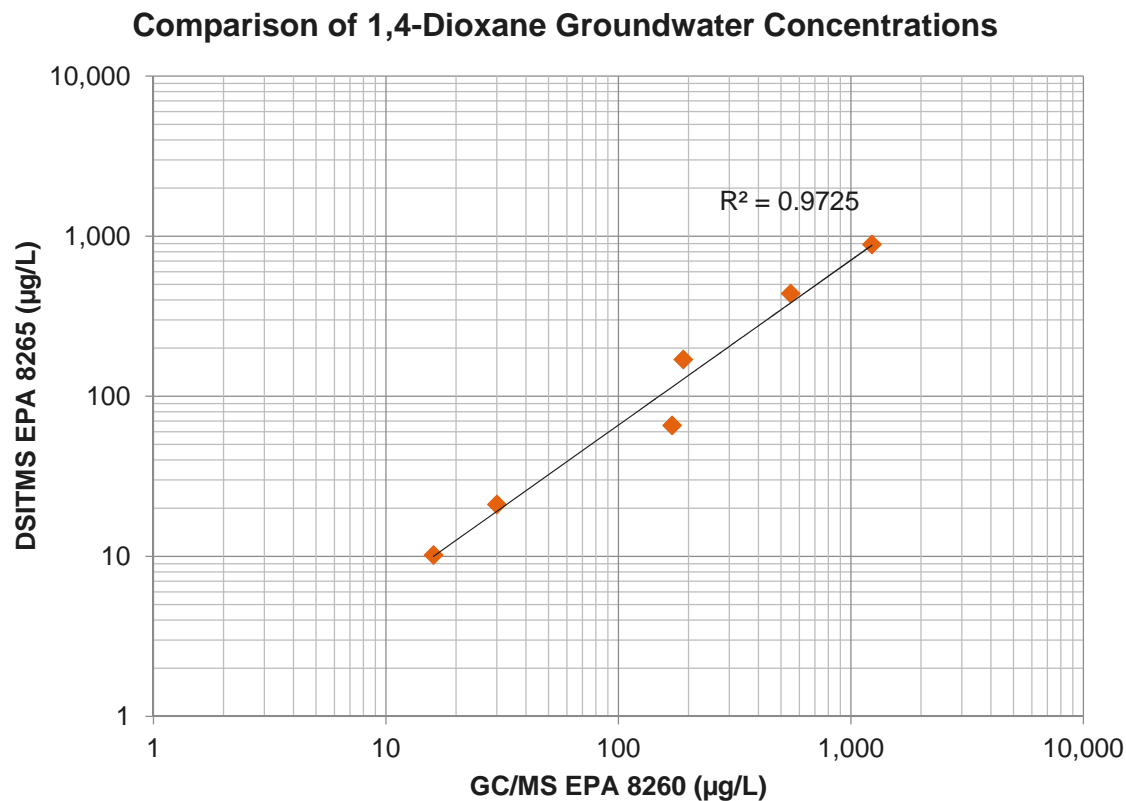
- USEPA 8265 (DSITMS)
- On this mobilization the DL for 1,4-dioxane in soil: 40 µg/Kg
- DL for 1,4-dioxane in groundwater: 20 µg/L
- Split samples sent to Merit Laboratories



Comparison of Groundwater Analytical Methods

Good agreement between the methods

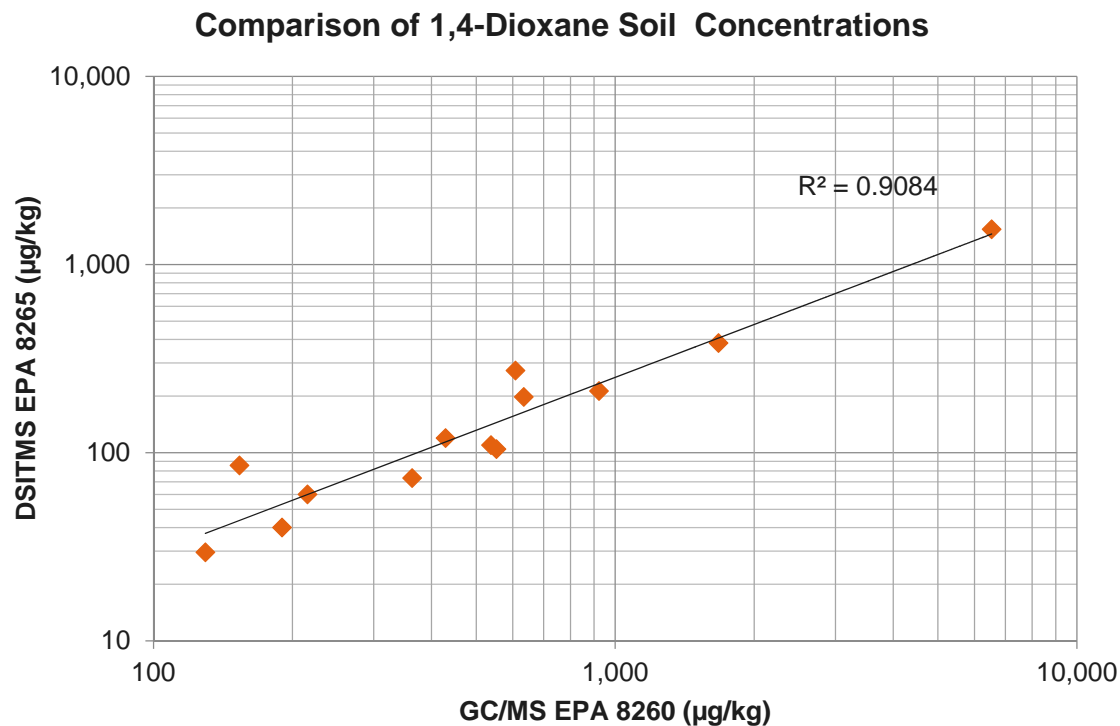
- DSITMS reliable indicator of 1,4-dioxane in groundwater
 - Bias slightly low for groundwater (~50%)



Comparison of Soil Analytical Methods

DSITMS reliable indicator of 1,4-dioxane in soil

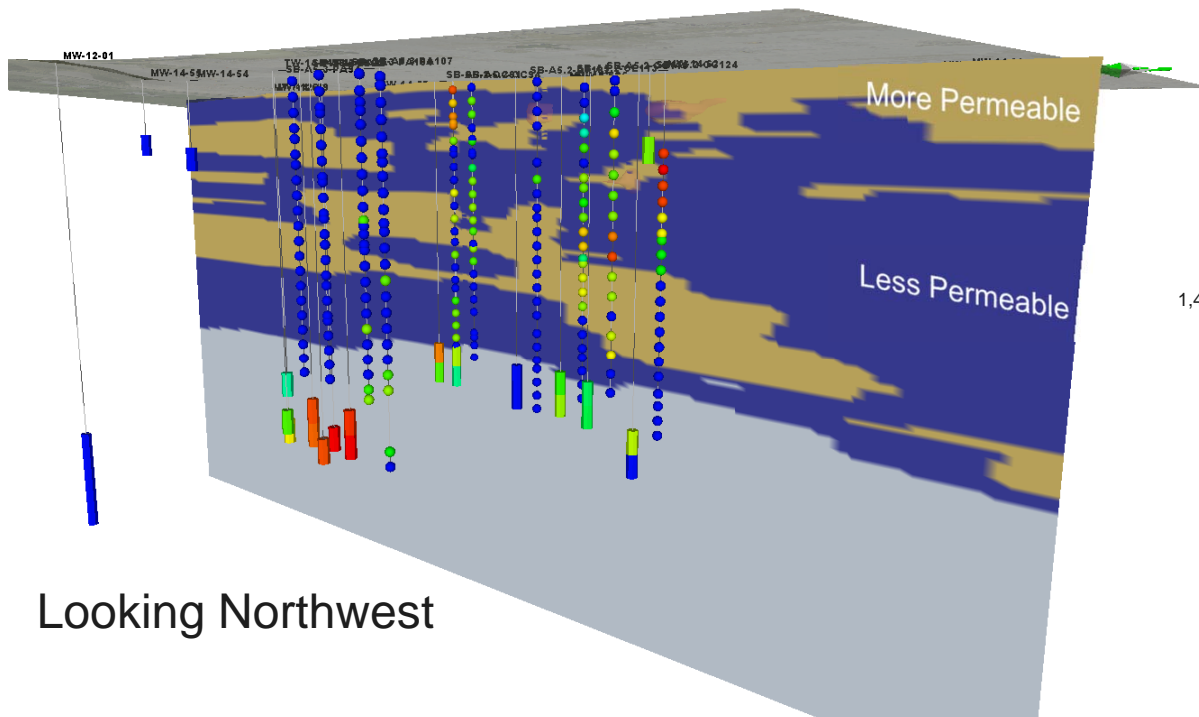
- Biased low for soil by a about a factor of ~3X
- Effects of continued extraction were not significant



Investigation Results

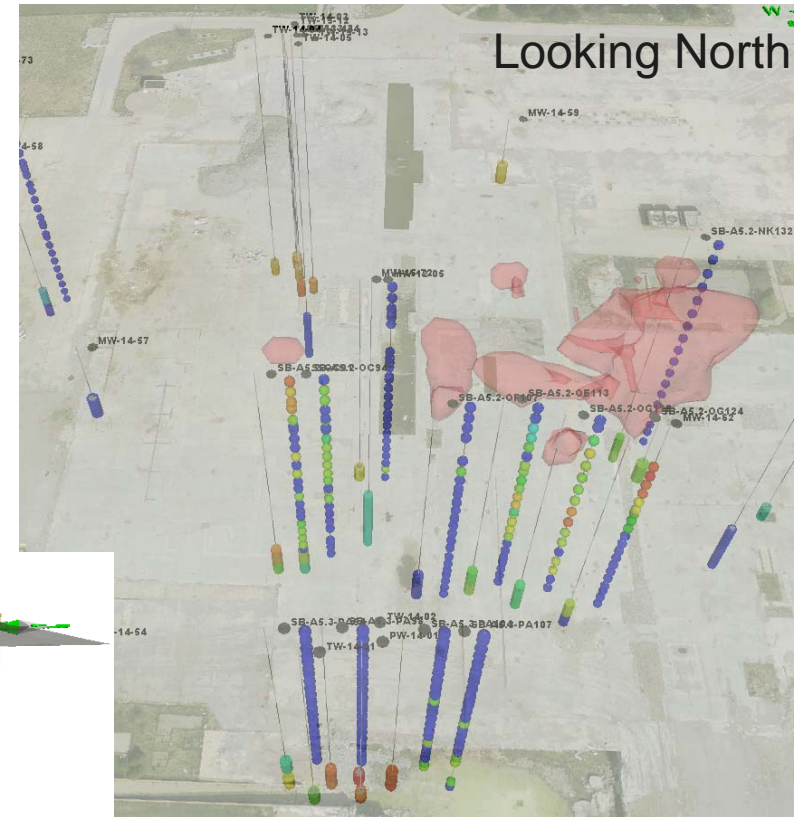
Hydrostratigraphic Model

Analytical Model

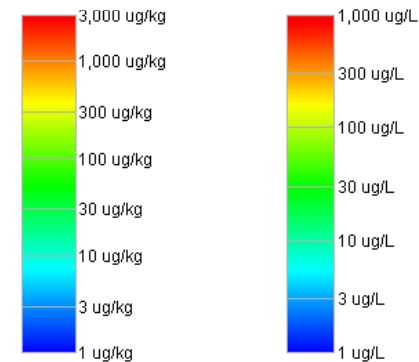


Looking Northwest

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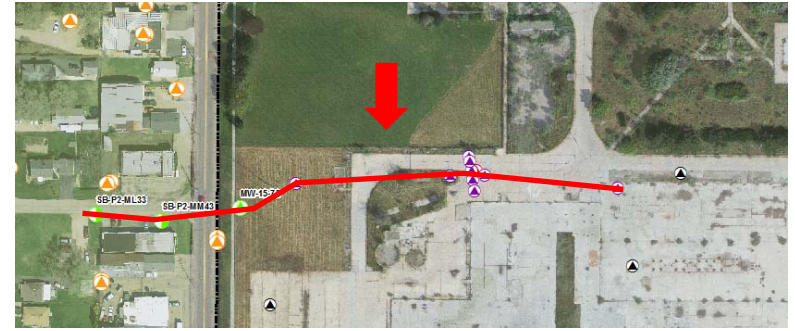


1,4-Dioxane Soil (spheres) 1,4-Dioxane Groundwater (cylinders)



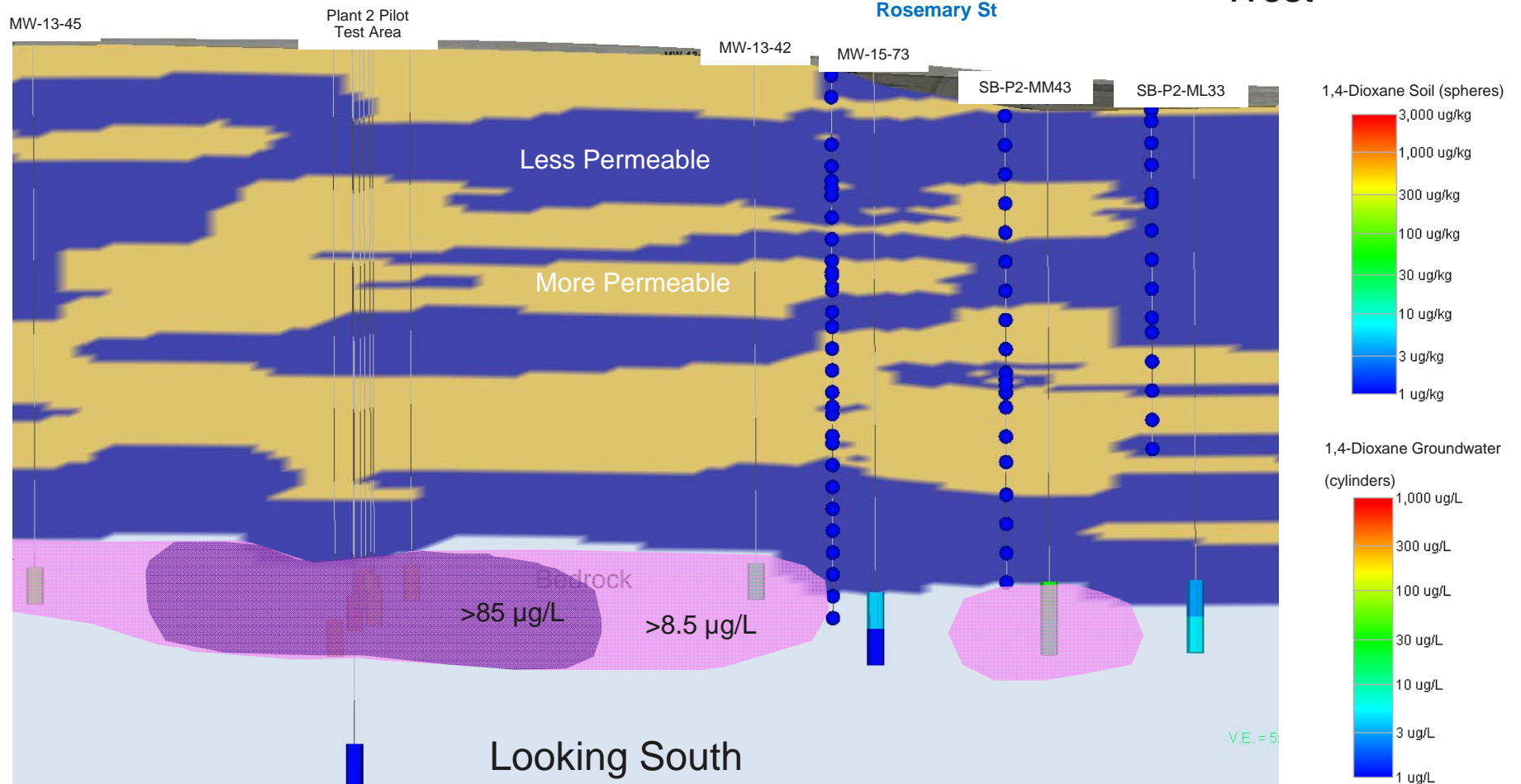
A correction value of 3x has been applied to all soil samples based on correlations between mobile and fixed laboratory split sample results

Northern Plant 2 and Off-site Borings



East

West



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Lower 1,4-Dioxane Toe Investigation Summary

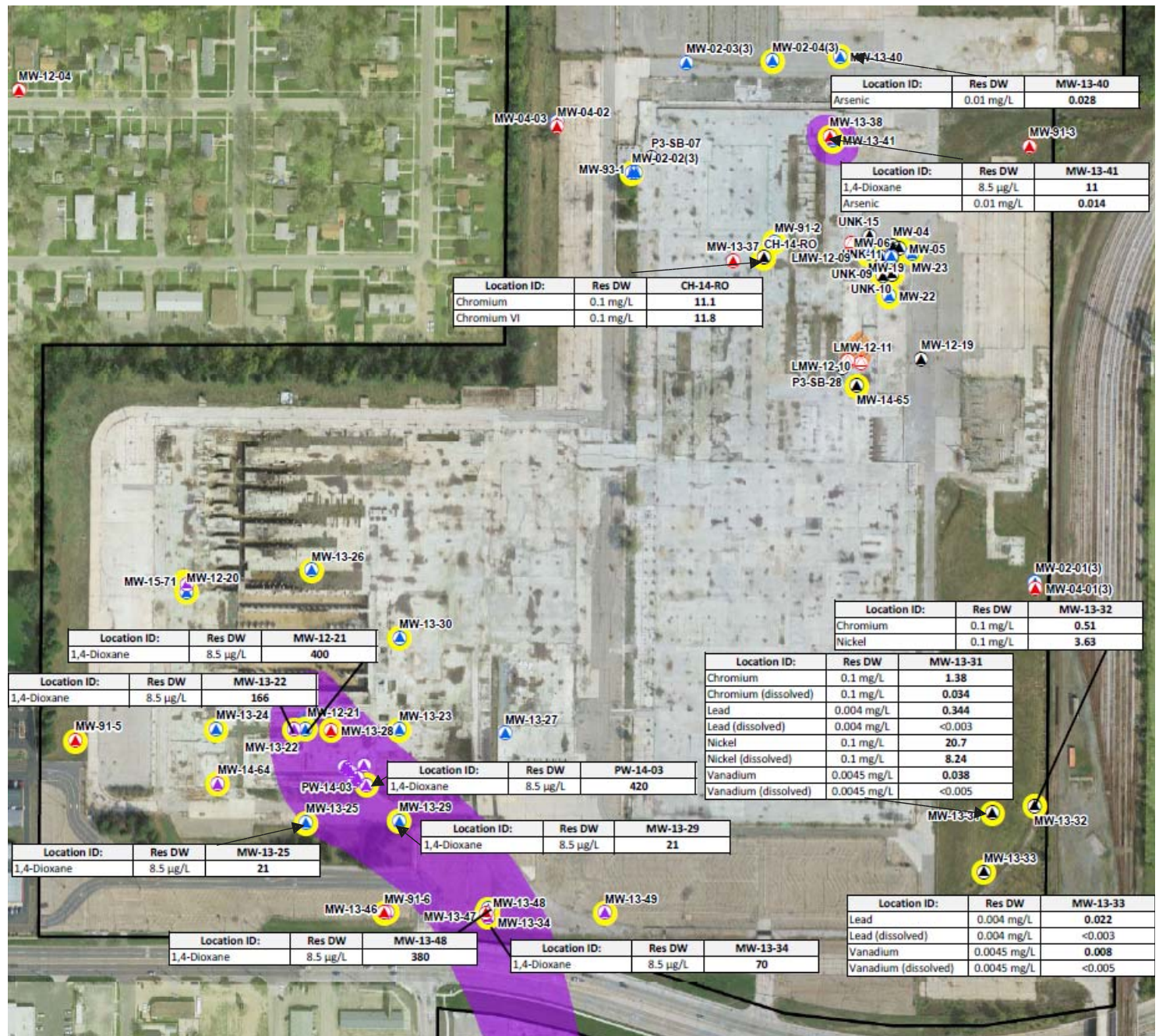
- Concentration of 1,4-dioxane in core of the plume is variable and characterized by higher concentrations of 1,4-dioxane in narrow zones
- The results of the investigation suggest that some 1,4-dioxane migrates from the perched zone to the lower zone, or has in the past
 - Contribution may be minor relative to the core migrating south from Plant 3
- There is an indication the former APC may contribute 1,4-dioxane to the weathered bedrock impacts
- Initial sampling at the MW-13-42 replacement well (aka MW-15-73) indicated 1,4-dioxane below 8.5 µg/L
- The nested well adjacent to well MW-12-05 (aka MW-15-72) indicates a concentration of 1,4-dioxane generally consistent with the core of the plume.

Fourth Quarter 2015 Groundwater Sampling Event

Plant 3 Results

Results generally consistent with previous

- Elevated concentrations of nickel in Area 16

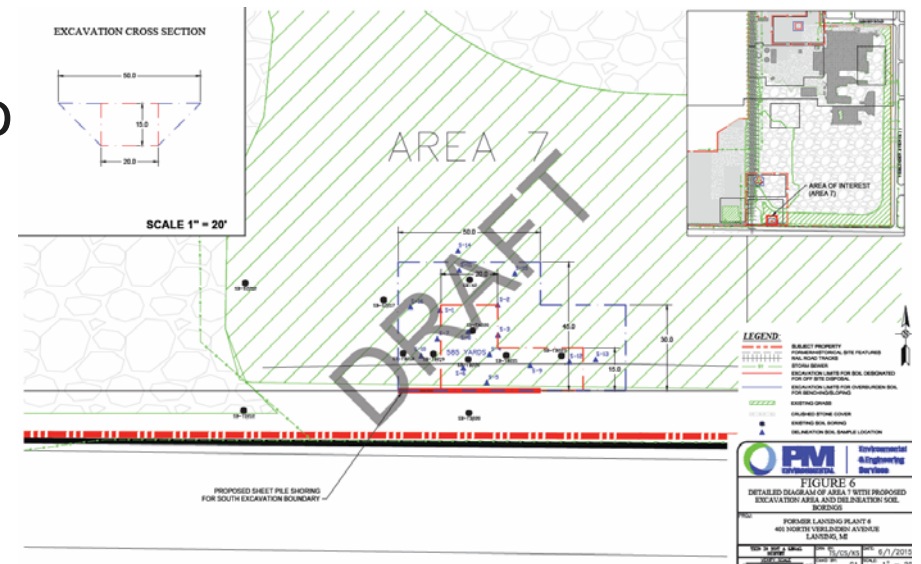


Plant 6 Excavations

Area 7

Excavation is complete

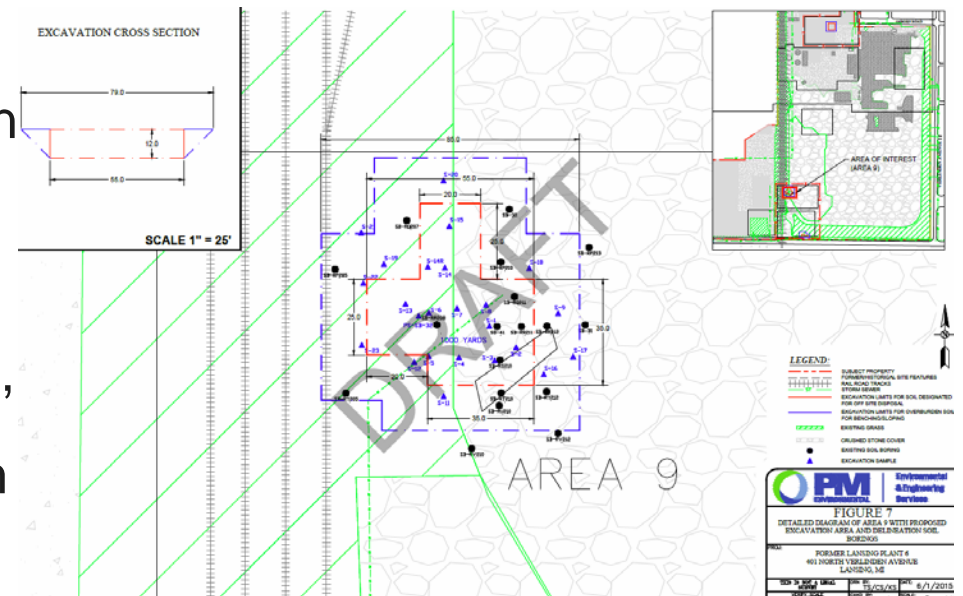
- A concrete slab was present along the floor of most of the excavation limiting the depth to 11.0-12.0 feet below grade surface (bgs)
- Floor samples were collected at gaps in the concrete slab
- Final seeding and erosion control is needed



Area 9

Excavation and restoration is complete

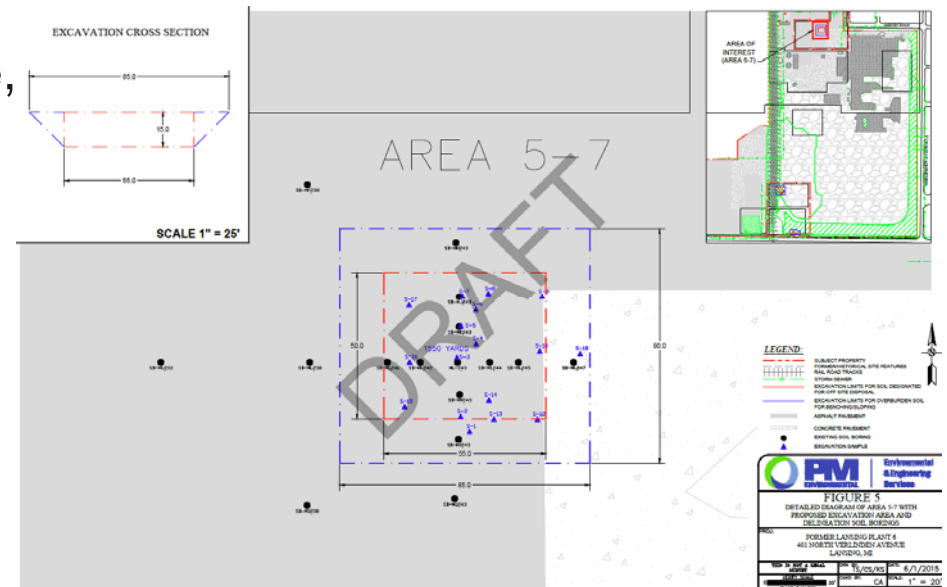
- Excavation encountered multiple 6 to 8-inch unknown pipes which introduced water into the excavation
- Concrete bulkheads in the manholes upstream and downstream of the excavation within the 36-inch storm sewer pipe, and a clay plug across the 36-inch storm sewer corridor upstream from the excavation area were needed to help manage storm water
- The excavation needed to be dewatered after initial removal of most of the impacted soils



Area 5-7

Excavation and restoration is complete.

- Excavation encountered multiple 6-8-inch unknown pipes which introduced water into the excavation area
- All pipes were capped using concrete, bentonite and expandable foam
- Rain and snow events introduced water into the excavation
- Efforts were made to keep the excavation dewatered during excavation
- Impacted soils were too saturated to truck offsite; therefore, lime kiln dust was mixed with the stockpiled soil to allow for loading, transportation and disposal



Next Steps



- Continue metals monitoring in tracer study wells to verify reducing concentrations of metals
- Refine the conceptual design and cost estimates for remedial alternatives for the lower 1,4-dioxane plume
 - If necessary, identify and evaluate alternate technologies that may be viable and any additional data needs
- Refine the conceptual design and cost estimates for remedial alternatives for the Plant 2 LNAPL
 - Evaluate need for additional Plant 2 source characterization
- Evaluate need for further characterization of the lower 1,4-dioxane impacts.
 - Vertical migration at Plant 2 from the perched zone to the weathered bedrock
 - Fate/transport, stability of the lower 1,4-dioxane plume
- Evaluate need and possible scope for additional characterization of the APC impacts to verify off-site deep impacts are not related to RACER

Schedule 2016

First Quarter 2016

- Tracer Study Memo
- Lower 1,4-Dioxane Investigation Memo
- Fourth Groundwater Monitoring Report
- First Quarter Groundwater Sampling Event

Second Quarter 2016

- Annual Groundwater Monitoring Report
- Plant 6 – Targeted Excavation Summary Report