

# Former Perryville Feed Store Leaking UST Site, Goodyear, AZ

Characterization/Remediation of Extensive  
Contamination within a Deep “Smear Zone”

*Presented by*

Jeff Rackow, PE



Clean Air, Safe Water,  
Healthy Land for Everyone



# Presentation Topics

- Site Location
- Project Summary
- Objectives
- Background
- Irrigation Well and Vertical Flow
- Nature and Extent of Contamination
- Remediation Approach
- Pump-and-Treat (P&T)
- Soil Vapor Extraction (SVE)
- Treatment System Design and Photographs
- Remediation System Performance
- Results/Lessons Learned

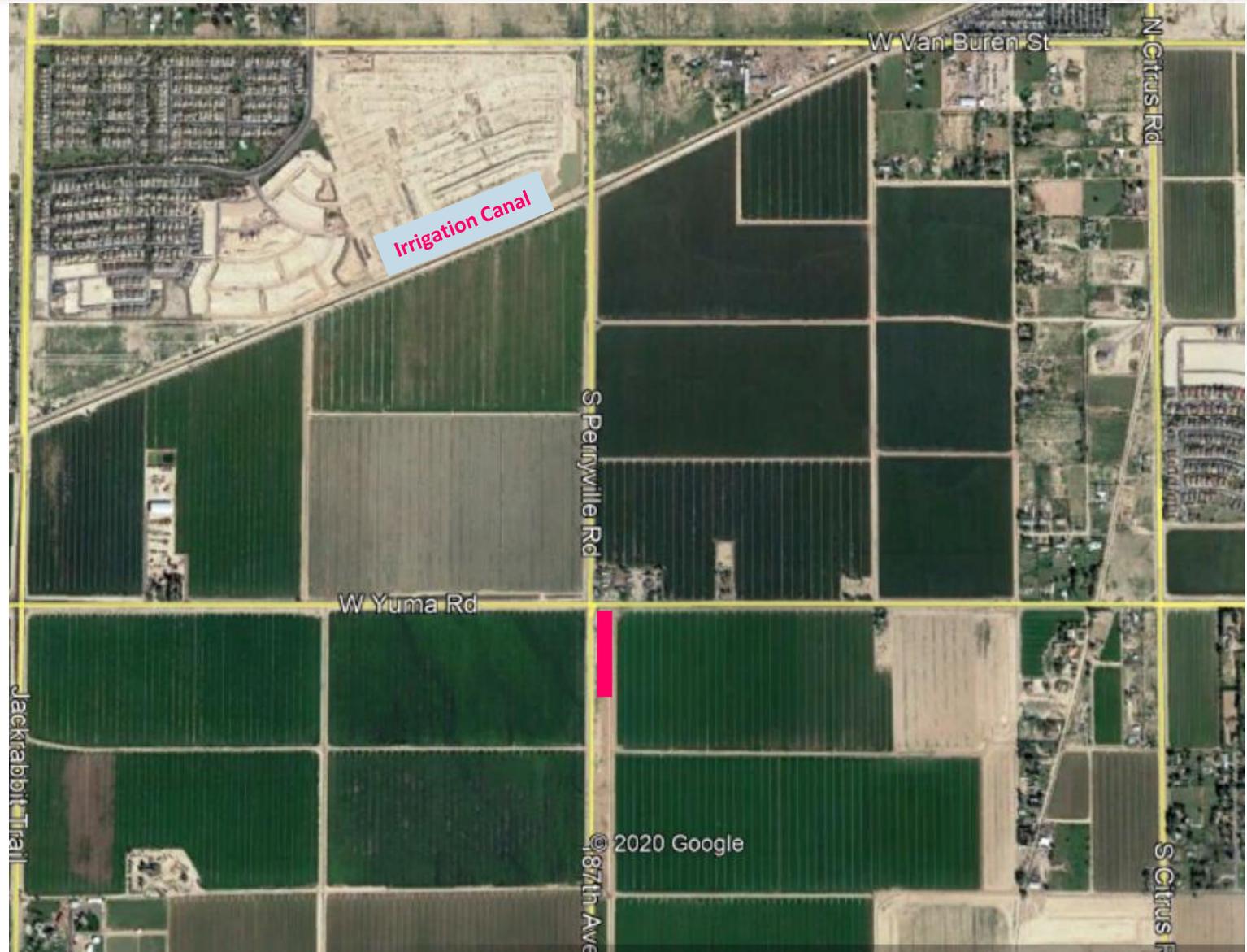


# Site Location

## Location:

- ~ 5 miles west of Phoenix Goodyear Airport
- 1.8 mile south of I-10

Former Perryville FS Property



# Site Map



Subject  
Property



Former Leaking  
UST System



GW Flow  
Direction



North



- ADEQ is conducting GW investigation and remediation under its State Lead Leaking UST Program
- Extensive gasoline-related GW contamination (LNAPL & dissolved-phase) exists, including through ~150 ft thick “smear zone”
- “Smear zone” created by decades of pumping from deep, high-capacity irrigation well located ~200 feet east of Leaking UST zone
- LNAPL present in multiple wells (currently 5)
- Dissolved-phase benzene in GW currently up to 12,500 µg/L
- Remediation is on-going using multiple methods

- Continue GW remediation
- More fully characterize extent of onsite LNAPL plume
- Continue attempts to gain access offsite (west) to complete GW characterization
- Modify, enhance, optimize remediation based on results of supplemental characterization
- Further evaluate treated discharge alternative
- Reduce BTEX concentrations over time to acceptable risk-based levels

- Former agricultural supply store, retail gas & diesel [1940s-1991]
- Fuel release discovered during UST closure, holes in multiple tanks [July 1991]
- CSM: Fluctuating GW levels (~58 to ~ 175 ft bgs), resulting from nearby high-capacity/deep irrigation well pumping. “Smear Zone” created (submerged & residual NAPL) [1970s -2020]
- Initial SVE systems remove reported 98,690 lbs of VOCs (~15,183 gals gas); LNAPL recovery 800 gals [ 1996-2000]

- Vertical characterization with 5 deep borings/wells (~220 ft bgs). HydroPunch & PDB data reveals ~150 ft thick “smear zone” [2017-2018, 2023]
- Remedial Alternatives Analysis: AS/SVE, thermal, P&T with SVE. Ultimately, P&T with SVE and LNAPL recovery selected [2019-July 2020]
- High-capacity irrigation well shut-off and removed [June 2020]
- Full-network GW sampling performed for pre-remediation baseline. High VOCs present (LNAPL; dissolved benzene up to ~20,000 ug/L) [Aug 2020]
- P&T design/permit/construct/test is completed [~Aug 2020-Dec 2020]
- Official startup of P&T with O&M [Jan 2021]

- Official startup of SVE system [April 2022]
- P&T reinjection well (INJ-1) gradually loses infiltration capacity, can't effectively be rehabilitated [Jan 2021-Aug 2022]
- P&T discharge alternatives evaluated (e.g., connect to RID vs installing replacement IWs [April-June 2022]
- AZPDES permitting (application, issuance, modification) [July-Nov 2022]
- P&T system shut off after ~26M gals throughput [Sept 2022]. LNAPL recovery and SVE continue
- Replacement injection well (INJ-2) installed [July 2023]
- Extensive LNAPL (~12 ft thick) surprisingly detected in INJ-2 [Oct 2023]
- Plans developed to further characterize LNAPL plume using 4 new MWs [recent status]
- LNAPL recovery and SVE continue [current status]

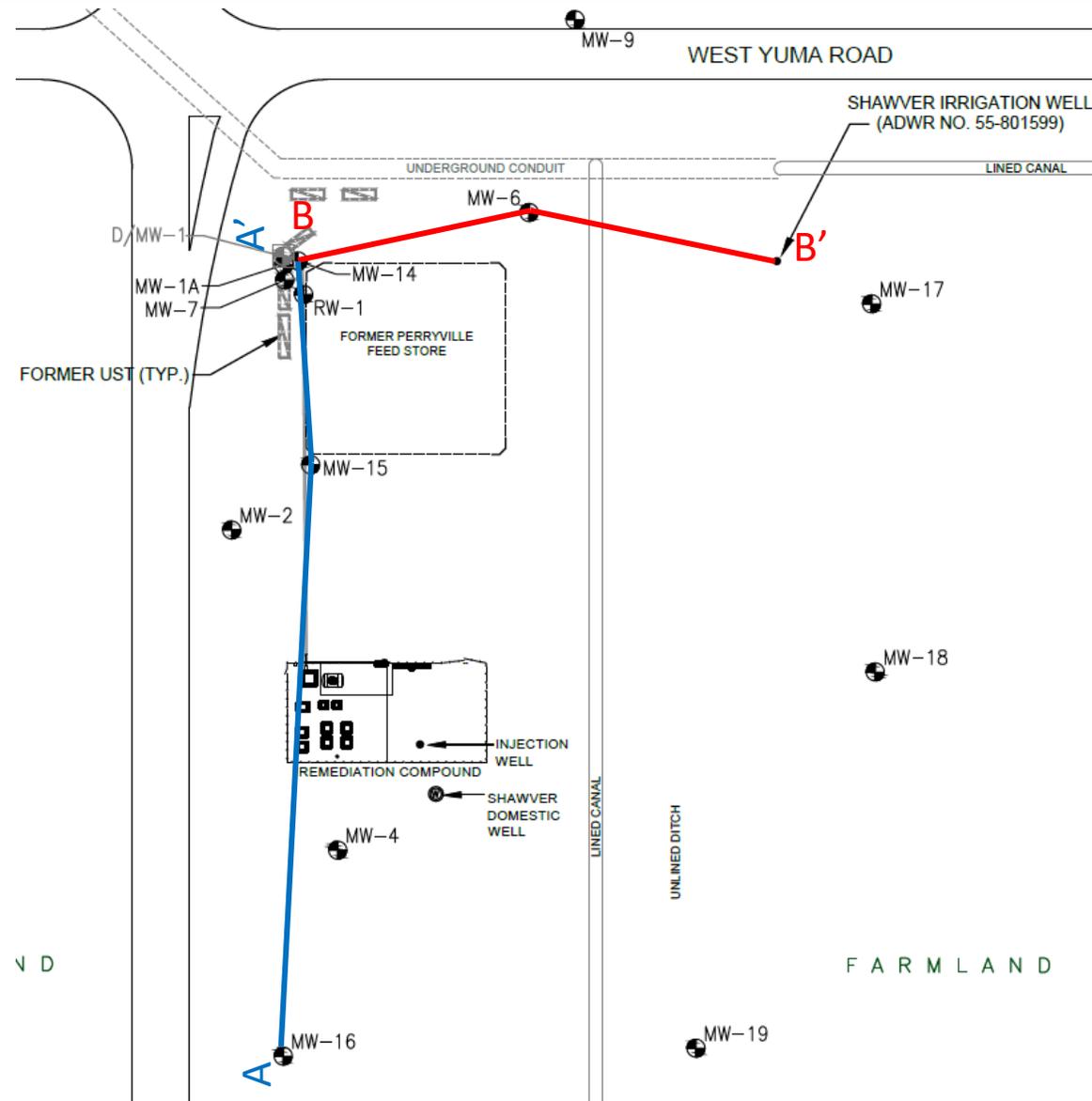
# Shawver Irrigation Well

- Located ~200 ft east of leaking UST zone
- Installed in Aug 1951 (ADWR record)
- Depth = 440 ft; casing diameter = 20 in (field measurements)
- Perforation (mills-knife cuts) interval 202 - 440 ft (video log)
- Pumping rate/capacity ~ 2,000 gpm. Reportedly operated from 1,000 - 2,000 gpm over lifecycle
- Pump removed by land owner, Jan 10, 2020
- Well casing video logged, Jan 17, 2020
- Casing in poor condition; multiple breaches and corroded perforations

# Downward Vertical Flow (2017)

- Geophysical & spinner logging conducted on deep onsite wells MW-14 (source area) and MW-15 (nearby downgradient)
- Determination of average vertical flow velocity and net flow
- 0.25 - 0.5 gpm downward flow without irrigation well pumping
- 5 - 7 gpm downward flow when irrigation well pumped at ~1000 gpm
- Data confirmed irrigation well pumping had significant impact on vertical distribution of contamination in aquifer

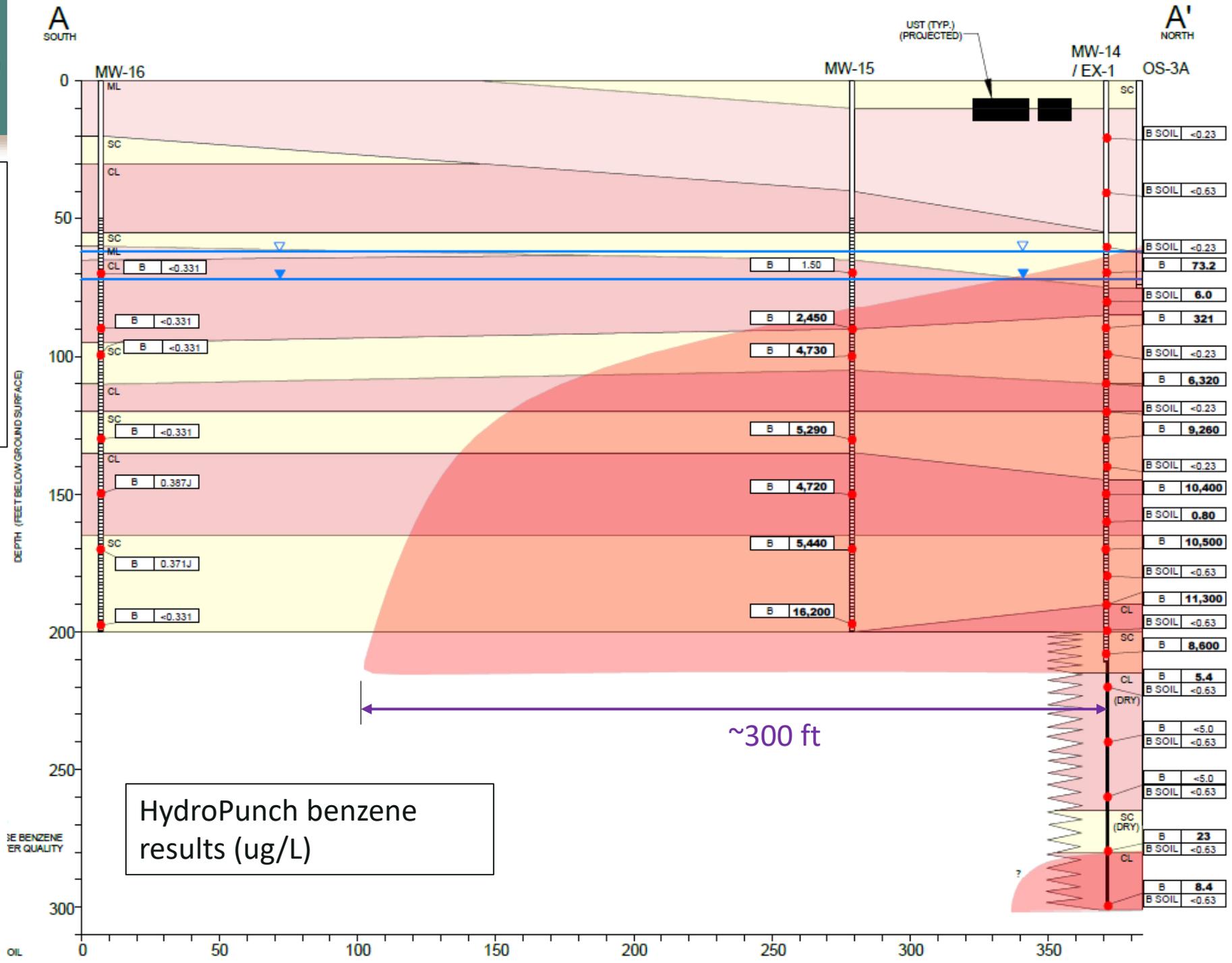
# Extent of Contamination



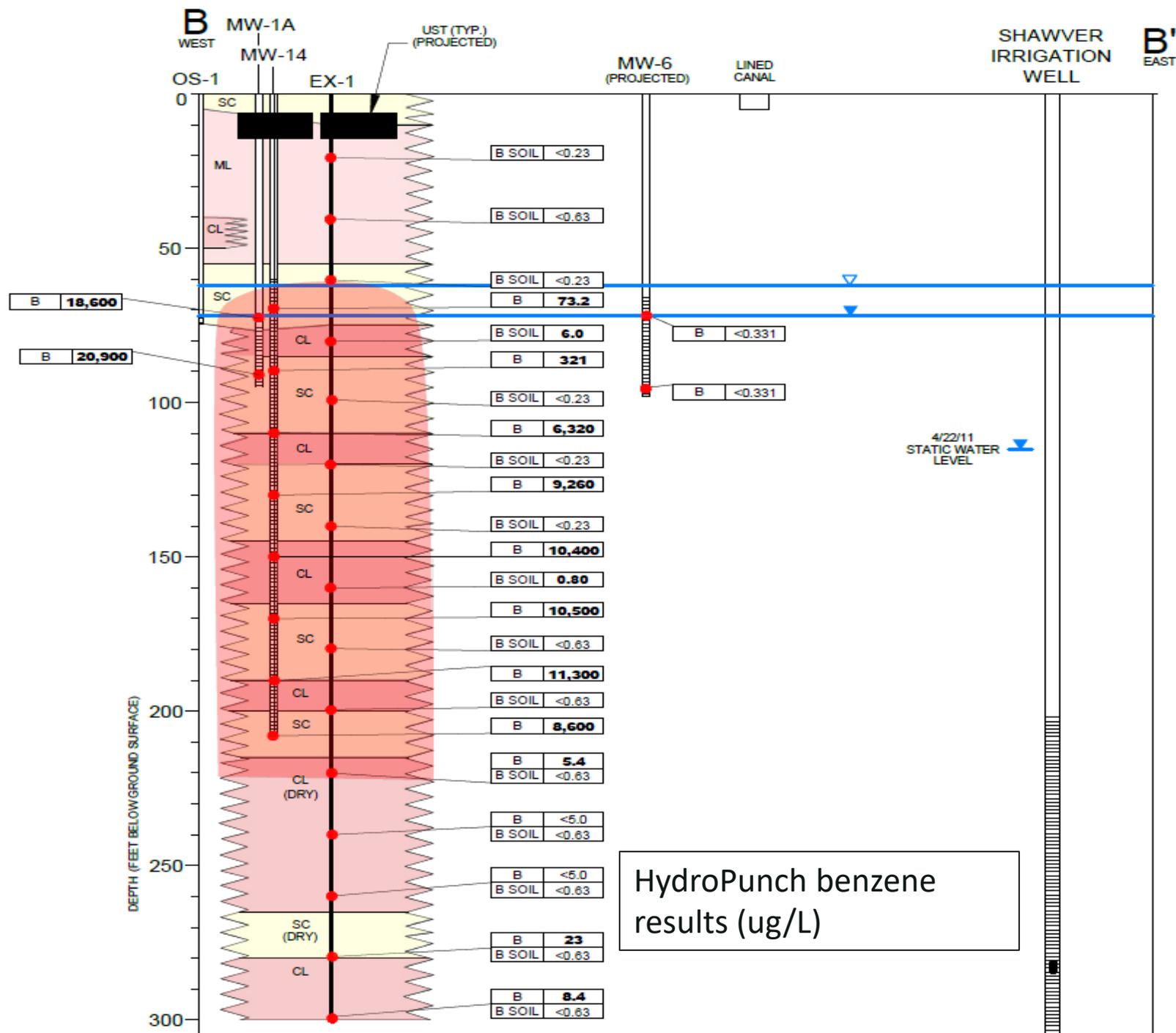
# Cross Section A-A' (N/S)

## Depth to Water:

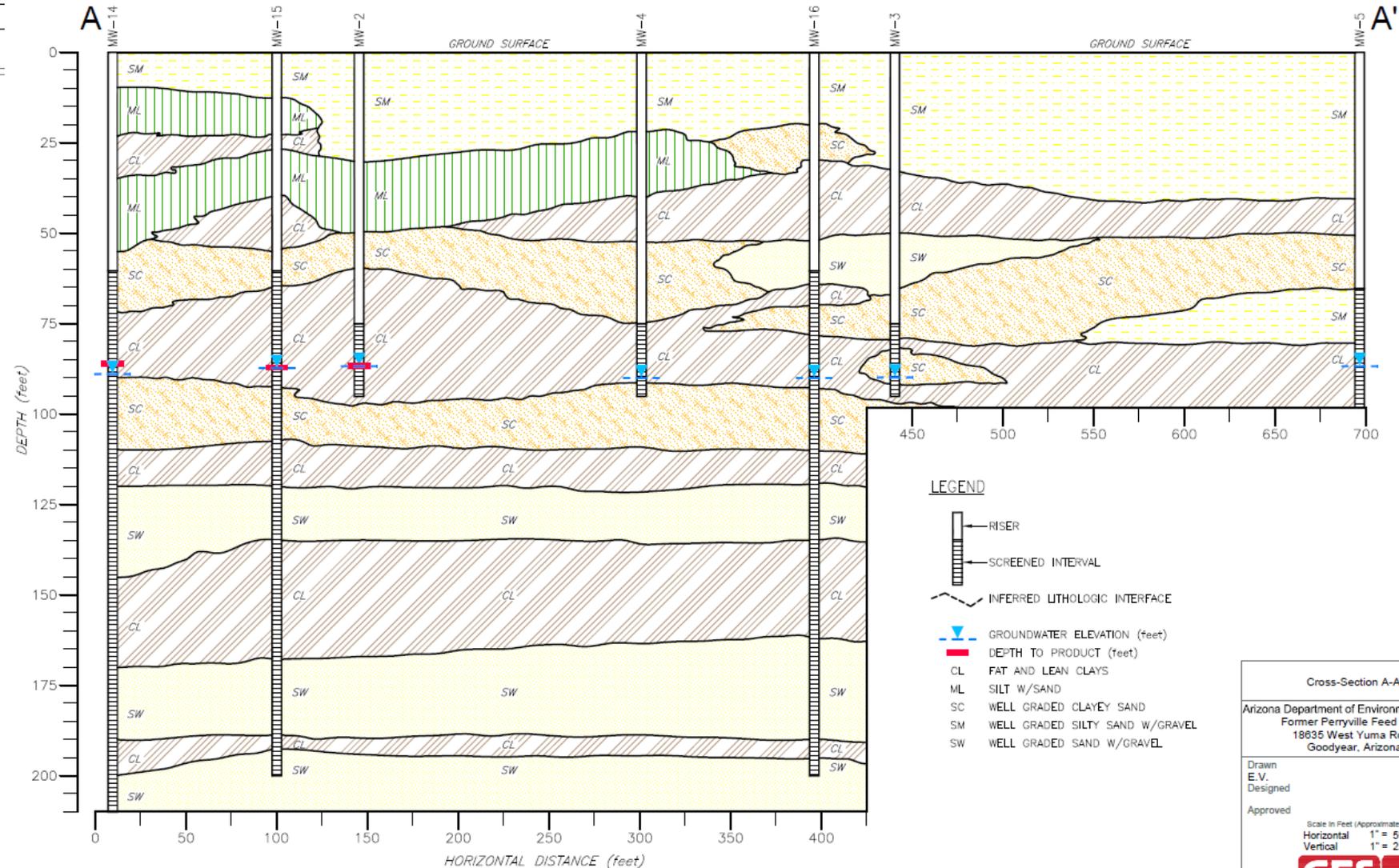
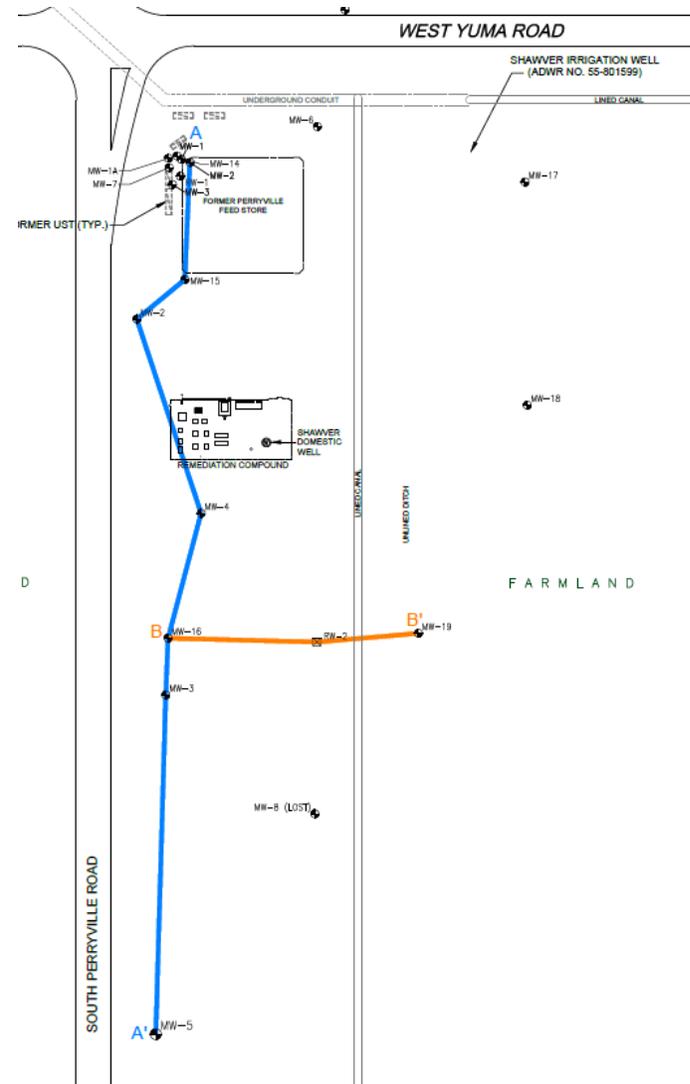
- DTW 2017 ~ 65 ft
- DTW 2021 ~ 75 ft
- DTW 2023 ~ 89 ft
- 2017-2023 DTW Decline ~ 24 ft
- Deepest Recorded DTW ~ 175 ft (ADWR 1954 to 1974)



# Cross Section B-B' Source Area (E/W)



# Geologic Cross-Section A-A' (N/S)



Cross-Section A-A'

Arizona Department of Environmental Quality  
Former Perryville Feed Store  
18835 West Yuma Road  
Goodyear, Arizona

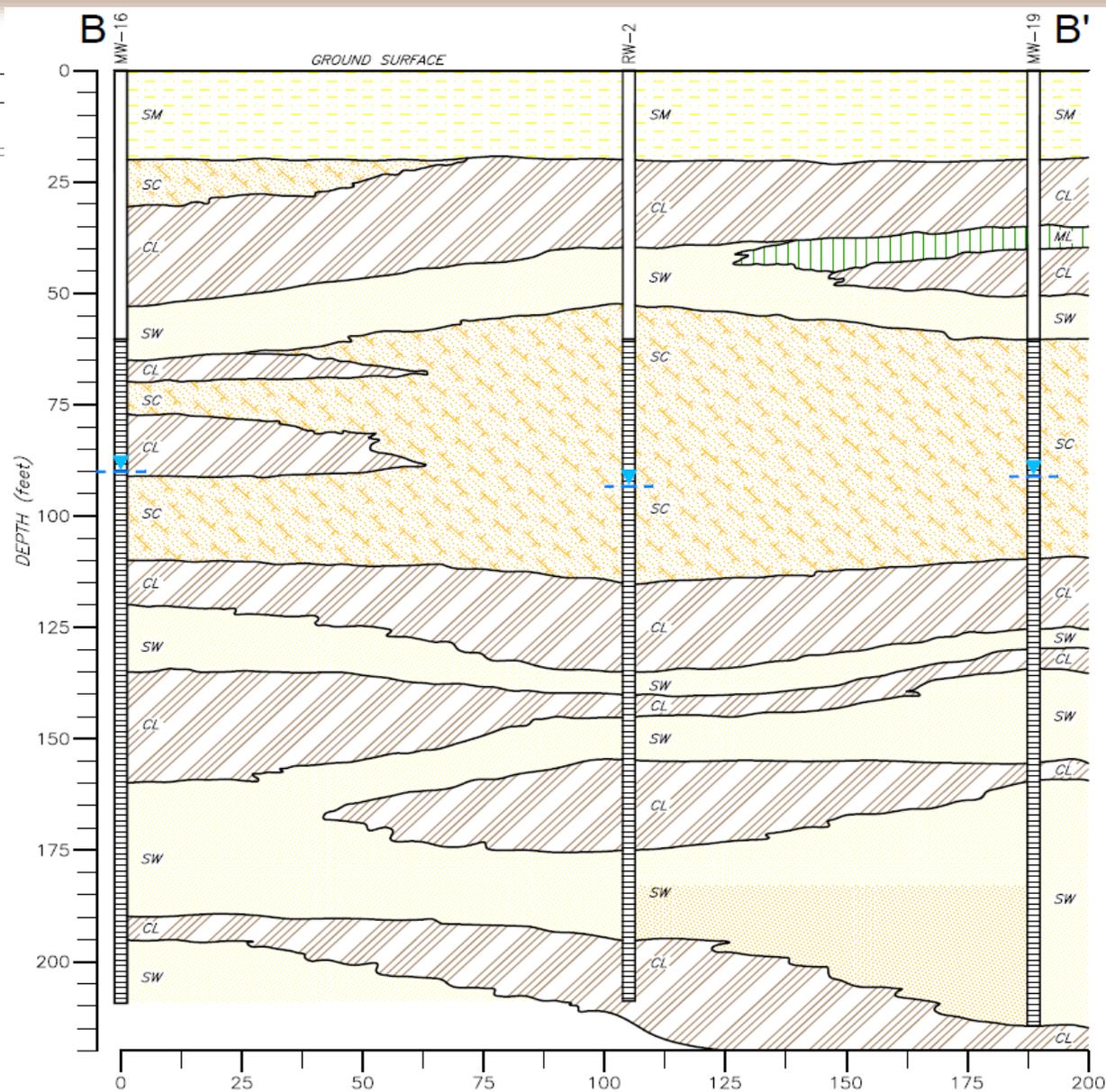
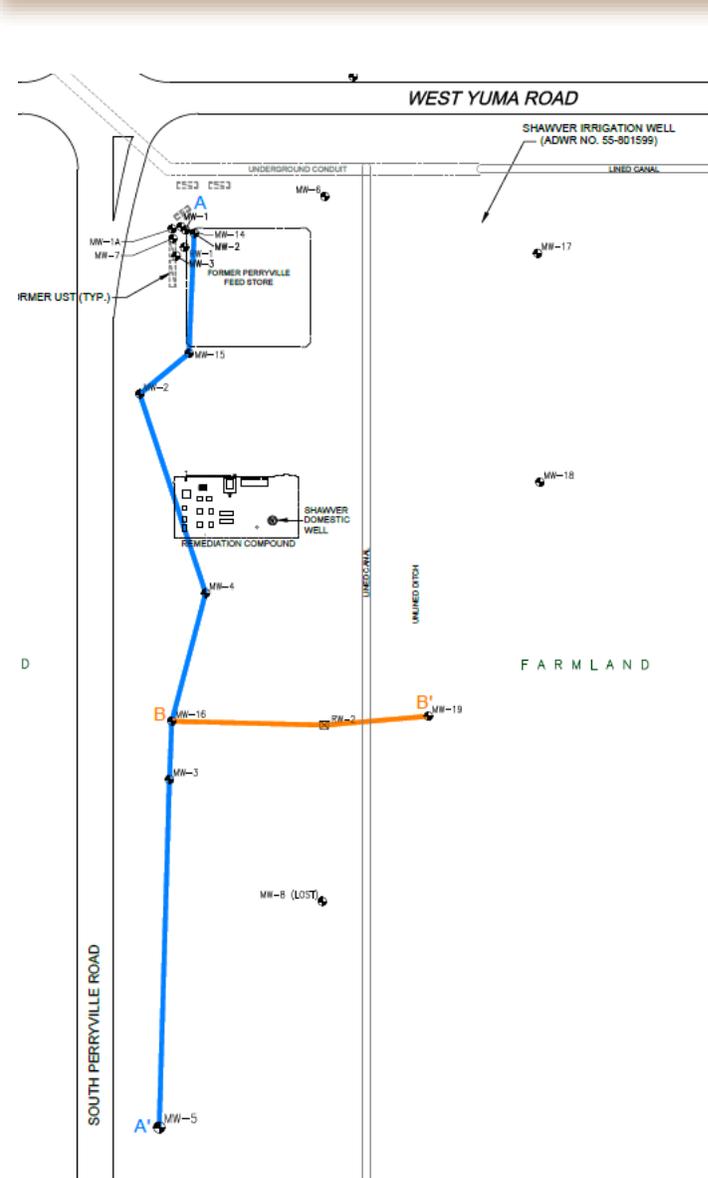
Drawn: E.V.  
Designed:  
Approved:

Date: 02/09/24  
Figure:

Scale in Feet (Approximate):  
Horizontal 1" = 50'  
Vertical 1" = 25'

**GESM**  
Groundwater & Environmental Services, Inc.

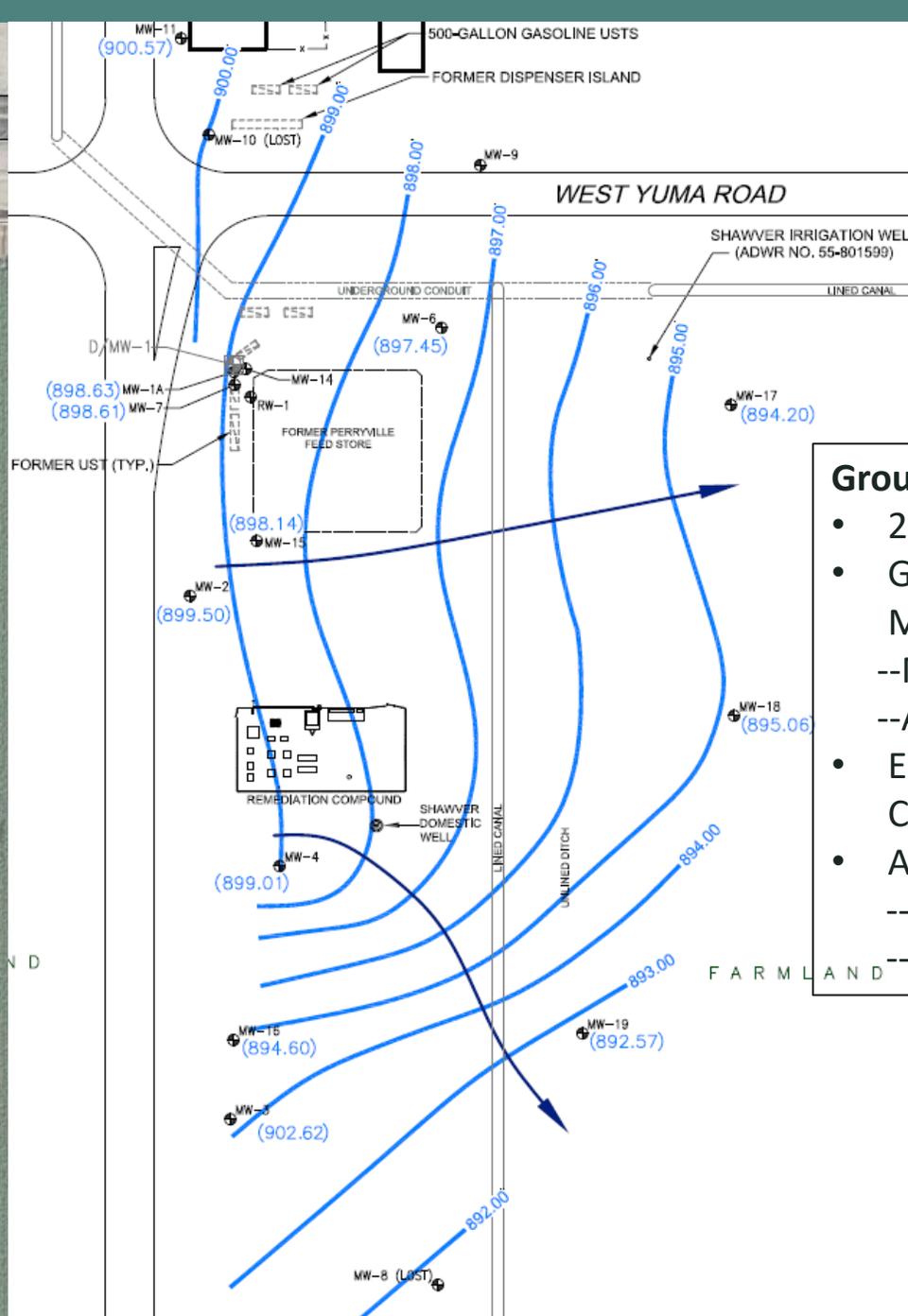
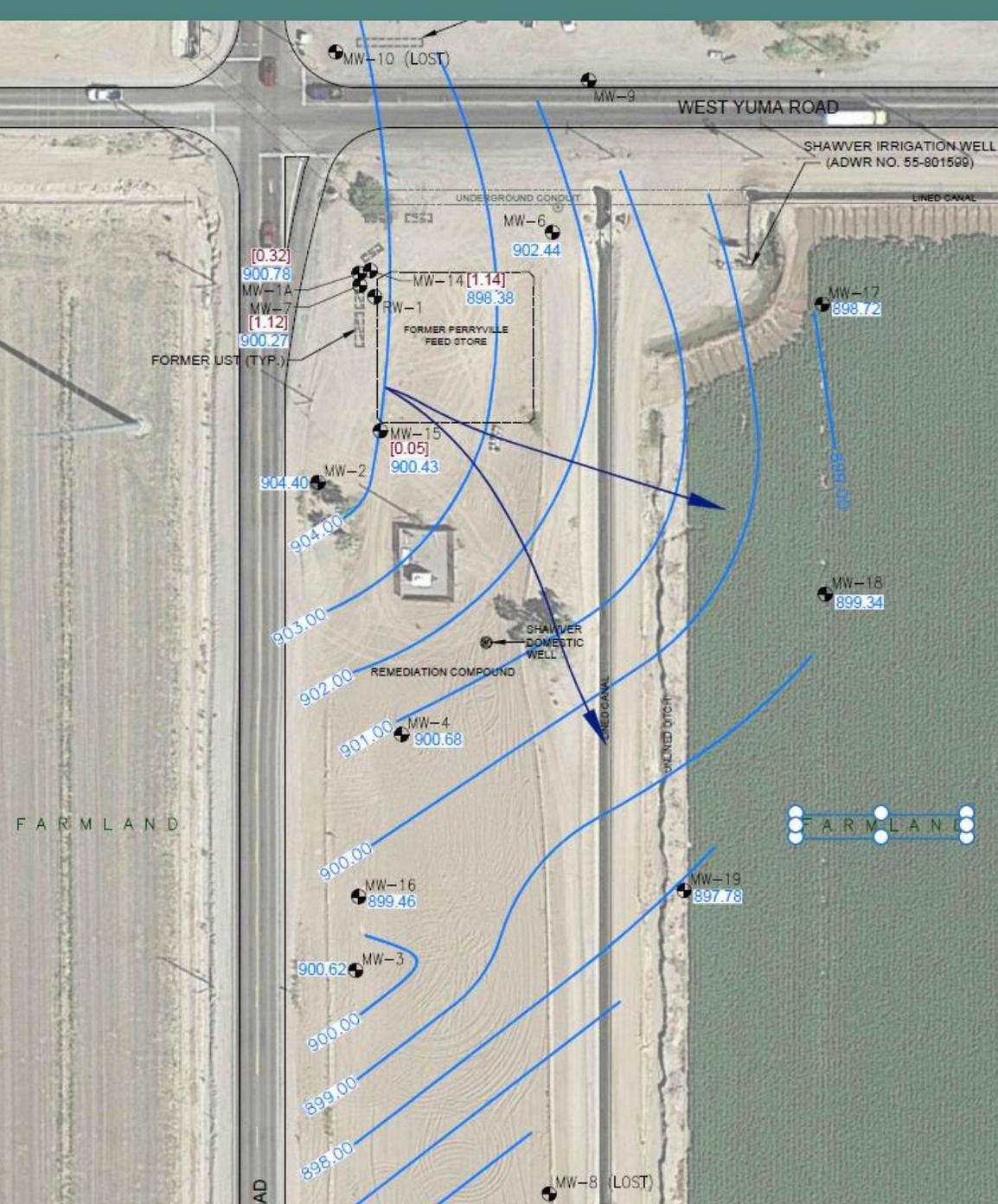
# Geologic Cross-Section B-B' (E/W)



## LEGEND

- RISER
  - SCREENED INTERVAL
  - INFERRED LITHOLOGIC INTERFACE
  - GROUNDWATER ELEVATION (feet)
- CL FAT AND LEAN CLAYS
  - ML SILT W/SAND
  - SC WELL GRADED CLAYEY SAND
  - SM WELL GRADED SILTY SAND W/GRAVEL
  - SW WELL GRADED SAND W/GRAVEL

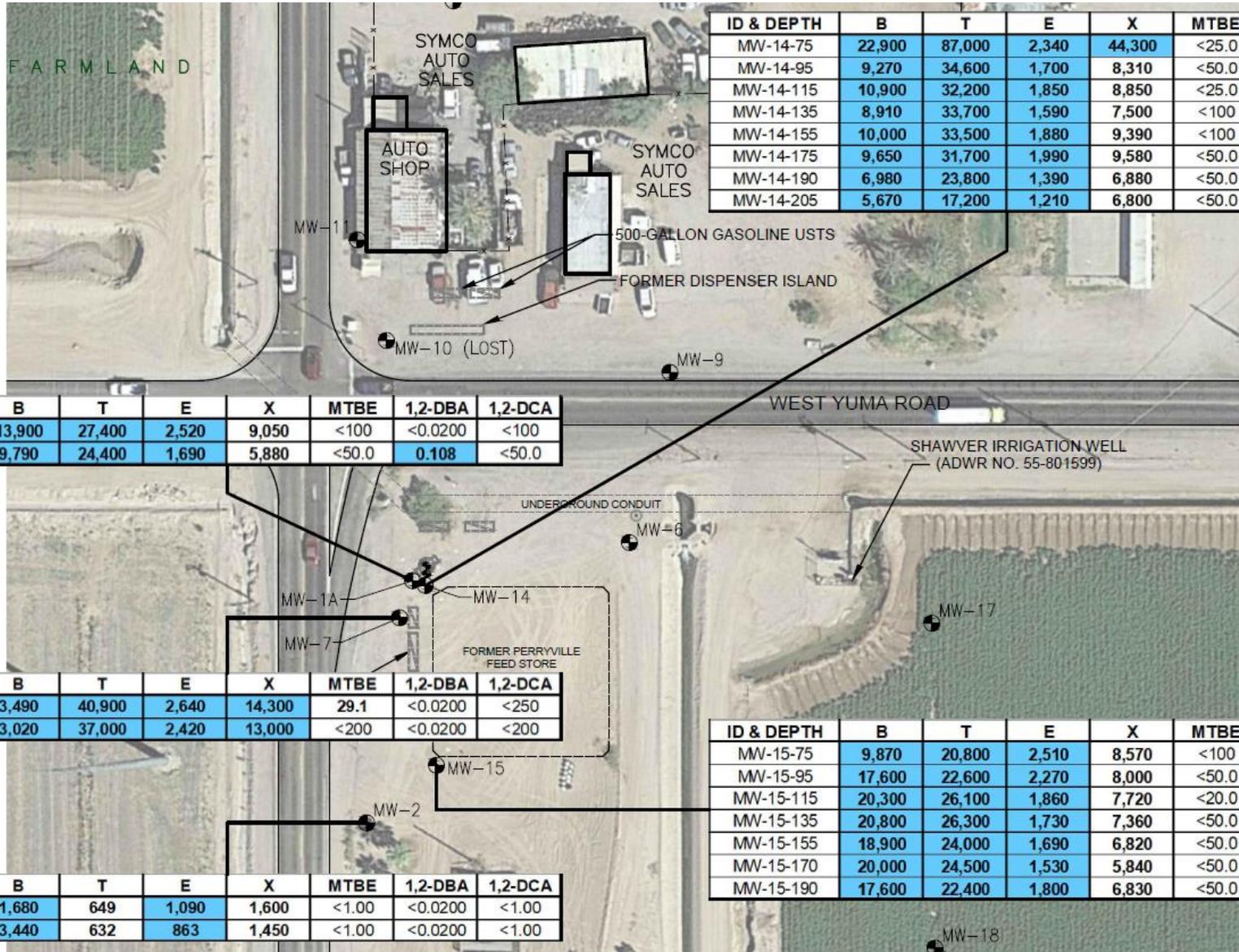
Cross-Section B-B'	
Arizona Department of Environmental Quality Former Perryville Feed Store 18635 West Yuma Road Goodyear, Arizona	
Drawn E.V.	Date 02/09/24
Designed	Figure
Approved	Scale In Feet (Approximate) Horizontal 1" = 25' Vertical 1" = 25'
Groundwater & Environmental Services, Inc.	



**Groundwater:**

- 20 Network MWs
- GW Level Contour Maps:
  - May 2021 (left)
  - Aug 2022 (right)
- E & SE GW Flow (2 Components)
- Ave Gradients:
  - S/SE = 0.034 feet/ft
  - East = 0.016 feet/ft

# GW Analytical Data (Aug 2020 - Baseline)



ID & DEPTH	B	T	E	X	MTBE	1,2-DBA	1,2-DCA
MW-14-75	22,900	87,000	2,340	44,300	<25.0	0.14	<25.0
MW-14-95	9,270	34,600	1,700	8,310	<50.0	0.23	<50.0
MW-14-115	10,900	32,200	1,850	8,850	<25.0	0.24	<25.0
MW-14-135	8,910	33,700	1,590	7,500	<100	0.23	<100
MW-14-155	10,000	33,500	1,880	9,390	<100	0.24	<100
MW-14-175	9,650	31,700	1,990	9,580	<50.0	0.22	<50.0
MW-14-190	6,980	23,800	1,390	6,880	<50.0	0.18	<50.0
MW-14-205	5,670	17,200	1,210	6,800	<50.0	0.16	<50.0

ID & DEPTH	B	T	E	X	MTBE	1,2-DBA	1,2-DCA
MW-1A-75	13,900	27,400	2,520	9,050	<100	<0.0200	<100
MW-1A-90	9,790	24,400	1,690	5,880	<50.0	0.108	<50.0

ID & DEPTH	B	T	E	X	MTBE	1,2-DBA	1,2-DCA
MW-7-75	3,490	40,900	2,640	14,300	29.1	<0.0200	<250
MW-7-90	3,020	37,000	2,420	13,000	<200	<0.0200	<200

ID & DEPTH	B	T	E	X	MTBE	1,2-DBA	1,2-DCA
MW-2-75	1,680	649	1,090	1,600	<1.00	<0.0200	<1.00
MW-2-90	3,440	632	863	1,450	<1.00	<0.0200	<1.00

ID & DEPTH	B	T	E	X	MTBE	1,2-DBA	1,2-DCA
MW-15-75	9,870	20,800	2,510	8,570	<100	13.9	<100
MW-15-95	17,600	22,600	2,270	8,000	<50.0	13.3	<100
MW-15-115	20,300	26,100	1,860	7,720	<20.0	15.4	<50.0
MW-15-135	20,800	26,300	1,730	7,360	<50.0	14.4	8.3
MW-15-155	18,900	24,000	1,690	6,820	<50.0	14.1	<50.0
MW-15-170	20,000	24,500	1,530	5,840	<50.0	13.4	<50.0
MW-15-190	17,600	22,400	1,800	6,830	<50.0	12.3	<50.0

**Dissolved Contamination:**

- Benzene Source Area:  
~3,000 to ~23,000 µg/L
- High BTEX to 205 ft bgs

# GW Contamination at MW-15



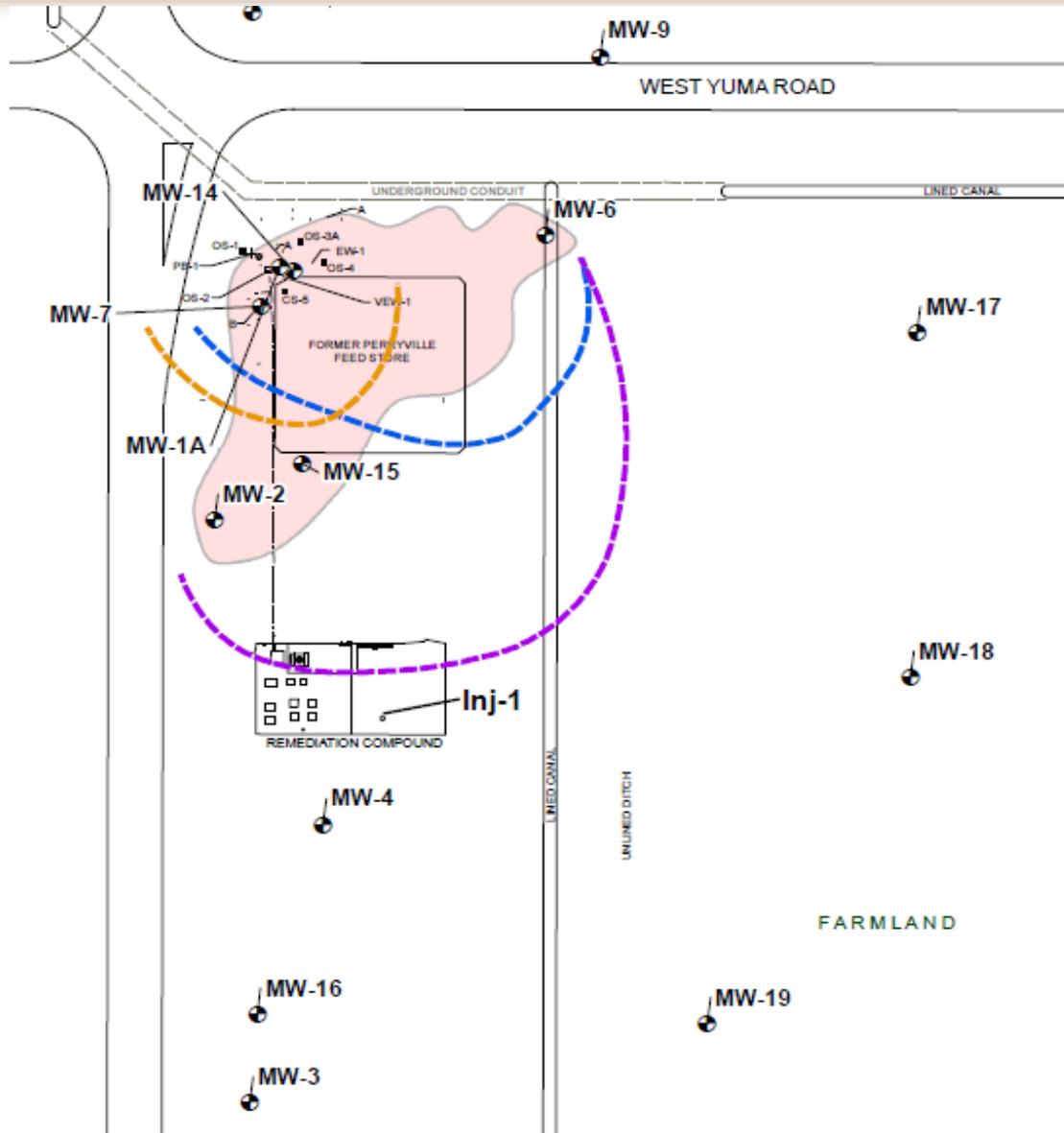
Well ID - Depth	Date	TOC (ft)	DTW (ft)	GWE (ft)	DTP (ft)	FPT (ft)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	MTBE (µg/L)
<b>ADEQ Aquifer Water Quality Standards (AWQS) (µg/L)</b>							<b>5.0</b>	<b>1,000</b>	<b>700</b>	<b>10,000</b>	<b>94</b>
MW-15-70 <sup>3</sup>	04/29/19	978.33	68.91	909.42	-	-	1.50	9.72	2.96	14.9	<0.367
MW-15-75	08/12/20	978.33	74.23	904.10	-	-	9,870	20,800	2,510	8,570	<100
MW-15-75	01/21/21	978.33	76.79	901.54	-	-	6,520	17,100	2,090	10,300	<250
MW-15-75	05/06/21	978.33	76.60	901.73	-	-	3,760	11,400	1,740	8,250	<250
MW-15-75	11/30/21	978.33	75.39	902.94	-	-	3,660	22,000	2,300	10,000	<100
MW-15-90 <sup>3</sup>	12/18/17	978.33	66.56	911.77	-	-	10,600	14,400	1,570	7,510	<50
MW-15-90 <sup>3</sup>	04/29/19	978.33	68.91	909.42	-	-	2,450	4,160	708	2,590	2.87
MW-15-95	08/12/20	978.33	74.23	904.10	-	-	17,600	22,600	2,270	8,000	<50.0
MW-15-95	01/21/21	978.33	76.79	901.54	-	-	13,300	24,500	1,930	9,540	<1000
MW-15-95	05/06/21	978.33	76.60	901.73	-	-	11,100	26,100	2,170	10,500	<1000
MW-15-95	11/30/21	978.33	75.39	902.94	-	-	5,710	35,700	2,570	11,500	<250
MW-15-95	12/28/23	978.33	87.32	891.01	87.17	0.15	4300	7800	1400	6300	5.40
MW-15-100 <sup>3</sup>	12/18/17	978.33	66.56	911.77	-	-	9,580	12,800	1,440	6,670	<50
MW-15-100 <sup>3</sup>	04/29/19	978.33	68.91	909.42	-	-	4,730	8,150	1,440	4,550	7.39
MW-15-115	08/12/20	978.33	74.23	904.10	-	-	20,300	26,100	1,860	7,720	<20.0
MW-15-115	01/21/21	978.33	76.79	901.54	-	-	12,600	20,800	1,670	8,370	<1000
MW-15-115	05/06/21	978.33	76.60	901.73	-	-	10,700	22,200	1,840	8,540	<1000
MW-15-115	11/30/21	978.33	75.39	902.94	-	-	4,980	31,400	2,100	9,120	<250
MW-15-130 <sup>3</sup>	12/18/17	978.33	66.56	911.77	-	-	7,380	9,240	840	4,200	<50
MW-15-130 <sup>3</sup>	04/29/19	978.33	68.91	909.42	-	-	5,290	8,940	1,760	4,910	8.02

# GW Contamination at MW-15 (cont...)

Well ID - Depth	Date	TOC (ft)	DTW (ft)	GWE (ft)	DTP (ft)	FPT (ft)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	MTBE (µg/L)
<b>ADEQ Aquifer Water Quality Standards (AWQS) (µg/L)</b>							<b>5.0</b>	<b>1,000</b>	<b>700</b>	<b>10,000</b>	<b>94</b>
MW-15-135	08/12/20	978.33	74.23	904.10	-	-	20,800	26,300	1,730	7,360	<50.0
MW-15-135	01/21/21	978.33	76.79	901.54	-	-	12,000	20,400	1,650	8,450	<1000
MW-15-135	05/06/21	978.33	76.60	901.73	-	-	10,300	22,100	1,730	8,570	<1000
MW-15-135	11/30/21	978.33	75.39	902.94	-	-	5,240	32,900	2,200	9,780	<250
MW-15-150 <sup>3</sup>	12/18/17	978.33	66.56	911.77	-	-	7,130	8,740	809	3,690	16.2 <sup>J</sup>
MW-15-150 <sup>3</sup>	04/29/19	978.33	68.91	909.42	-	-	4,720	7,970	1,480	4,520	7.25
MW-15-155	08/12/20	978.33	74.23	904.10	-	-	18,900	24,000	1,690	6,820	<50.0
MW-15-155	01/21/21	978.33	76.79	901.54	-	-	14,500	22,400	1,900	9,780	<1000
MW-15-155	05/06/21	978.33	76.60	901.73	-	-	8,460	18,200	1,600	8,020	<1000
MW-15-155	11/30/21	978.33	75.39	902.94	-	-	4,450	27,800	1,870	8,120	<250
MW-15-155	12/28/23	978.33	87.32	891.01	87.17	0.15	1600	4700	1100	5900	<1.00
MW-15-170 <sup>s</sup>	12/18/17	978.33	66.56	911.77	-	-	6,980	8,570	820	3,920	<50
MW-15-170 <sup>3</sup>	04/29/19	978.33	68.91	909.42	-	-	5,440	9,030	1,730	4,990	10.1
MW-15-170	08/12/20	978.33	74.23	904.10	-	-	20,000	24,500	1,530	5,840	<50.0
MW-15-170	01/21/21	978.33	76.79	901.54	-	-	12,900	21,300	1,810	8,690	<1000
MW-15-170	05/06/21	978.33	76.60	901.73	-	-	9,340	21,800	1,600	8,020	<1000
MW-15-170	11/30/21	978.33	75.39	902.94	-	-	4,490	28,300	1,980	8,620	<200
MW-15-190	08/12/20	978.33	74.23	904.10	-	-	17,600	22,400	1,800	6,830	<50.0
MW-15-190	01/21/21	978.33	76.79	901.54	-	-	16,300	23,300	2,030	9,500	<1000
MW-15-190	05/06/21	978.33	76.60	901.73	-	-	9,590	23,600	1,850	8,280	<1000
MW-15-190	11/30/21	978.33	75.39	902.94	-	-	4,410	27,700	2,030	9,050	<200
MW-15-190	12/28/23	978.33	87.32	891.01	87.17	0.15	1800	8600	1600	8,200	<1.00

- GW remediation: 1) P&T to contain/control plume migration + deep contaminant flushing; 2) SVE to remove contaminant mass from upper portion of “smear zone”; 3) manual LNAPL recovery
- Why P&T? Impacted zone thickness renders other “traditional” remediation strategies (air sparging, ISCO, bio-injection) infeasible or impractical
- P&T addresses saturated ~150 ft thick “smear zone” (~70 - 220 ft bgs) characterized at source to at least MW-15 downgradient
- ReInjection of treated GW serves as hydraulic barrier against further plume migration
- GW drawdown exposes top of “smear zone” enabling SVE mass removal
- System is expandable (can add EWs & SVE wells, automate LNAPL recovery)

# P&T: Source Area RW-1 Capture



**Legend**

- Wells
- Well Capture Zone**
  - 100 GPM
  - 75 GPM
  - 55 GPM
- Approximate Impact Extent above AWQS

**8 Wells w/Pressure Transducers to Asses CZ:**

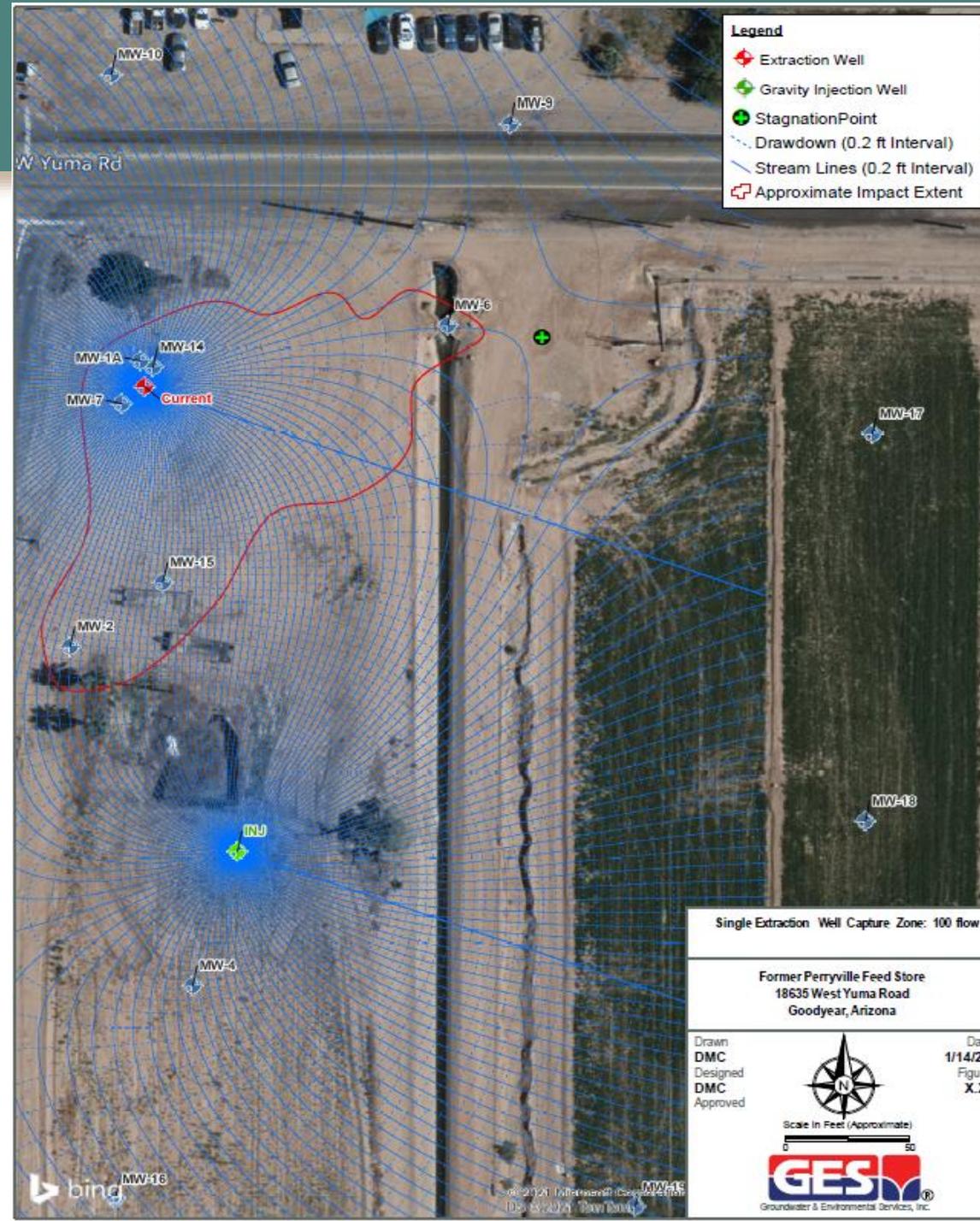
- EW-1, INJ-1
- MW-2, MW-4, MW-7, MW-14, MW-15, MW-19

**P&T Objectives:**

- Containment to prevent plume migration offsite
- COC concentration reduction (mass removal) over time

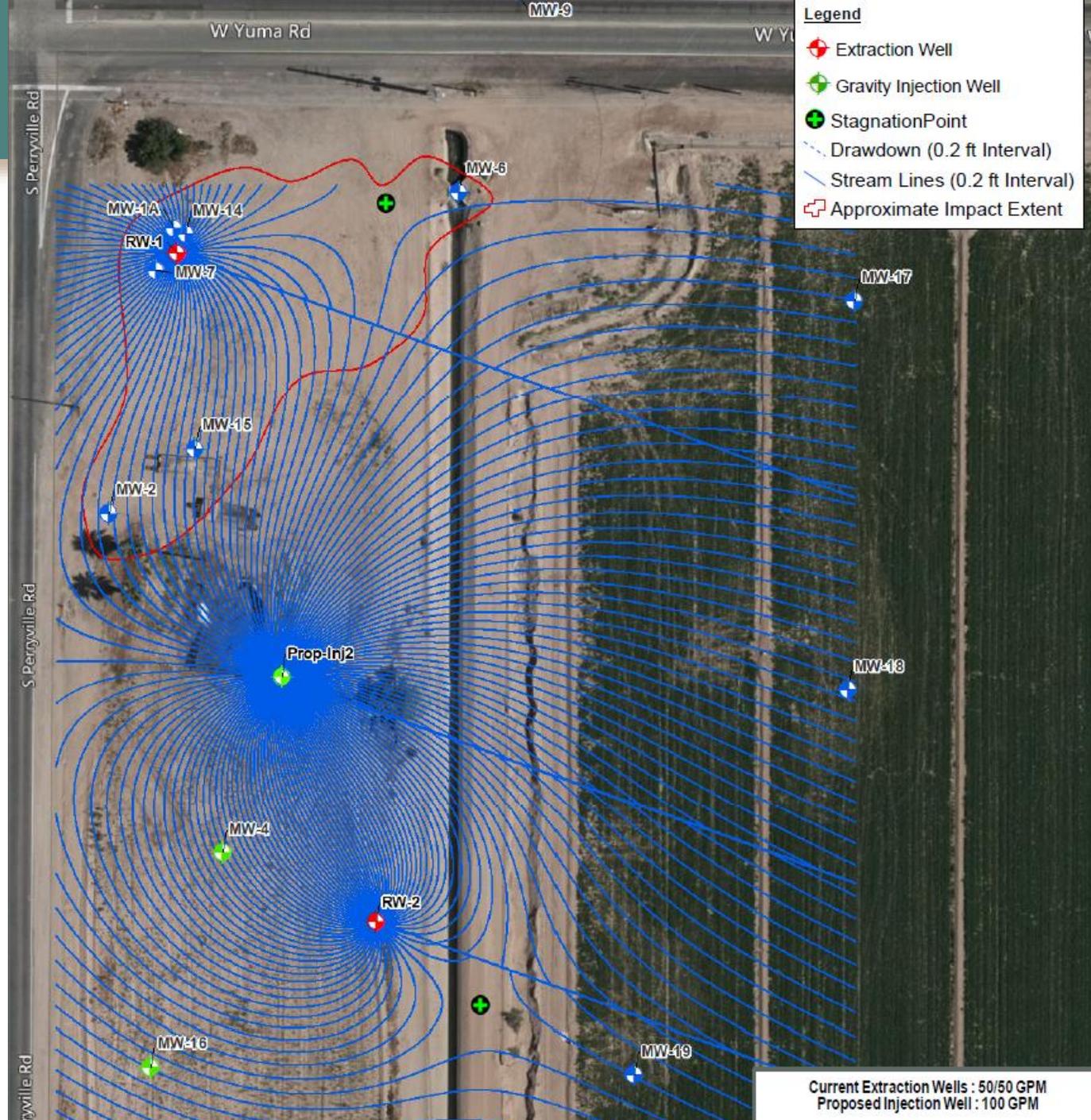
# P&T: Capture Zone Simulation

- 100 GPM Pumping of RW-1



# P&T: Capture Zone Simulation

- 50/50 GPM Pumping of RW-1 and RW-2



# P&T System Process Diagram

## LEGEND

- LGAC: LIQUID PHASE GRANULAR ACTIVATED CARBON
- V.GAC: VAPOR PHASE GRANULAR ACTIVATED CARBON
- S.T.A.S.: SHALLOW TRAY AIR STRIPPER
- CHECK VALVE
- PG PRESSURE GAUGE
- ⊙ SAMPLE PORT
- FM FLOWMETER / TOTALIZER
- ▽ FLOW CONTROL VALVE
- PROCESS AIR FLOW
- PROCESS WATER FLOW

## EQUIPMENT SPECIFICATIONS

S.T.A.S.: QED ENVIRONMENTAL SYSTEMS QED-12.4HF: 1-120 GALLONS PER MINUTE; 304 STAINLESS STEEL TRAYS.

METERED ANTI-SCALANT PUMP: GRACO MONGOOSE ELECTRONIC LOW PRESSURE METERING PUMP; 30 GALLONS PER DAY MAXIMUM FLOW. POLYVINYLIDENE FLUORIDE PUMP MATERIALS, SEALS, CHECKS AND LIQUID CONTACTING MATERIALS.

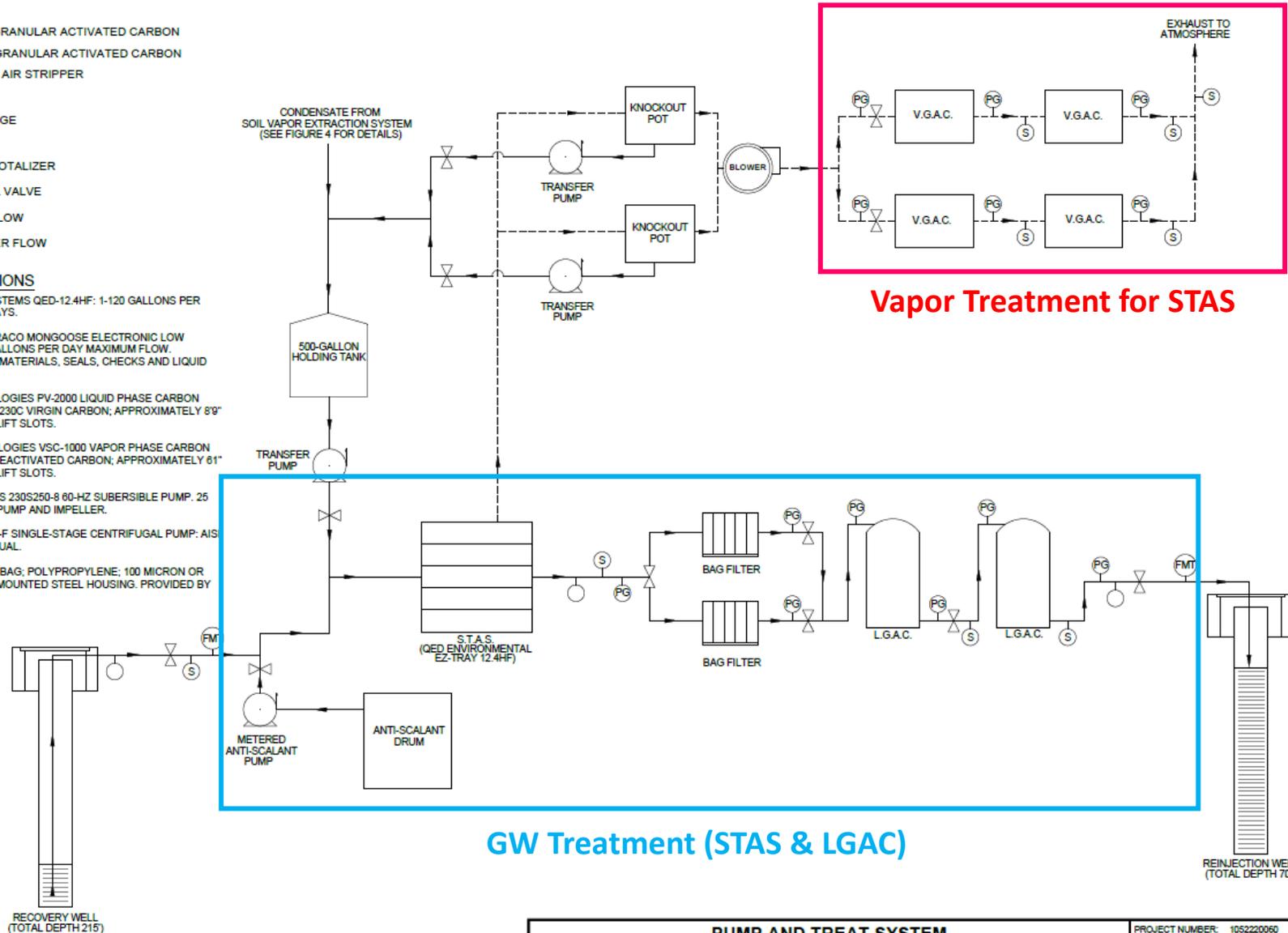
L.G.A.C.: EVOQUA WATER TECHNOLOGIES PV-2000 LIQUID PHASE CARBON ADSORBER WITH AQUACARB® AC1230C VIRGIN CARBON; APPROXIMATELY 8'9" HEIGHT ON 4' X 4' SKID WITH FORKLIFT SLOTS.

V.G.A.C.: EVOQUA WATER TECHNOLOGIES VSC-1000 VAPOR PHASE CARBON ADSORBER WITH VOCARB® VC-S REACTIVATED CARBON; APPROXIMATELY 61" HEIGHT ON 4' X 4' SKID WITH FORKLIFT SLOTS.

RECOVERY WELL PUMP: GRUNDFOS 230S250-8 60-HZ SUBSERSIBLE PUMP, 25 HORSEPOWER; STAINLESS STEEL PUMP AND IMPELLER.

TRANSFER PUMP: G&L PUMPS NPE-F SINGLE-STAGE CENTRIFUGAL PUMP; AIS TYPE 316 STAINLESS STEEL OR EQUAL.

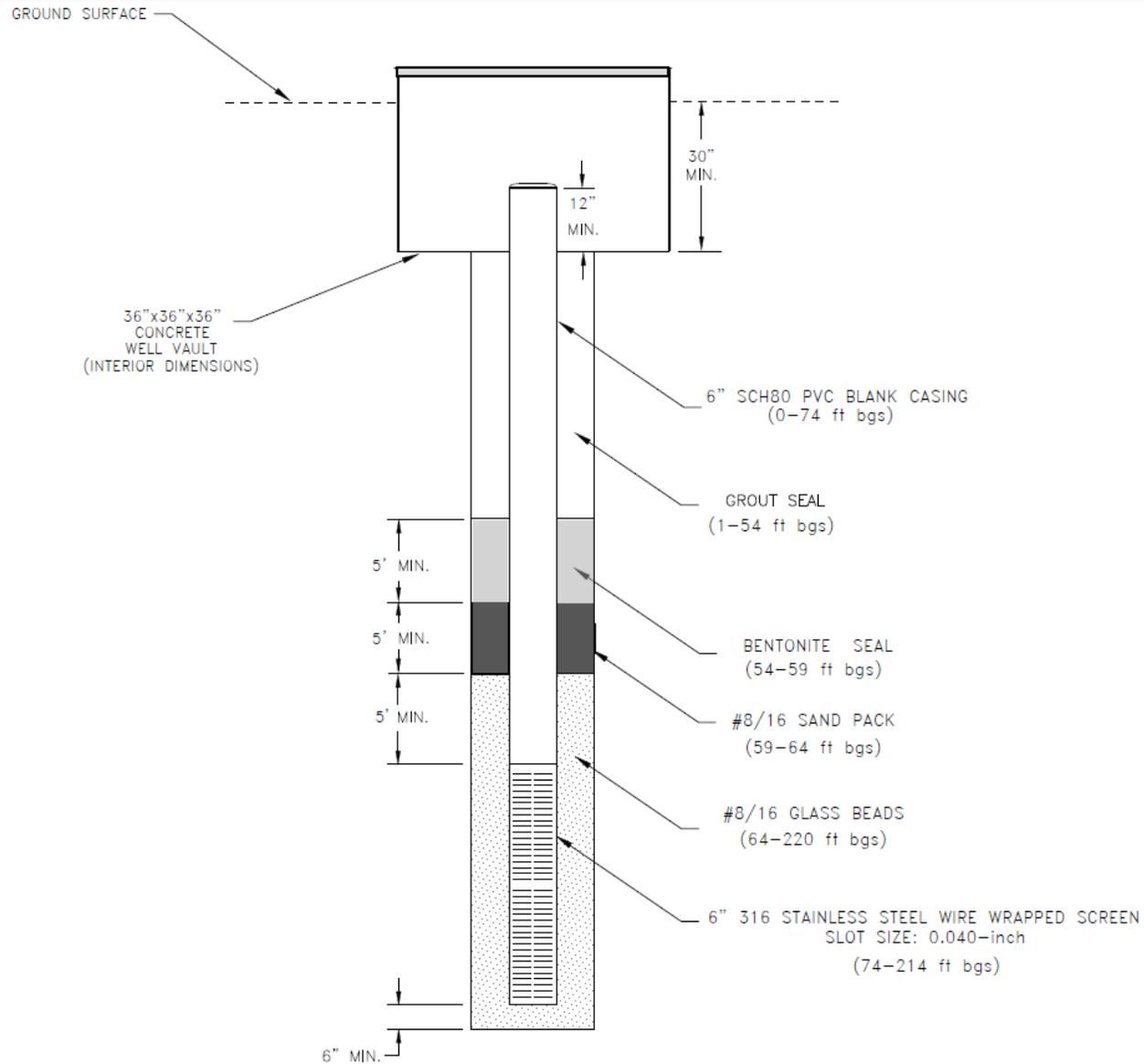
BAG FILTER: PENTAIR FELT FILTER BAG; POLYPROPYLENE; 100 MICRON OR EQUAL. INSTALL IN CUSTOM, SKID-MOUNTED STEEL HOUSING. PROVIDED BY QED.



**GW Treatment (STAS & LGAC)**

**Vapor Treatment for STAS**

# Reinjection Well INJ-2



## As-Built INJ-2:

- 6" Sch 80 PVC blank casing (0 to 74 ft)
- 6" dia SS wire wrapped screen (74 to 214 ft)
- Grout seal (1 to 54 ft)
- Bentonite seal (54 to 59 ft)
- #8/16 CSS sand pack (59 to 64 ft)
- #8/16 glass beads filter pack (64 to 220 ft bgs)

- Three source area SVE wells; screen intervals:
  - MW-1A: 75'-95'
  - MW-7: 54'-94'
  - MW-14: 60'-210'
- Nominal 250 cfm capacity Thermox unit; propane-fired
- Removes/volatilizes NAPL that's not manually recovered
- In combination with P&T and site declining water levels (~12' over the past 2 years), removes contaminant mass from upper portion of "smear zone"
- Observed remediation rates since start-up in April 2022:
  - 6.7 - 276 lbs/day TVH as GRO
  - 0.24 - 2.7 lbs/day benzene



# Sediment Filters, Air Stripper, Process Pipe



# P&T Shallow-Tray Air Stripper (STAS)



# LGAC, VGAC Vessels & Discharge Stack



# Reinjection Well Vault and Casing (INJ-1)



# Reinjection Well Vault, Casing, and LNAPL (INJ-2)



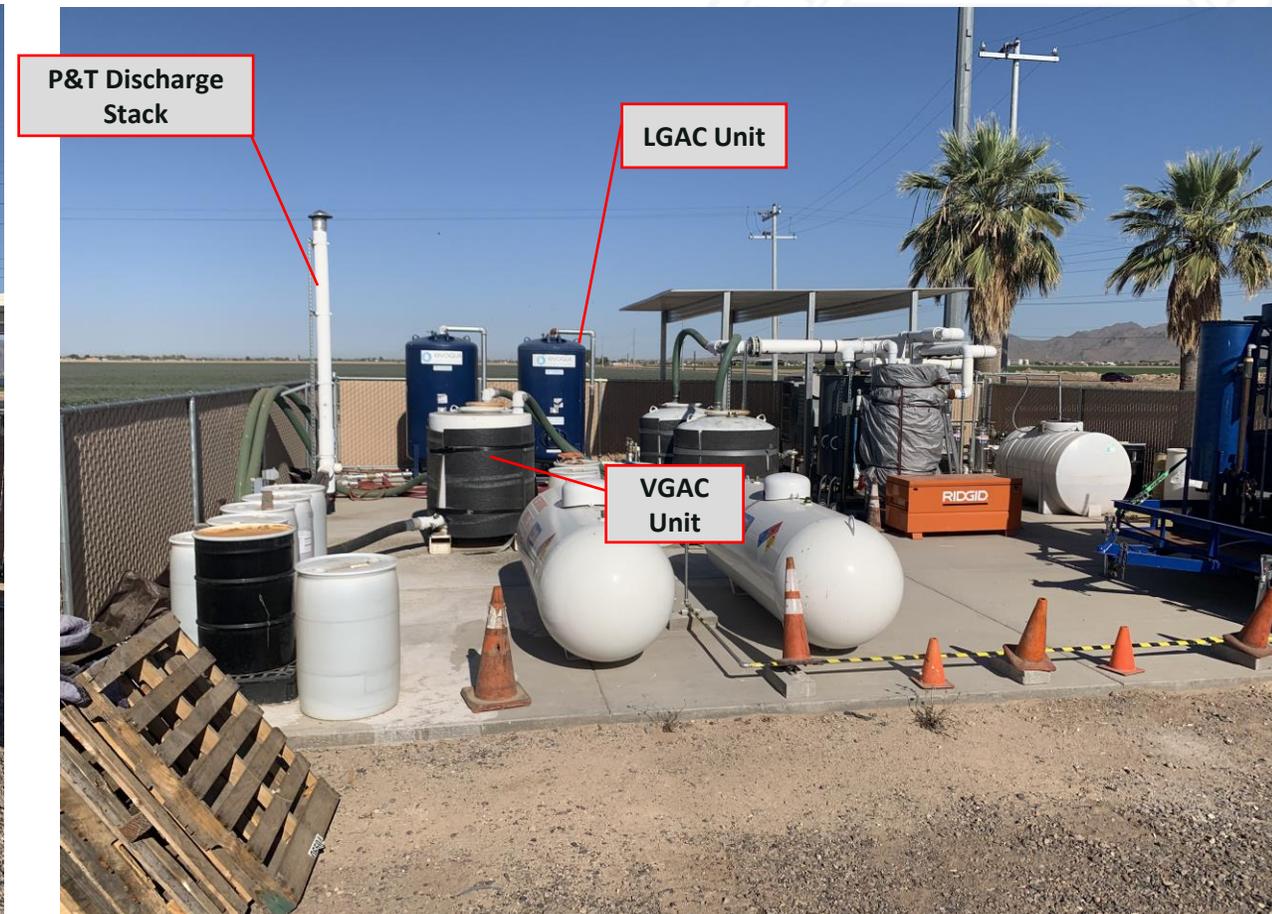
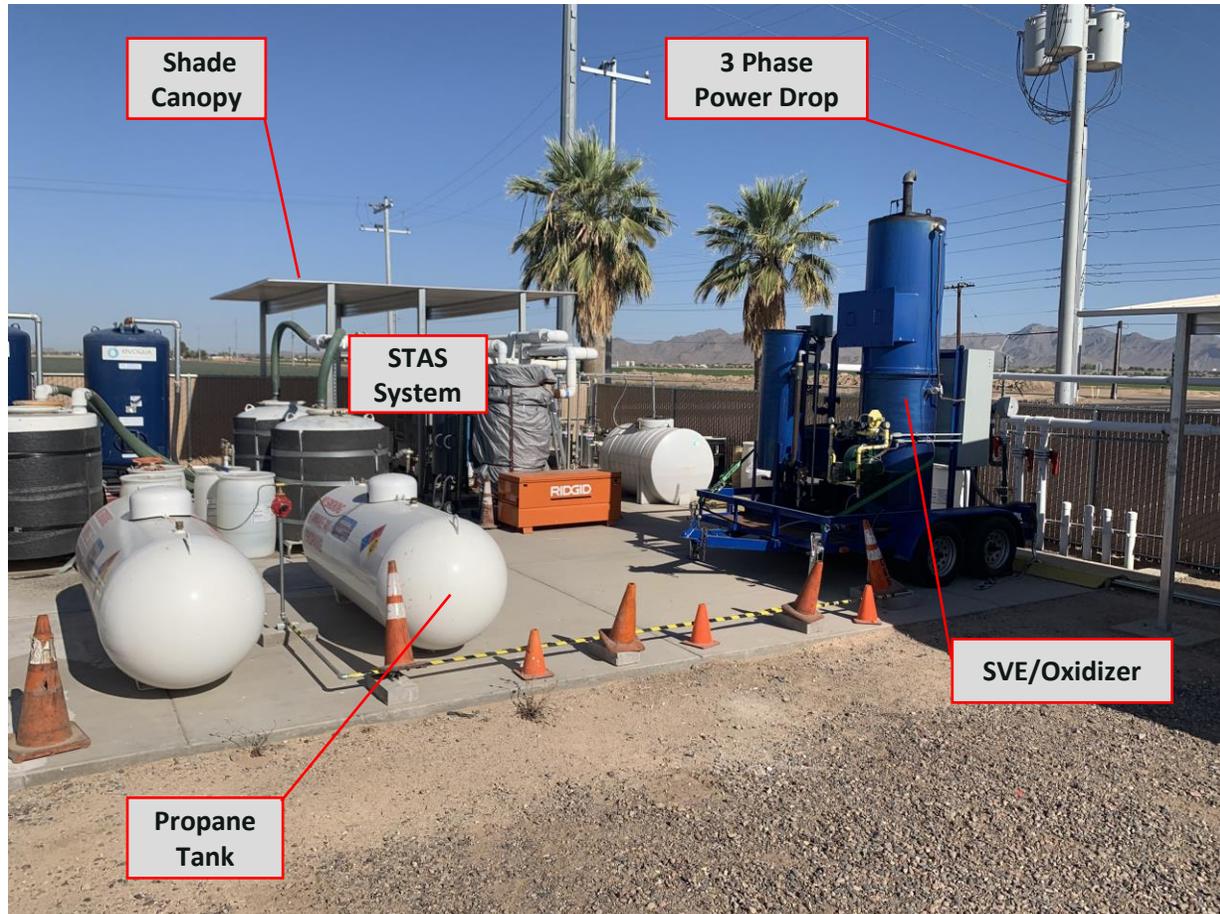


## Soil Vapor Extraction (SVE)

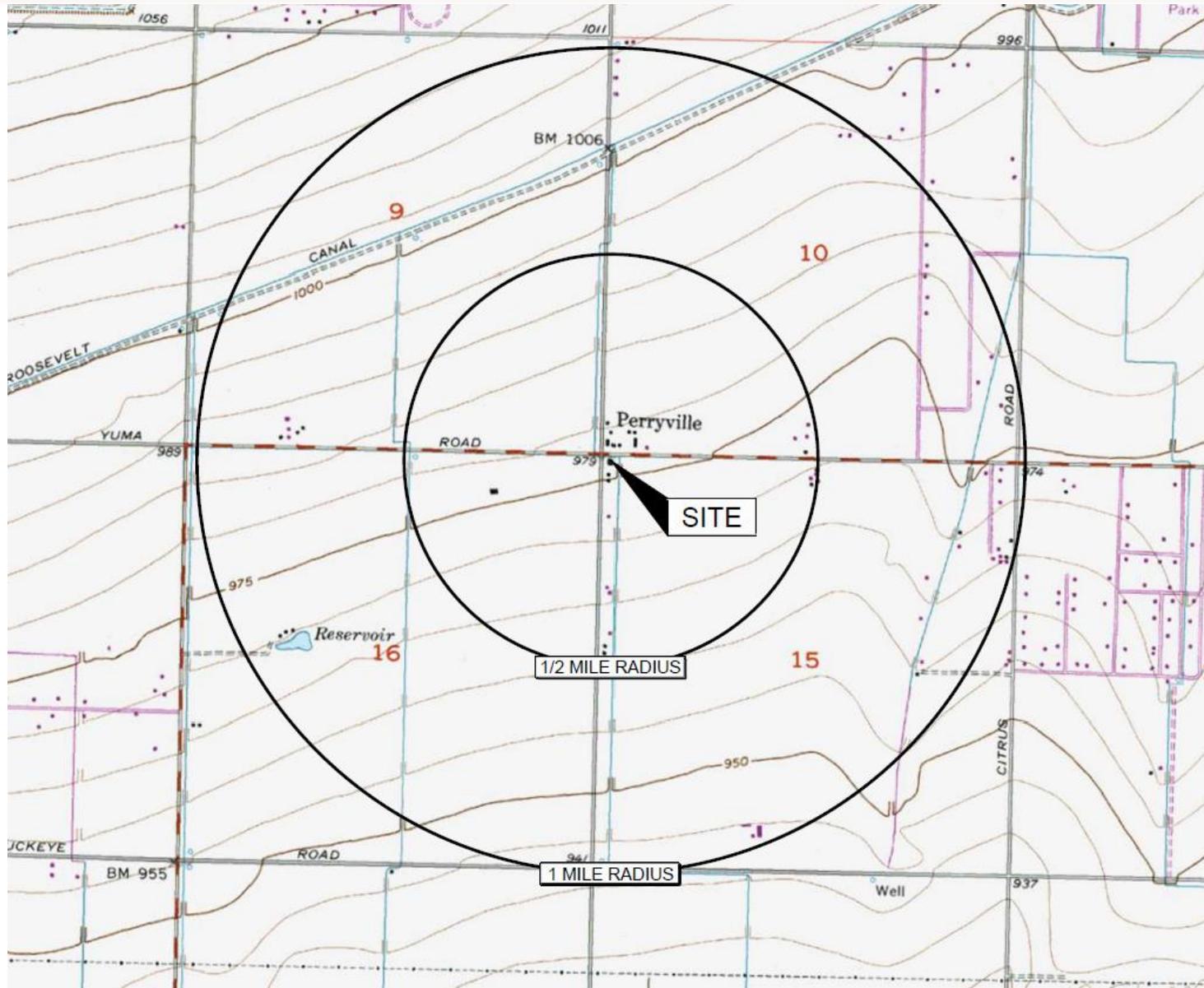
### Thermal/Catalytic Oxidizer Unit:

- ADEQ SVEU General Air Permit
- 250 cfm nominal extraction capacity
- > 95% contaminant destruction efficiency
- Propane-fired
- Multiple fail-safes
- Operates with or without P&T

# Treatment Plant (facing west)



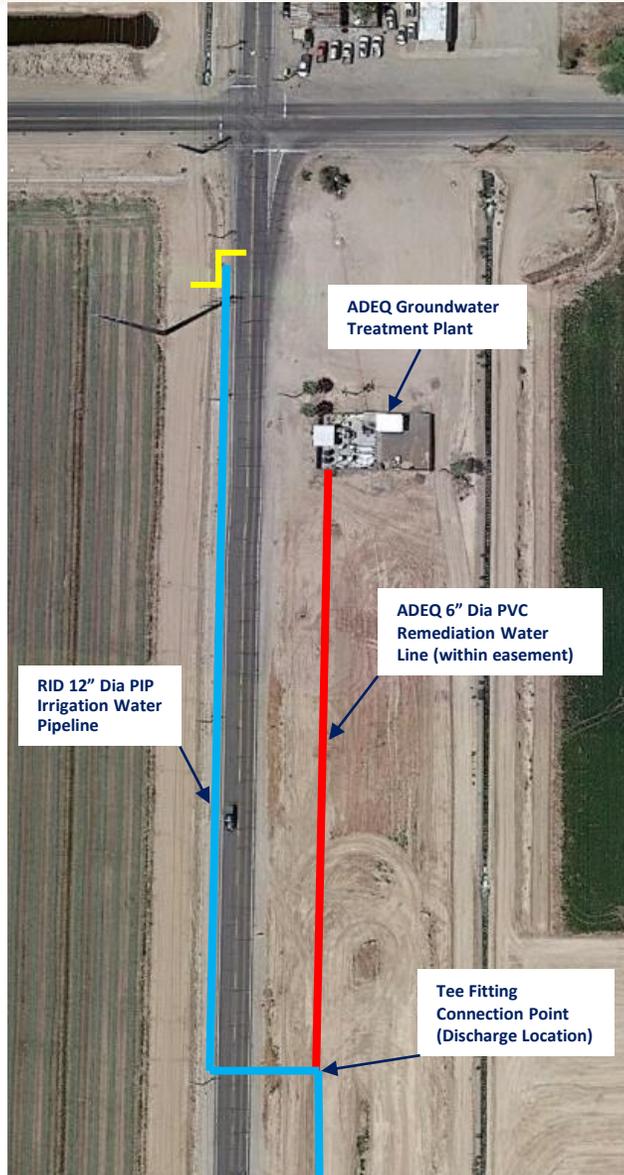
# Discharge Alternative: Roosevelt Irrigation District (RID)



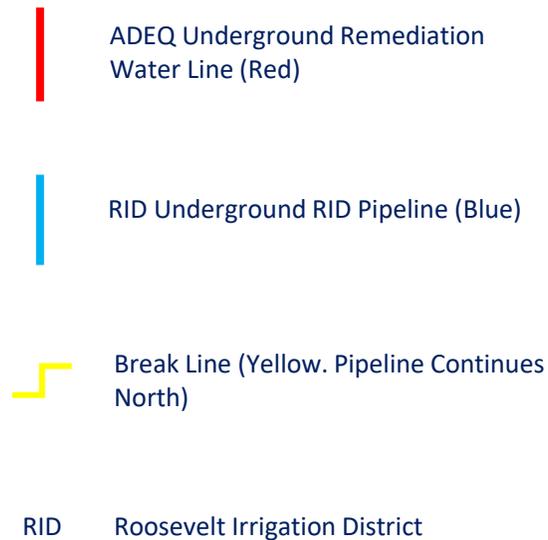
## Discharge Alternative:

- RID Main Canal is  $\frac{3}{4}$ -mile north
- Tie-in to RID system
- AZPDES permit
- Boron TMDL (problematic)
- RID Discharge Agreement

# Potential Connection to RID Pipeline



## Conceptual Plan for Tie-In Connection

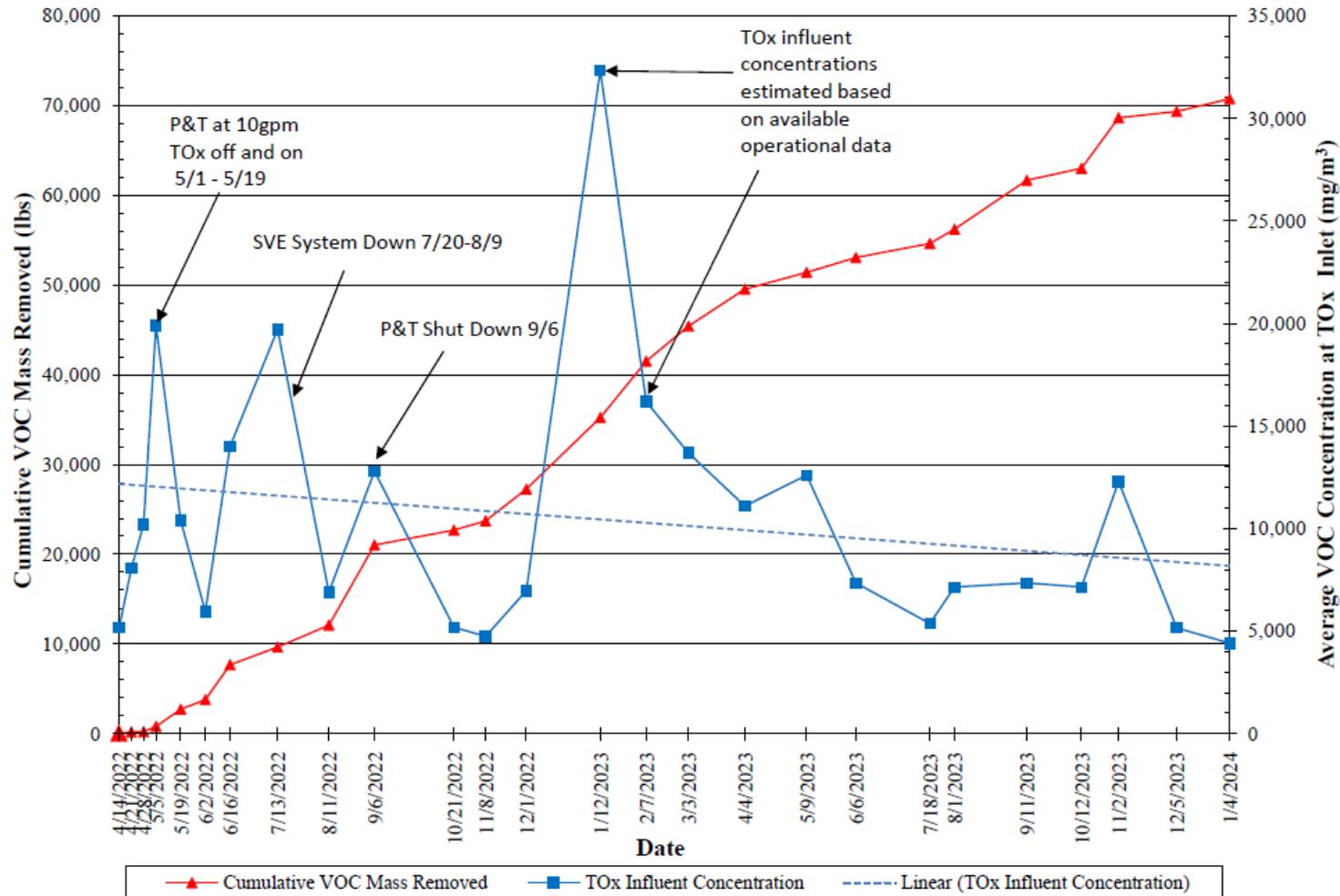


### Sustainable Solution:

- Relatively low flow of treated continuous discharge (~100 gpm)
- Would serve as primary means of discharge
- Potentially eliminate need to replace IWs and/or minimize IW maintenance
- IWs would serve for back-up use (periods of canal & pipeline maintenance)
- Would facilitate more reliable plume capture by maintaining remedy pumping rate

# SVE Performance (Mid April 2022 – Early Jan 2024)

**CUMULATIVE VOC MASS REMOVED AND TO<sub>x</sub> INFLUENT CONCENTRATIONS**  
Former Perryville Feed Store  
18635 West Yuma Road, Goodyear, Arizona

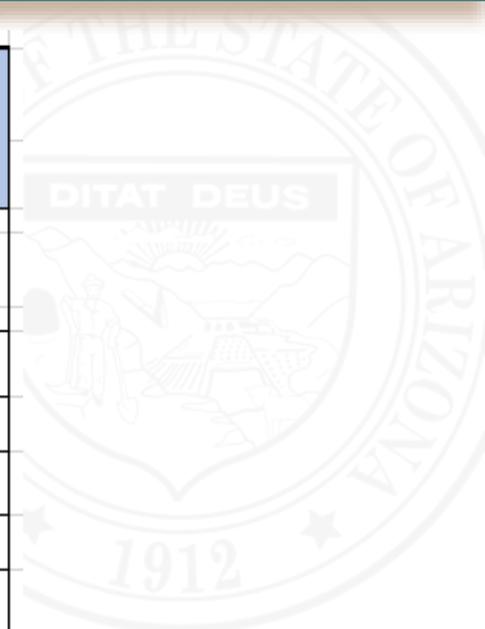


**Mass Removed:**

- 70,750 lbs TVH
- ~10,885 equivalent gals of gasoline

<b>CONTAMINANT MASS REMOVAL BY REMEDIAL PROCESS</b>			
<b>Former Perryville Feed Store Site, Goodyear, AZ</b>			
<b>Technology</b>	<b>Date Range</b>	<b>Amount (lbs)</b>	<b>Amount (gals)*</b>
SVE & LNAPL Recovery	Early to Mid - 1990s	103,890	15,983
P&T	Jan 2021 - Sept 2022	2,905	447
LNAPL Recovery	April 2022 - Dec 2023	3,263	502
SVE	April 2022 - Dec 2023	70,753	10,885
<b>Totals</b>	<b>---</b>	<b>180,811</b>	<b>27,817</b>

Notes:  
 lbs = pounds  
 gals = gallons  
 LNAPL = light non-aqueous phase liquid (free-phase product)  
 P&T = pump and treat  
 SVE = soil vapor extraction  
 \*gasoline equivalent assumes a fuel density of 6.5 lbs/gal



- Original injection well (INJ-1) improperly constructed; limited infiltration volume and could not be rehabilitated
- Surprises:
  - LNAPL impact at INJ-2 despite no evidence during well development
  - Insufficient LNAPL characterization
  - INJ-2 location & design appears ideal for effective LNAPL recovery (287 gals recovered from Oct 2023 - Dec 2023)
  - MW-19 dissolved phase impact (only 1 event, multiple depths, purpose for RW-2). No additional impact events above AWQS
- Naturally occurring boron levels will likely preclude discharge to RID (AZPDES concentration-based TMDL)
- Significant remediation so far accomplished; however, much more needed
- Expect the unexpected at this site!

# Thanks to ADEQ State Lead Contractors

- ATC: Expanded site characterization (primarily MW installations/monitoring, aquifer testing, geophysical logging), partial remedial system design, P&T system construction management, reporting [2016- 2020]
- GES: P&T and SVE system start-up/O&M; installation of multiple treatment plant improvements, construction management, remediation performance monitoring, P&T capture zone modeling/evaluation, RW and IW installations, aquifer testing, on-going GW monitoring, reporting, planning for supplemental LNAPL characterization [2020 - present]

# Thank you!

- Questions?
- Comments?



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**Clean Air, Safe Water,  
Healthy Land for Everyone**

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