Battelle

2018 Chlorinated Conference | April 8-12 | Palm Springs, CA

AECOM Imagine it. Delivered.

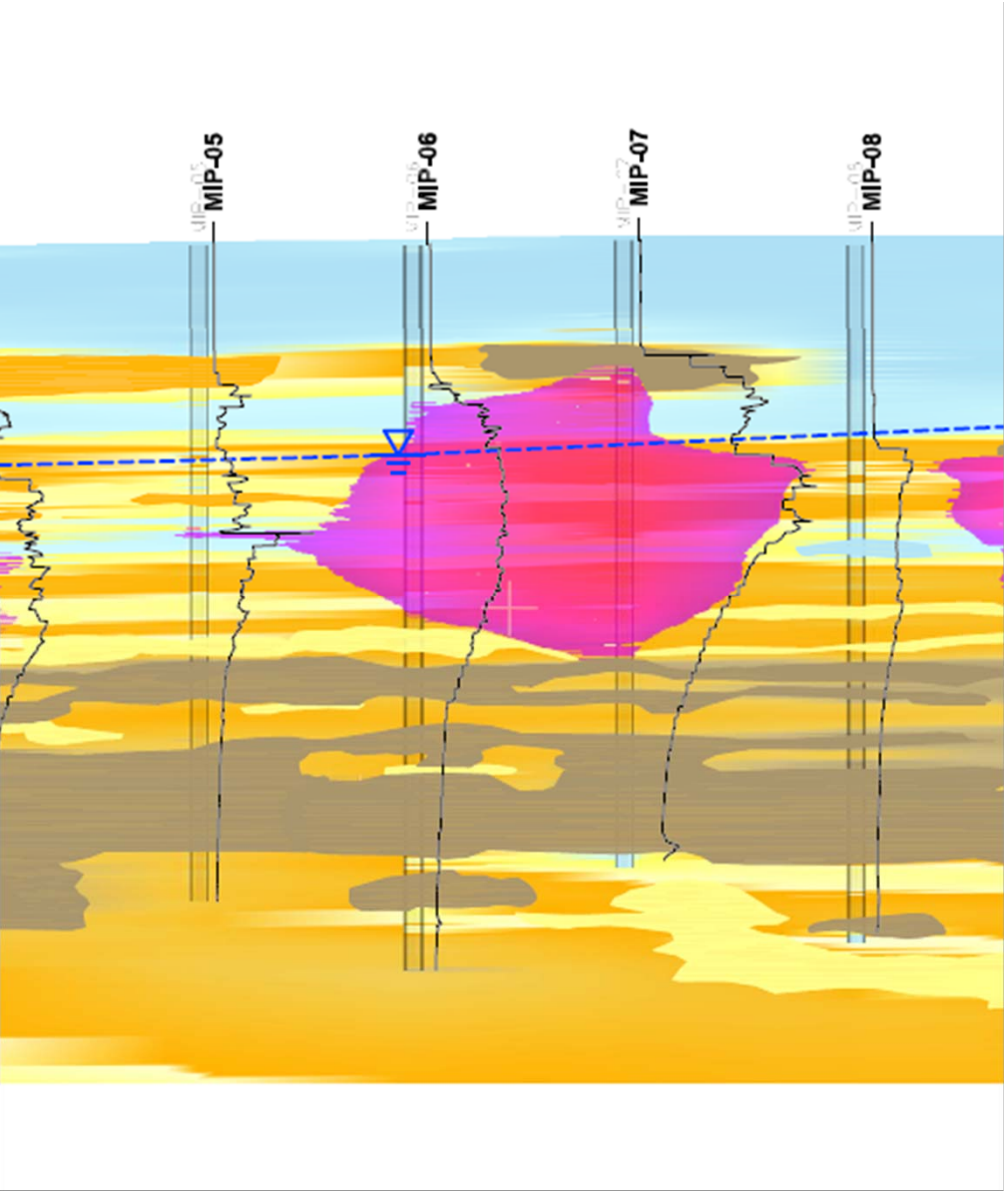
A Geology Focused approach at Three Industrial Sites to Enhance Conceptual Site Models and Remedial Design

Katharine Carr, PG

April 11, 2018

What is a Geology Focused Approach ?

- Why ?
  - Too often the heterogeneities inherent to the subsurface are not adequately accounted for in the CSM resulting in potentially preventable inefficiencies and suboptimal performance of the site remedy
- How ?
  - Leveraging all available aspects historical information (borelogs, analytical , aquifer performance data), Regional Data, Environmental Sequence Stratigraphy (ESS) interpretations, identification).
  - Engagement with your team across disciplines and practices
- Three Case studies will be presented for three industrial sites, two in Southern California and one in Minnesota. These sites are impacted with chlorinated solvents, gasoline, and pentachlorophenol/diesel, respectively.



01

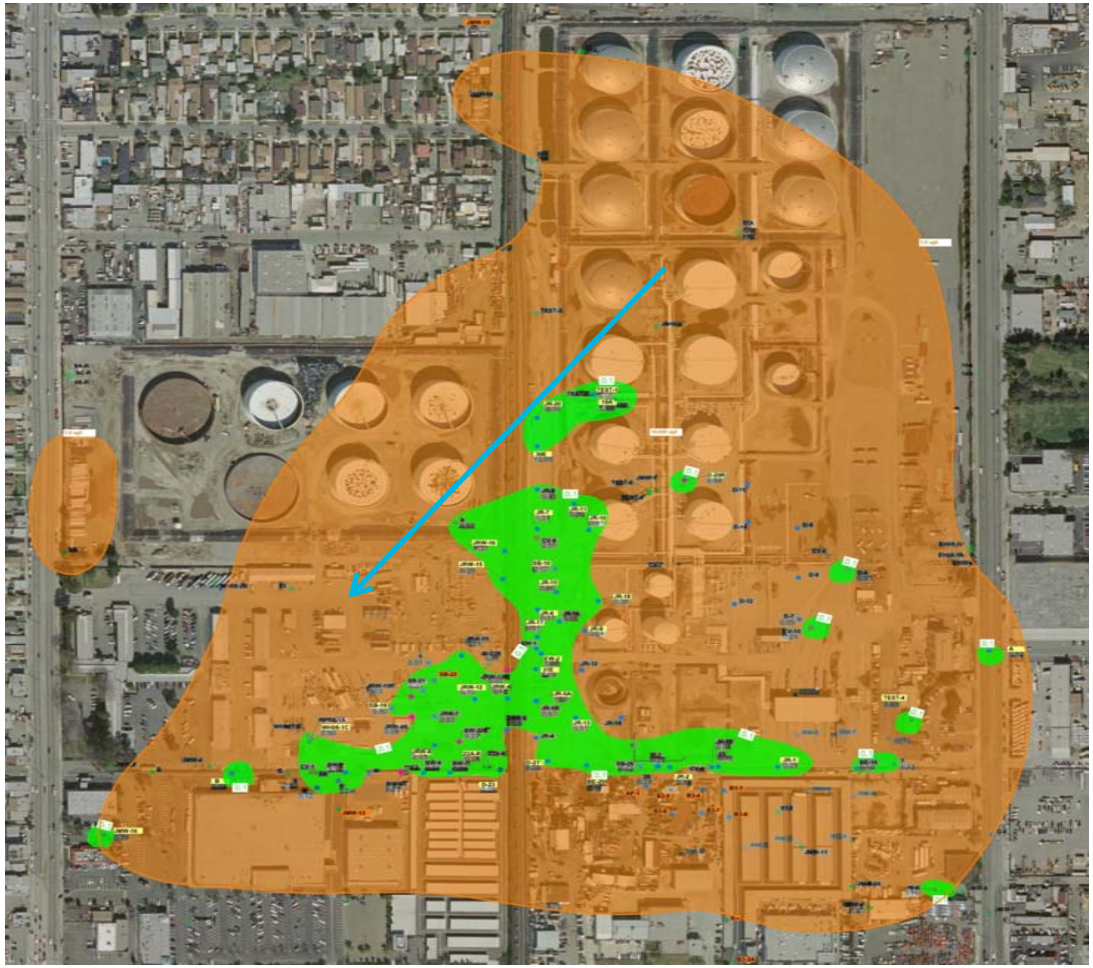
Petroleum Site

AECOM

Site Status

Historical operations at the Site have impacted the groundwater with LNAPL (water table) and dissolved phase BTEX (multiple aquifers)

Approximate extent of LNAPL and BTEX plume in the Water Table Unit



AECOM

Enhancement of a Conceptual Site Model and Full-Scale Remedial Design Utilizing High Resolution Data

Assaf A. Rees, P.E. (AECOM, Long Beach, CA) | Katharine Carr Green, P.G. (AECOM, Long Beach, CA)

AECOM

BACKGROUND/OBJECTIVES

- The water table unit at a former refinery is contaminated with BTEX and fuel oxygenates.
- Previous CSMs, characterized the vadose and water table zones as consisting of primarily silt and clay with two discontinuous silty sand and fine sand units sandwiched between clay and silt in the vadose zone (0-10 feet below ground surface) and underlying deep zones (starting at 35 feet bgs).
- An *in situ* biosparging system was proposed to be installed to prevent off-site migration of contaminates. **See Poster #938 in Session G6.**
- An *in situ* biosparging pilot study was conducted in 2013 through 2014 and during the implementation of this study it was determined that the water table consisted of at least three distinct sand zones (Shallow A, Intermediate B and Deep C zones) and that the first 40 feet bgs was more coarse grained than originally characterized.

Figure 1. Pilot study area

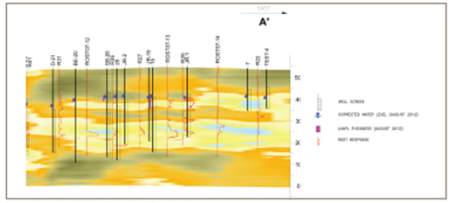


Figure 2. Pre-investigation Boundary CSM X section

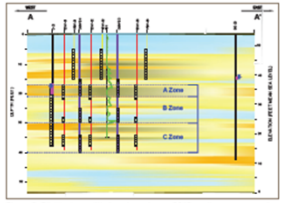


Figure 3. Pilot test area lithology based upon 2013 continuous core and sparging well performance

APPROACH/ACTIVITIES

- For full scale implementation of the biosparging remedy, further investigation was needed to delineate the treatment area in high resolution, specifically the vertical extent of dissolved-phase VOCs across the entire site boundary and to identify specific permeable zones within the treatment area.
- Due to the large number of underground and above ground structures and utilities, space for the system is at a premium.
- Eleven borings were drilled along the site boundary to a maximum depth of 71 feet bgs using MiHPT (Membrane Interface Probe and hydraulic profiling tool) technologies equipped with various VOC, pressure response and electrical conductivity detectors.
- Two continuously cored confirmation borings were drilled and logged directly adjacent to two MiHPT locations, MIP-02 and MIP-05.

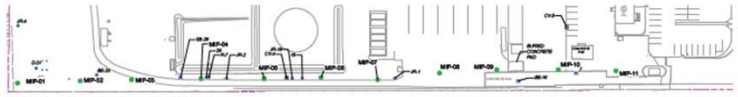
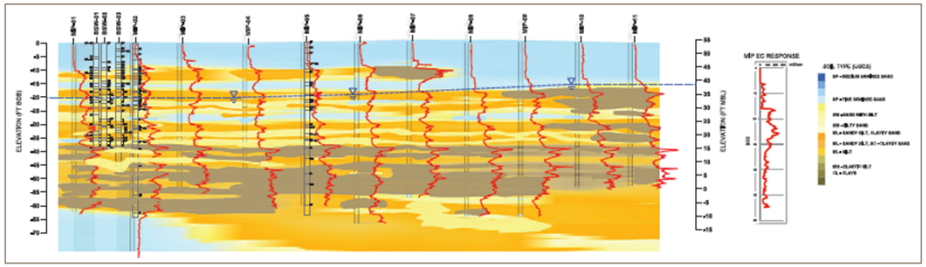


Figure 4. Investigation Area Site map for full scale remedy

www.aecom.com

RESULTS



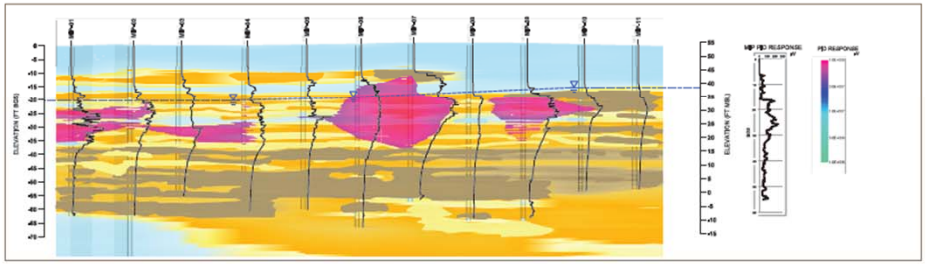
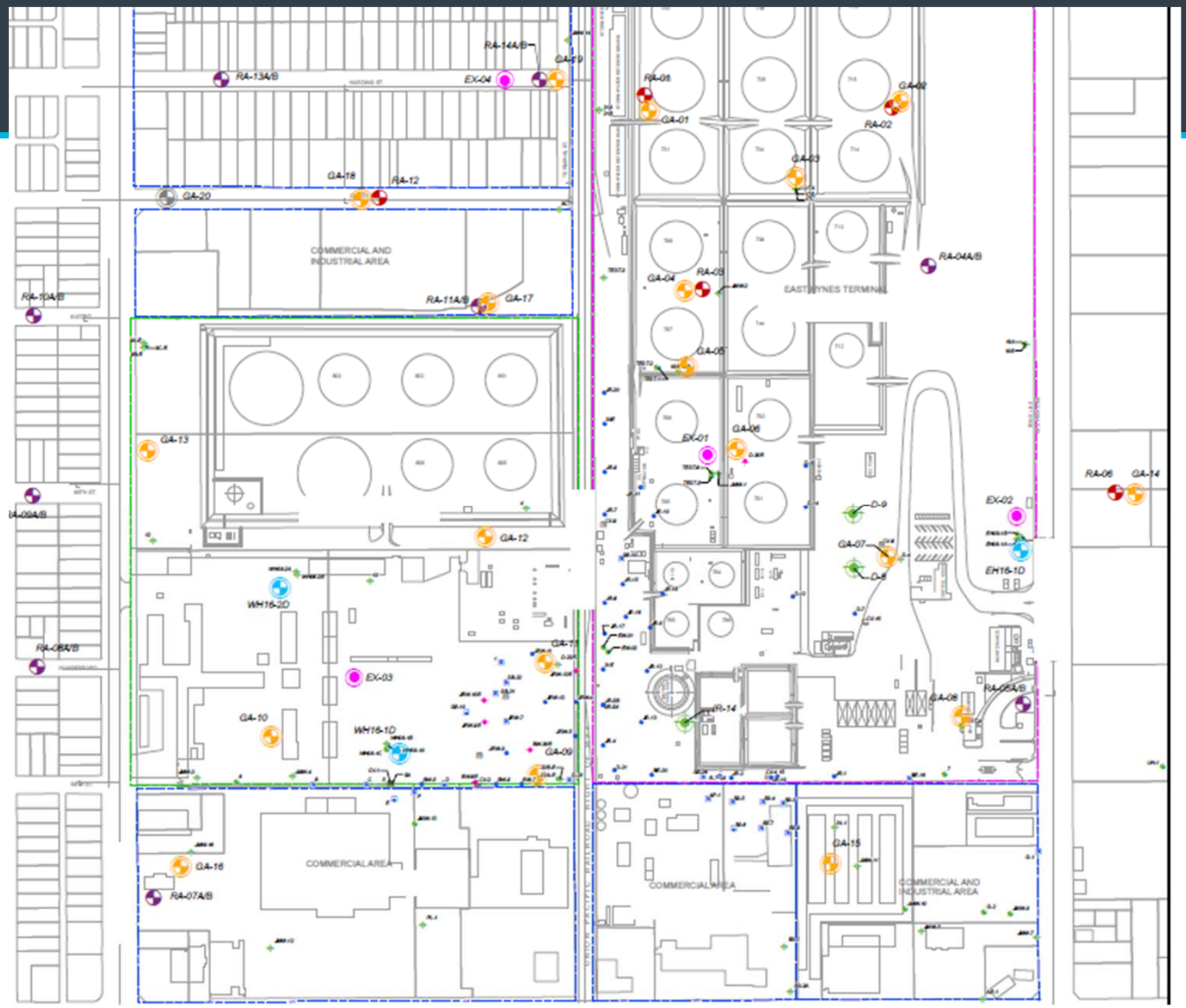


Figure 6. Updated Site Boundary Geologic Cross Section with Electrical Conductivity and 2013 -2016 Continuous Core data

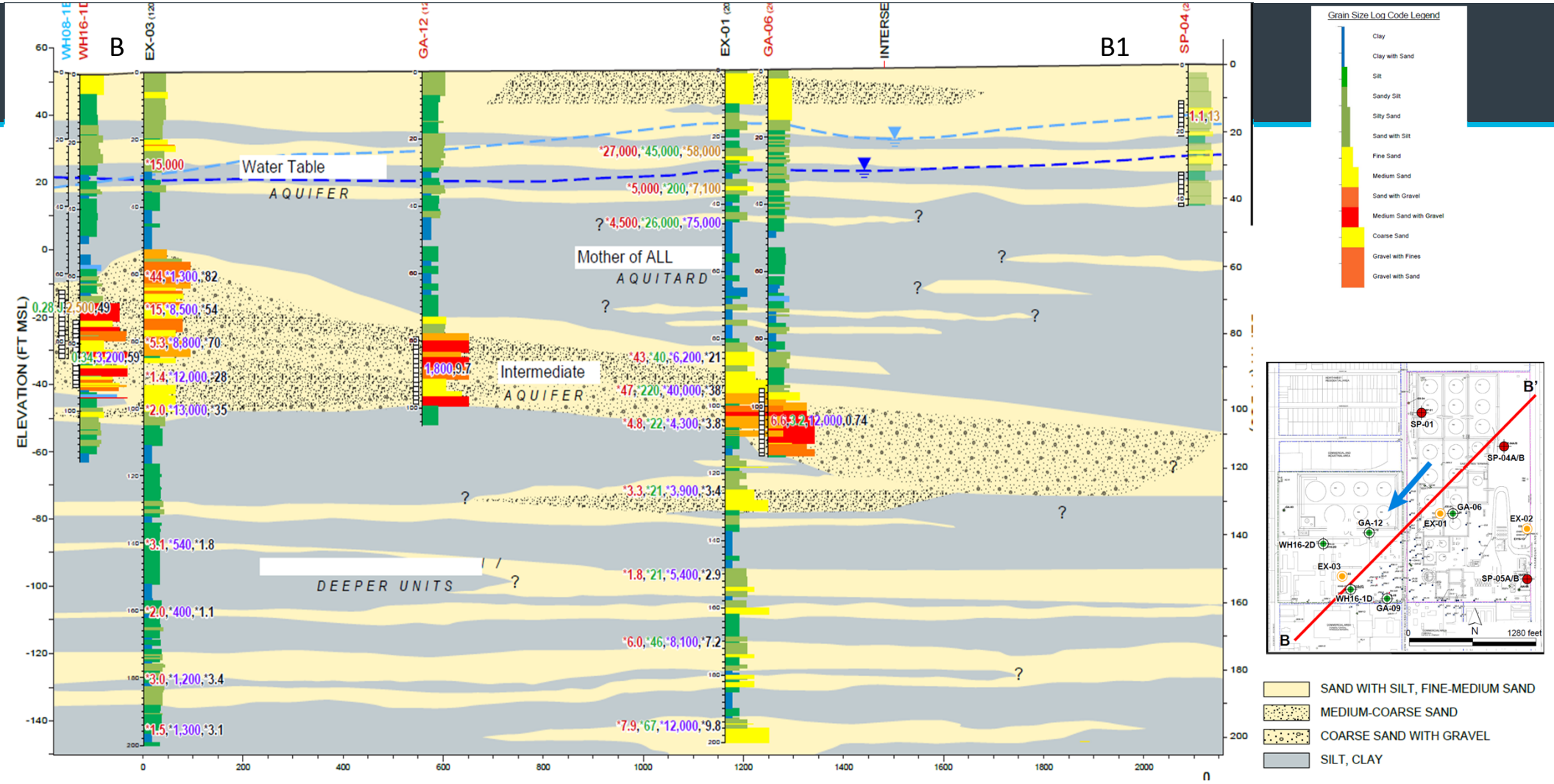
Figure 6. Updated Site Boundary Conceptual Model

- The high resolution investigation confirmed assumptions concluded from the pilot test performance and identified a more complex, yet more connective geological heterogeneity within the target treatment area of the site.
- The high resolution characterization and the updated CSM of the southern boundary, clearly indicated the high flux zones, which constitute the target zones for remediation
- The highest flux zone was identified as the top 10 ft of the saturated zone, from approximately 20 to 30 ft bgs (referred to as the A Zone). A secondary flux zone was identified from approximately 30 to 39 ft bgs (referred to as the B Zone)
- Biosparging well screen intervals were determined based on this characterization and set at 28 to 30 ft bgs for the A Zone and 37 to 39 ft bgs for the B Zone.
- Approximately up to eight (several units merge at various points) continuous coarse-grain sediment beds were observed at depths previously characterized as either homogeneously fine-grained or discontinuous fine silty sand.
- The vertical and horizontal extent of chemical impacts to the water table zones was also confirmed, allowing for a more targeted system design. See Poster #938 in Session G6.
- The investigation was a successful a path forward for a more focused and efficient remedial action.

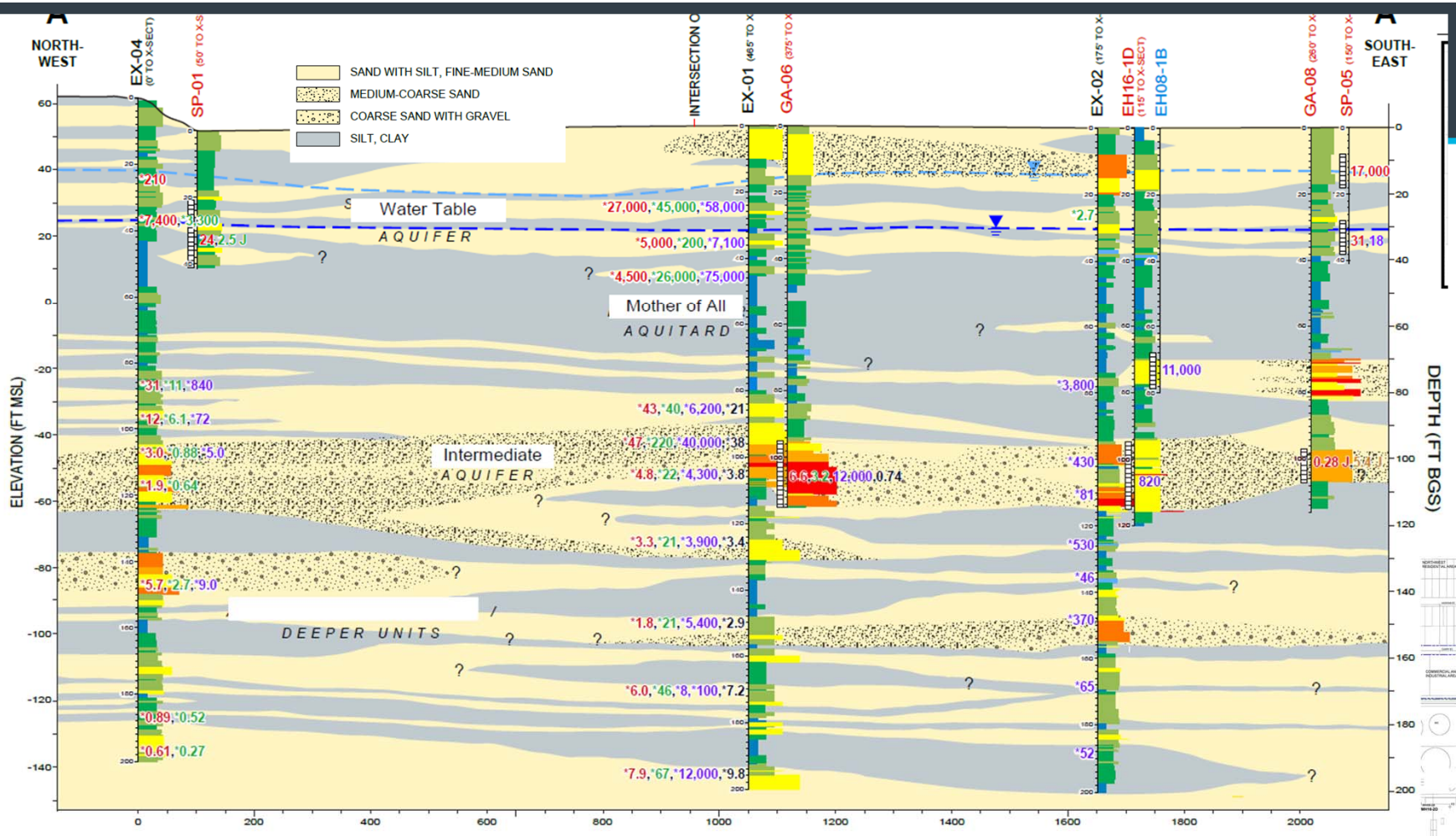
AECOM


RA-14A/B
GA-19
RA-13A/B
EX-04
RA-01
GA-01
GA-02
RA-02
GA-18
RA-12
GA-20
COMMERCIAL AND INDUSTRIAL AREA
GA-03
RA-04A/B
GA-04
RA-03
EASTERNES TERMINAL
RA-10A/B
RA-11A/B
GA-17
GA-05
GA-13
EX-01
GA-06
RA-06
GA-14
EX-02
D-9
GA-12
GA-07
D-8
EH16-1D
WH16-2D
RA-08A/B
GA-11
EX-03
GA-10
WH16-1D
GA-09
GA-08
RA-14
GA-16
COMMERCIAL AREA
RA-07A/B
GA-15
COMMERCIAL AREA
COMMERCIAL AND INDUSTRIAL AREA

AECOM


B
B1
WH08-1E
WH16-1D
EX-03
GA-12
EX-01
GA-06
INTERSE
SP-04
Water Table
AQUIFER
Mother of ALL
AQUITARD
Intermediate
AQUIFER
DEEPER UNITS
ELEVATION (FT MSL)
Grain Size Log Code Legend
Clay
Clay with Sand
Silt
Sandy Silt
Silty Sand
Sand with Silt
Fine Sand
Medium Sand
Sand with Gravel
Medium Sand with Gravel
Coarse Sand
Gravel with Fines
Gravel with Sand
B'
SP-01
SP-04A/B
GA-06
EX-02
GA-12
EX-01
WH16-2D
EX-03
SP-05A/B
WH16-1D
GA-09
N
1280 feet
SAND WITH SILT, FINE-MEDIUM SAND
MEDIUM-COARSE SAND
COARSE SAND WITH GRAVEL
SILT, CLAY

AECOM


A
NORTH-WEST
EX-04 (0' TO X-SECT)
SP-01 (50' TO X-S
INTERSECTION O
EX-01 (485' TO X
GA-06 (375' TO X
EX-02 (175' TO X-
EH16-1D (115' TO X-SECT)
EH08-1B
GA-08 (260' TO X
SP-05 (150' TO X-
A
SOUTH-EAST
SAND WITH SILT, FINE-MEDIUM SAND
MEDIUM-COARSE SAND
COARSE SAND WITH GRAVEL
SILT, CLAY
Water Table
AQUIFER
Mother of All
AQUITARD
Intermediate
AQUIFER
DEEPER UNITS
ELEVATION (FT MSL)
DEPTH (FT BGS)
*210
*7,400,*3,300
24,2.5 J
*27,000,*45,000,*58,000
*5,000,*200,*7,100
*4,500,*26,000,*75,000
*2.7
17,000
31,18
*31,*11,*840
*12,*6.1,*72
*3.0,*0.88,*5.0
*1.9,*0.64
*43,*40,*6,200,*21
*47,*220,*40,000,*38
*4.8,*22,*4,300,*3.8
6.6,3.2,12,000,0.74
*3,800
11,000
*430
*81
820
0.28 J
*530
*46
*370
*3.3,*21,*3,900,*3.4
*5.7,*2.7,*9.0
*1.8,*21,*5,400,*2.9
*6.0,*46,*8,*100,*7.2
*65
*52
*0.89,*0.52
*0.61,*0.27
*7.9,*67,*12,000,*9.8
Grain Size Log Code Legend
Clay
Clay with Sand
Silt
Sandy Silt
Silty Sand
Sand with Silt
Fine Sand
Medium Sand
Sand with Gravel
Medium Sand with Gravel
Coarse Sand
Gravel with Fines
Gravel with Sand
A
EX-04
SP-01
GA-06
EX-01
EX-02
EH16-1
SP-05A/B
GA-08

AECOM

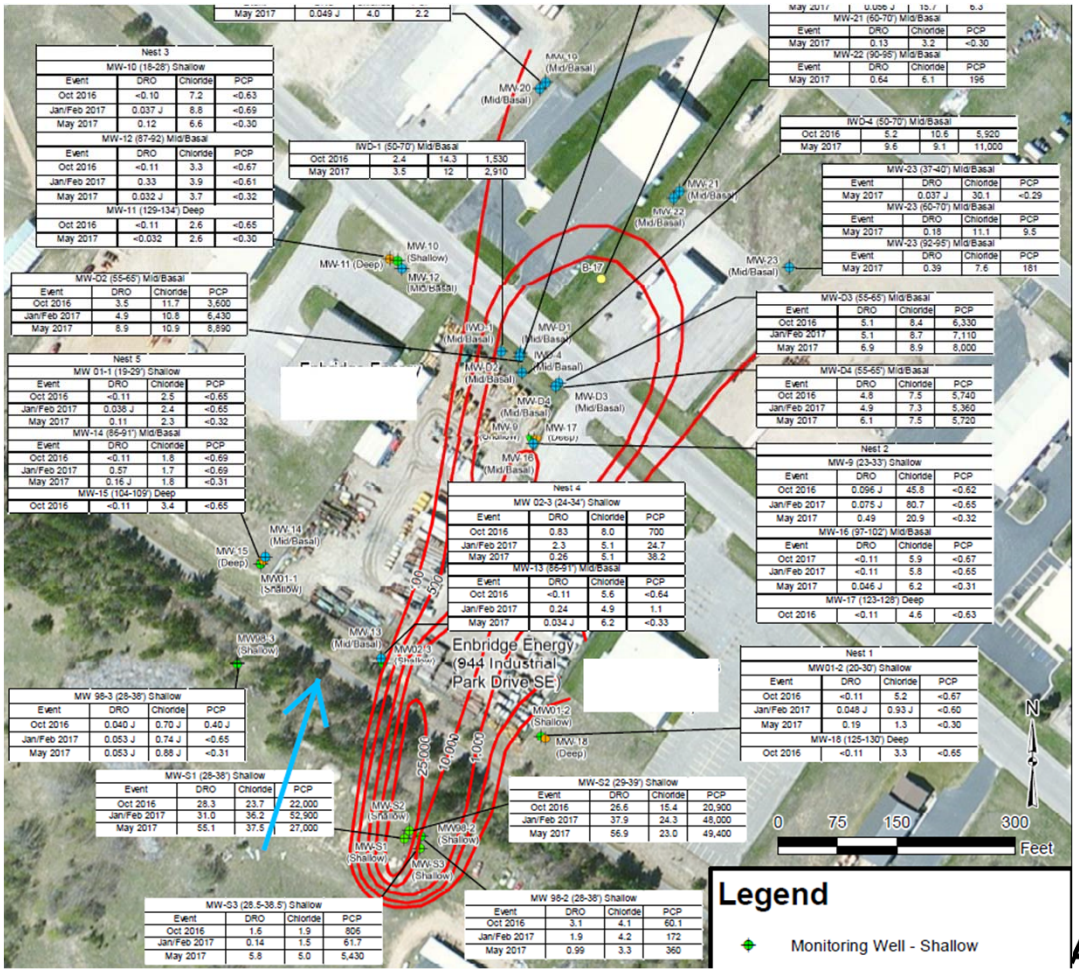
02

Pentachlororphenol/Diesel

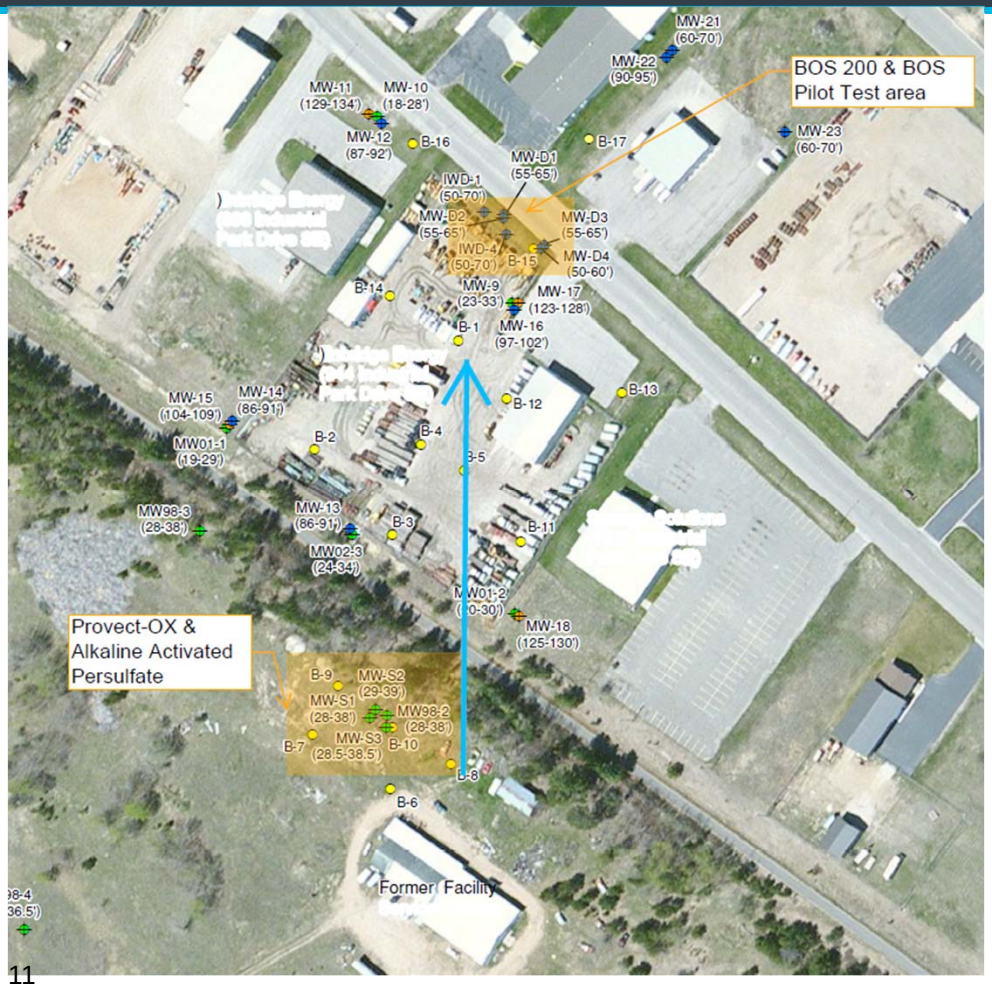
AECOM

Site Background

– A Former Wood Treatment Facility (Facility) operated to treat telephone and power line poles during the 1970s. Wood Power Poles were treated with a PCP mixed with Diesel



Remediation Pilot Tests

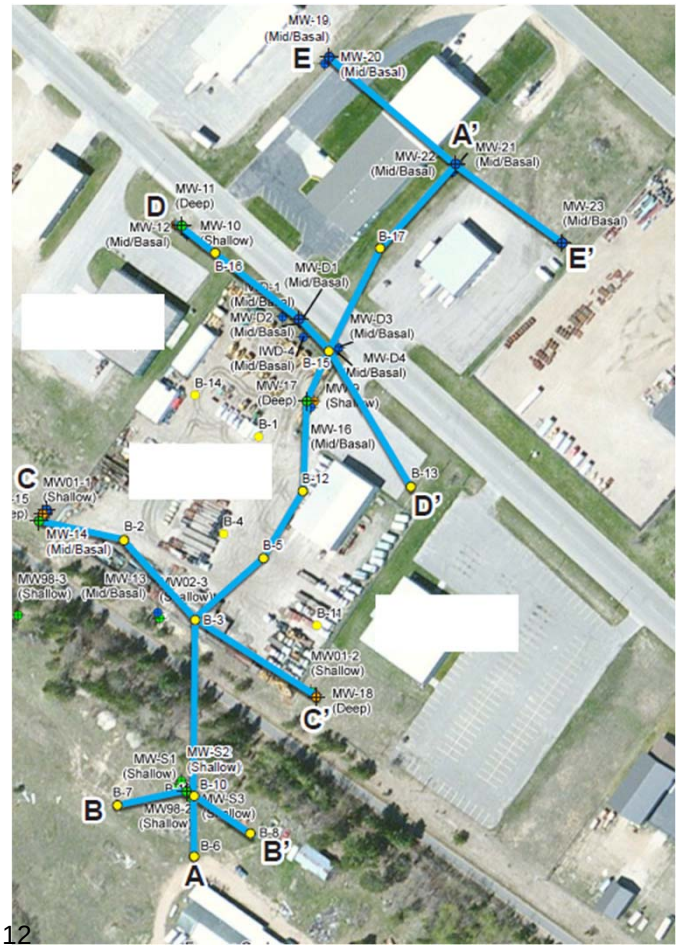


Source Area : Both Methods were fairly successful; Issues with low injection rates and pH buffering .

Downgradient : Methods only partially implemented due subsurface issues . Where successfully implemented, No significant effect observed.

AECOM

Geology Focused Remedial Path



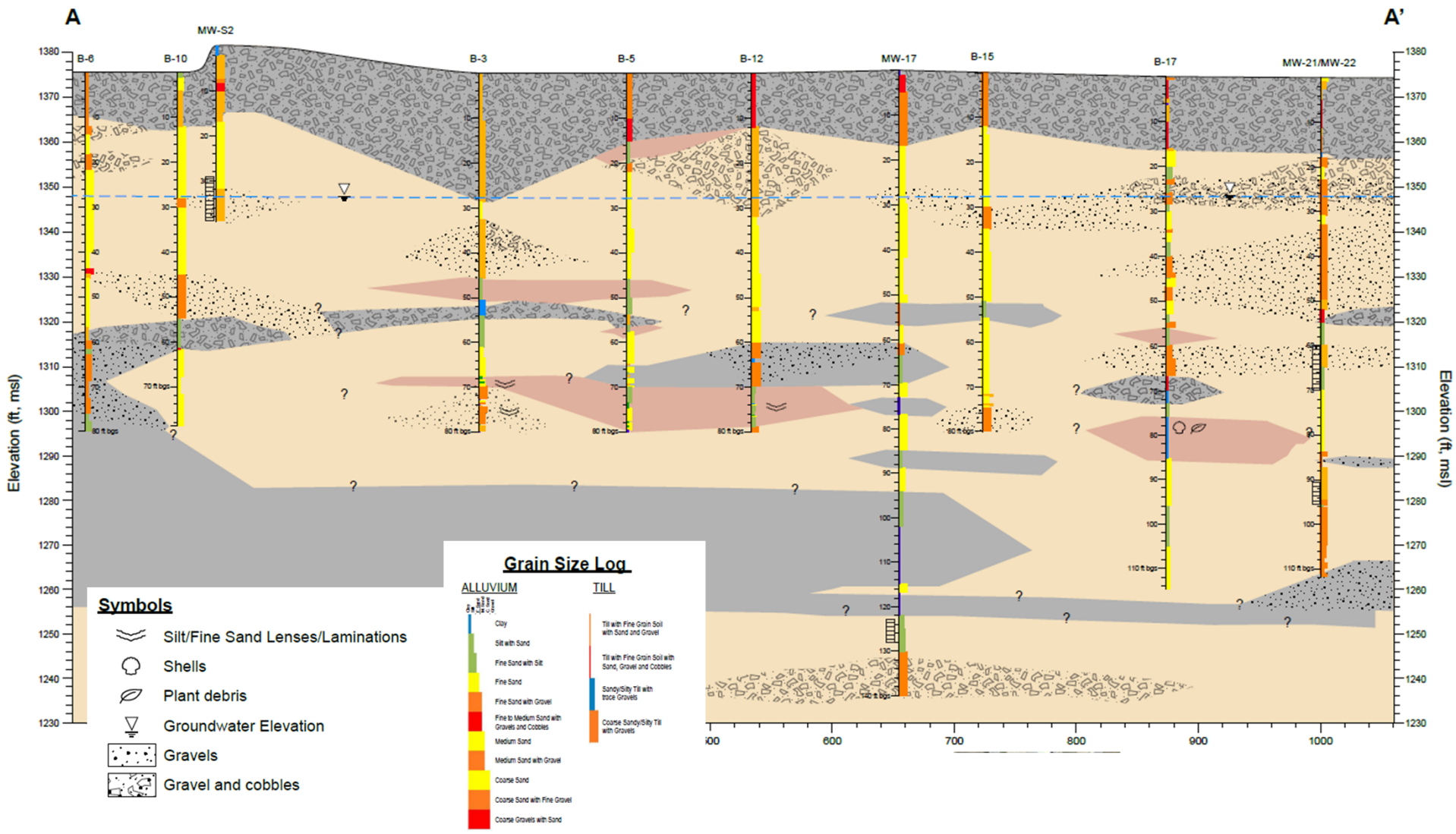
ESS evaluation utilizing historical data and timed to coincide with onsite drilling activities.

Leverage data collected during pilot tests to aid in geologic interpretation

Further delineation by installation of additional downgradient wells and collect of core for Bench scale testing

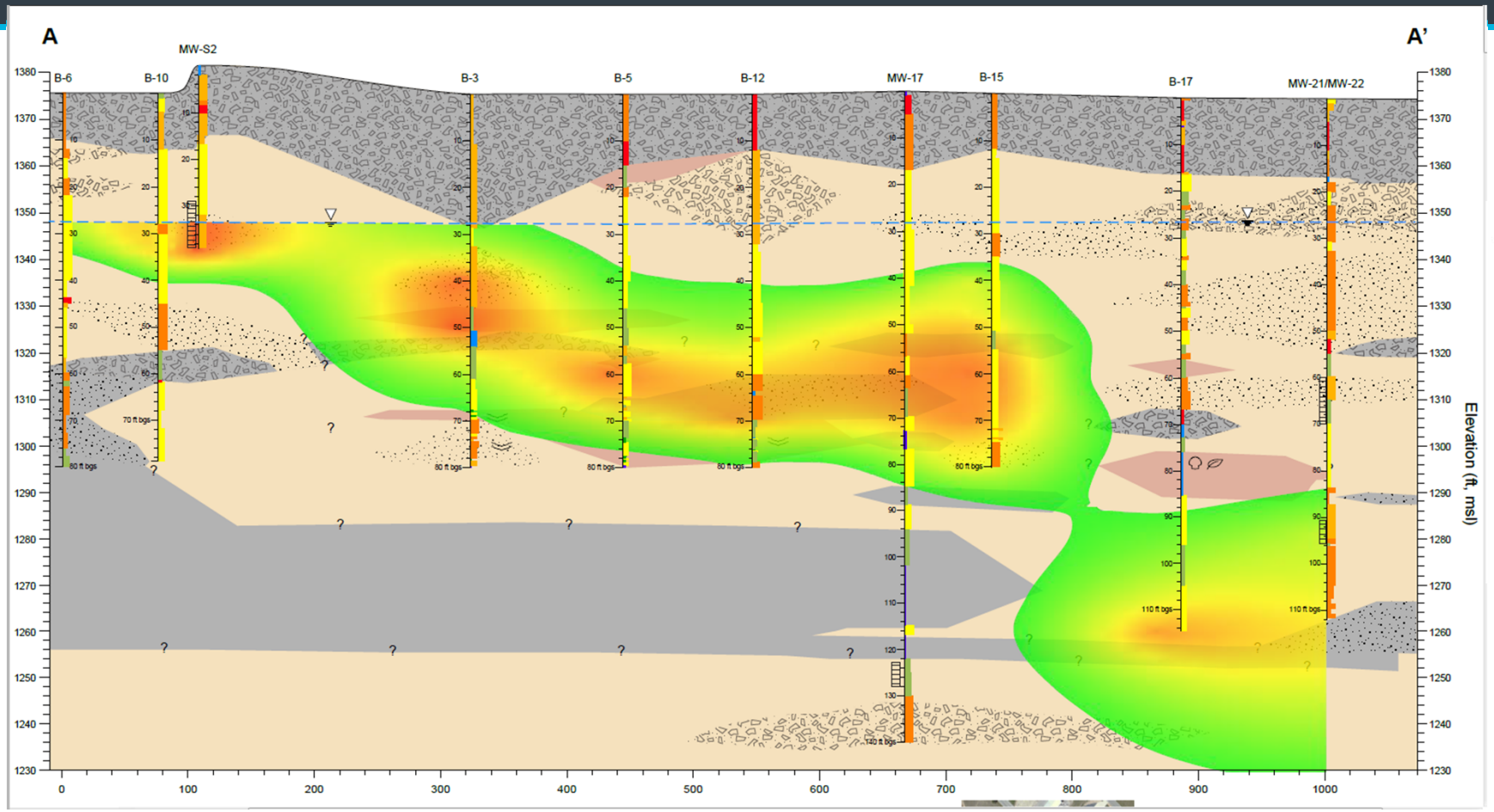
Update of Conceptual site model and full scale remediation design.

AECOM

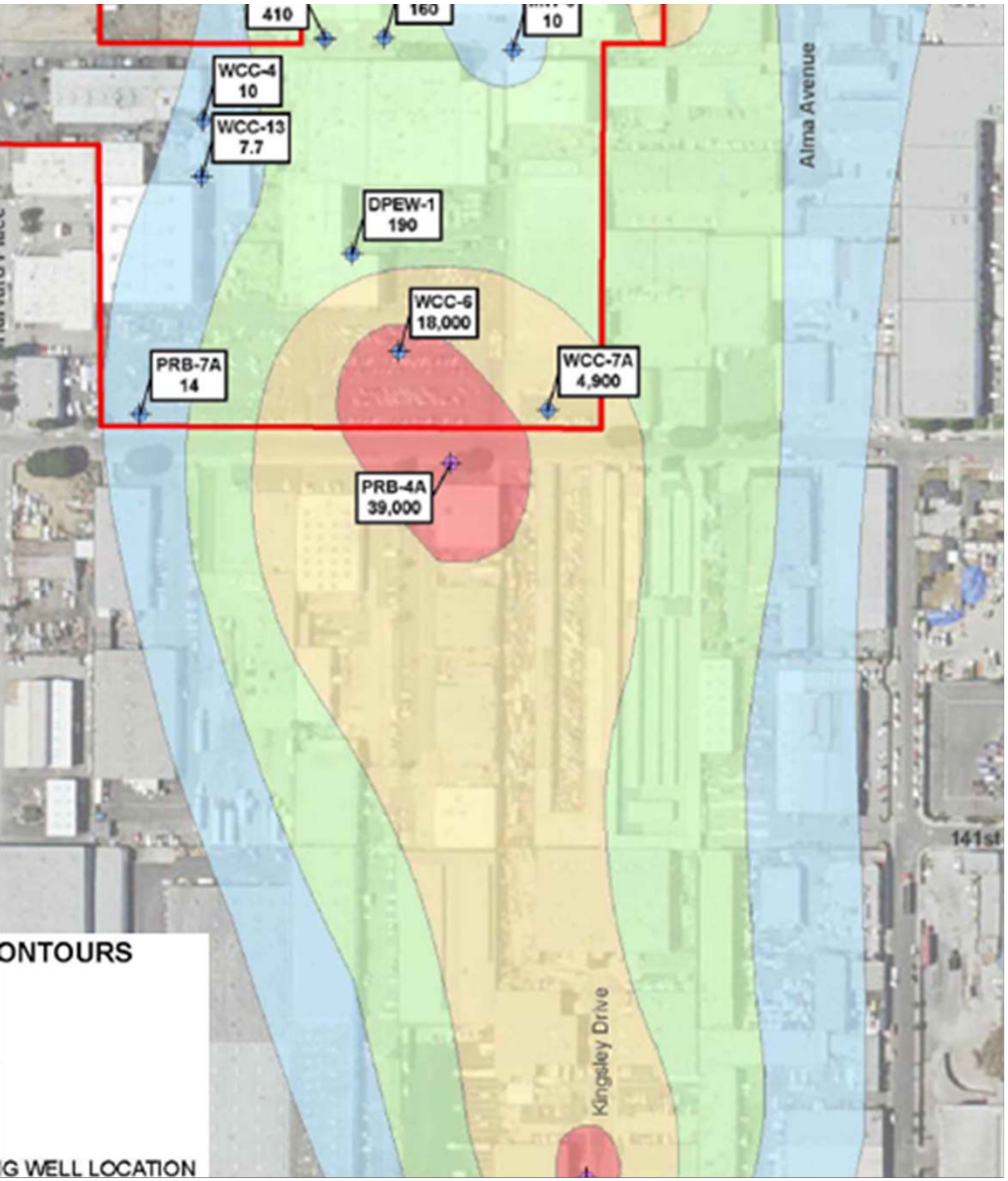

A
A'
MW-S2
B-6
B-10
B-3
B-5
B-12
MW-17
B-15
B-17
MW-21/MW-22
Elevation (ft, msl)
Symbols
Silt/Fine Sand Lenses/Laminations
Shells
Plant debris
Groundwater Elevation
Gravels
Gravel and cobbles
Grain Size Log
ALLUVIUM
TILL
Clay
Silt with Sand
Fine Sand with Silt
Fine Sand
Fine Sand with Gravel
Fine to Medium Sand with Gravels and Cobbles
Medium Sand
Medium Sand with Gravel
Coarse Sand
Coarse Sand with Fine Gravel
Coarse Gravels with Sand
Till with Fine Grain Soil with Sand and Gravel
Till with Fine Grain Soil with Sand, Gravel and Cobbles
Sandy/Silty Till with trace Gravels
Coarse Sandy/Silty Till with Gravels

AECOM

Cross Section A-A1 – PCP Plume



AECOM

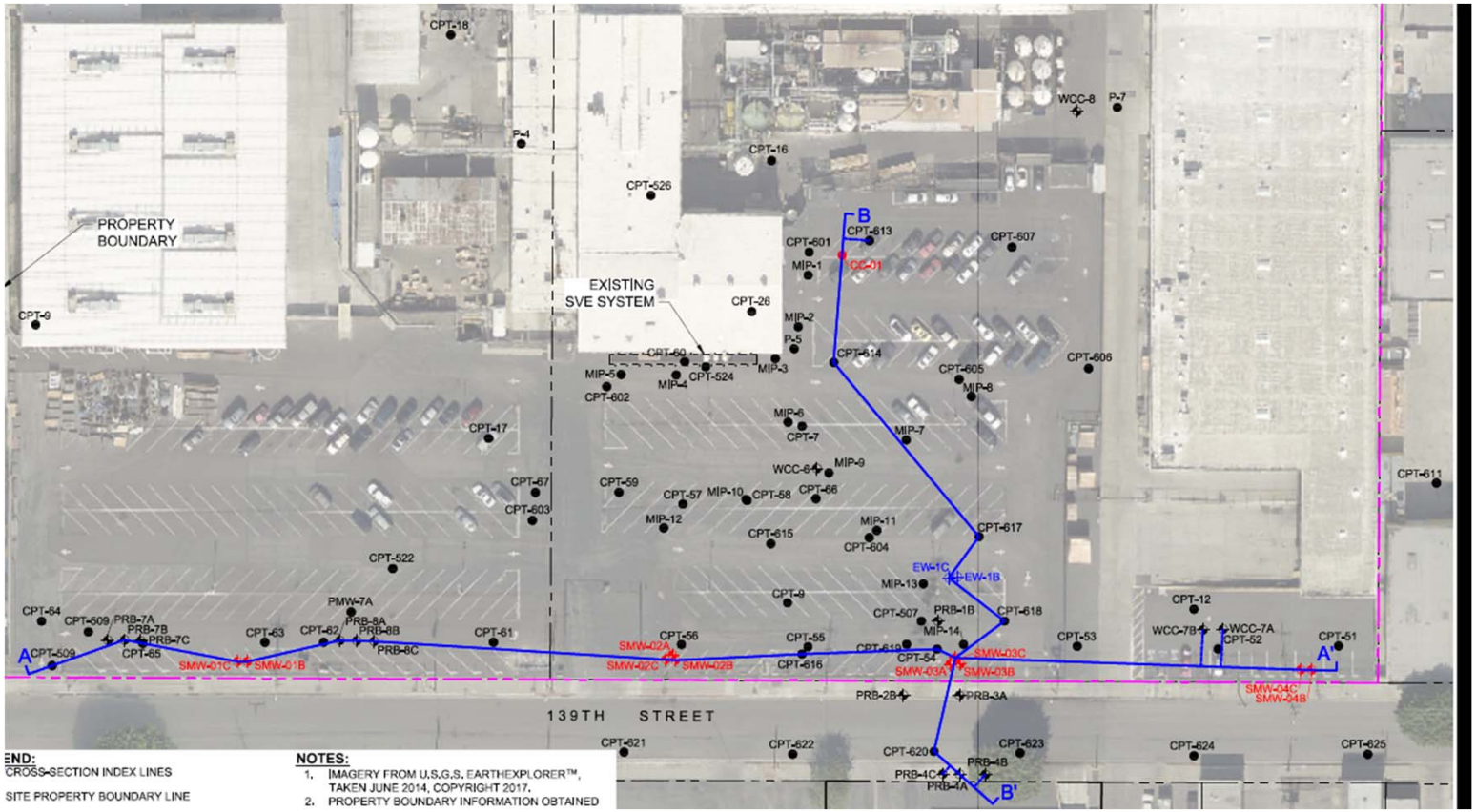


03

Chlorinated Solvent Site

AECOM

Site Background



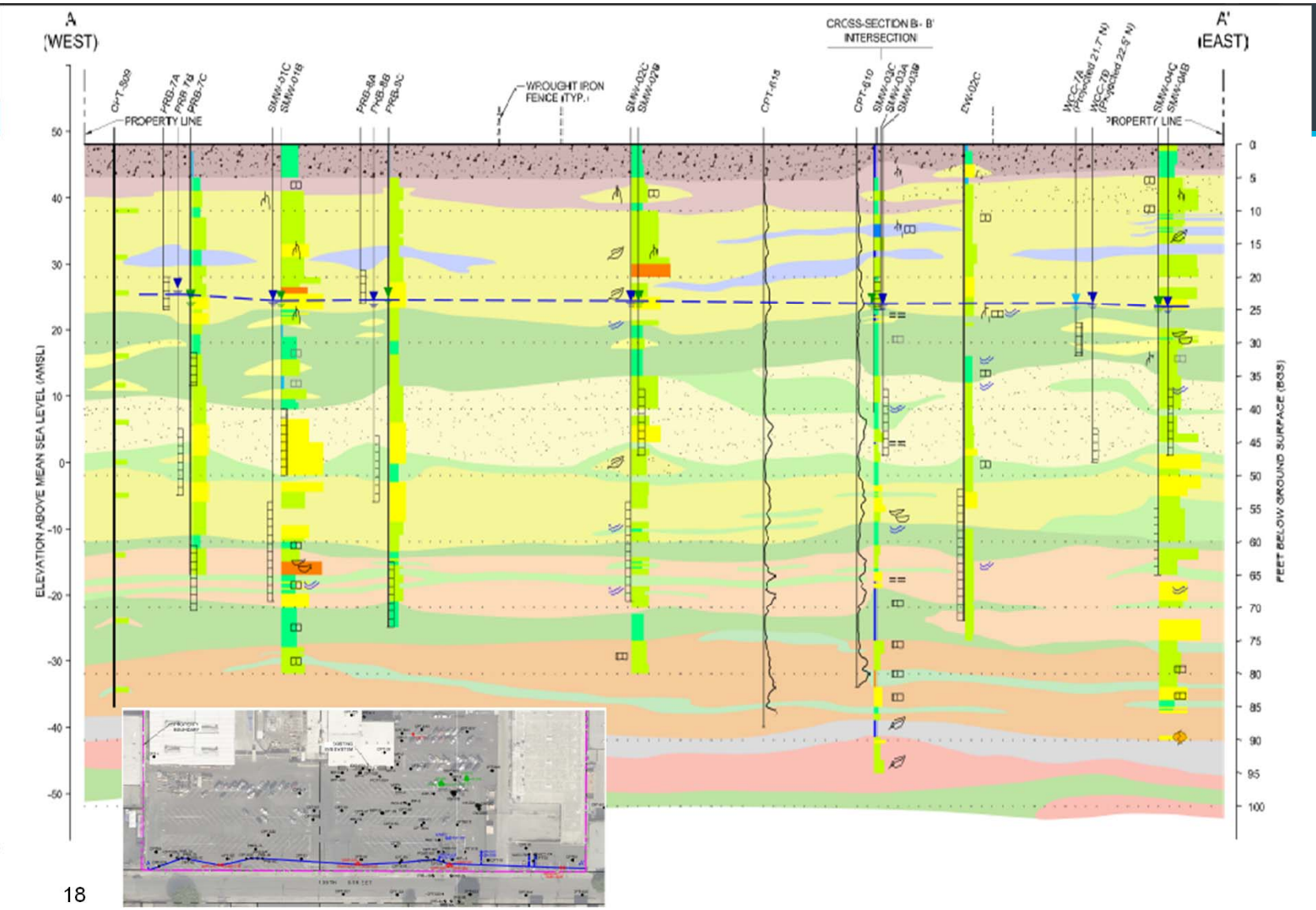
Historical aerospace manufacturing operation have impacted groundwater with PCE and TCE

Between 1995 and 2015 an extensive amount of investigation work was conducted onsite and a pilot ZVI remedy was conducted

AECOM

Geology Focused Approach

- Remedial Goals:
  - Prevent offsite migration of dissolved phase plume (plume containment via EW/IW network)
  - Treat Core of the dissolved phase plume (Enhanced Anaerobic In-Situ BioRemediation)
  - Downgradient Plume – ISCO
- Strategy: Leverage historical data and enhance the CSM using ESS techniques. Identification of Data Gaps followed by targeted field verification.



GRAIN SIZE LOG

CLAY
SILT-SANDY SILT
FINE SAND W/ FINES
FINE SAND
MEDIUM SAND W/ FINES
MEDIUM SAND
COARSE SAND W/ FINES
COARSE SAND
GRAVEL

CPT RESPONSE

DEPTH

ABBREVIATIONS

BGS	BELOW GROUND SURFACE
FT	FEET
MSL	MEAN SEA LEVEL
ZVI PRB	ZERO VALENT IRON PERMEABLE REACTIVE BARRIER

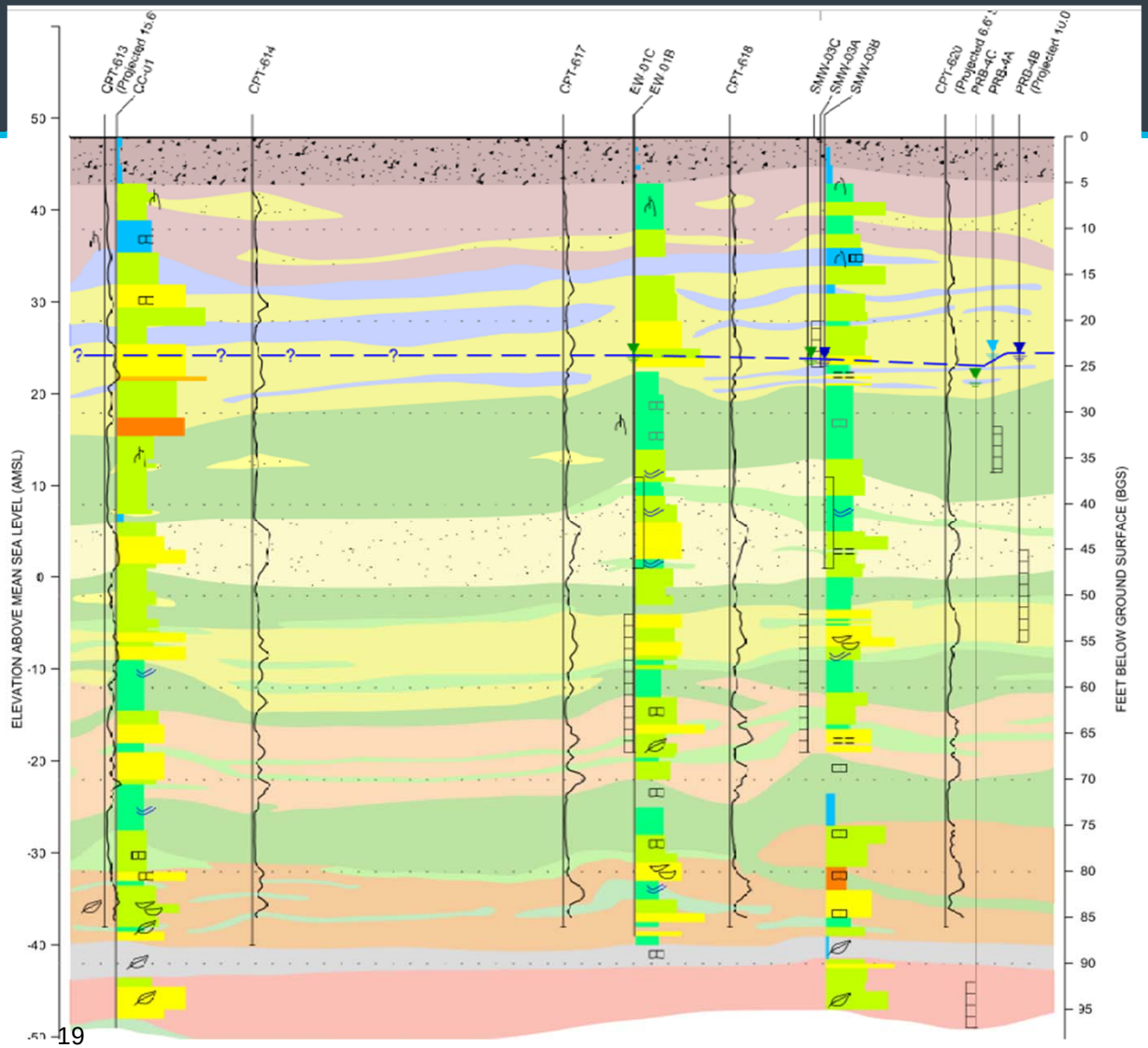
ZONE COLOR CLASSIFICATIONS

- FILL / LAND REWORK
- FLOOD PLAIN DEPOSITS
- UNIT A
- UNIT B
- UNIT C1
- UNIT C2
- UNIT D
- UNIT E
- CONDUCTIVE LAYERS
- CONFINING UNITS
- 50' AQUITARD

SYMBOLS

- RIP UP CLASTS (AQUITARD MATERIALS)
- ROOT CHANNELS, ILLUVIAL ORGANIC MATTER AND CLAY
- PLANT DEBRIS, HIGH ORGANIC MATTER
- CALCAREOUS NODULES/CEMENTATION
- NON-CALCAREOUS NODULES/CEMENTATION
- SAND LENSES/LAMINATIONS
- ZVI PRB
- SHELL FRAGMENTS
- WELL SCREEN

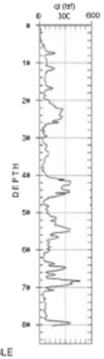
AECOM



GRAIN SIZE LOG

- CLAY
- SILT-SANDY SILT
- FINE SAND W/ FINES
- FINE SAND
- MEDIUM SAND W/ FINES
- MEDIUM SAND
- COARSE SAND W/ FINES
- COARSE SAND
- GRAVEL

CPT RESPONSE



ABBREVIATIONS

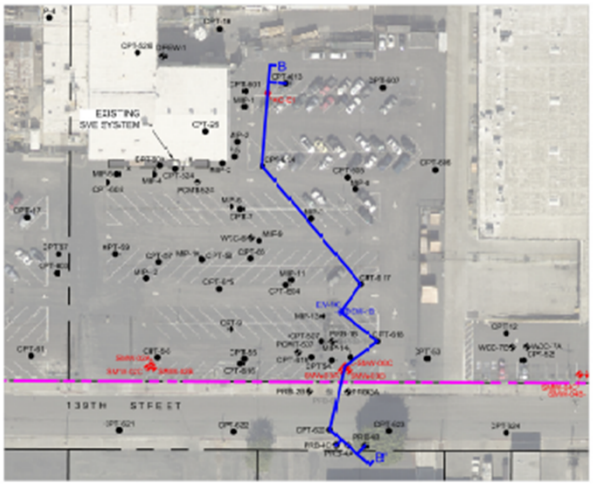
BGS	BELOW GROUND SURFACE
FT	FEET
MSL	MEAN SEA LEVEL
ZVI PRB	ZERO VALENT IRON PERMEABLE REACTIVE BARRIER

ZONE COLOR CLASSIFICATIONS

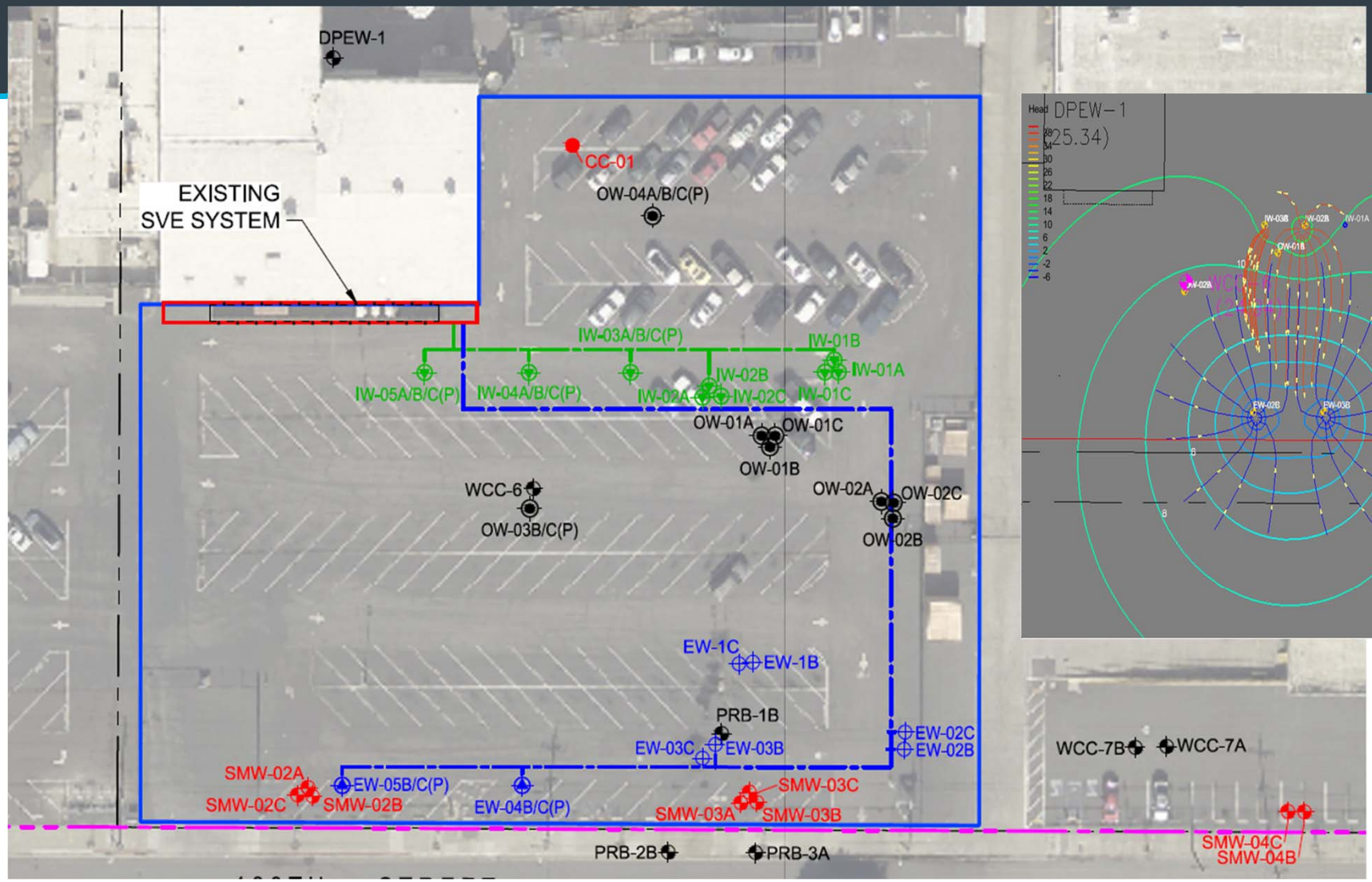
- FILL / LAND REWORK
- FLOOD PLAIN DEPOSITS
- UNIT A
- UNIT B
- UNIT C1
- UNIT C2
- UNIT D
- UNIT E
- CONDUCTIVE LAYERS
- CONFINING UNITS
- 50' AQUITARD

SYMBOLS

- RIP UP CLASTS (AQUITARD MATERIALS)
- ROOT CHANNELS, ILLUVIAL ORGANIC MATTER AND CLAY
- PLANT DEBRIS, HIGH ORGANIC MATTER
- CALCAREOUS NODULES/CEMENTATION
- NON-CALCAREOUS NODULES/CEMENTATION
- SAND LENSES/LAMINATIONS
- ZVI PRB
- SHELL FRAGMENTS
- WELL SCREEN



SITE PLAN
1" = 120'


DPEW-1
EXISTING
SVE SYSTEM
CC-01
OW-04A/B/C(P)
IW-03A/B/C(P)
IW-01B
IW-01A
IW-05A/B/C(P)
IW-04A/B/C(P)
IW-02B
IW-02A
IW-02C
IW-01C
OW-01A
OW-01C
OW-01B
WCC-6
OW-03B/C(P)
OW-02A
OW-02C
OW-02B
EW-1C
EW-1B
PRB-1B
EW-03C
EW-03B
EW-02C
EW-02B
SMW-02A
SMW-02C
SMW-02B
EW-05B/C(P)
EW-04B/C(P)
SMW-03C
SMW-03A
SMW-03B
PRB-2B
PRB-3A
WCC-7B
WCC-7A
SMW-04C
SMW-04B

Head
DPEW-1
(25.34)
WCC-7A
(24.85)

AECOM

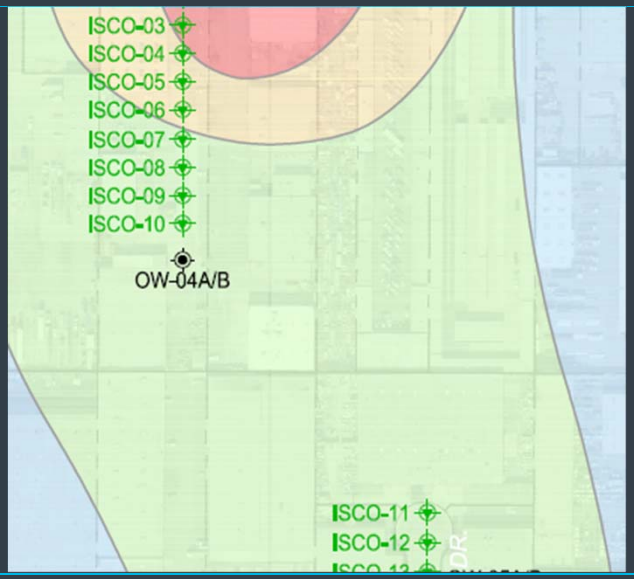
Closing

- Site Characterization is CHALLENGING
- Leverage historical site and regional data
- Collaboration across disciplines and areas of technical expertise throughout the process.

Battelle

2018 Chlorinated Conference | April 8-12 | Palm Springs, CA

AECOM Imagine it. Delivered.



Thank You!

T 310-569-1053
E Katharine.Carr@aecom.com