Air Force Civil Engineer Center

Integrity - Service - Excellence

FORMER
WILLIAMS AIR FORCE BASE

Site ST012
Former Liquid Fuels Storage Area Remedial Action

BRAC Cleanup Team Call
21 April 2016

Site ST012 Update

- Site Operations Update
- Annual Groundwater Monitoring Results
- EBR Status Update

ED_005025_00006126-00002

Steam Enhanced Extraction (SEE) System Operational Status Overview

ED_005025_00006126-00003

Site ST012 SEE System Status Summary (through 18 April)

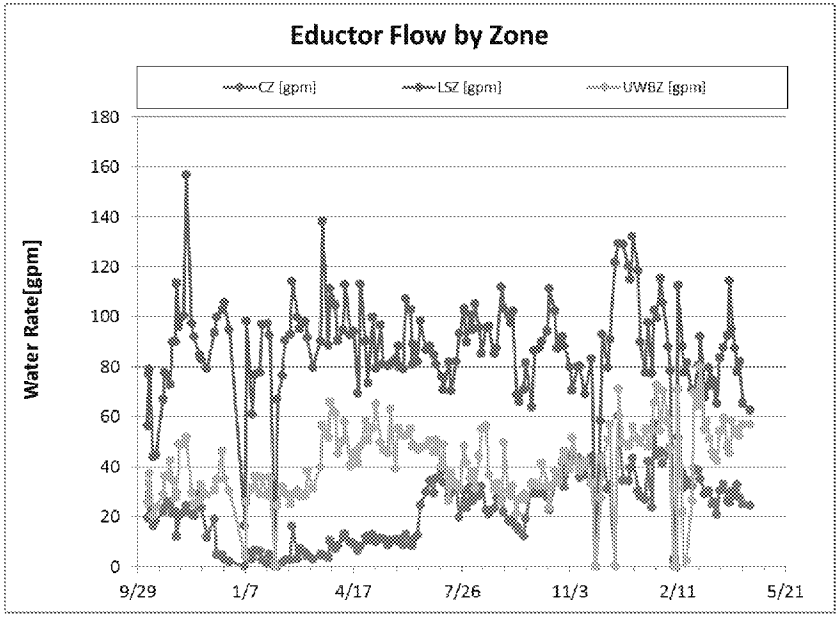
	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft^2)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	04/18/16	
Last Temperature Data Update	04/18/16	
Estimated Total Days of Operation	422	days
Days of Operation	567	days
Days of Operation vs. Estimate	134	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	5,906,273	kWh
Used Electrical Energy vs. Estimate	52	%
Total Steam Injected	302.4	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	94	%
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	1,201,544	lbs
Total Mass Removed as NAPL	1,391,026	lbs
Average Daily NAPL Mass Removal Last Week	132	lbs/day
Total Vapor and Liquid Mass Removal (based on PID readings)	2,592,570	lbs
Average Power Usage Rate Last Week	467	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last	380	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	0.2	gallons per minute (gpm)
Average Water Extraction Rate Last Week	145	gpm
Total Water Extracted	93,608,046	gallons
Total Recovered Light Non-Aqueous Phase Liquid	211,724	gallons
Average Water Discharge Rate Last Week	174	gpm
Total Treated Water Discharge	123,494,000	gallons

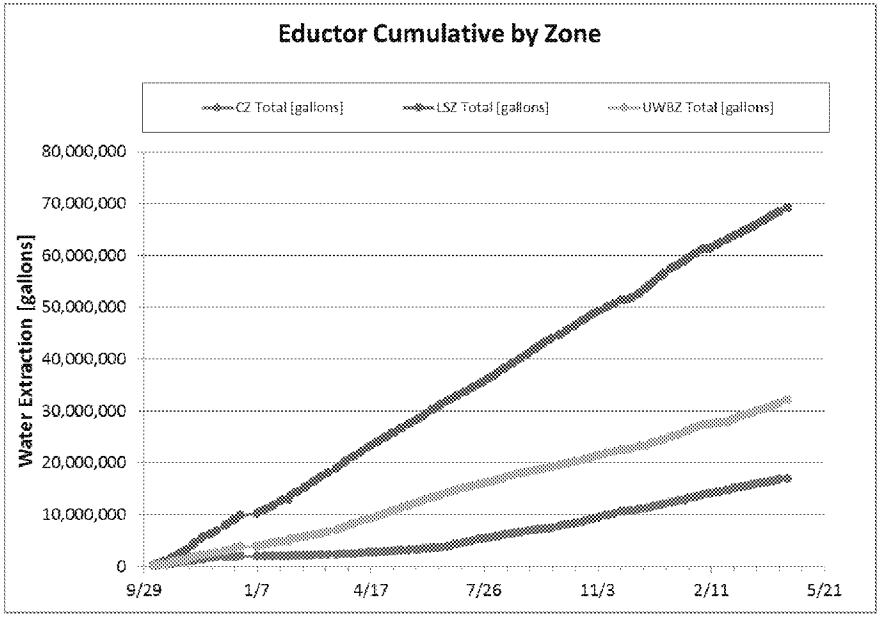
ST012 SEE Operational Progress

- **SEE System Operations** **04 March – 18 April**
  - **A site-wide depressurization was initiated 04 March 2016**
  - **Average liquid extraction rate of 146 gpm**
  - **Typically all six eductor skids were online at a time**

ED_005025_00006126-00005

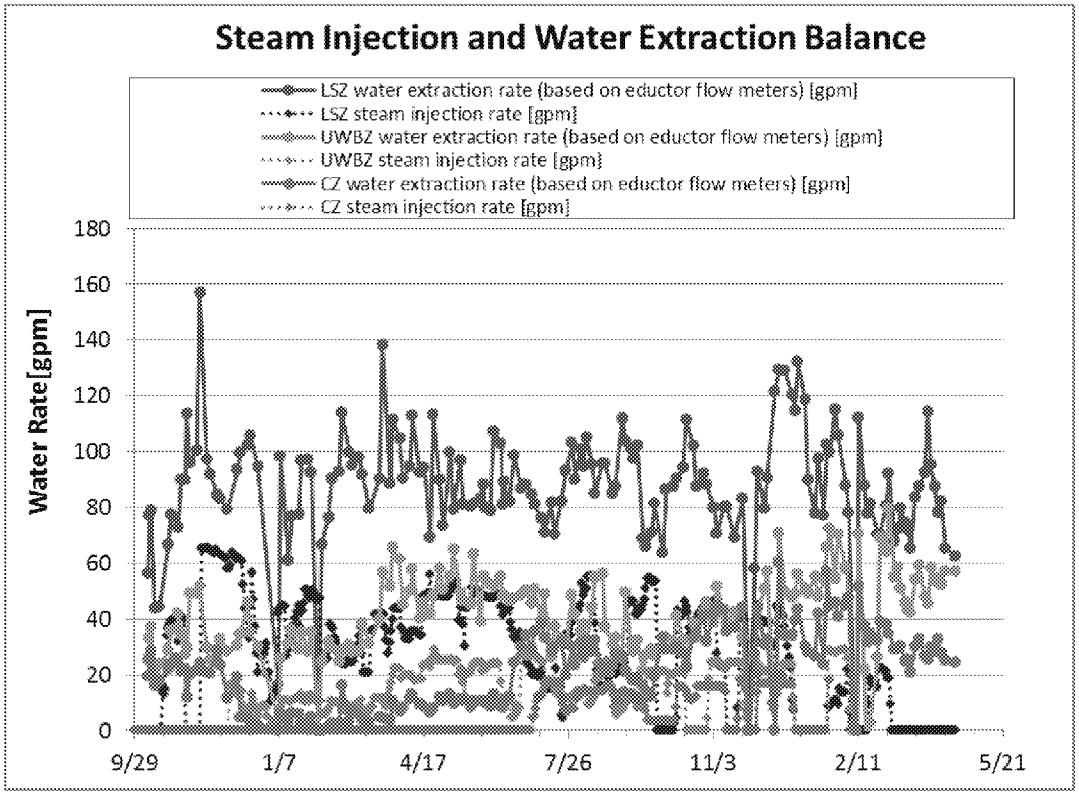
Site ST012 SEE System Water Extraction by Zone





- **Eductor extraction rates per zone are based on individual eductor feed and return meters**

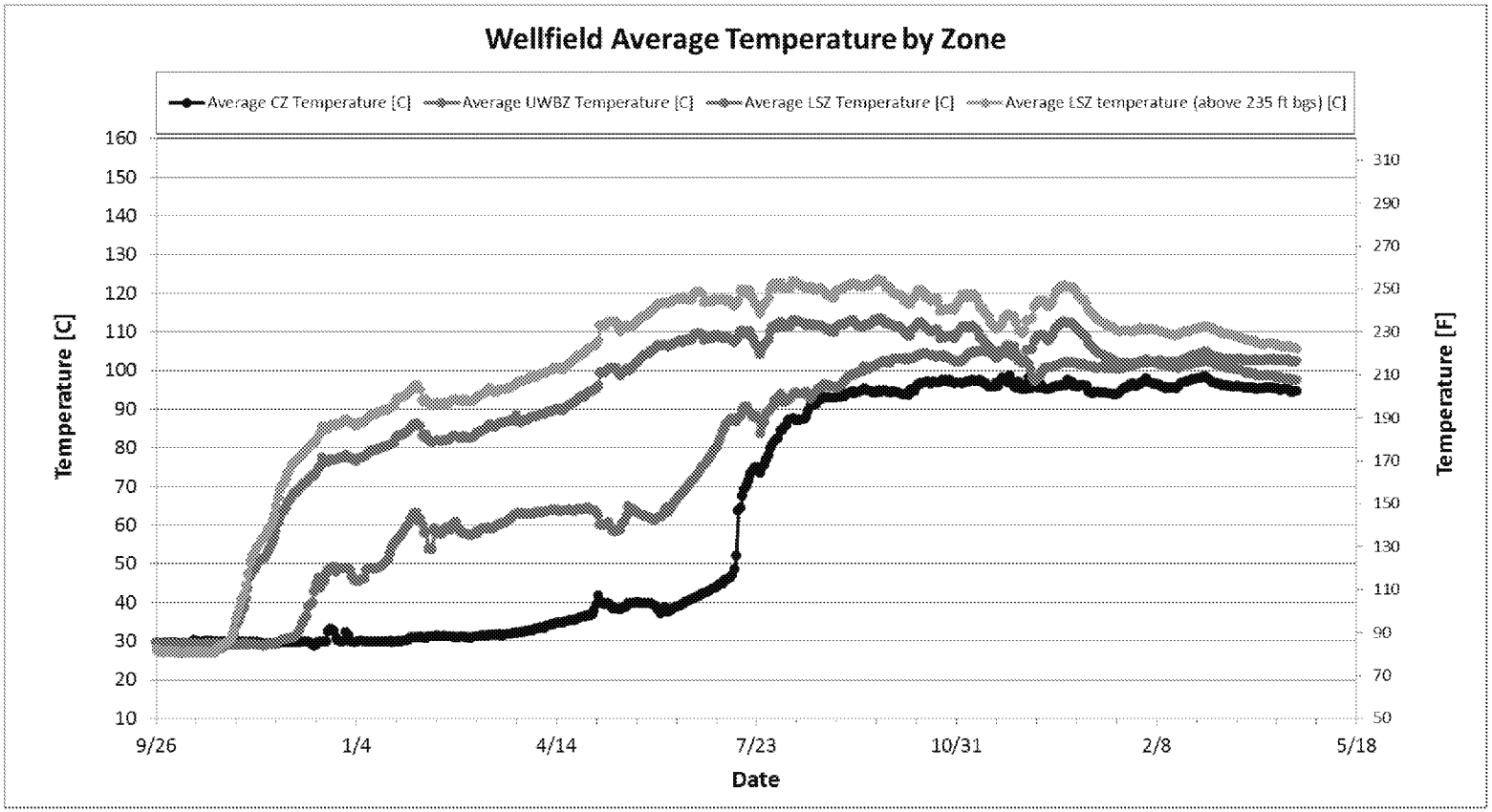
Site ST012 SEE System Injection/Extraction Balance



	CZ [gallons]	UWBZ [gallons]	LSZ [gallons]
Water extracted to date	16,954,000	32,097,000	69,108,000
Water injected to date	3,885,000	9,890,000	22,542,000
Net extraction	13,069,000	22,207,000	46,566,000

Note: water extracted to date per zone is based on individual eductor meters

Average Soil Temperatures



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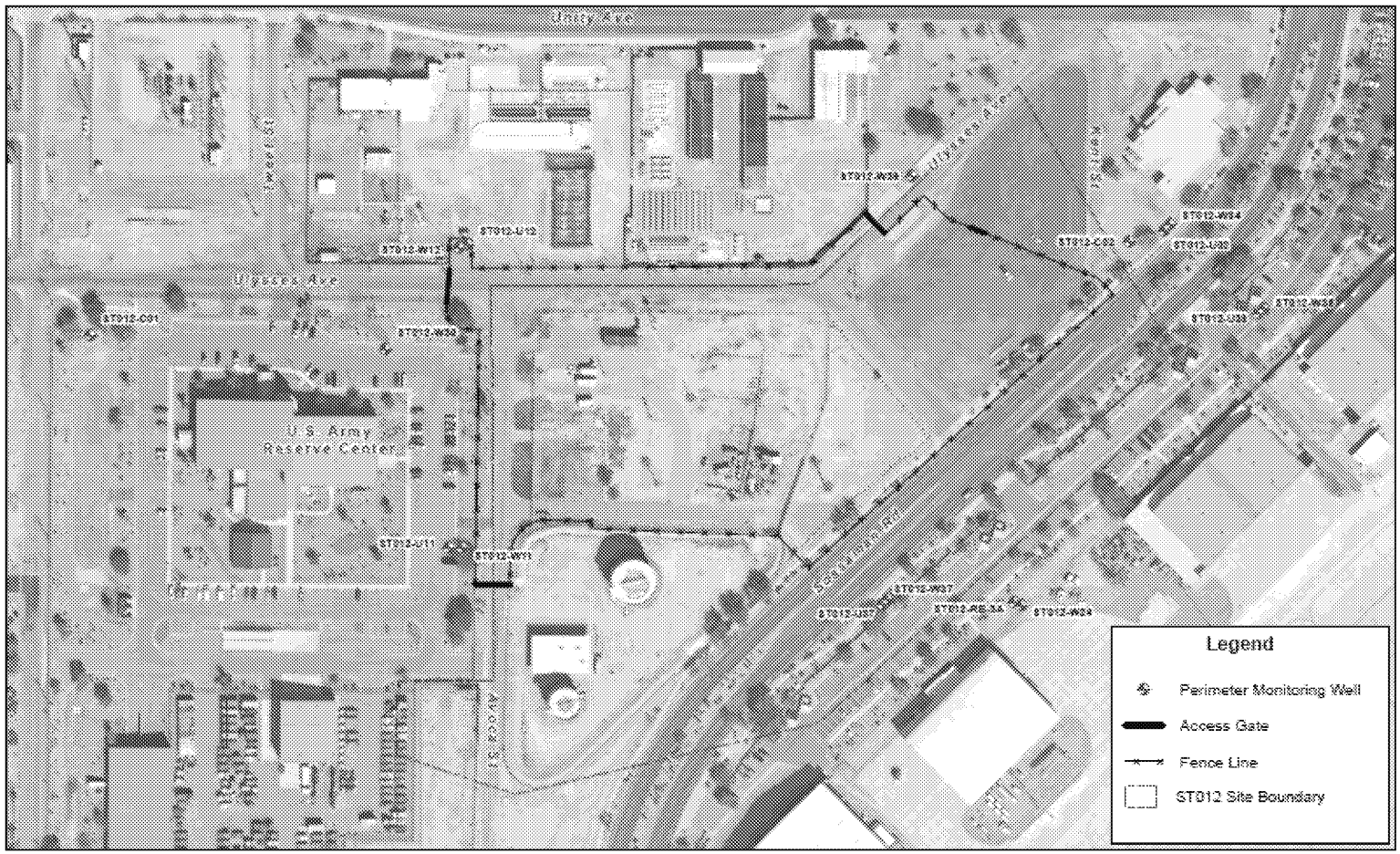
ST012 Perimeter Groundwater Monitoring

Site ST012 SEE Perimeter Groundwater Monitoring Wells



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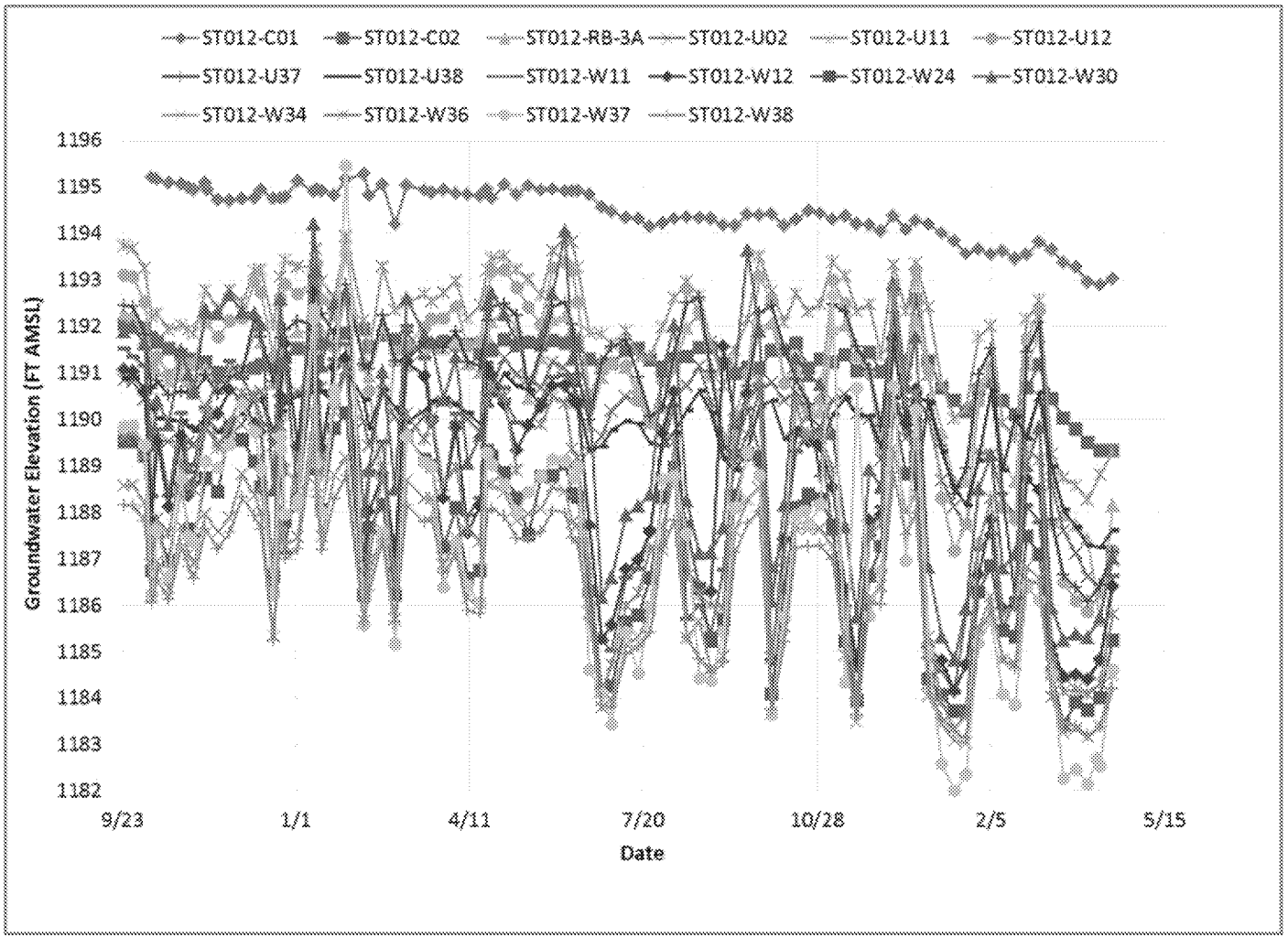
Site ST012 SEE Perimeter Groundwater Elevations



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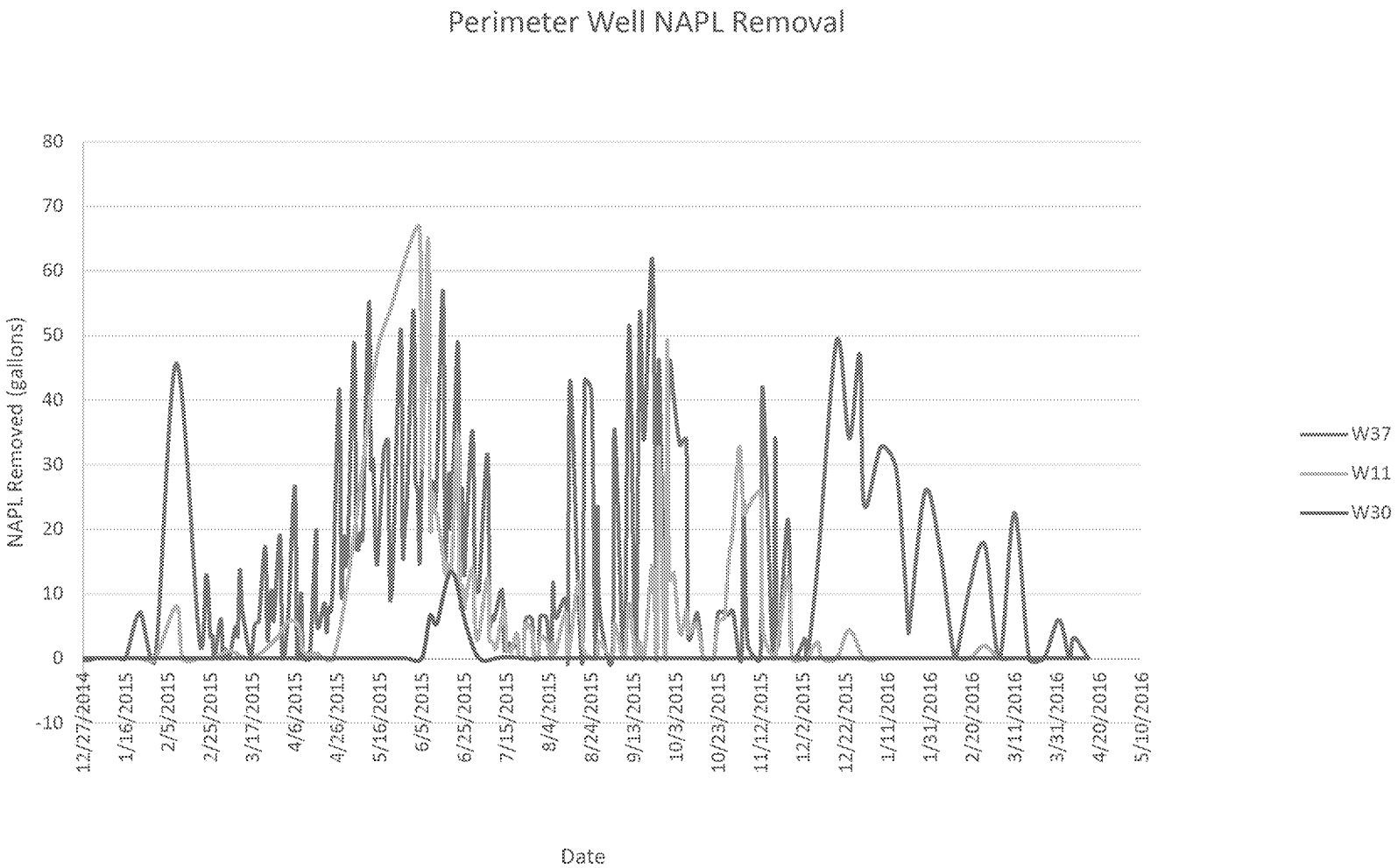
Site ST012 SEE Perimeter LNAPL



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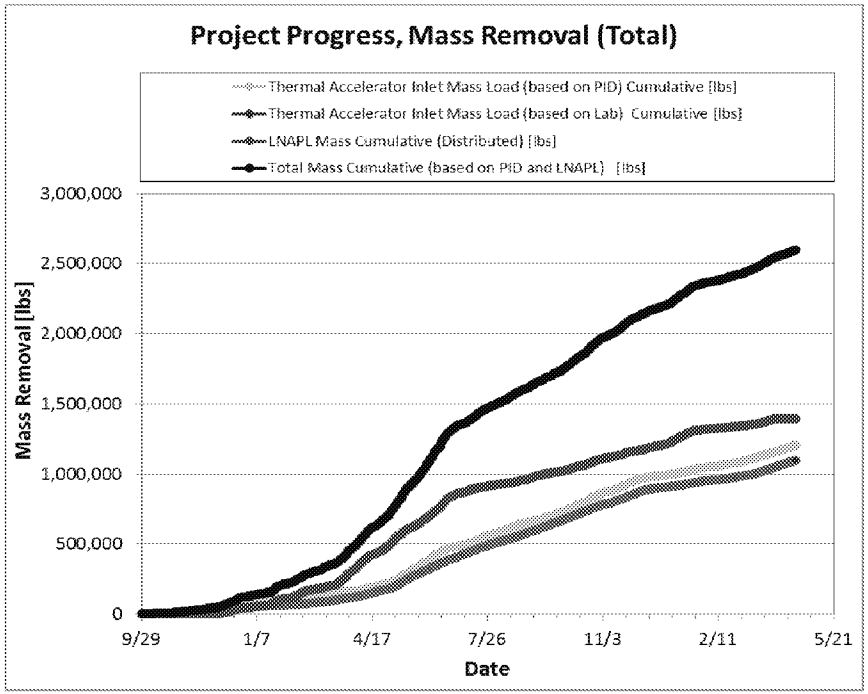
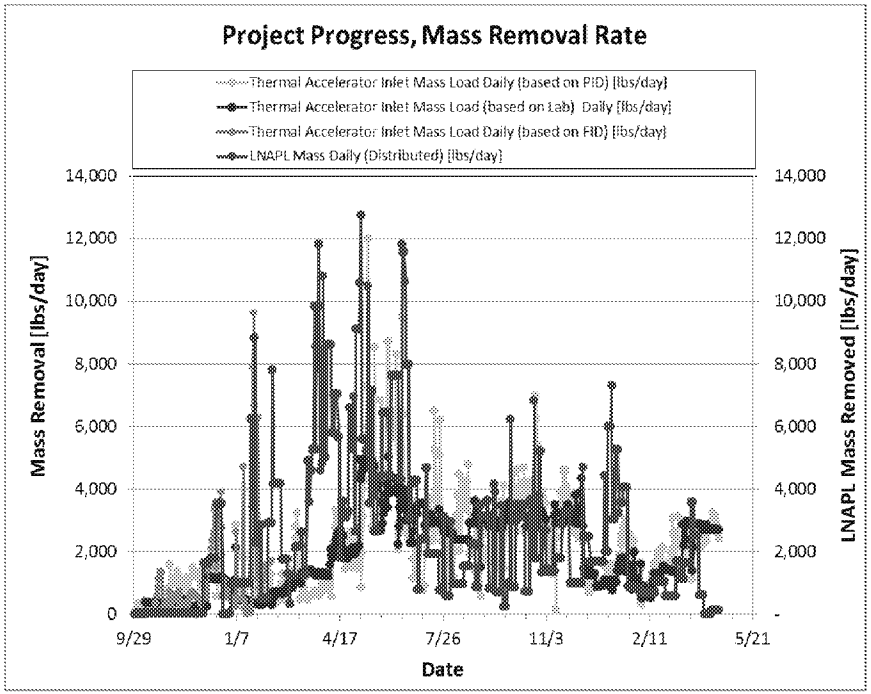
Mass Removal

ED_005025_00006126-00013

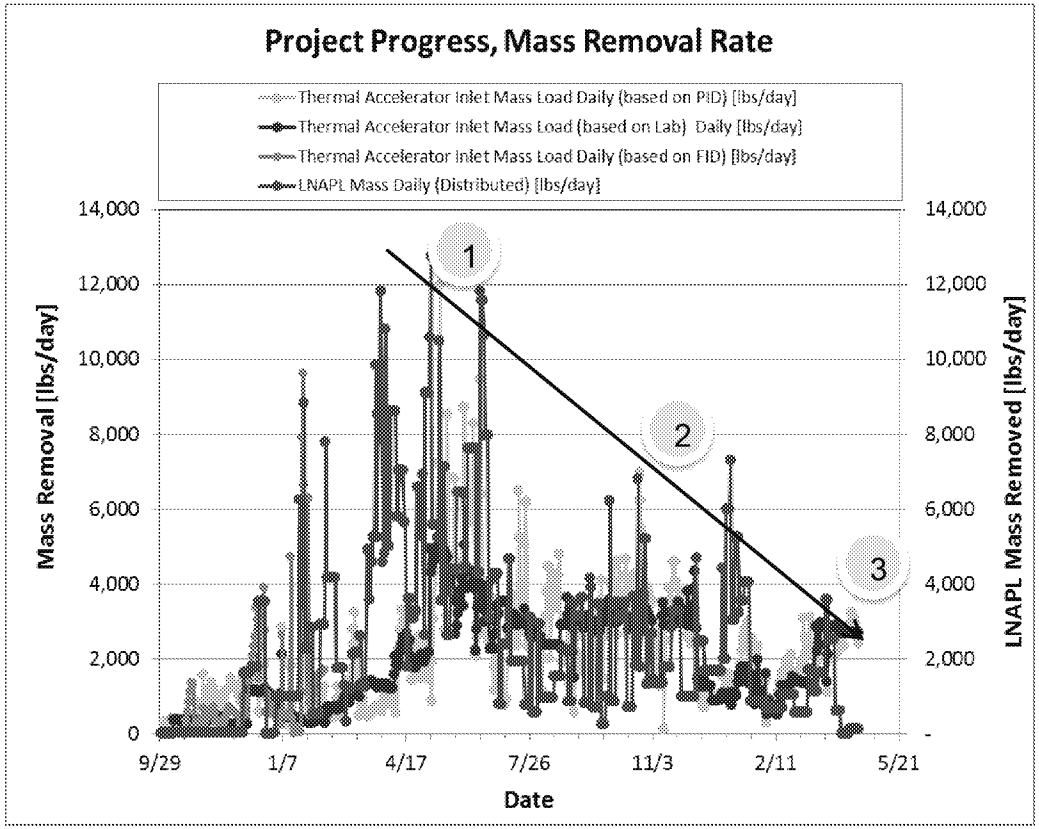
Site ST012 SEE System Mass Removal





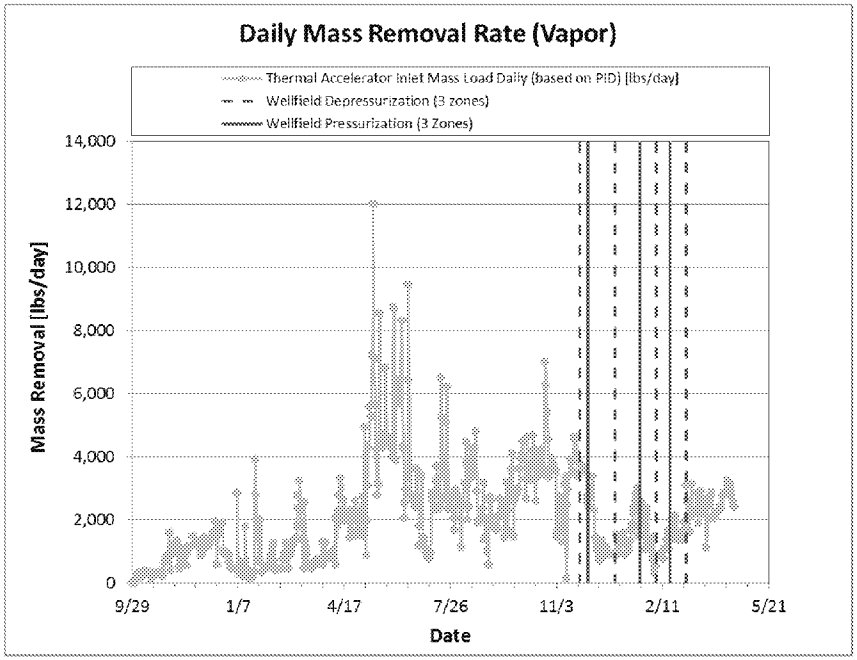
- **Total Contaminant Mass Removal: 2,592,570 lbs recovered**
- **An estimated 1,391,026 lbs (211,724 gallons) as non-aqueous phase liquid (NAPL)**
- **An estimated 1,201,544 lbs of mass (PID) removed in the vapor phase**

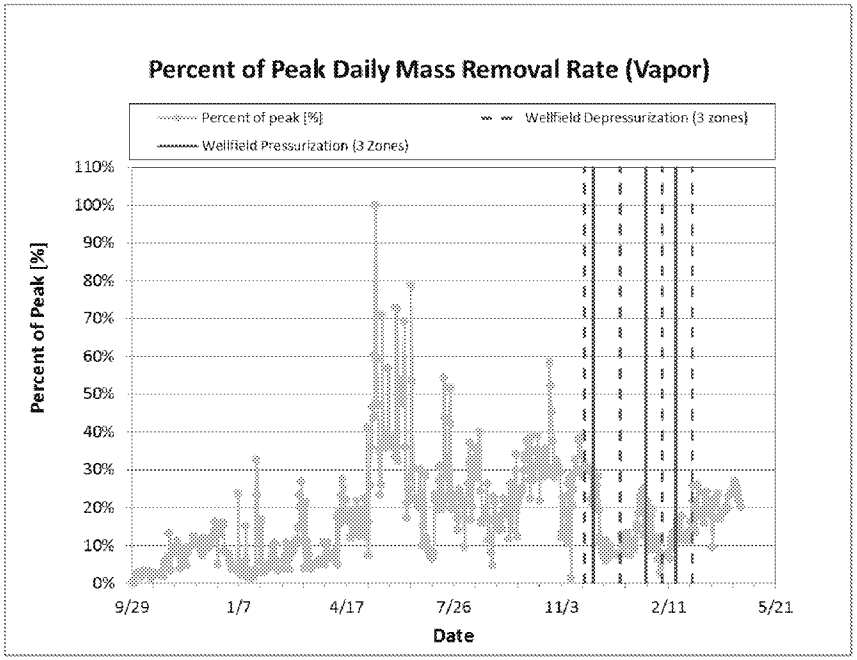
Site ST012 SEE System Mass Removal



- 1: Clear peak mass removal
- 2: Clear diminishing mass removal rate with SEE transition from LSZ to CZ/UWBZ
- 3: Clear diminishing removal rate with transition to site wide depressurization sequences

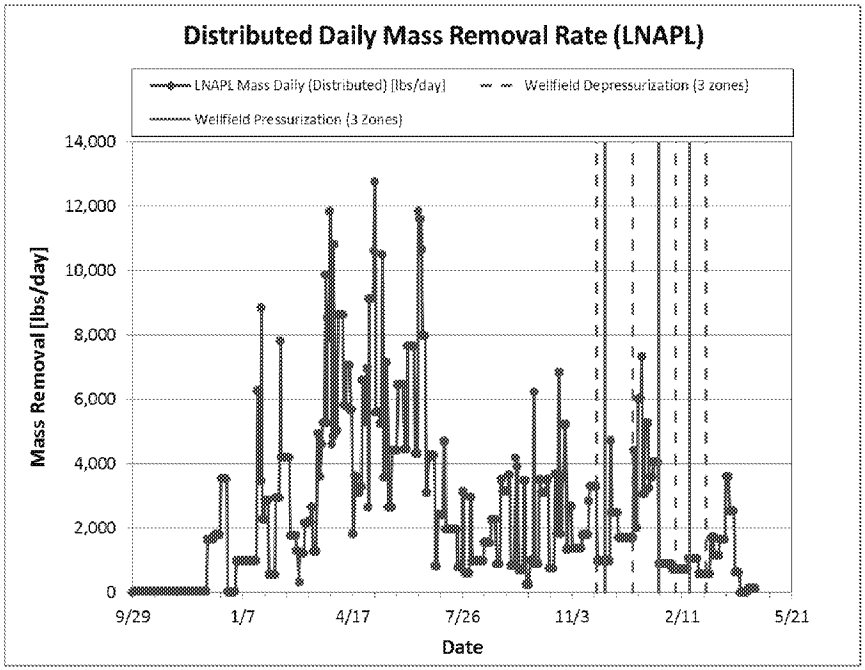
Site ST012 SEE System
Daily Mass Removal - Vapor

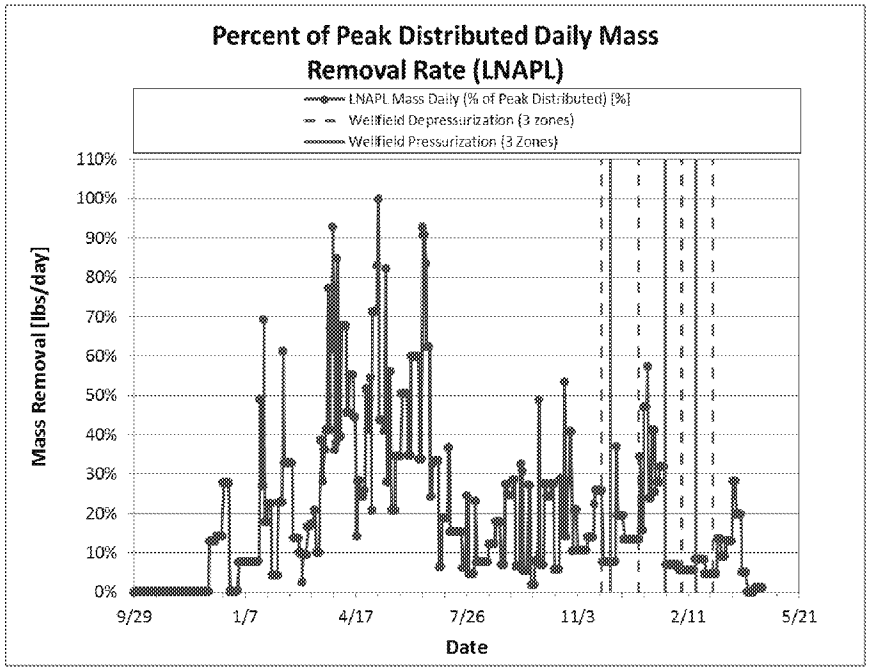




- **Daily vapor mass removal peaked on 14 May 2015 at 12,009 lbs/day**
- **Vapor mass removal rates has been varying between 9% to 27% of the peak during recent depressurization, with an average at ~21%.**

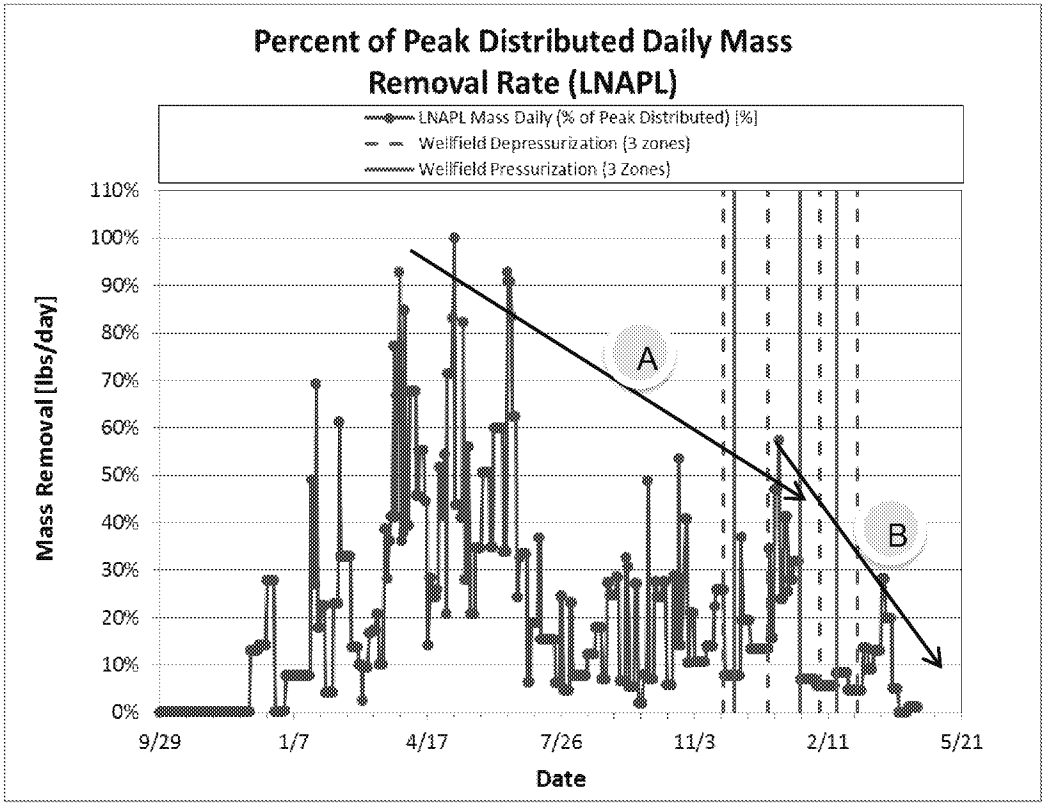
Site ST012 SEE System
Daily Mass Removal - LNAPL





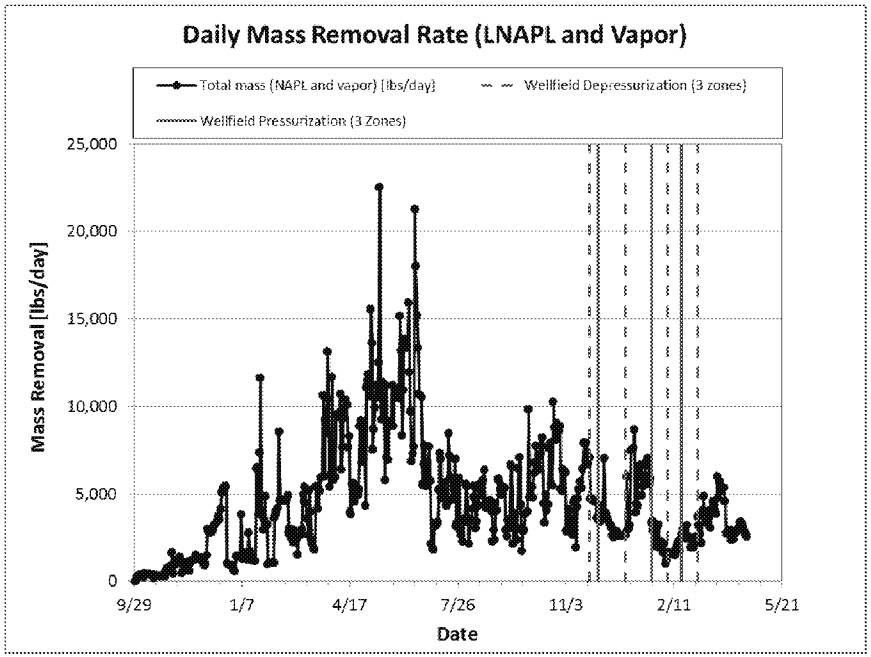
- **Daily LNAPL mass removal peaked on 05 May 2015 at 12,760 lbs/day**
- **LNAPL recovery increased up to ~28% of the peak during depressurization. The average has been 9% of peak since the depressurization was initiated.**
- **Last LNAPL transfer on 18 April 2016; estimated 130 lbs/day of LNAPL since 11 April 2016 (~1% of peak).**

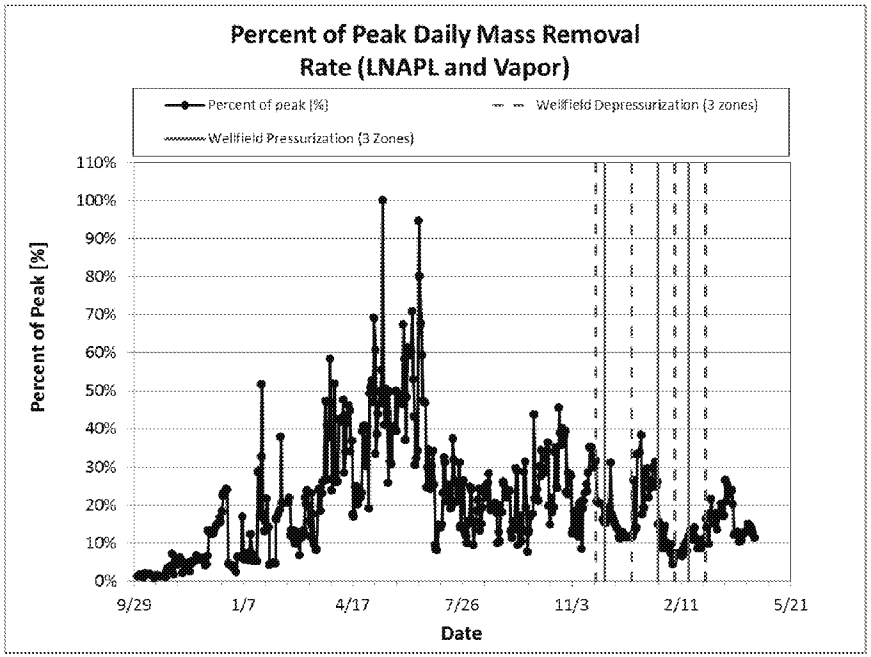
Site ST012 SEE System
Daily Mass Removal - LNAPL



- **A: Trend prior to concurrent depressurizations was a decreasing LNAPL removal rate**
- **B: Trend during concurrent depressurizations shows progressively muted removal rate and delayed response**

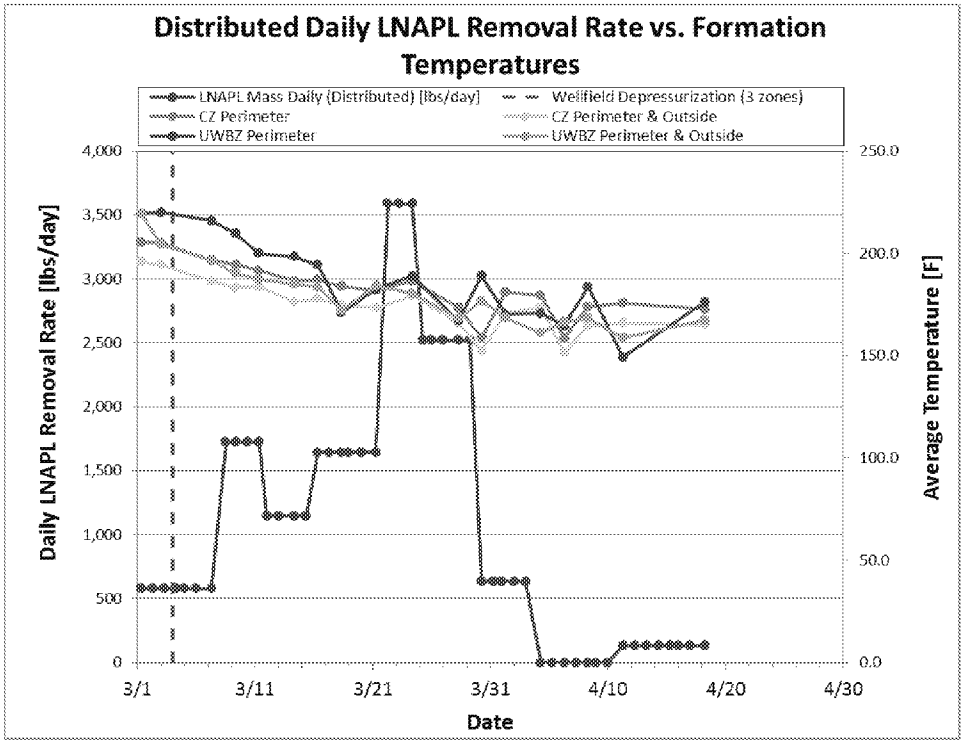
Site ST012 SEE System
Daily Mass Removal – Total





- **Mass removal peaked on 14 May 2015 at 22,506 lbs/day**
- **Mass recovery increased to >20% of the peak during latest depressurization and then dropped to ~12% of the peak (primarily vapor mass removal)**

Depressurization Mass Removal



- Perimeter wellfield temperatures decreased steadily since depressurization cycle initiated on 04 March 2016
- LNAPL accumulation had a delayed peak following the depressurization
- LNAPL accumulation may correlate more with hydraulic changes across the site rather than the decrease in perimeter well temperatures

Concentration Trends During Pressure Cycling

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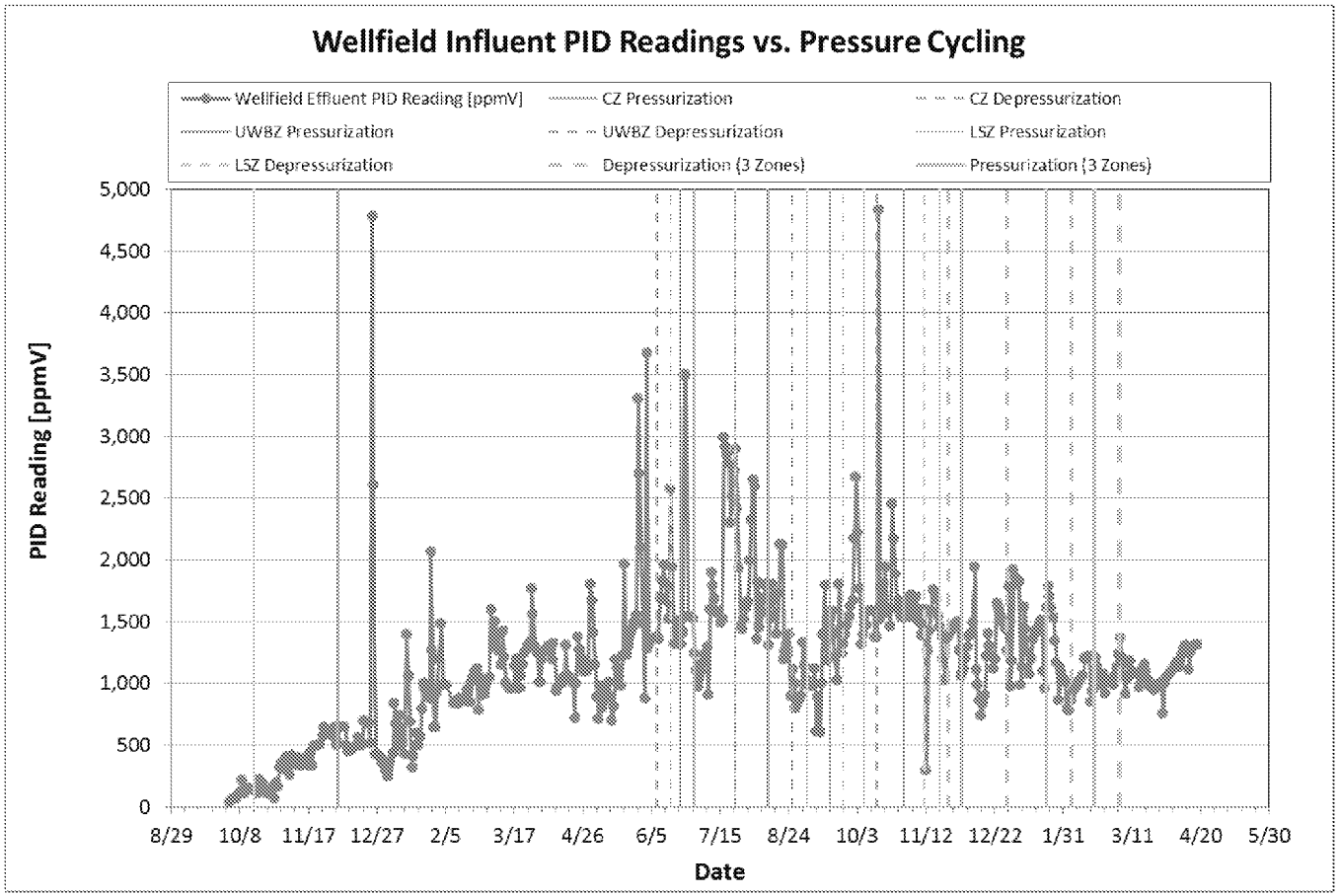
Pressure Cycling and Vapor Concentrations Over Time

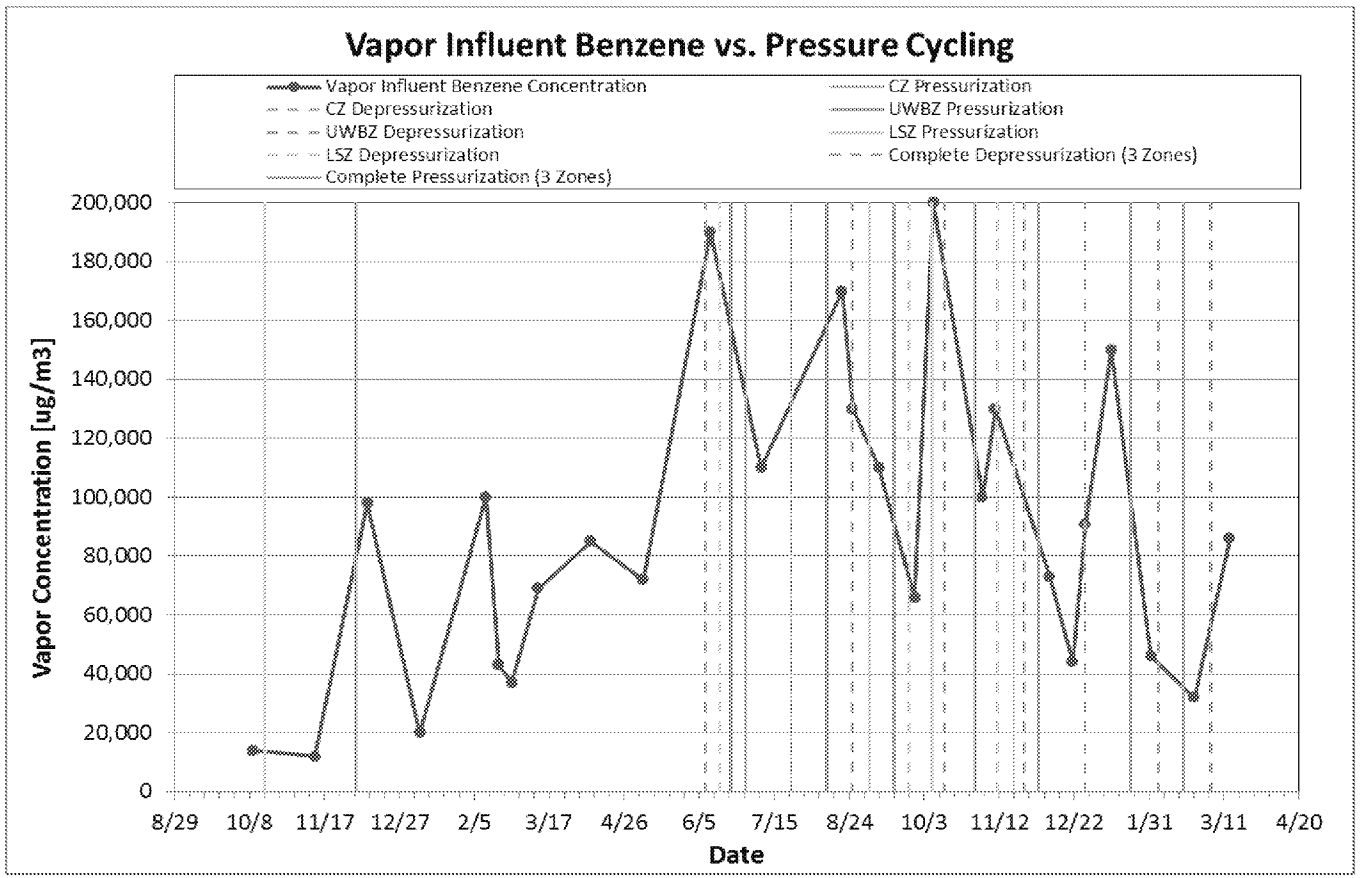
Wellfield Vapor Influent PID Concentrations over Time



- **Wellfield PID concentrations remain relatively stable during site-wide pressurization and depressurization events**

Pressure Cycling and Benzene Vapor Concentrations Over Time

Extracted Vapor Benzene Concentrations over Time
(measured at thermal accelerator influent [includes air stripper effluent] by EPA Method TO-15)

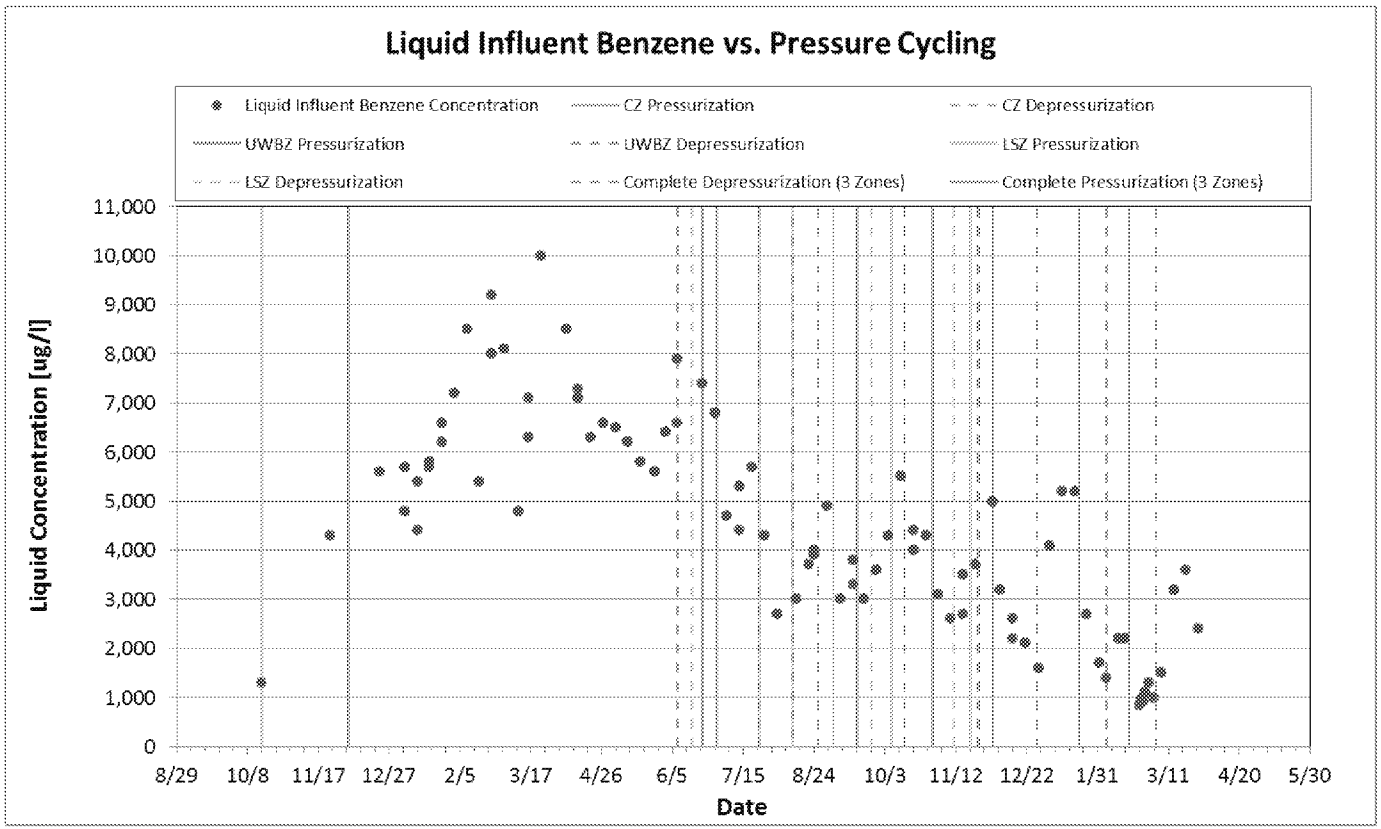


- **Benzene concentrations have fluctuated during pressure cycling**

Please note: Final laboratory reports have not yet been issued for vapor sample results collected on 31 March and 11 April, 2016.

Pressure Cycling and Benzene Liquid Concentration Over Time – UPDATE with NEW DATA

Extracted Liquid Benzene Concentrations over Time (measured at air stripper influent by EPA Method 8260B)



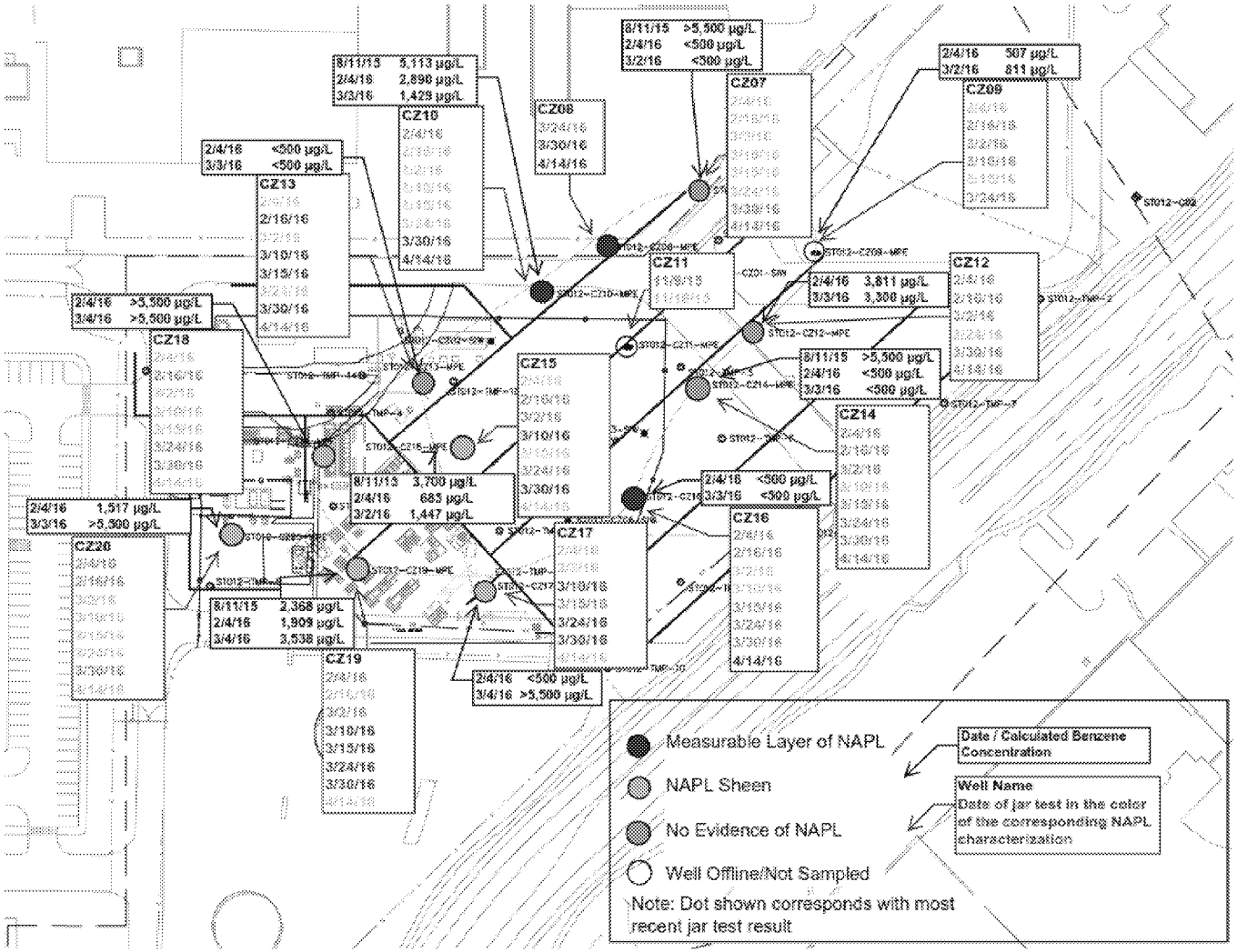
- **Benzene concentrations have declined**
- **Benzene concentrations have approached pre-heating concentrations**

Please note: Final laboratory reports have not yet been issued for liquid sample results collected on 4 and 11 April, 2016 (data not shown on graph).

Benzene Concentrations and NAPL Screening Results

ED_005025_00006126-00025

NAPL Screening Results and Calculated Benzene Concentrations – Cobble Zone August 2015 – April 2016



- Calculated benzene concentrations mixed (<500 to >5,500 µg/L) in March event
- Site wide depressurization initiated 04 March 2016
- NAPL screening results showed an increase in NAPL during depressurization with subsequent decrease in some locations

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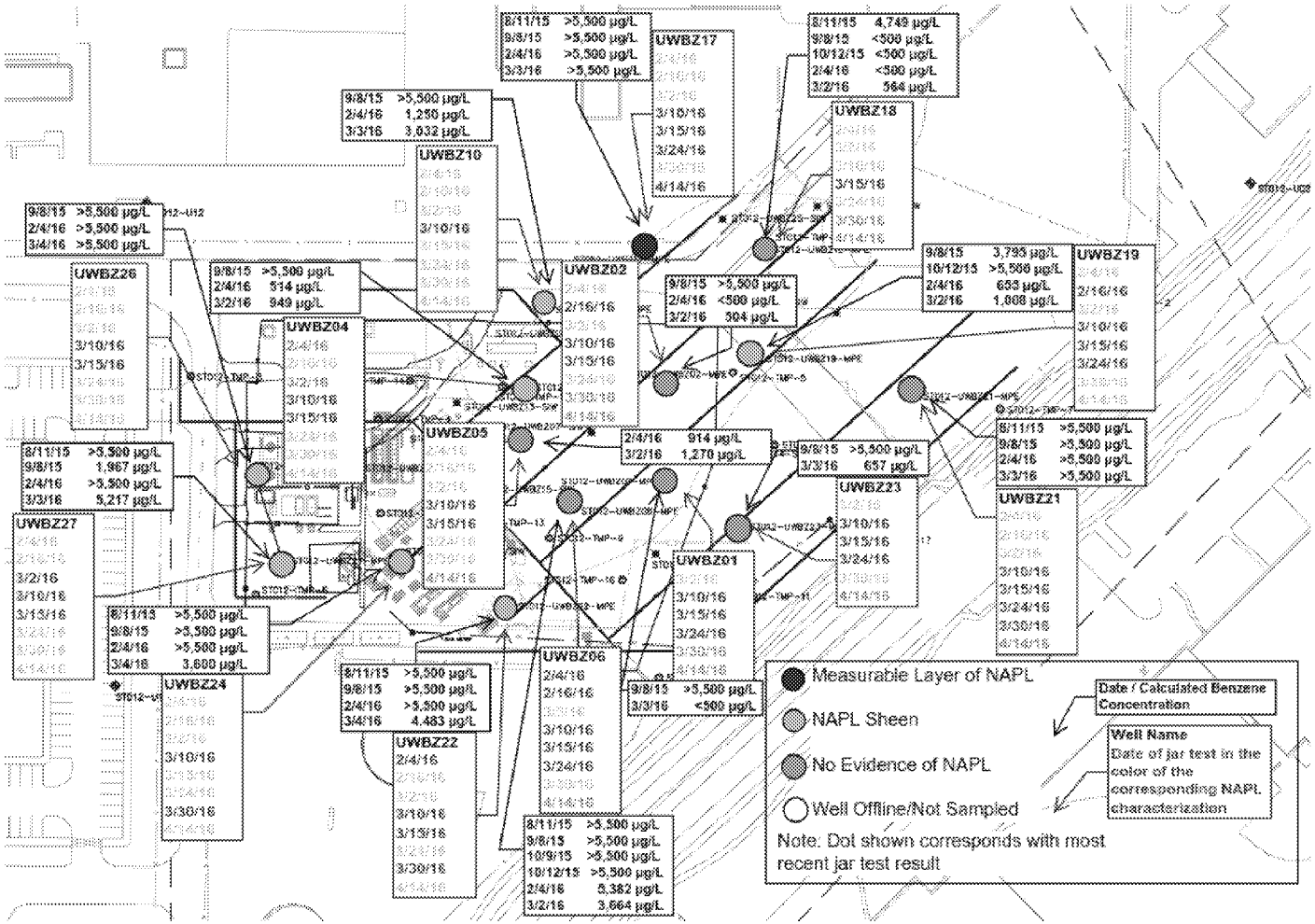
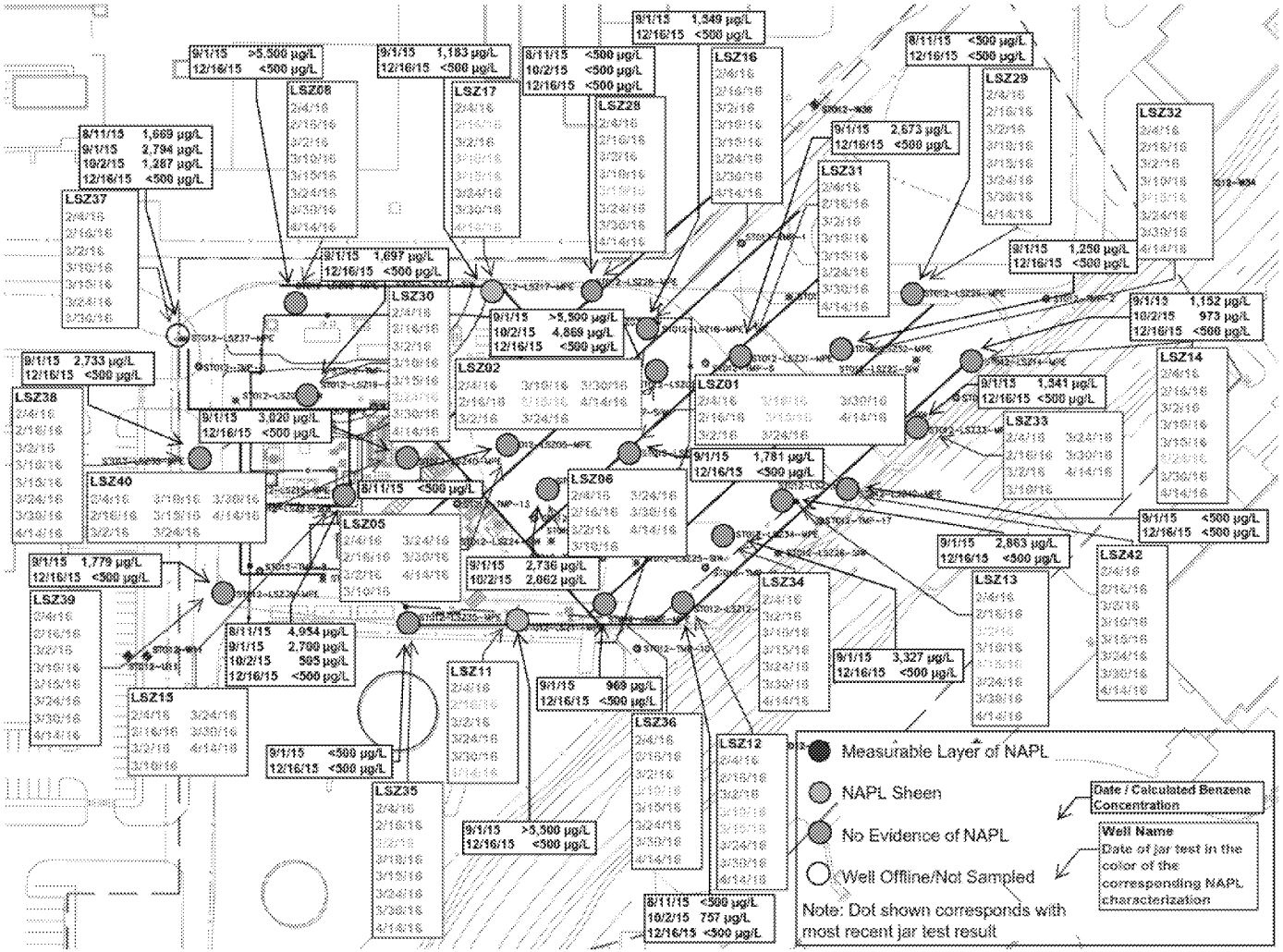
NAPL Screening Results and Calculated Benzene Concentrations – Upper Water Bearing Zone August 2015 – April 2016



- Calculated benzene concentrations mixed (<500 to >5,500 µg/L) in March event
- Site wide depressurization initiated 04 March 2016
- NAPL screening results showed an increase then decrease in NAPL during depressurization

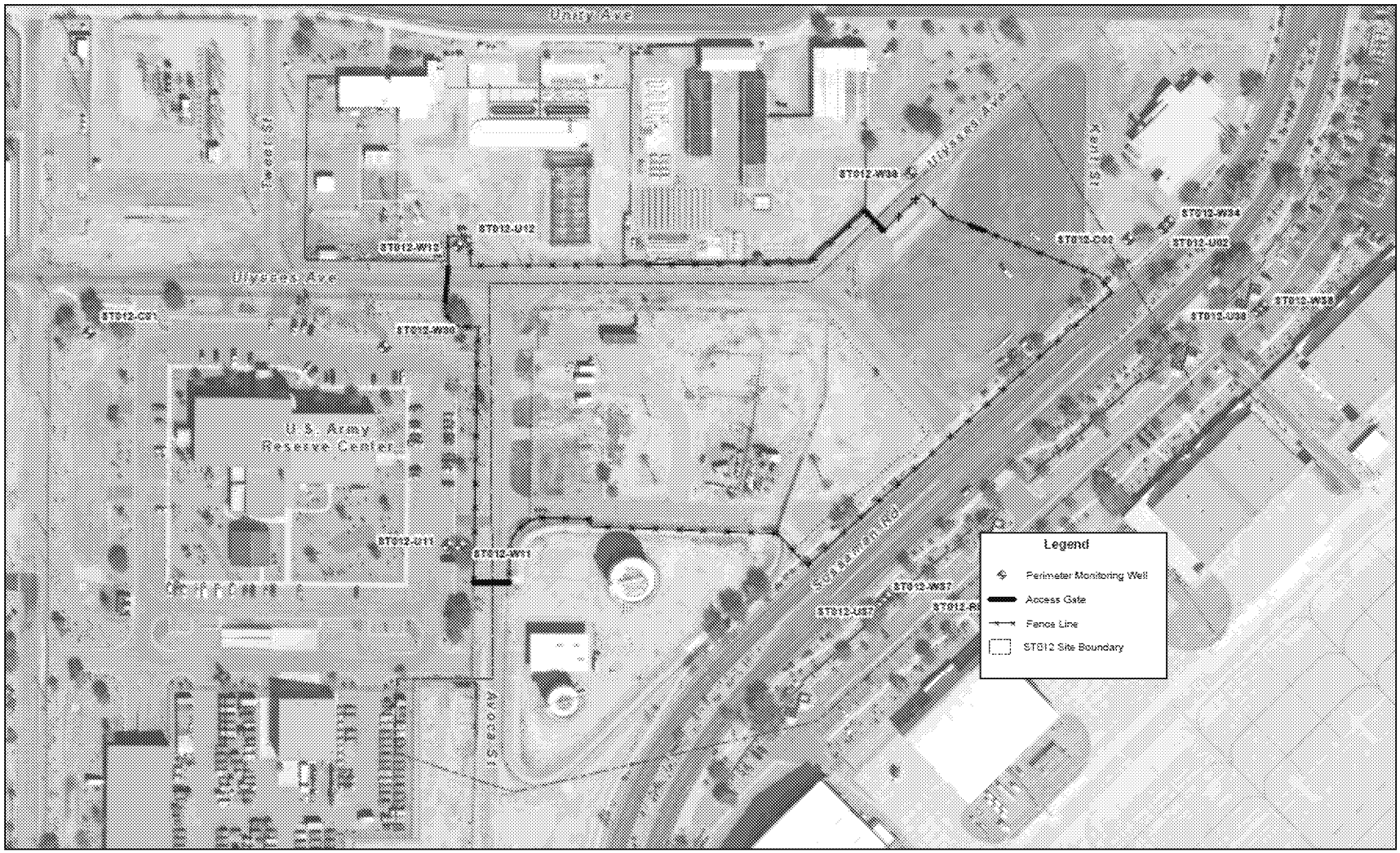
NAPL Screening Results and Calculated Benzene Concentrations – Lower Saturated Zone August 2015 – April 2016



- Calculated benzene concentrations <500 µg/L at all locations for 16 Dec 2015 event
- Site wide depressurization initiated 04 March 2016
- NAPL screening results showed some NAPL sheens during depressurization then returned to limited evidence of NAPL

Annual Groundwater Monitoring Overview

Site ST012
Perimeter Groundwater Monitoring Wells



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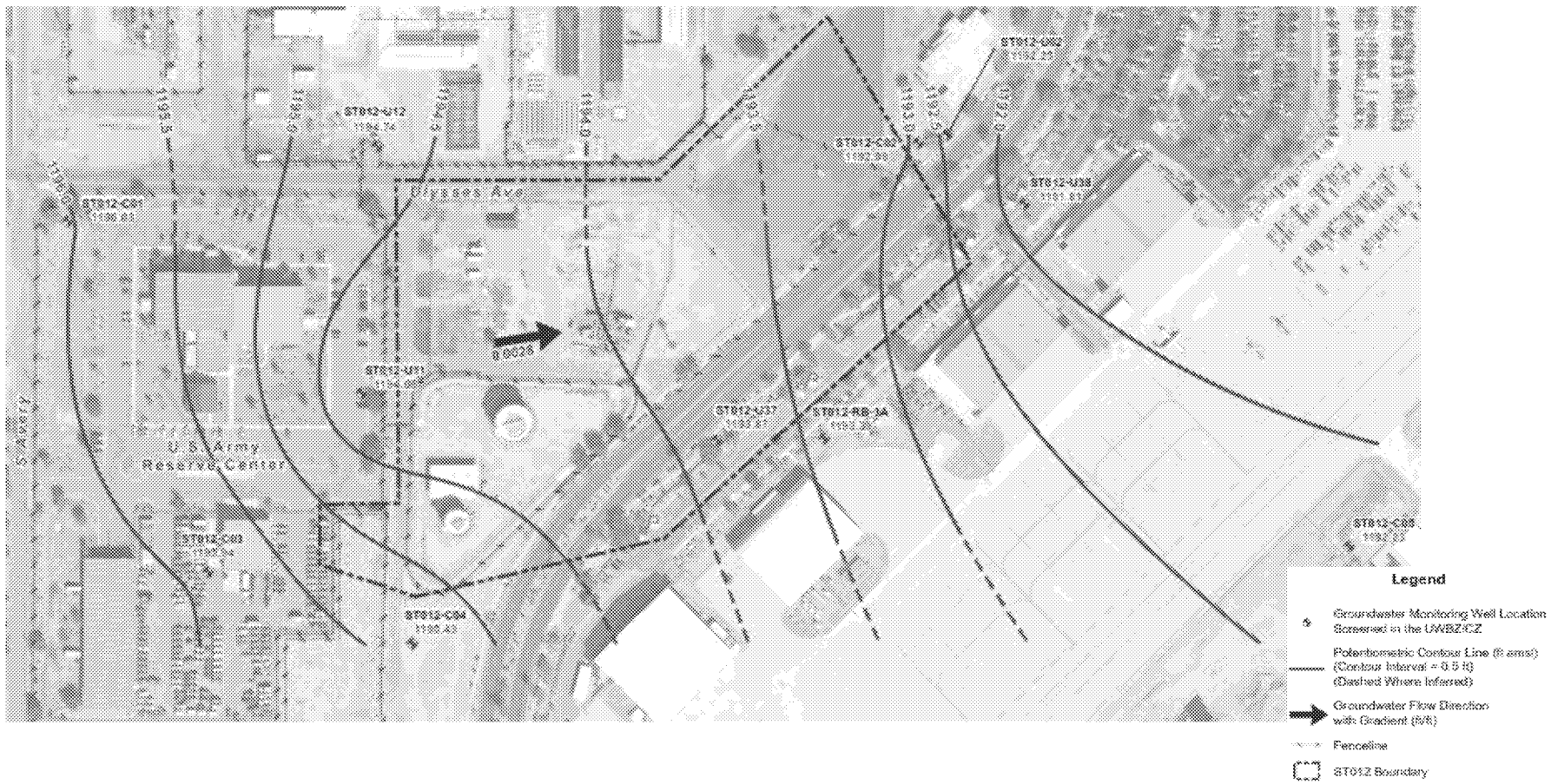
2015 UWBZ/CZ Potentiometric Map



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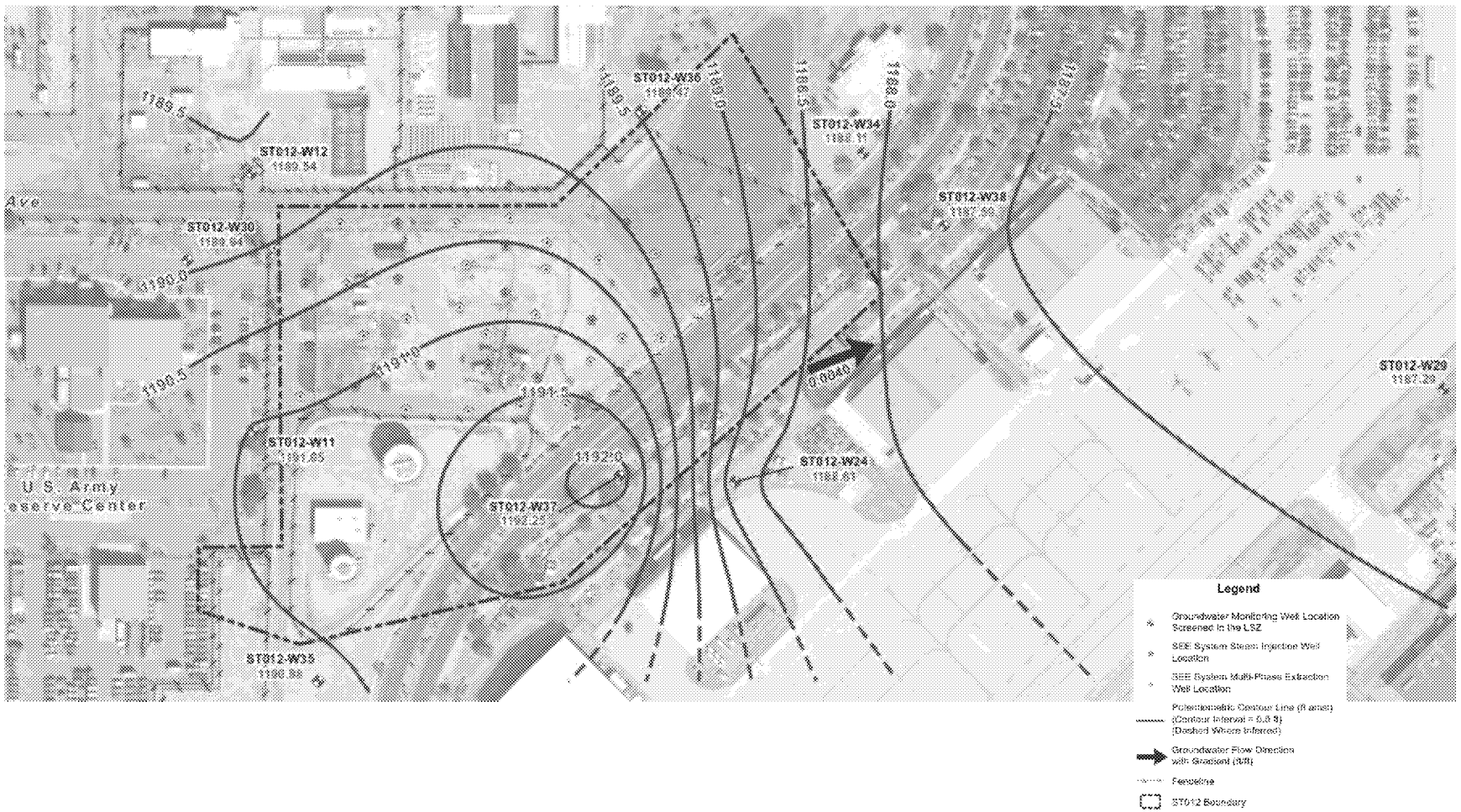
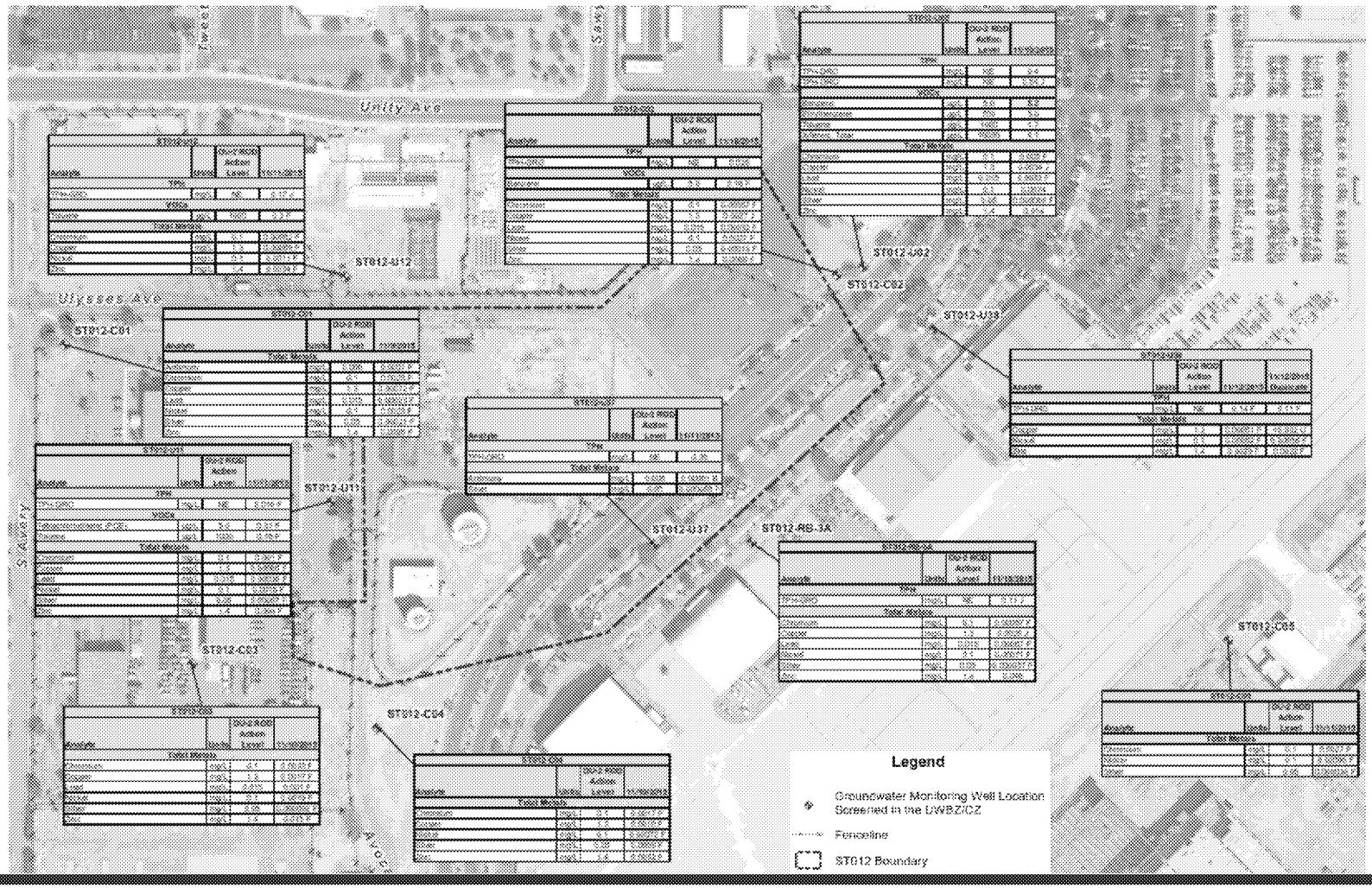
Site ST012
2015 Annual Groundwater Monitoring Event

2015 LSZ Potentiometric Map



Site ST012
2015 Annual Groundwater Monitoring Event

2015 UWBZ/CZ COC Map



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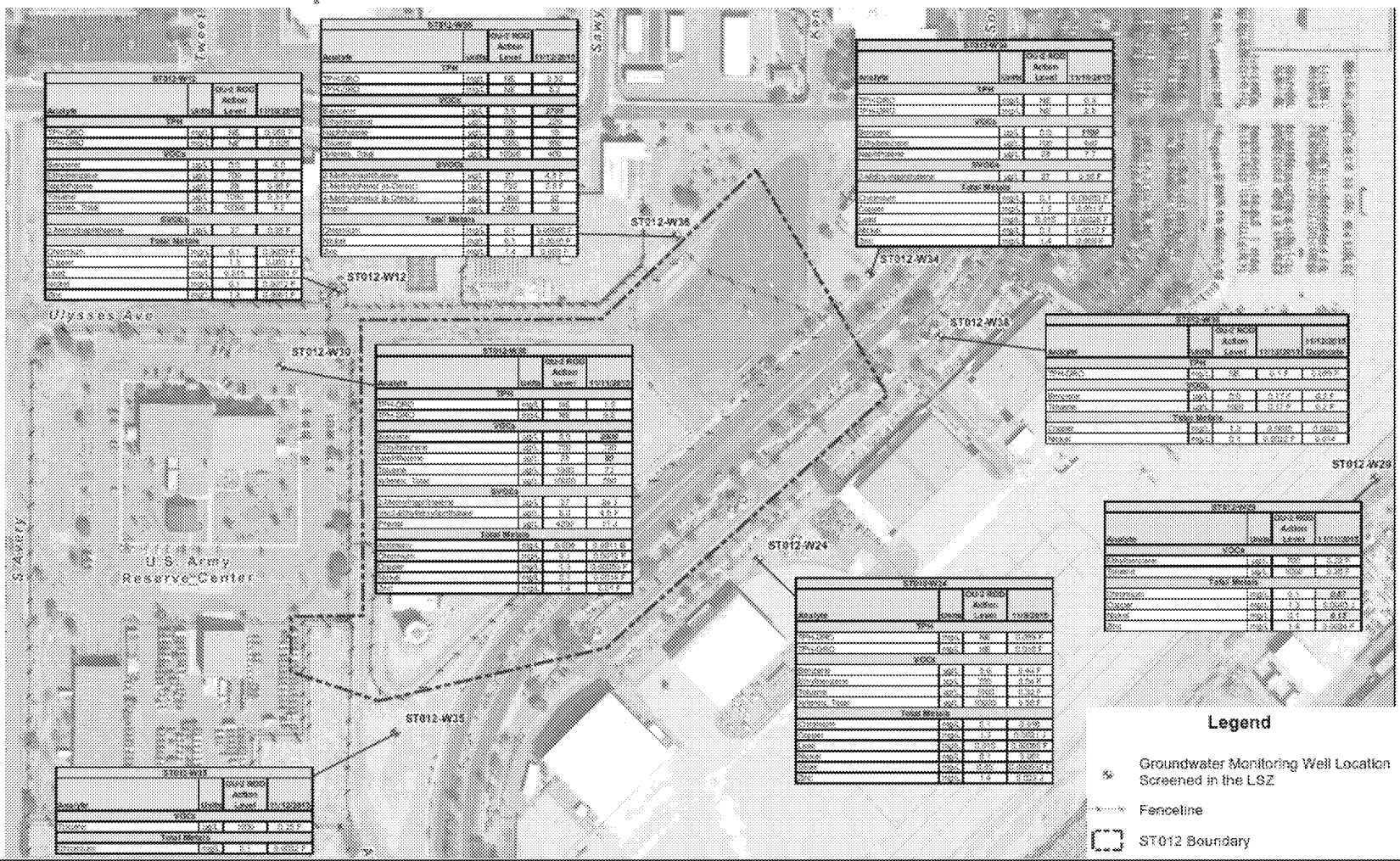
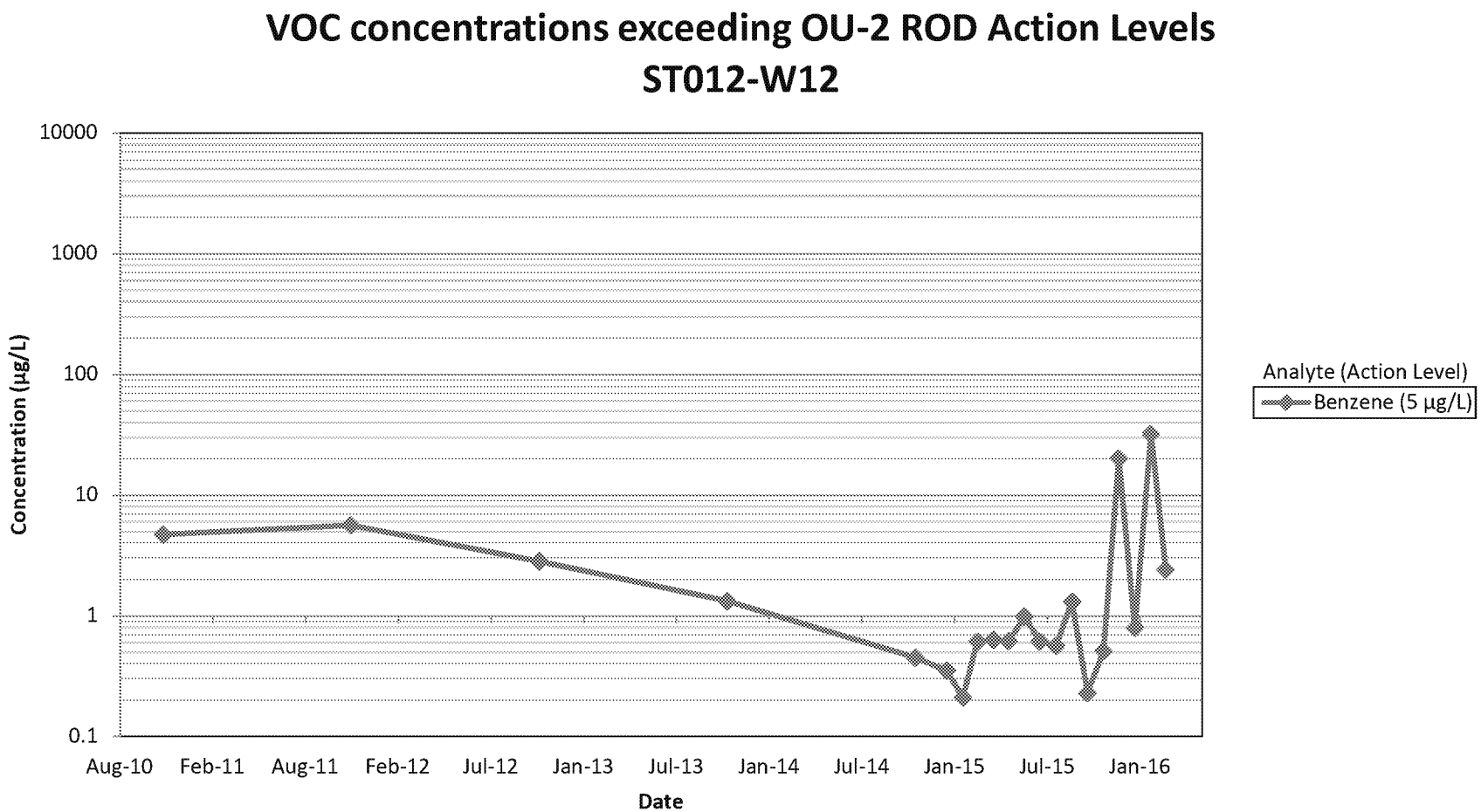
Site ST012
2015 Annual Groundwater Monitoring Event

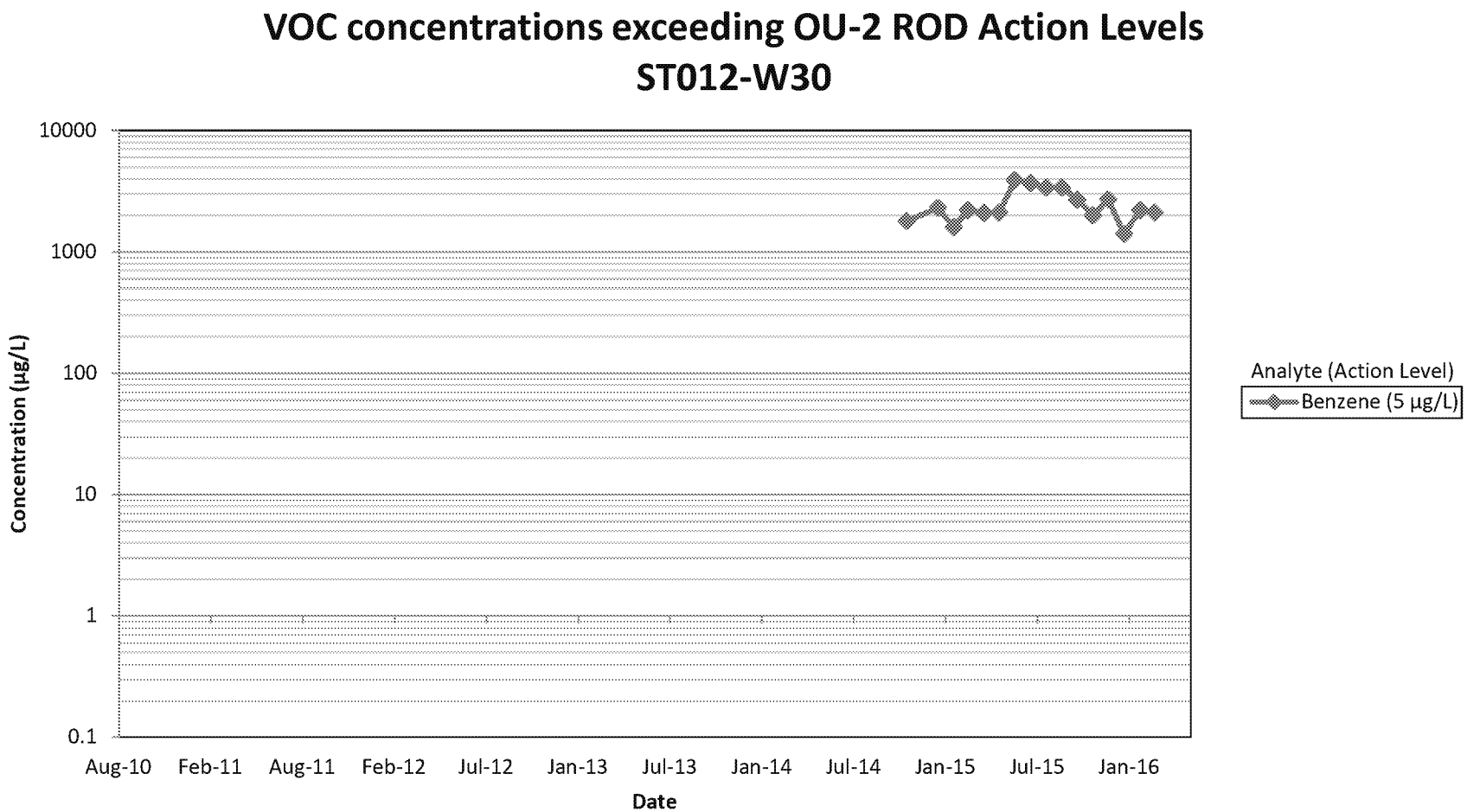
2015 LSZ COC Map



Benzene Concentrations at ST012-W12 Over Time



Benzene Concentrations at ST012-W30 Over Time



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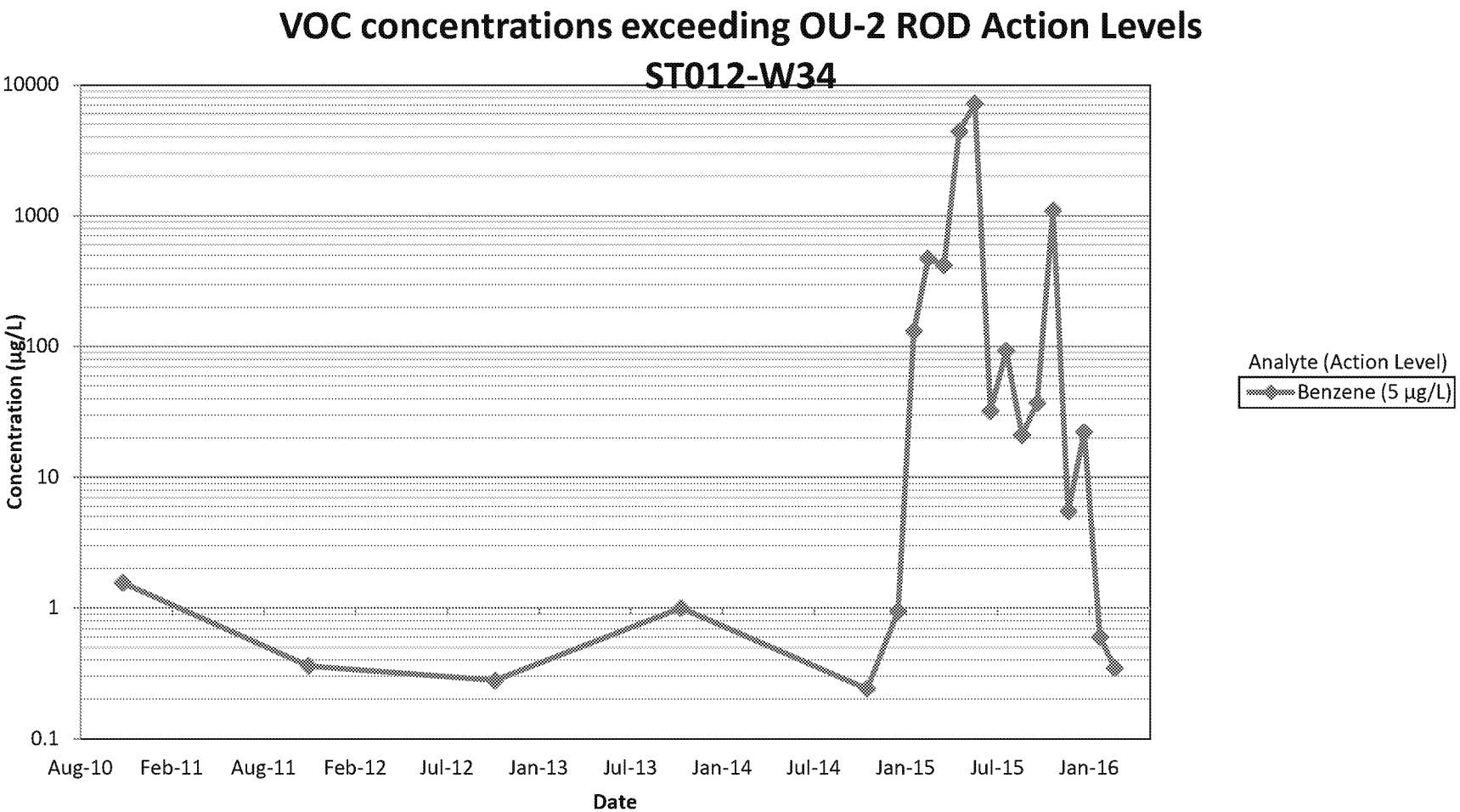
Benzene Concentrations at ST012-W34 Over Time



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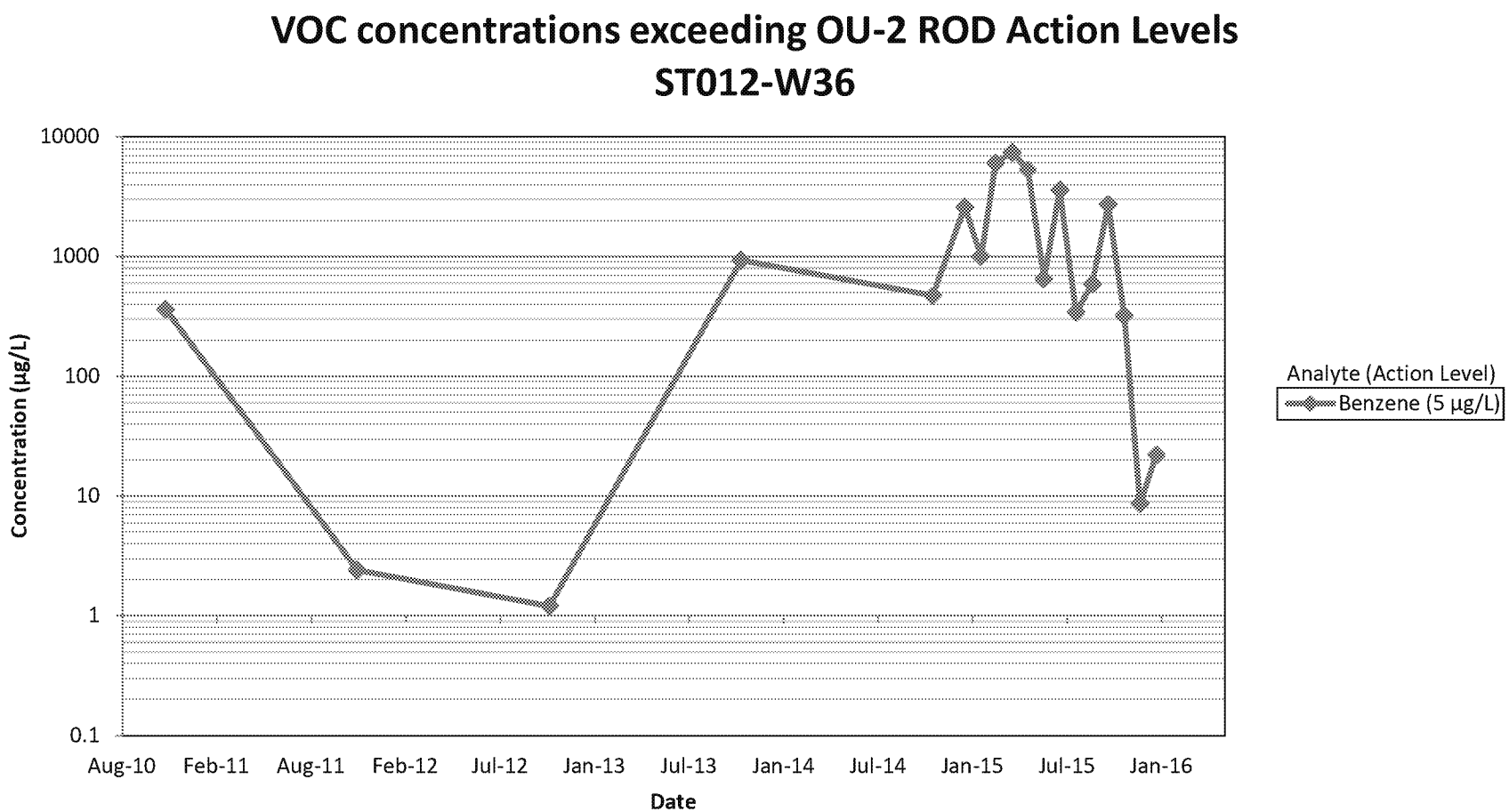
Benzene Concentrations at ST012-W36 Over Time



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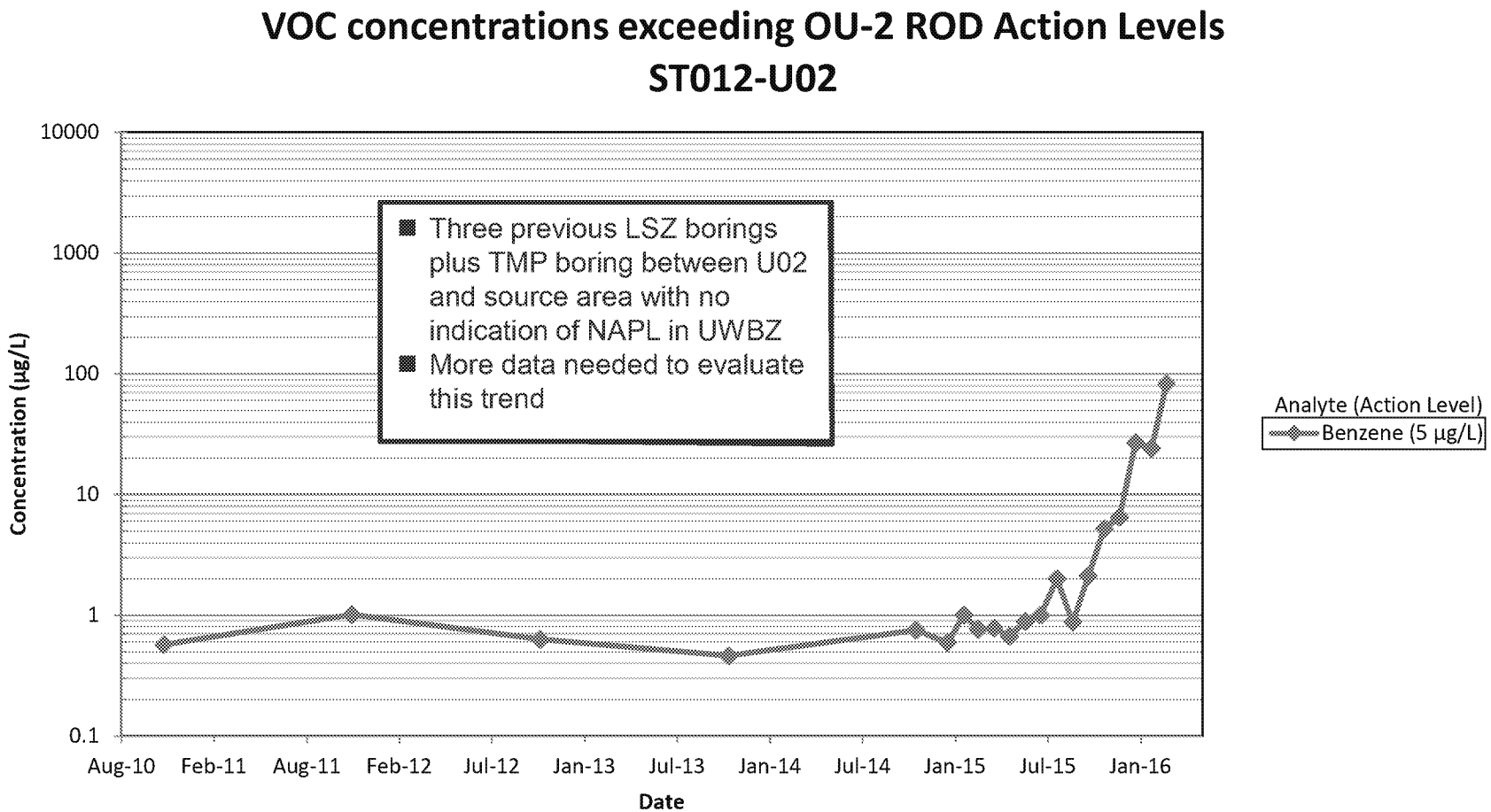
Benzene Concentrations at ST012-U02 Over Time



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Site ST012
Enhanced Bioremediation (EBR) Update

ED_005025_00006126-00040

Site ST012 EBR

- Draft Final RD/RAWP submitted
- Review of Phase 1 Injection Plan relative to ADEQ post-SEE characterization comments
- Path Forward for EBR

Site ST012 EBR

- **Preliminary Phase 1 Injections**
  - **Focus on areas of highest mass outside of SEE TTZs**
  - **Use some existing perimeter monitoring wells**
  - **Install additional perimeter wells**
  - **Implement batch injections of sulfate solution in perimeter wells**
  - **Continue extraction from SEE perimeter wells to promote distribution of sulfate solution through contaminated zones**
  - **Monitor conditions and adjust (e.g., inject location/amount, extraction location, extraction rate/duration)**

Site ST012
Characterization during EBR Phase 1

- Sonic drilling for continuous evaluation of soil cores
- Dye test kit screening for NAPL at suspect vertical intervals (based on visual, olfactory, and PID)
- Analytical to confirm/quantify positive dye test kits
- Gauging of existing wells for LNAPL
- Baseline EBR sampling
- Evaluate, adjust EBR injections (if necessary), and plan Phase 2

Site ST012
EBR Phase 2 Potential Components

- Additional wells for LNAPL or dissolved phase characterization (likely)
- Additional injection locations to improve sulfate distribution
- Change in extraction locations to improve sulfate distribution of sulfate
- Additional injection mass in areas of sulfate depletion
- Adjustments in sulfate solution concentration
- Adjustments to monitoring

Site ST012
EPA/ADEQ Concerns: LNAPL Containment and Benzene Plume Characterization

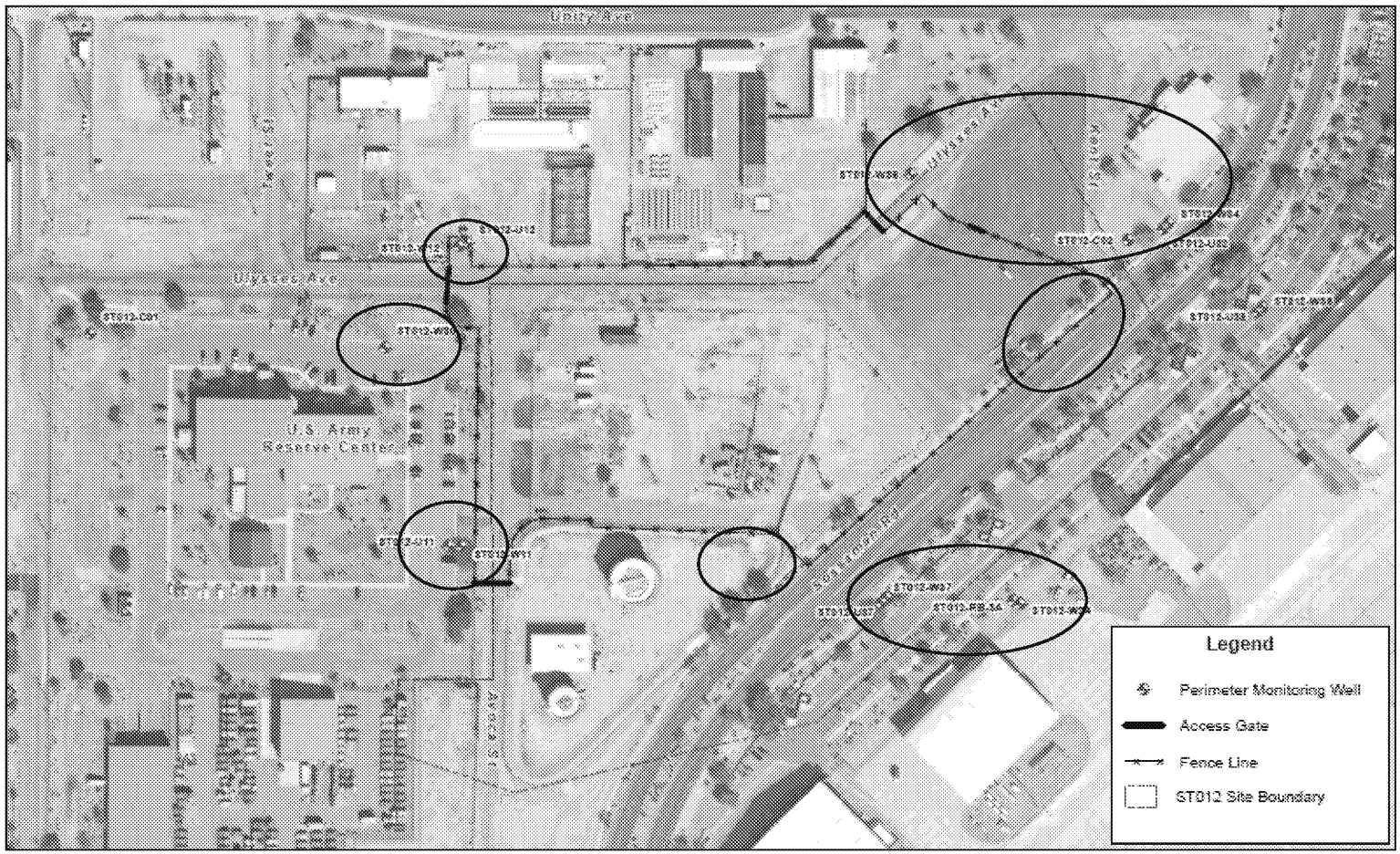
- **Draft Annual 2014 Groundwater Monitoring Report**
  - Concern with adequate characterization north of the site in the vicinity of W36
  - Concern with characterization to the east in the vicinity of W34
- **Draft SVE/SEE O&M 2014 Annual Report**
  - Concern with capture of mobilized contaminants during initial SEE operations
  - Concern with perimeter characterization in the vicinities of W24, W30, W34, W36
  - Concern with LNAPL in vicinity of W11, W37
- **Draft SVE/SEE O&M 2015 First Quarter Report**
  - Concern with plume characterization in the vicinities of W30, W34, W36

Site ST012
EPA/ADEQ Concerns on LNAPL Containment and Benzene Plume Characterization

- **Draft SVE/SEE O&M 2015 Second Quarter Report**
  - Concern with UWBZ containment in the vicinities of U02, U12, W36
  - Concern with LSZ containment in vicinity of W30
  - Concern with benzene in perimeter monitoring wells
- **Draft SVE/SEE O&M 2015 Third Quarter Report**
  - Concern that contaminant plume is not characterized; benzene concentrations at W34 and W36, extent of LNAPL at W11, W30, W37
  - Concern regarding LNAPL containment related to heating at TMP-2 and TMP-7
  - Concern regarding LNAPL containment related to heating at TMP-10
- **Draft RD/RAWP Addendum #2**
  - Concern regarding LNAPL mass outside the TTZs
    - Outside CZ/UWBZ TTZ where pre-design drilling identified LNAPL
    - Outside LSZ TTZ where LNAPL is currently being recovered (W11, W37)

Site ST012

EPA/ADEQ Concerns on LNAPL Containment and Benzene Plume Characterization



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Site ST012 EBR Design, Jar Test Results, Additional Characterization

- **Phase I injection/extraction – CZ (160 ft bgs)**

May move extraction wells further downgradient to pull more sulfate to these areas

Evaluate CZ for NAPL when drilling UWBZ/LSZ well. Potentially add CZ screen or well

Evaluate CZ for NAPL when drilling UWBZ/LSZ well. Potentially add CZ screen or well

Legend

- PERIMETER MONITORING WELL
- SIW CZ = 8
- MPE CZ = 14
- INDIVIDUAL TMP WITH THERMOCOUPLES = 17
- CZ RD/RAWP THERMAL TREATMENT ZONE
- PROPOSED INJECTION/SAMPLING LOCATION
- WATER LINE
- NATURAL GAS LINE
- SEWER LINE
- FENCE LINE
- ST012 BOUNDARY
- THERMAL INFLUENCE ZONE, 60% REMOVAL
- RDI ZONE, 30% REMOVAL
- MODEL EXTENT OF RESIDUAL LNAPL–BASE
- MODEL EXTENT OF RESIDUAL LNAPL–CONSERVATIVE

NOTE: MODEL EXTENT SHADING BASED ON EXPECTED PERCENT REMOVAL WITHIN EACH CONTOUR

Initial Sulfate (tons)

- Proposed Injection Location
- Proposed Extraction Location
- Additional Characterization (Deeper Location)

Most Recent Jar Test Result

- No Evidence of NAPL
- NAPL Sheen
- Measureable Layer of NAPL
- Area of EPA/ADEQ comment

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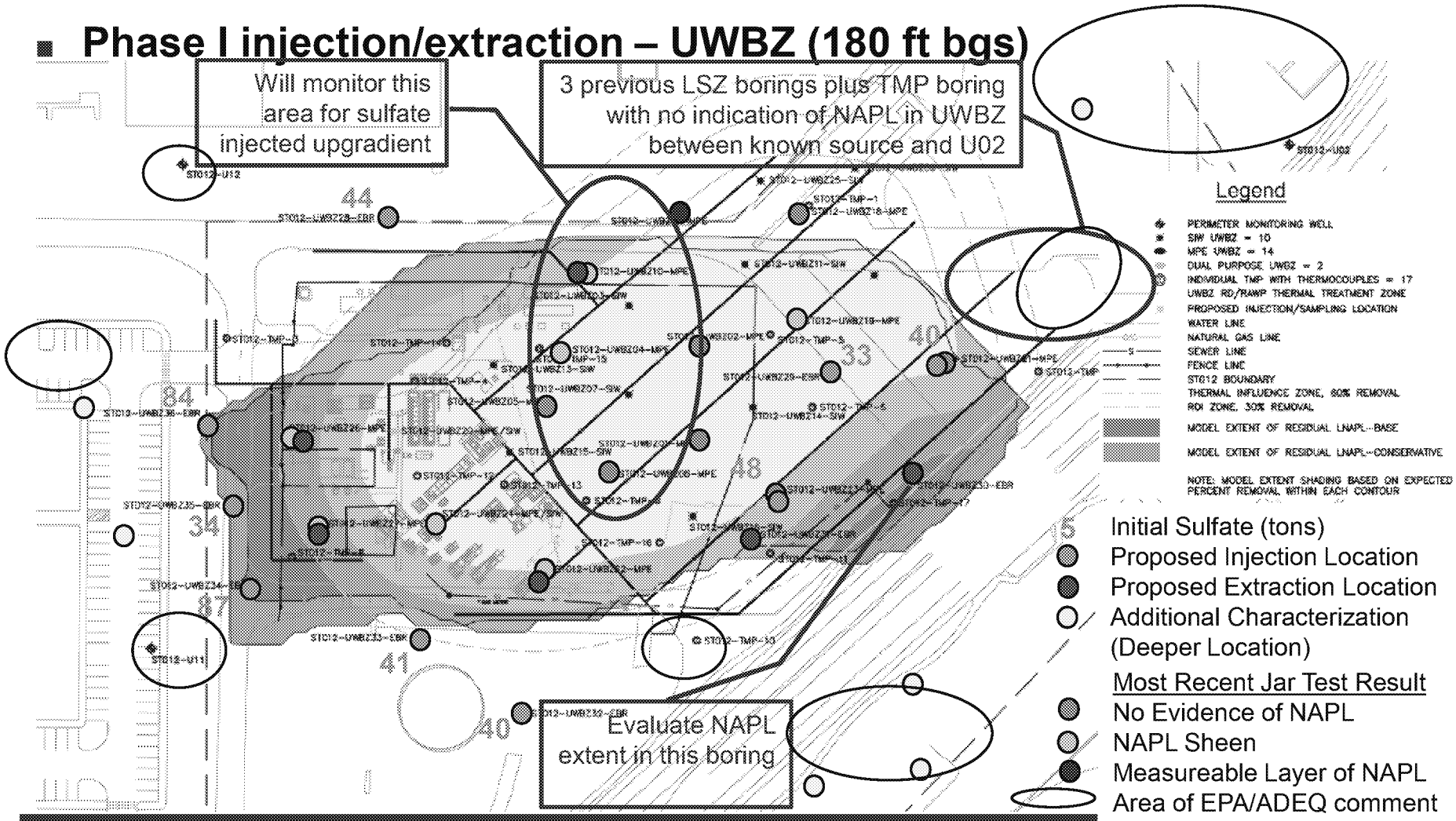
Site ST012 EBR Design and Jar Test Results

- **Phase I injection/extraction – UWBZ (180 ft bgs)**



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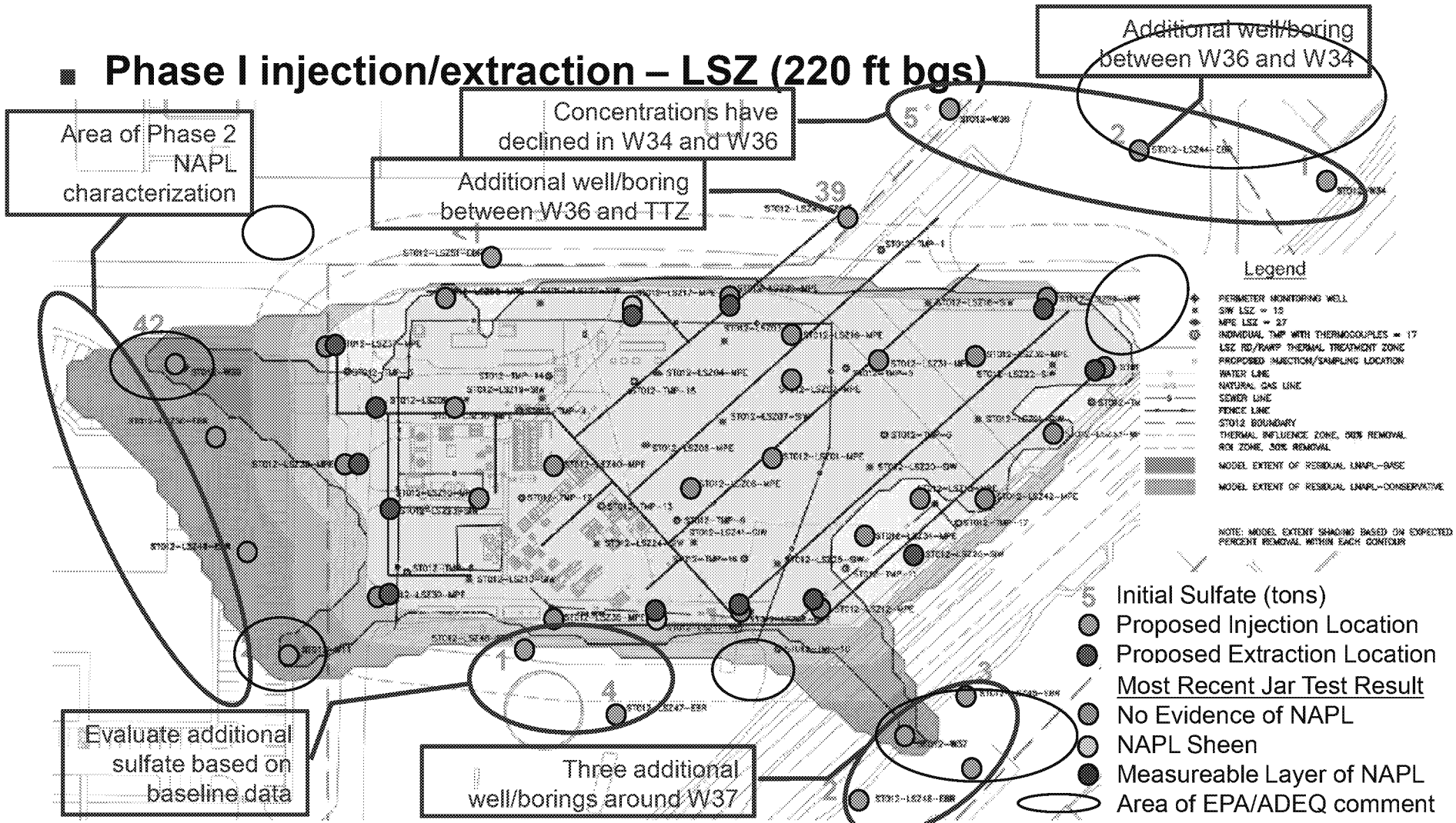
Site ST012 EBR Design and Jar Test Results

- **Phase I injection/extraction – LSZ (220 ft bgs)**



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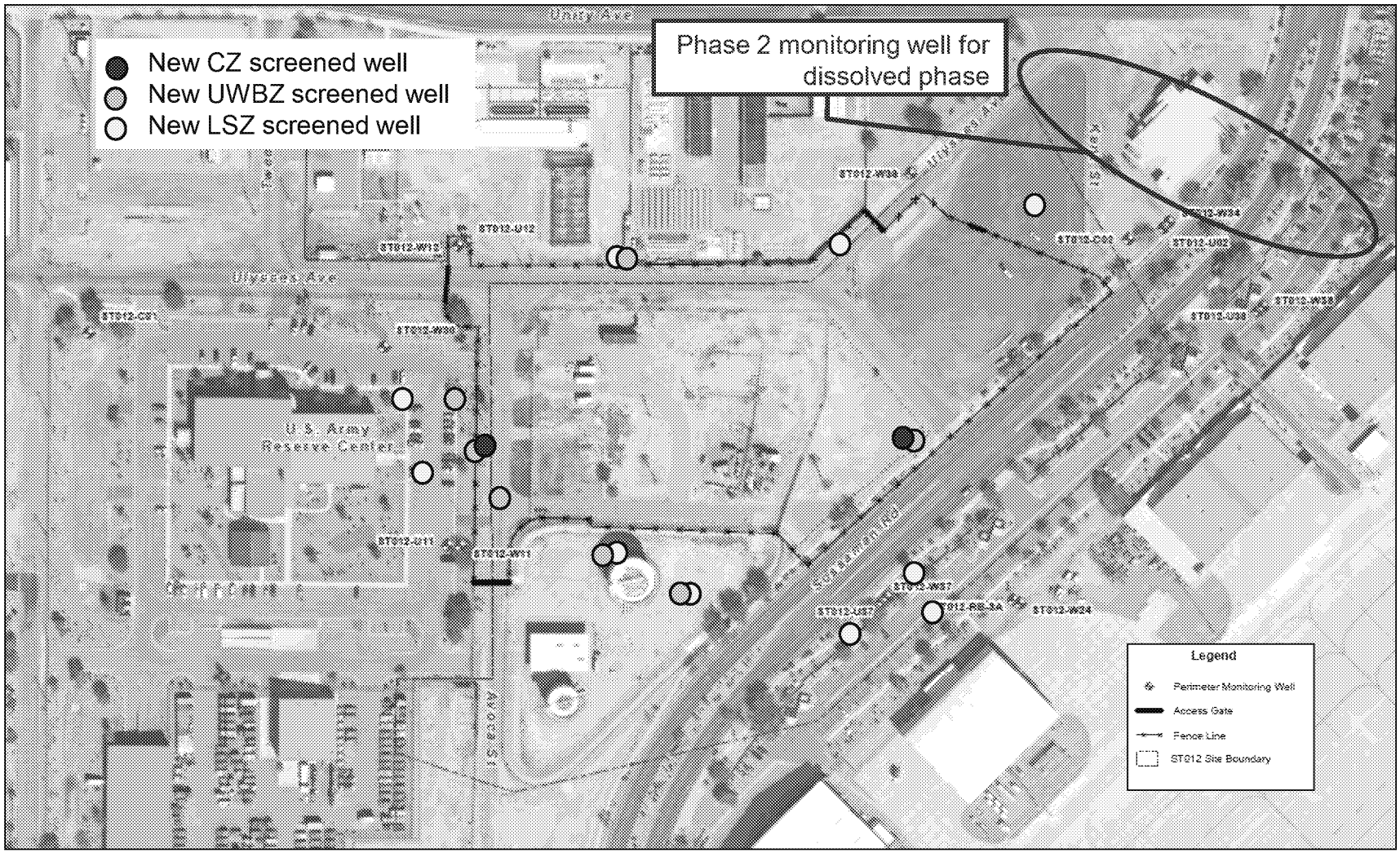
Site ST012
Additional Perimeter Groundwater Monitoring Well Locations



Site ST012 EBR

- Path Forward
  - SEE Completion
    - Post-steam extraction ongoing
      - NAPL removal is reduced
      - Most of site cooled below steam temperatures (monitoring CZ11 and TMP-01 areas
    - Anticipate extraction shutdown 29 April 2016
    - Decommissioning/demobilization May-August

Site ST012 EBR

- Path Forward
  - Implement EPR Phase 1
    - Begin drilling 2 May 2016
    - Pre-EBR sampling May-June 2016
    - Construct EBR treatment May – July 2016
    - Open up PMGA Cell Phone Lot by 1 June
    - Extraction starts – August 2016 (timing depends on final post SEE extraction/demolition and drilling completion)
    - Injection starts – August/September 2016