Post-Remediation High Resolution Site Characterization (HRSC)

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OVERVIEW

Site Characterization Methods and Tools

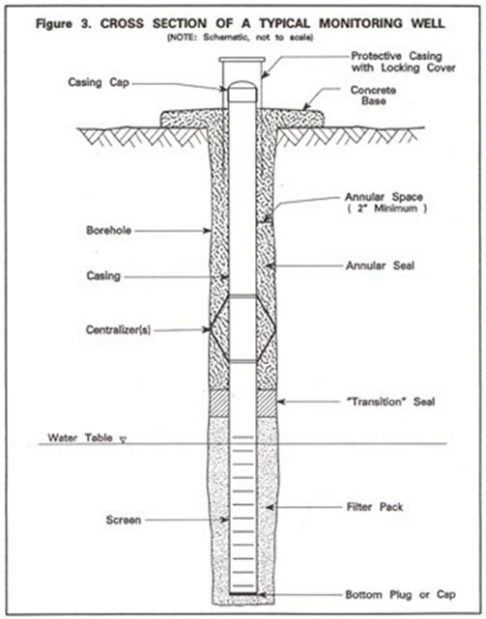
- Standard Site Characterization
- High Resolution Characterization

Case Study

- Site History
- Assessment Challenges
- Site Timeline
- Remediation Phases
- Post-Remediation HRSC
- Next Steps
- Considerations and Costs
- Resources

METHODS AND TOOLS

- STANDARD SITE CHARACTERIZATION METHODS
  - HOLLOW STEM AUGER BORINGS
  - SOIL SAMPLES EVERY 5 OR 10 FEET
  - GROUNDWATER WELL INSTALLATION
  - DATA LIMITED BY SCREENED INTERVALS AND WELL PLACEMENT

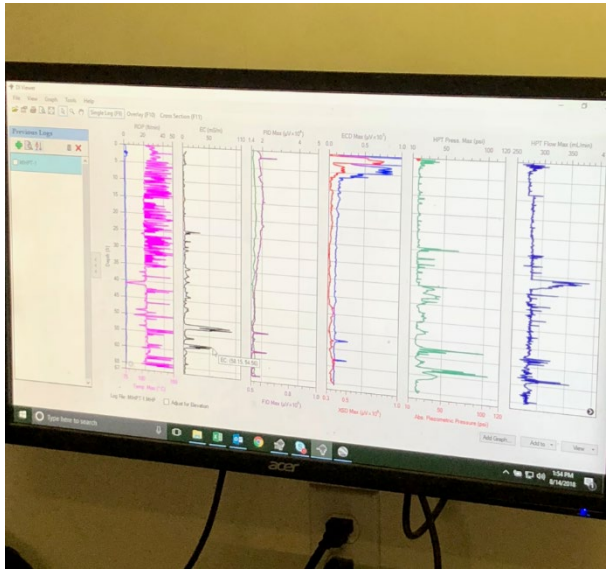


METHODS AND TOOLS

- STANDARD SITE CHARACTERIZATION
  - LIMITED DATA SETS WITH LOWER RESOLUTION
  - INCOMPLETE DELINEATION OF CONTAMINANTS
    - SOIL, SOIL VAPOR, GROUNDWATER
  - LACK OF UNDERSTANDING OF SITE GEOLOGY AND HYDROGEOLOGY
    - IMPROPERLY PLACED OR SCREENED WELLS
  - INCOMPLETE CONCEPTUAL SITE MODEL (CSM)
  - REMEDIAL DESIGNS
    - INCORRECT TREATMENT ZONES
    - REMEDY EFFECTIVENESS COMPROMISED

TECHNOLOGIES OVERVIEW

- HIGH RESOLUTION CHARACTERIZATION
  - HIGH DATA DENSITY
  - QUALITATIVE AND QUANTITATIVE
- DIRECT SENSING TOOLS
  - MEMBRANE-INTERFACE PROBES (MIP)
  - HYDRAULIC PROFILING TOOL (HPT)



METHODS AND TOOLS

GEOPHYSICS TOOLS

- NATURAL GAMMA LOGGING
- OPTICAL TELEVIEWER
- ELECTRICAL RESISTIVITY

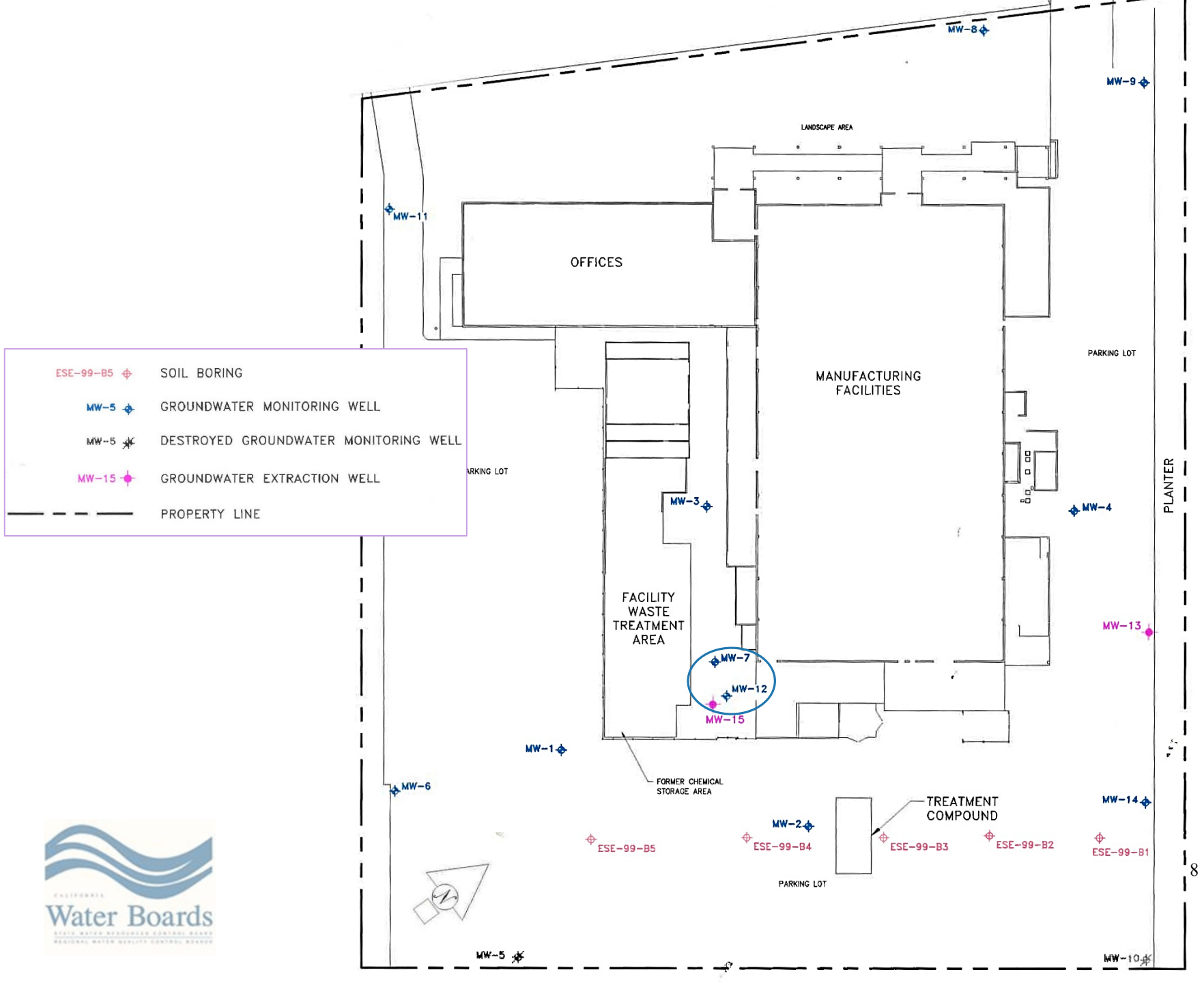
REMOTE SENSING TOOLS

- SATELLITES, DRONES

CASE STUDY

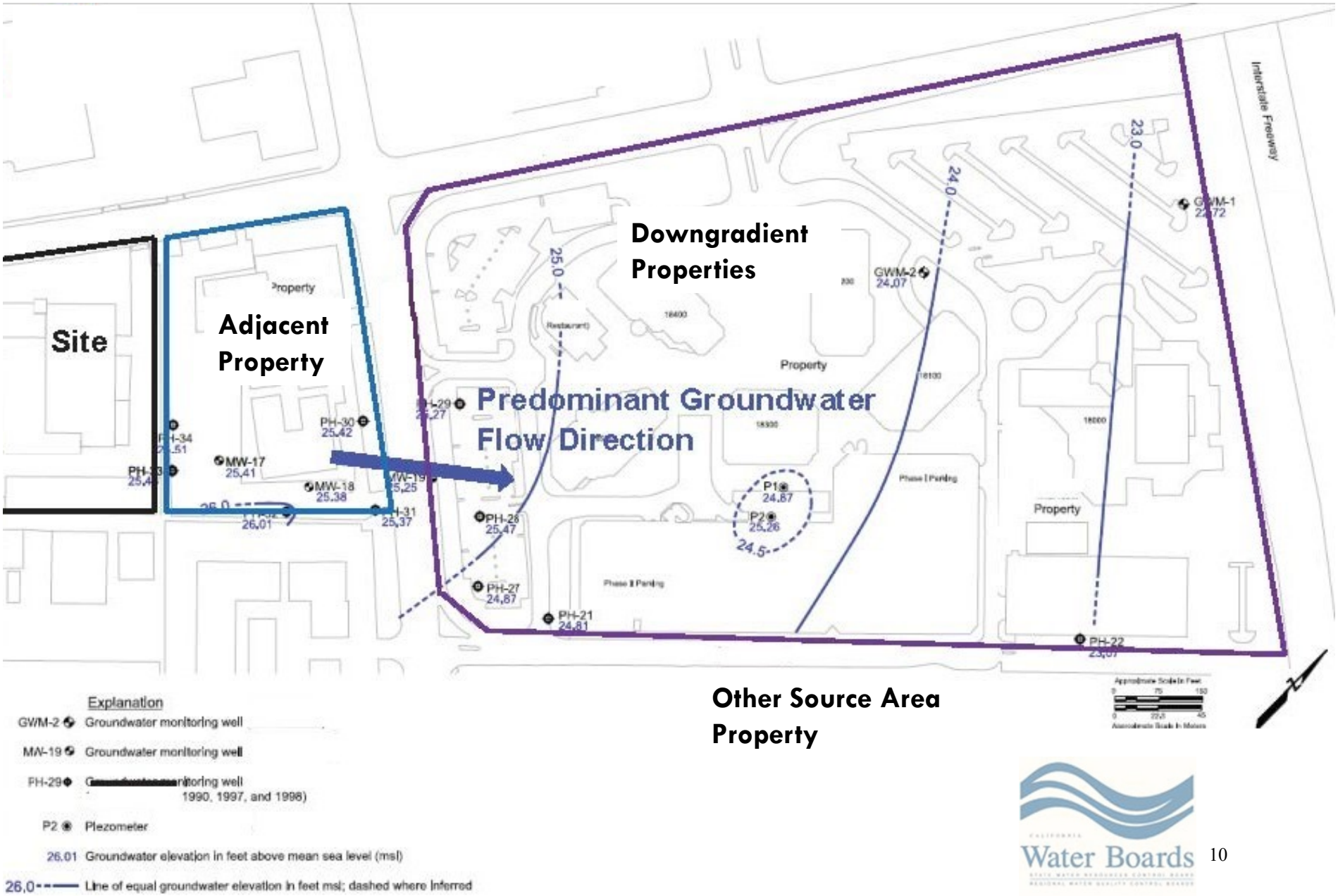
SITE HISTORY

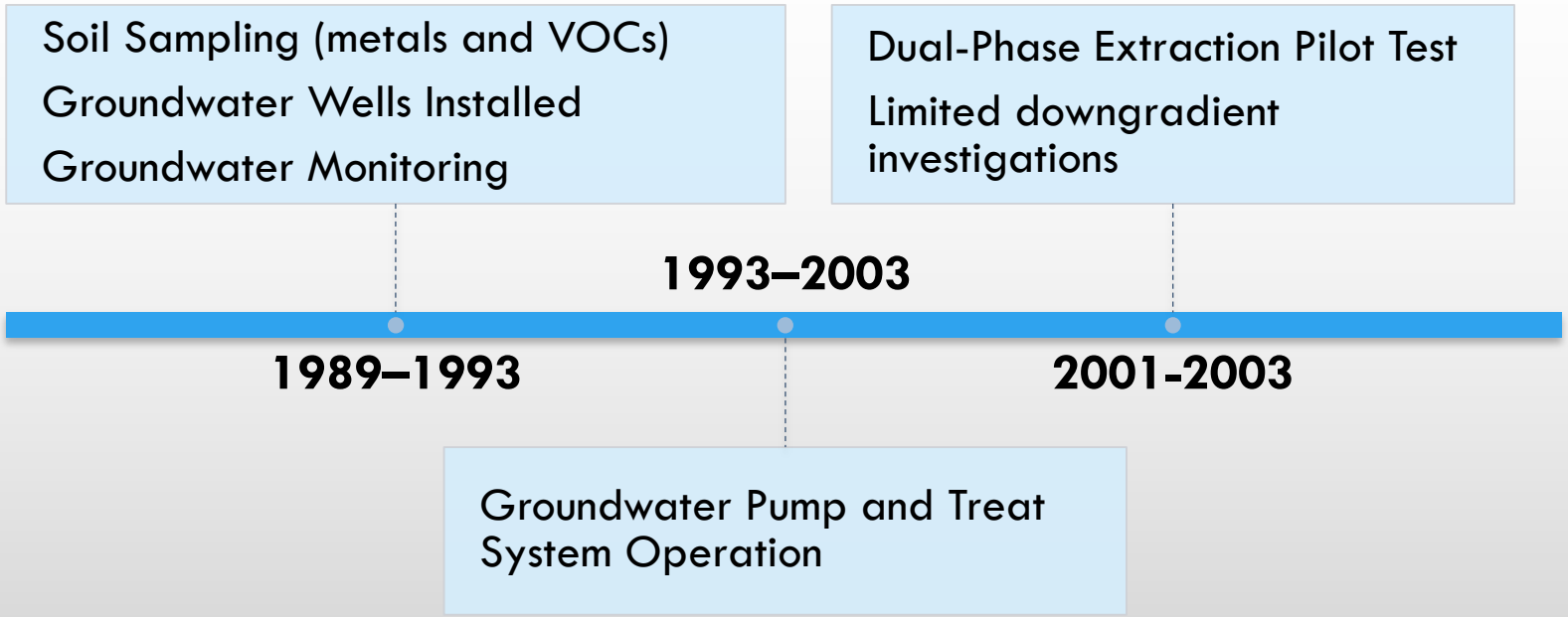
- PREVIOUS USE OF PROPERTY
  - CIRCUIT BOARD MANUFACTURING
- CONTAMINANTS OF CONCERN (COC)
  - TRICHLOROETHENE (TCE)
  - METALS
- DENSE NON-AQUEOUS PHASE LIQUIDS (DNAPL) FOUND IN SOIL
- DOWNGRADIENT COMMINGLED PLUME
  - OTHER RESPONSIBLE PARTY (RP) WAS AN AEROSPACE MANUFACTURING FACILITY
- MULTIPLE WATER BEARING ZONES


ESE-99-B5 SOIL BORING
MW-5 GROUNDWATER MONITORING WELL
MW-5 DESTROYED GROUNDWATER MONITORING WELL
MW-15 GROUNDWATER EXTRACTION WELL
PROPERTY LINE
MW-8
MW-9
LANDSCAPE AREA
MW-11
OFFICES
MANUFACTURING FACILITIES
PARKING LOT
PLANTER
MW-3
MW-4
FACILITY WASTE TREATMENT AREA
MW-13
MW-7
MW-12
MW-15
MW-1
FORMER CHEMICAL STORAGE AREA
MW-6
TREATMENT COMPOUND
MW-14
MW-2
ESE-99-B5
ESE-99-B4
ESE-99-B3
ESE-99-B2
ESE-99-B1
PARKING LOT
MW-5
MW-10

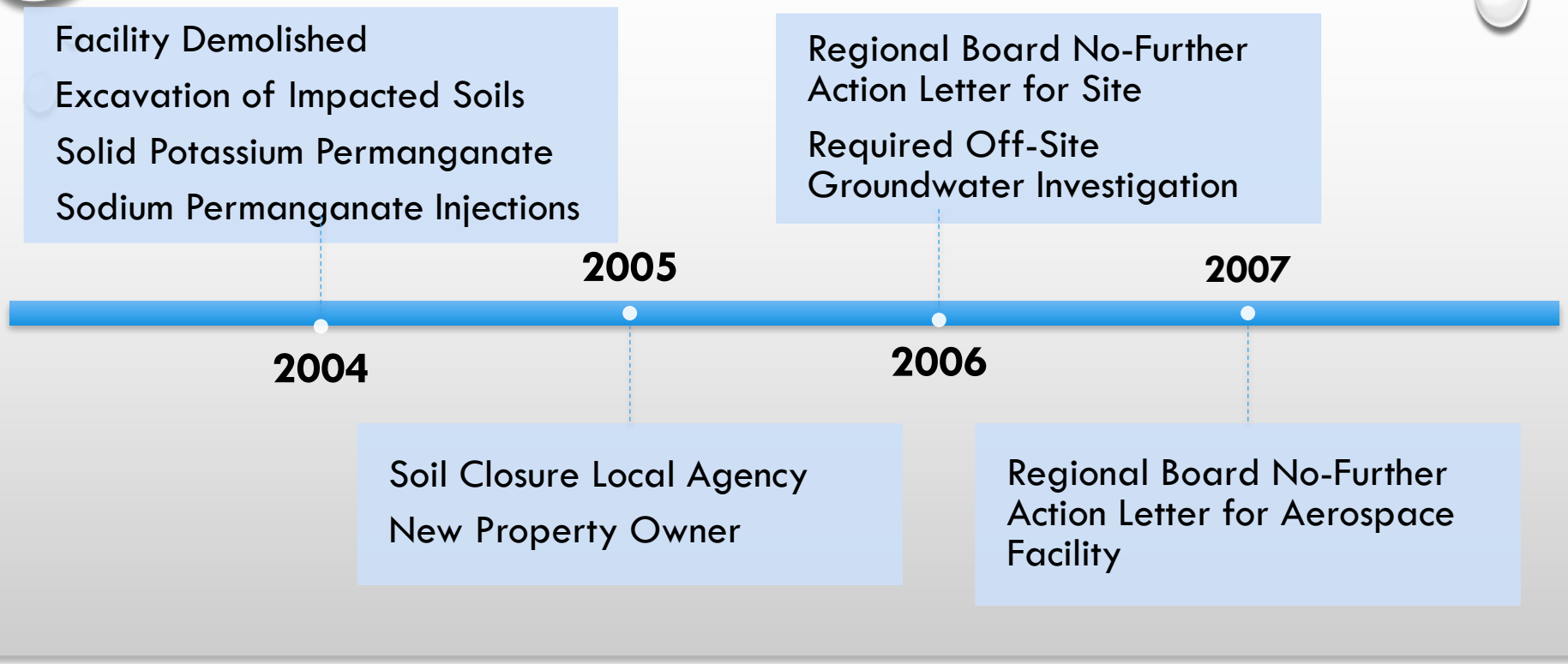
CHALLENGES

- Multiple Properties and Buildings
- Property owners
  - Access agreements
  - Property Transfers
- Utilities and public rights-of-way
- Potential Re-development

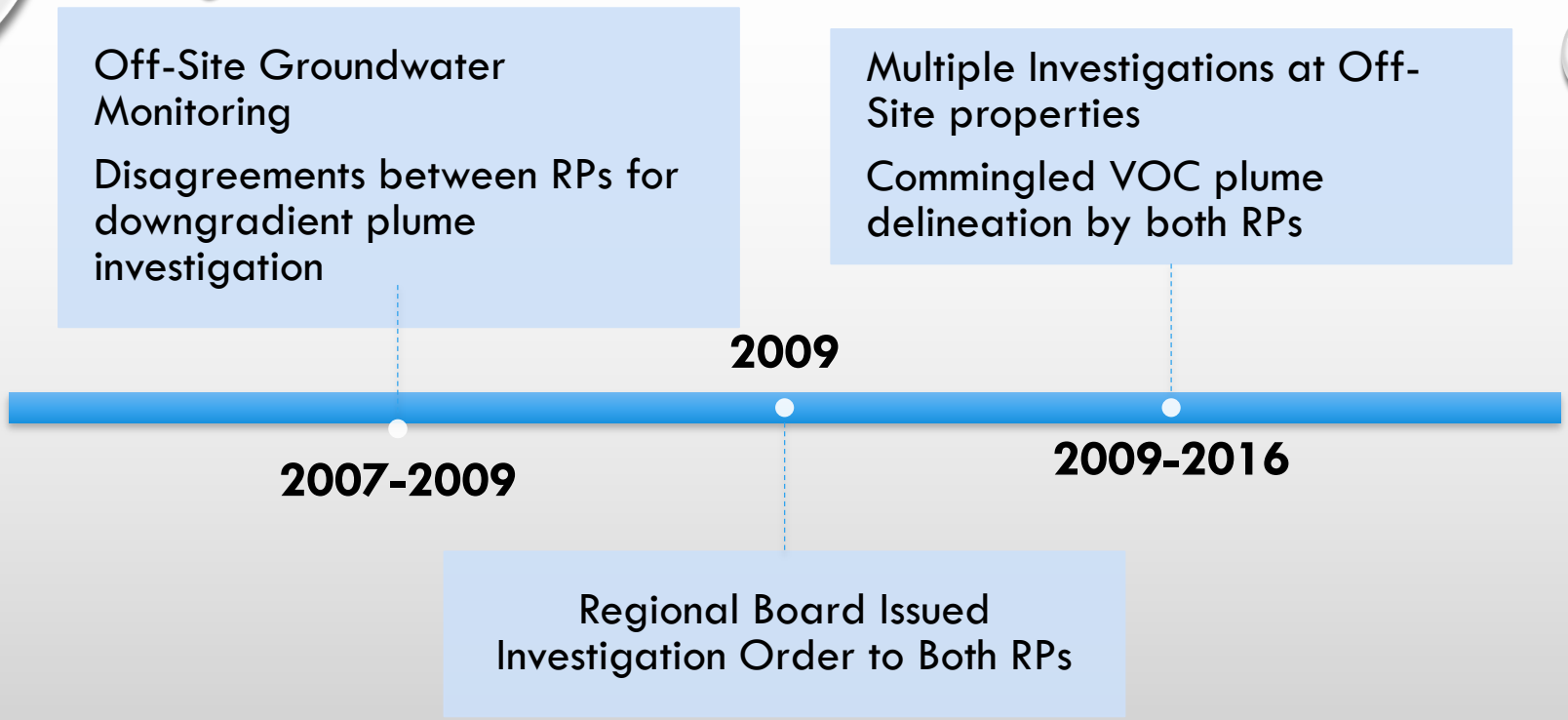

Site
Adjacent Property
Downgradient Properties
Predominant Groundwater Flow Direction
Other Source Area Property
Interstate Freeway
Property
Restaurant
Phase I Parking
Phase II Parking
GWM-1
GWM-2
24.07
MW-17
25.41
MW-18
25.38
MW-19
25.25
PH-28
25.47
PH-27
24.87
PH-21
24.81
PH-22
PH-30
25.42
PH-31
25.37
P1
24.87
P2
25.26
23.0
24.0
25.0
24.5
Explanation
GWM-2 Groundwater monitoring well
MW-19 Groundwater monitoring well
PH-29 Groundwater monitoring well
1990, 1997, and 1998)
P2 Piezometer
26.01 Groundwater elevation in feet above mean sea level (msl)
26.0 Line of equal groundwater elevation in feet msl; dashed where inferred



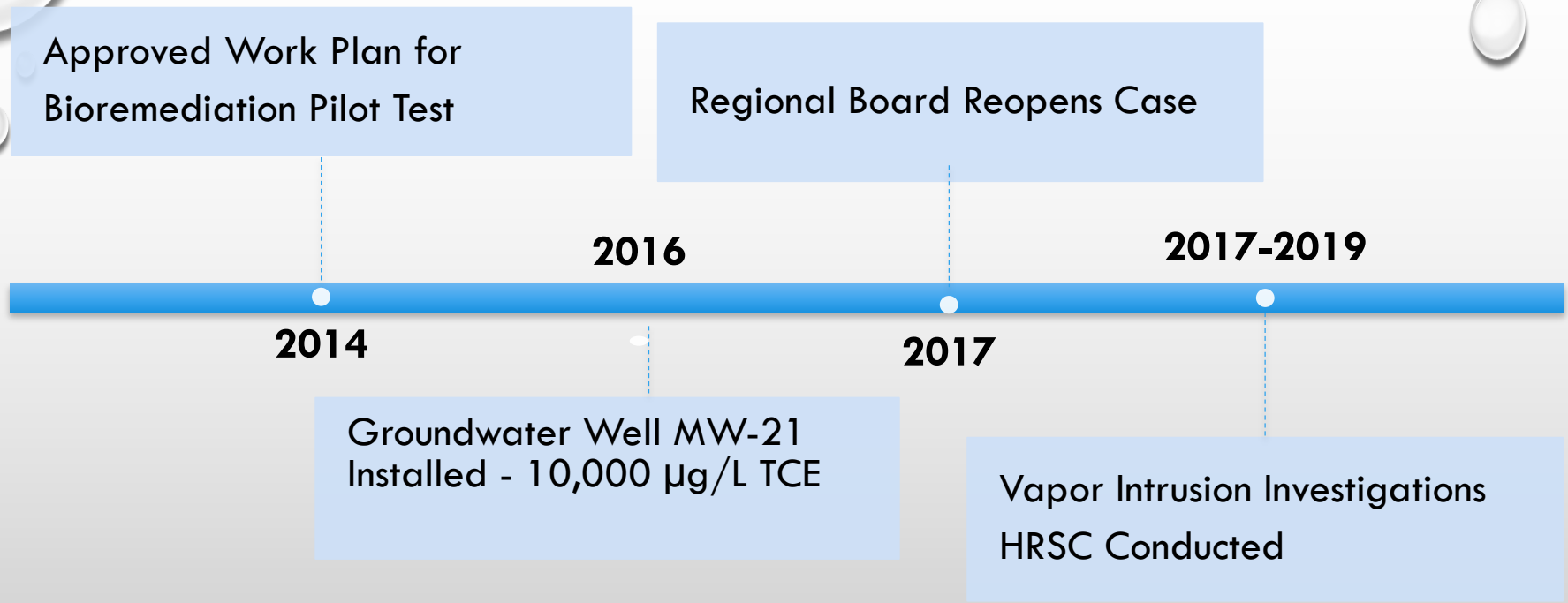
SITE TIMELINE



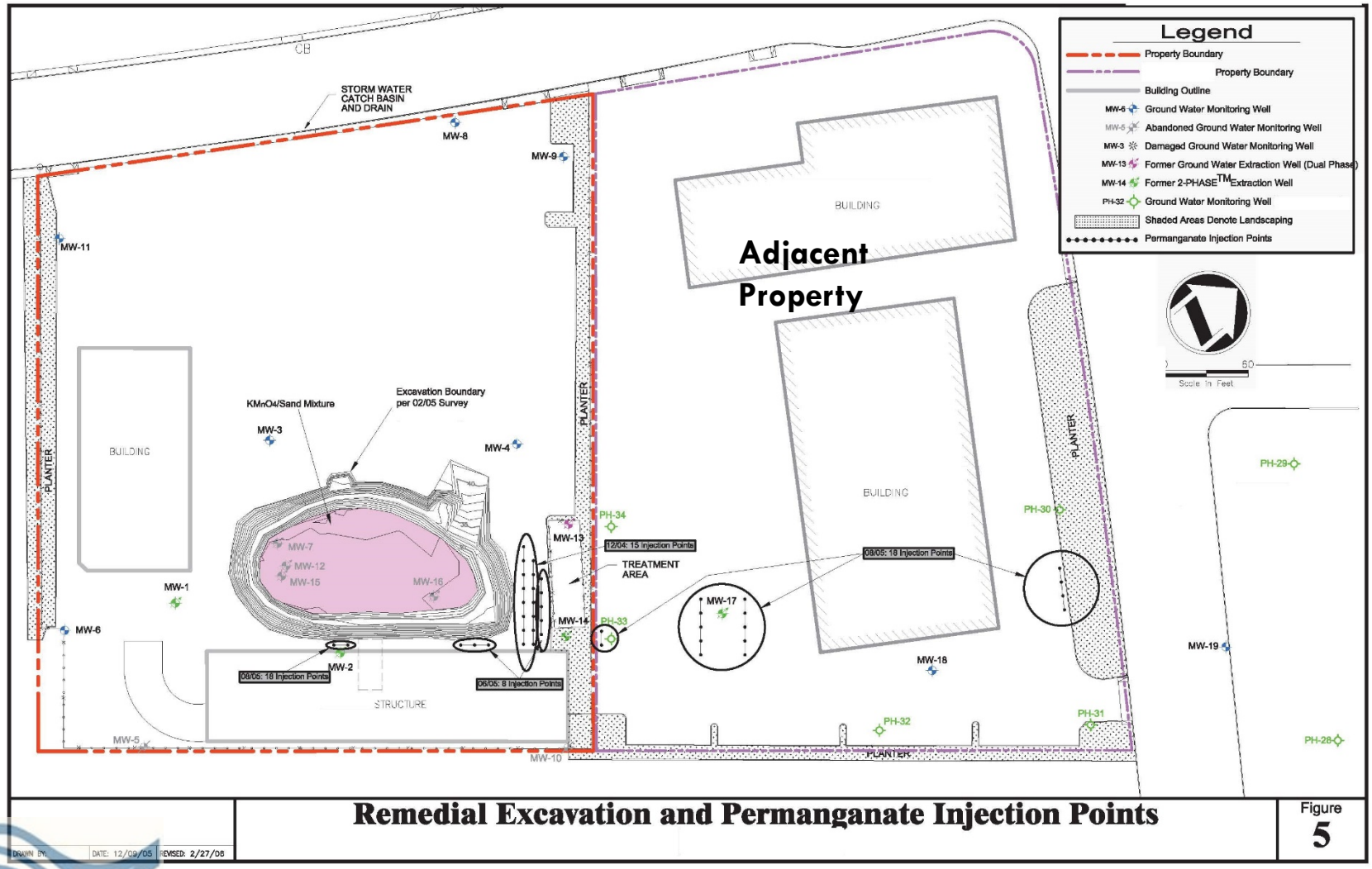
SITE TIMELINE



SITE TIMELINE

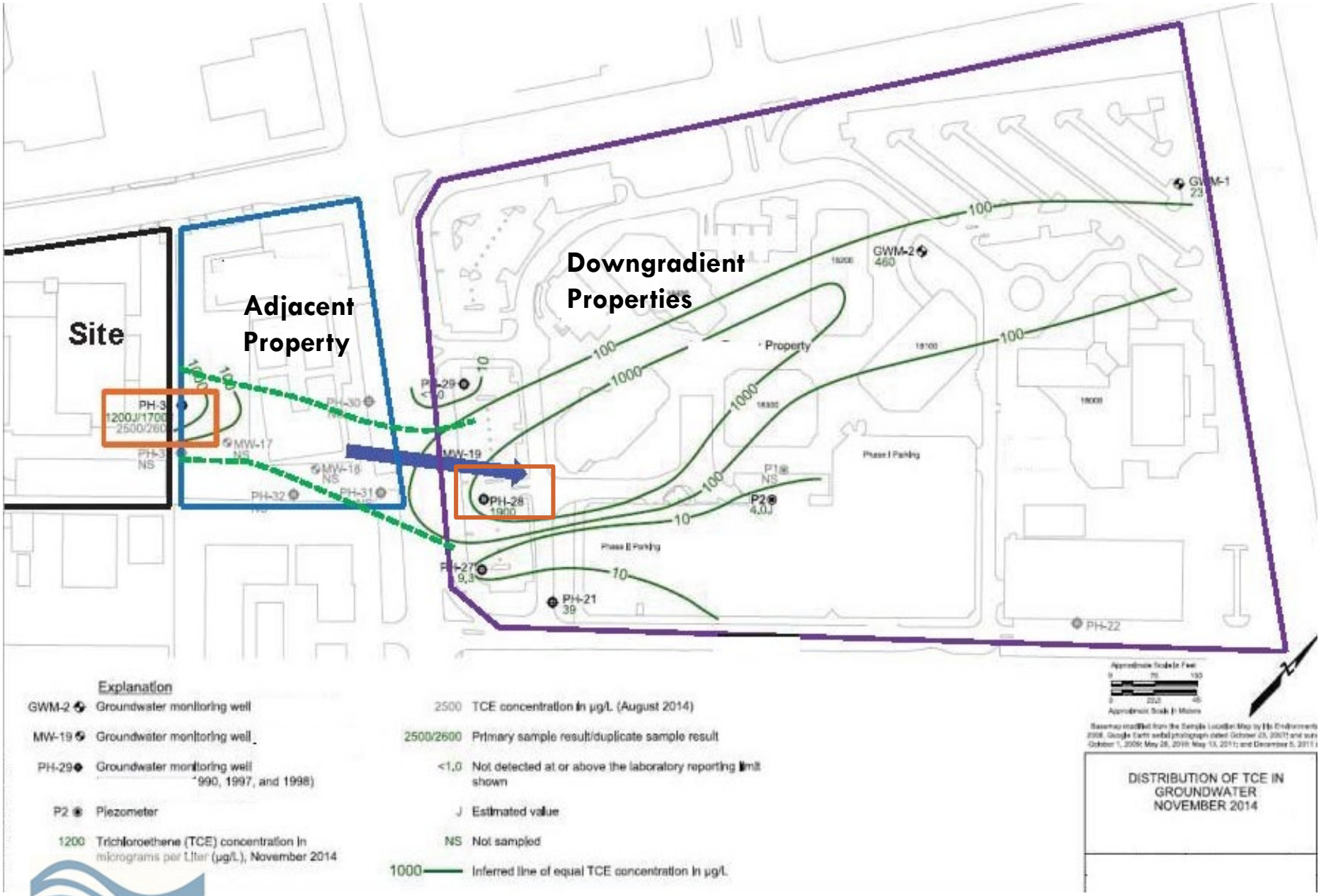


SITE TIMELINE



Remedial Excavation and Permanganate Injection Points

Figure 5



Water Boards

ON-SITE REMEDIATION PHASES

- GROUNDWATER PUMP AND TREAT SYSTEM
- DUAL-PHASE EXTRACTION PILOT TEST
- EXCAVATION
  - METALS AND TCE IMPACTED SOILS (TD ~ 31 FT. BGS)
  - SOLID POTASSIUM PERMANGANATE BACKFILL
- SODIUM PERMANGANATE INJECTIONS
- LESSONS LEARNED
  - SITE CSM WAS INCOMPLETE
  - REMEDIAL DESIGNS DID NOT REMOVE SOURCE AREA COMPLETELY
  - TCE IMPACTED GROUNDWATER STILL MIGRATING OFF-SITE

POST-REMEDIATION HRSC

Investigation Included 34 MIP/HPT Borings

- Electron capture detector (ECD)
- Halogen specific detector (XSD)
- Flame ionization detector (FID)
- Photoionization detector (PID)

27 Soil Borings

- Continuous coring for lithology
- Soil samples to confirm MIP responses
- Hydropunch™ grab groundwater samples
- 8 borings in excavation footprint

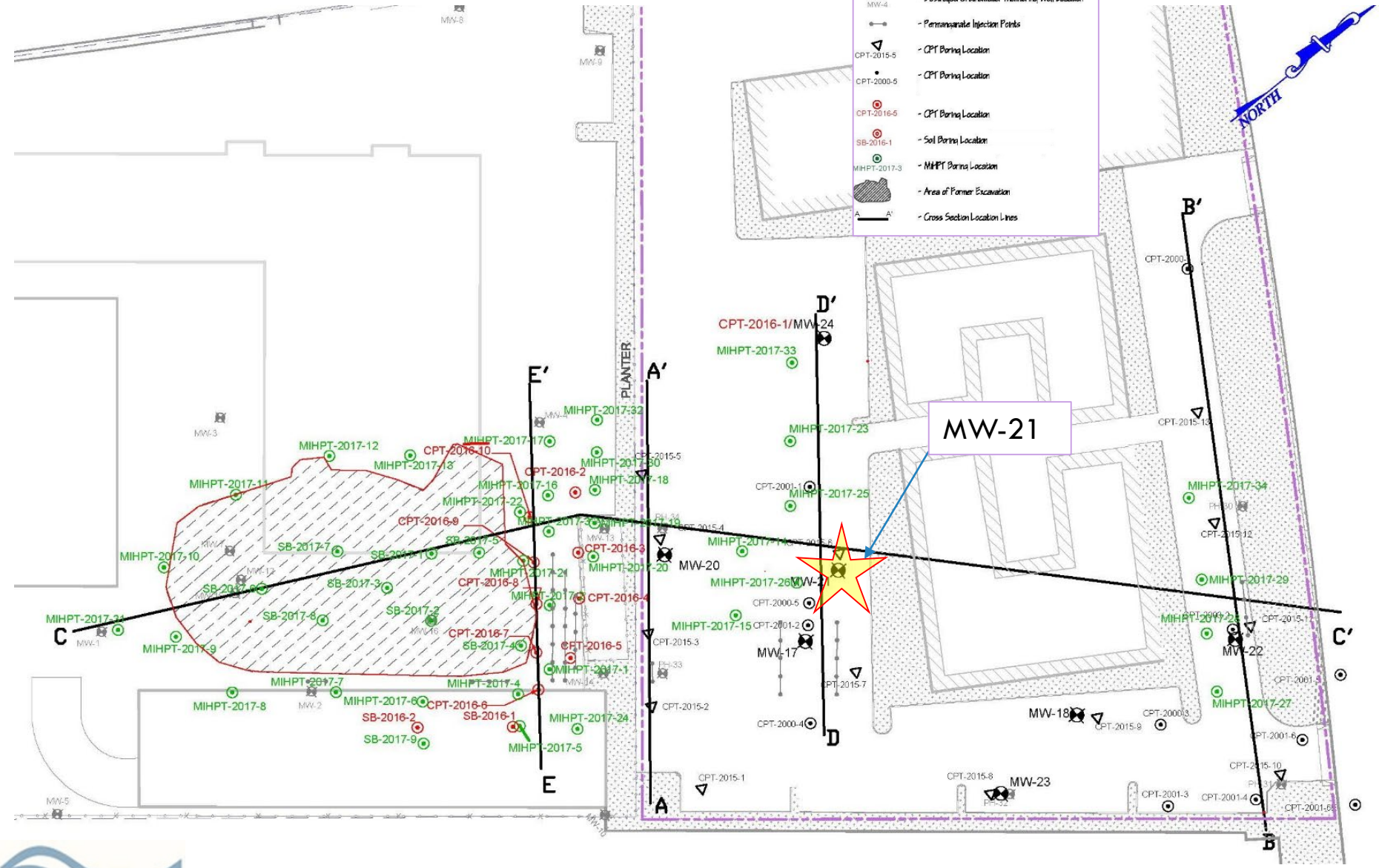
POST-REMEDIATION HRSC

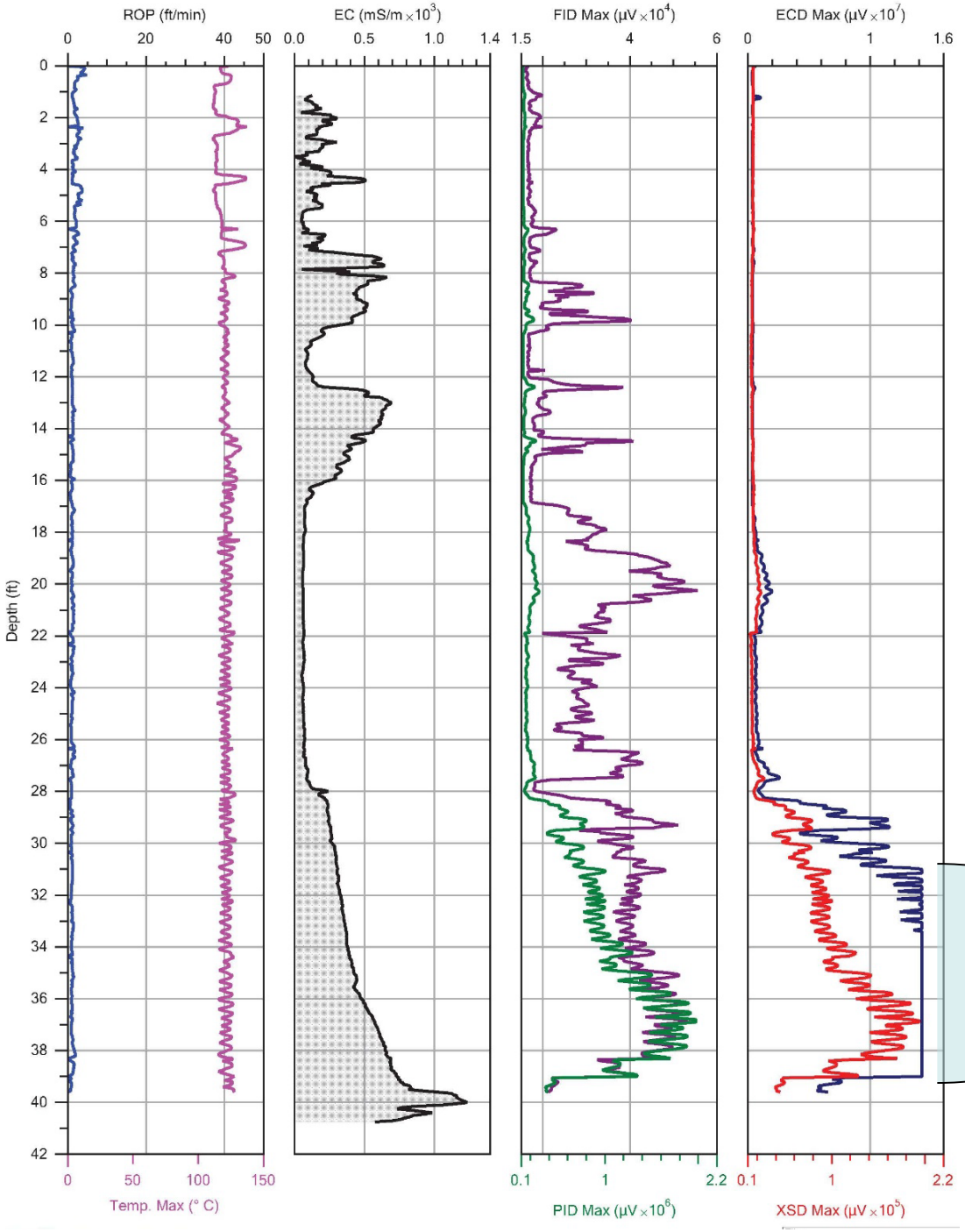
Hydrophobic Dye Testing of Soil and Groundwater Samples

- Oil Red O and/or Sudan IV dyes
- DNAPL not detected

Environmental Visualization Software

- Geologic interpretation
- Hydraulic conductivity (K) interpretation
- XSD detector responses


General Notes
- Groundwater Monitoring Well Location
- Destroyed Groundwater Monitoring Well Location
- Permanganate Injection Points
- CPT Boring Location
- CPT Boring Location
- CPT Boring Location
- Soil Boring Location
- MiHPT Boring Location
- Area of Former Excavation
- Cross Section Location Lines
NORTH
MW-21
CPT-2016-1/MW-24
MW-20
MW-17
MW-18
MW-23
MW-22
PLANTER
A
A'
B
B'
C
C'
D
D'
E
E'

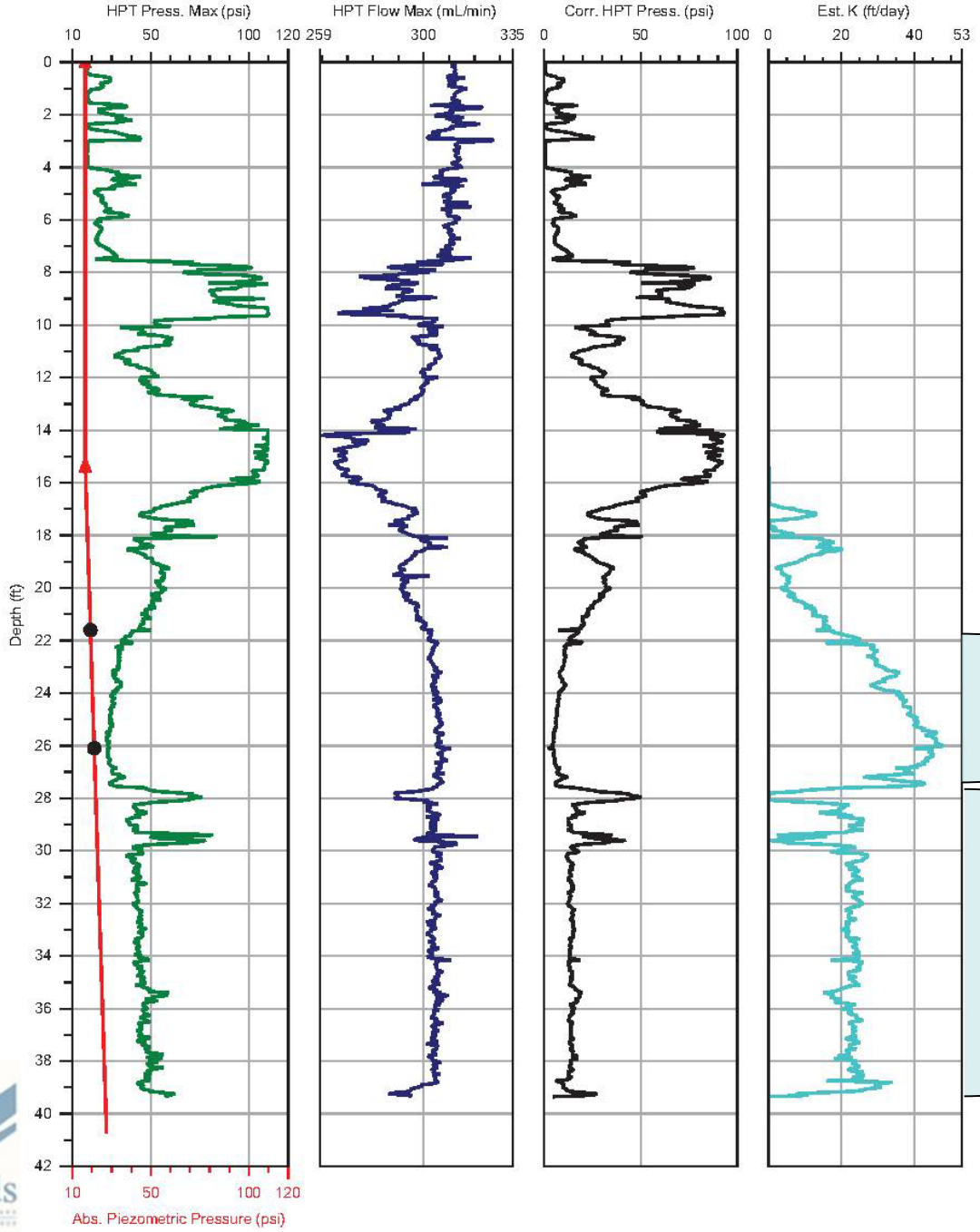


MiHPT-2017-19

Black – EC (mS/m x 10^3)
Green – PID Max (µV x 10^6)
Purple – FID Max (µV x 10^4)
Dk. Blue – ECD Max (µV x 10^7)
Red – XSD Max (µV x 10^5)

24,166.8 µg/L TCE
Groundwater

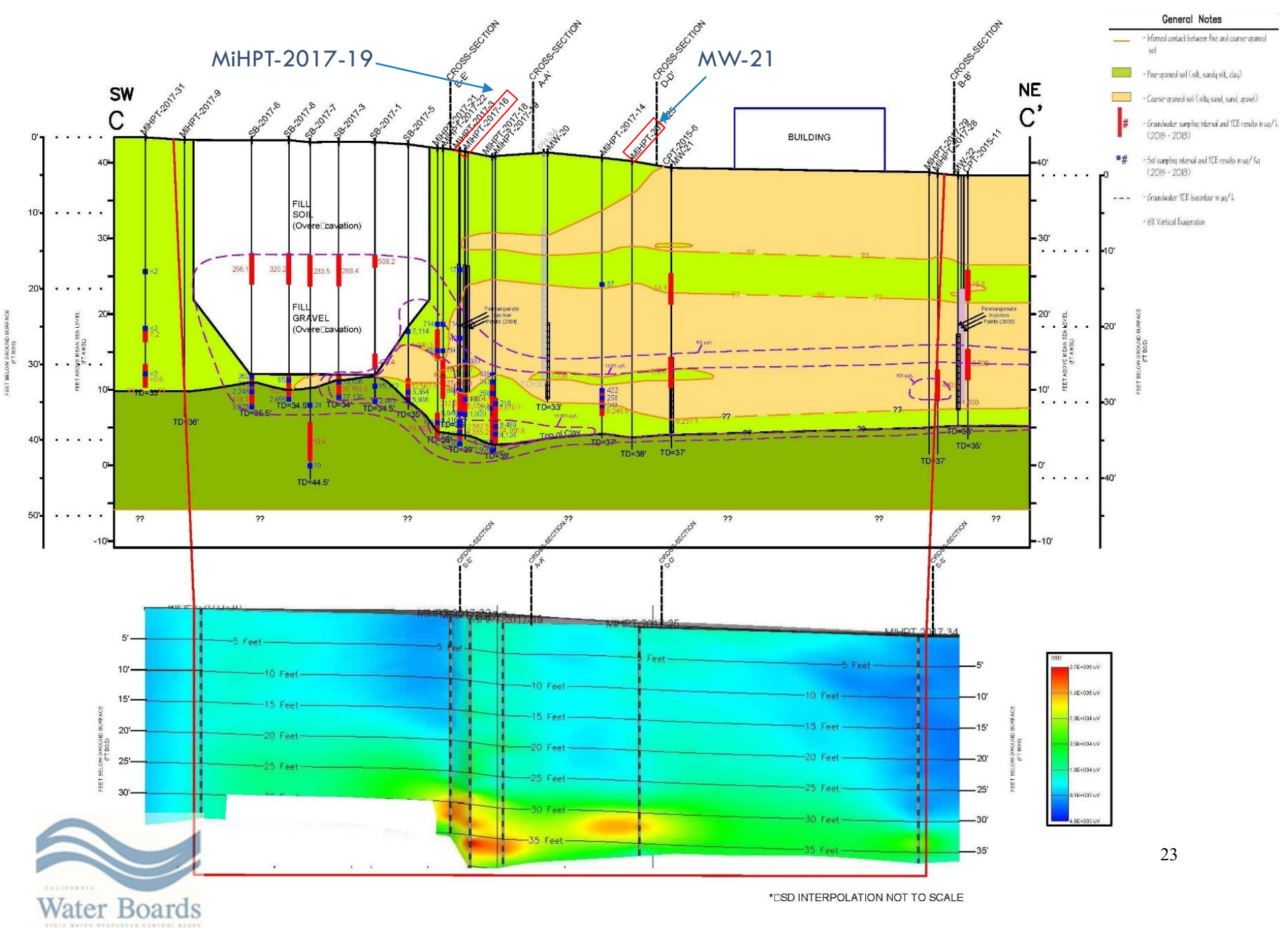
MiHPT-2017-19



Red – Absolute Piezometric Pressure (psi)
Green – HPT Pressure Max (psi)
Dk. Blue – HPT Flow Max (mL/min)
Black – Corrected HPT Pressure (psi)
Lt. Blue – Estimated K (ft/day)

Higher K zone

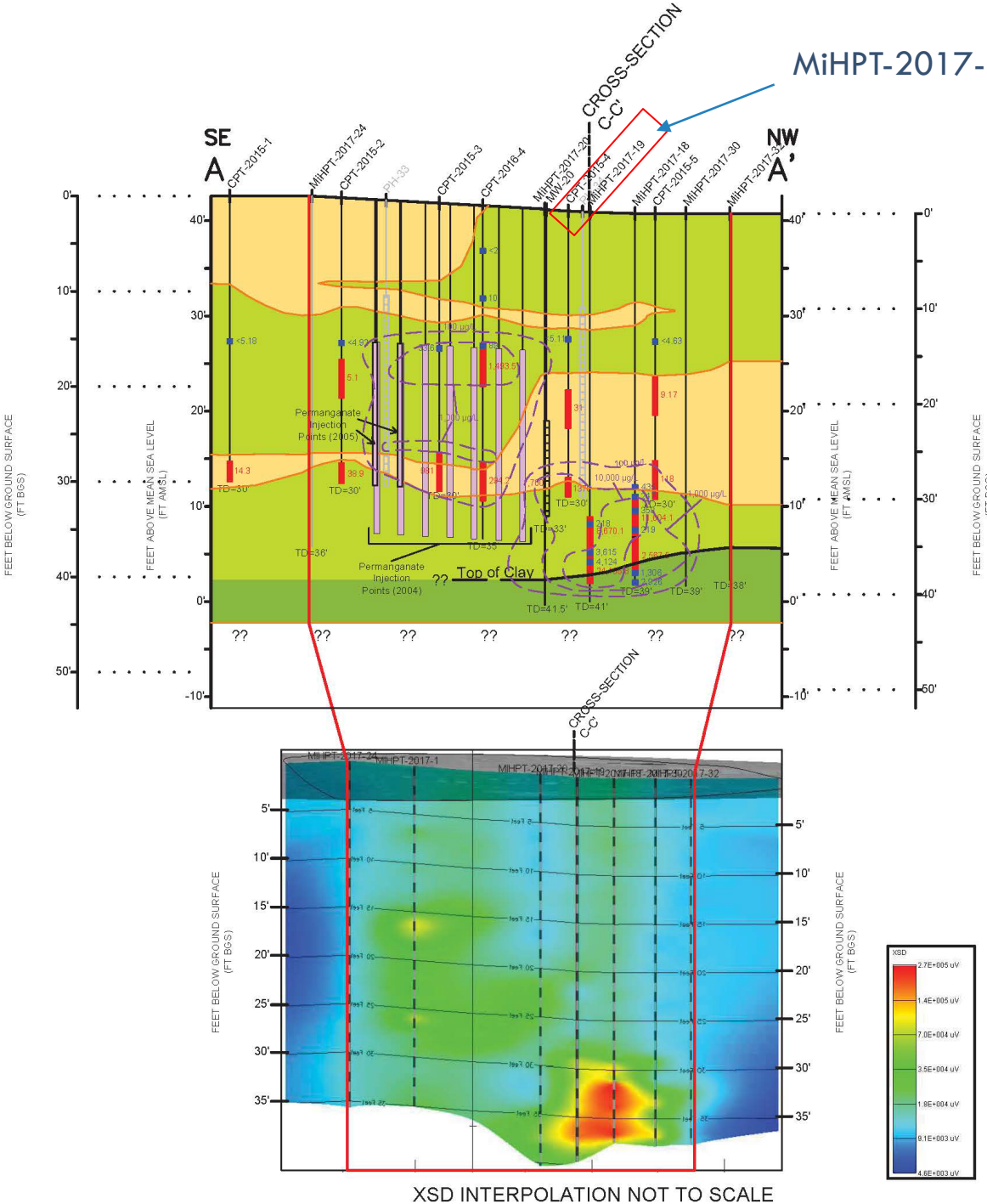
Lower K zone


MiHPT-2017-19
MW-21
SW
C
NE
C'
BUILDING
FILL
SOIL
(Overexcavation)
FILL
GRAVEL
(Overexcavation)
Top of Clay
General Notes
Inferred contact between fine and coarse-grained soil
Fine-grained soil (silt, sandy silt, clay)
Coarse-grained soil (silty sand, sand, gravel)
Groundwater sampling interval and TCE results in ug/L (2016 - 2018)
Soil sampling interval and TCE results in ug/Kg (2016 - 2018)
Groundwater TCE isocontour in ug/L
6X Vertical Exaggeration
5 Feet
10 Feet
15 Feet
20 Feet
25 Feet
30 Feet
35 Feet
*ISD INTERPOLATION NOT TO SCALE

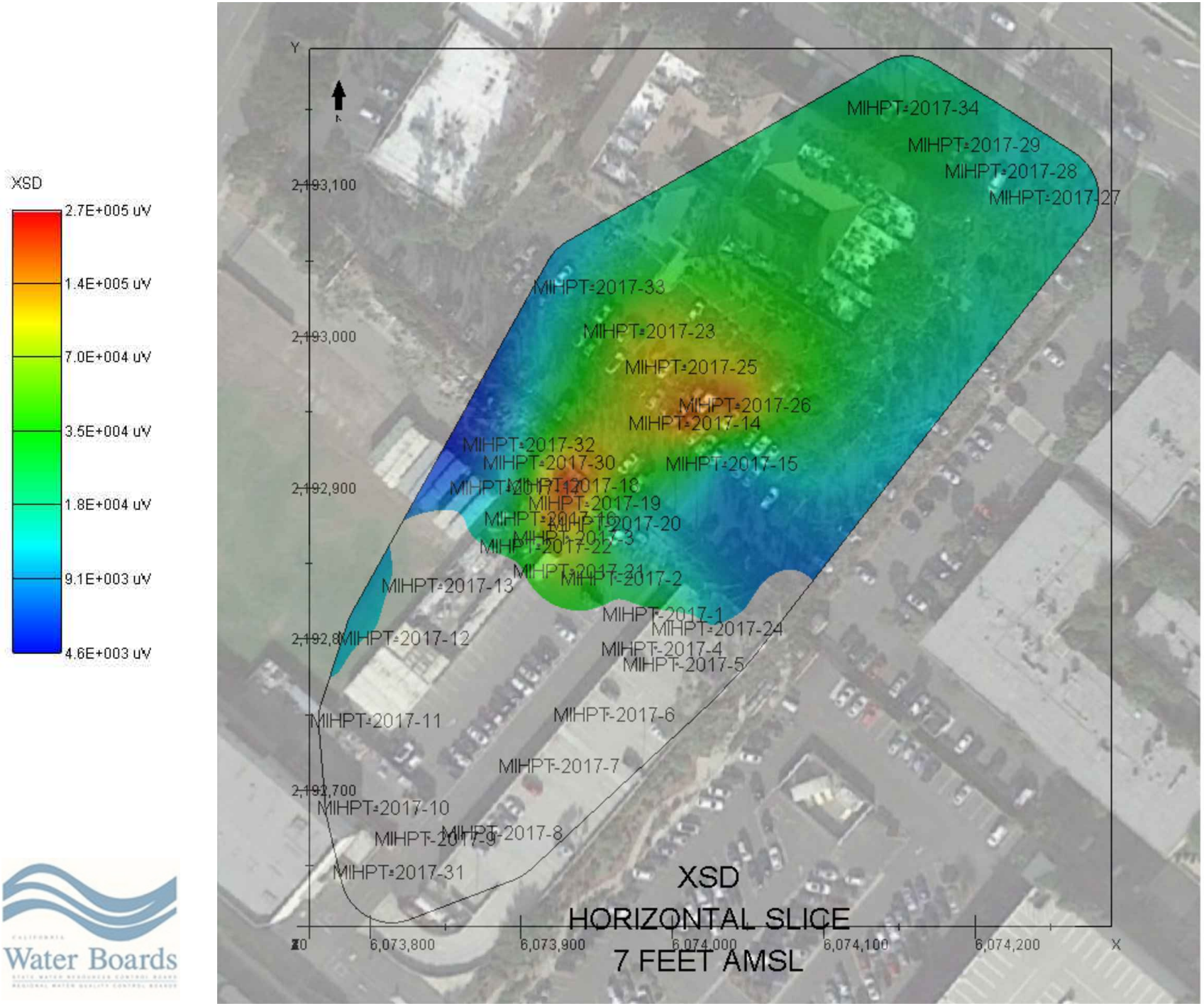
General Notes

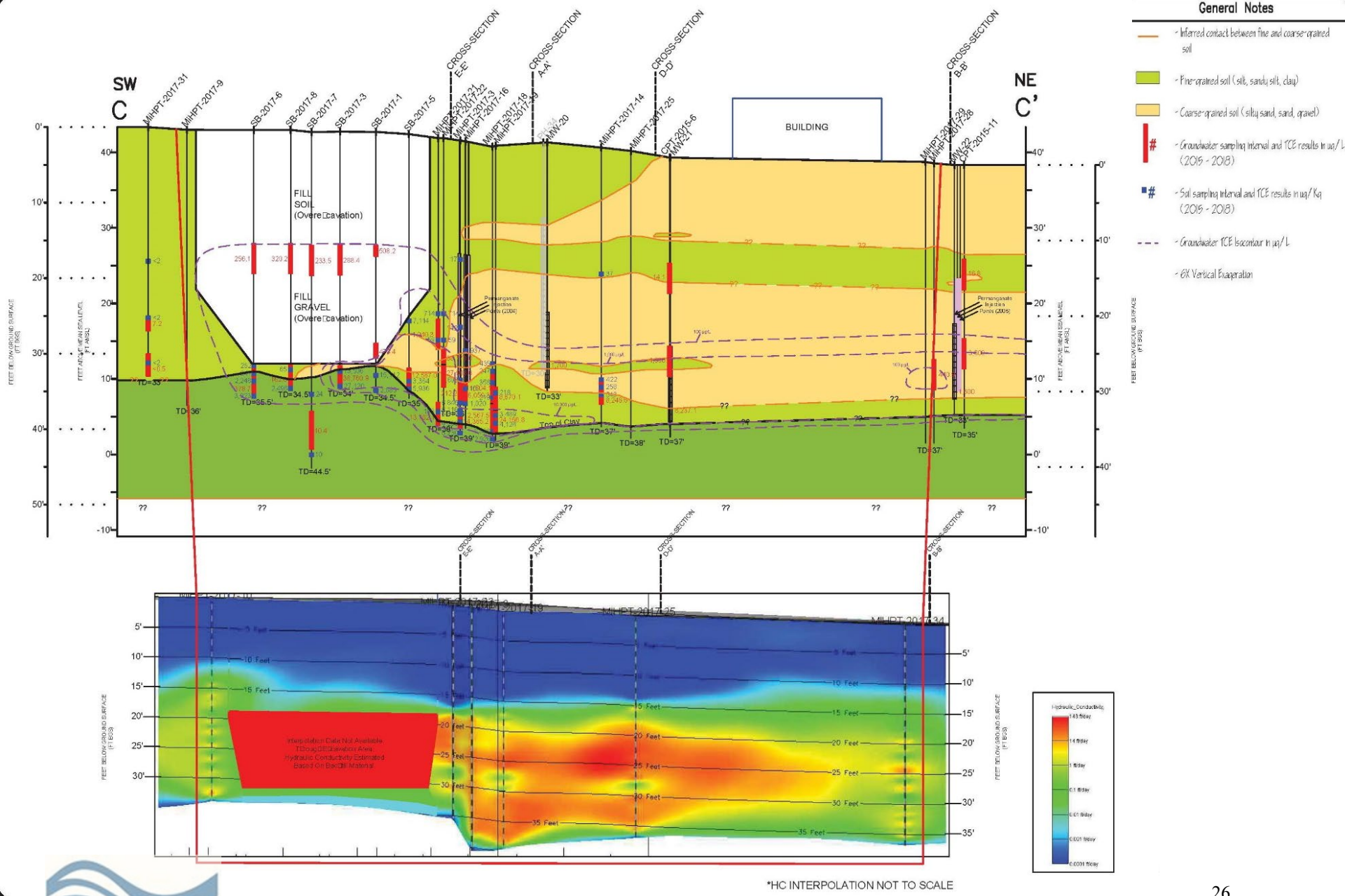
- Inferred contact between fine and coarse-grained soil
- Fine-grained soil (silt, sandy silt, clay)
- Coarse-grained soil (silty sand, sand, gravel)
- # - Groundwater sampling interval and TCE results in ug/L (2015 - 2018)
- # - Soil sampling interval and TCE results in ug/Kg (2015 - 2018)
- Groundwater TCE Isocontour in ug/L
- 4X Vertical Exaggeration

MiHPT-2017-19



XSD INTERPOLATION NOT TO SCALE

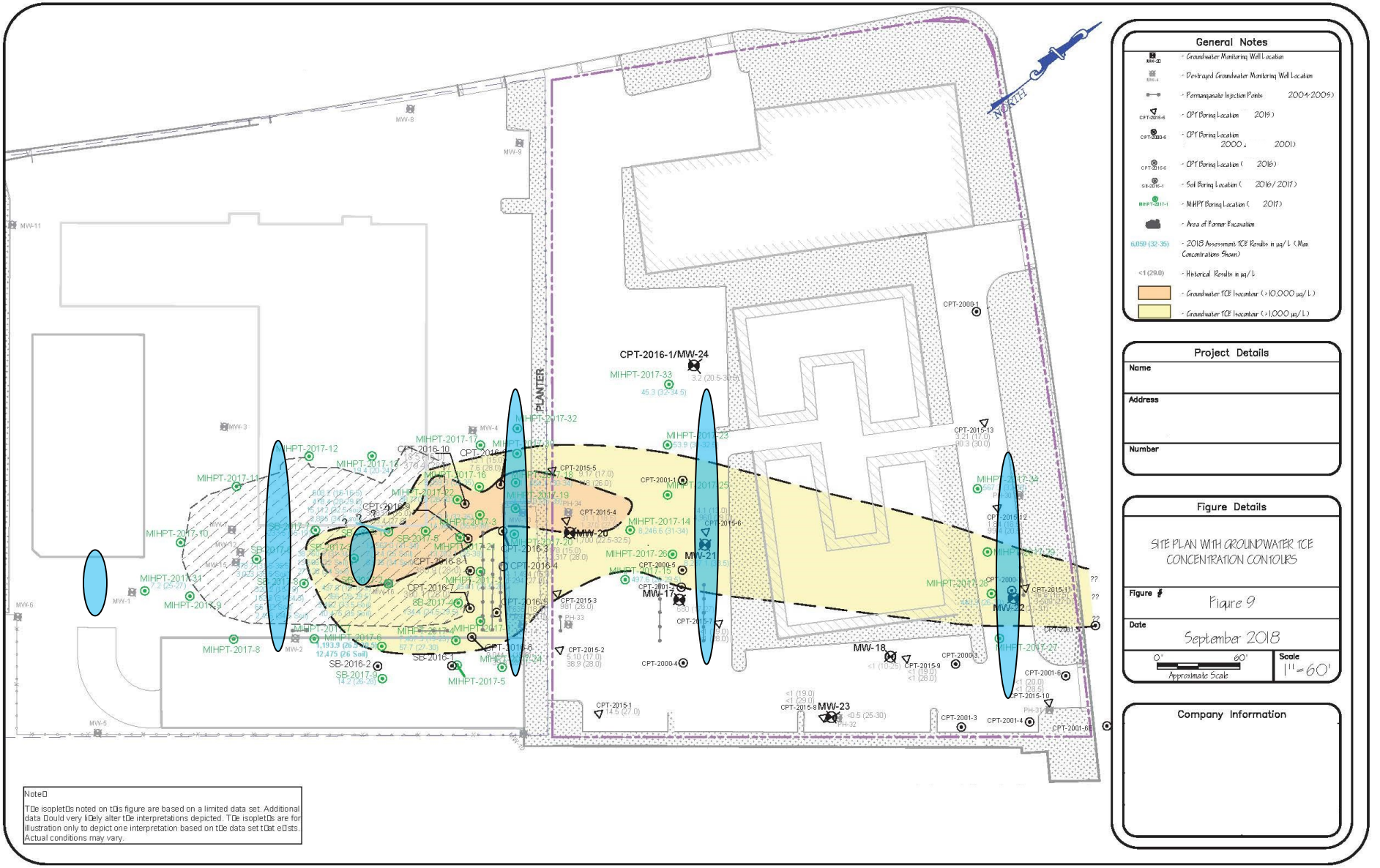

XSD
2.7E+005 uV
1.4E+005 uV
7.0E+004 uV
3.5E+004 uV
1.8E+004 uV
9.1E+003 uV
4.6E+003 uV
Y
X
2,193,100
2,193,000
2,192,900
2,192,800
2,192,700
6,073,800
6,073,900
6,074,000
6,074,100
6,074,200
MIHPT-2017-34
MIHPT-2017-29
MIHPT-2017-28
MIHPT-2017-27
MIHPT-2017-33
MIHPT-2017-23
MIHPT-2017-25
MIHPT-2017-26
MIHPT-2017-14
MIHPT-2017-32
MIHPT-2017-30
MIHPT-2017-15
MIHPT-2017-18
MIHPT-2017-19
MIHPT-2017-20
MIHPT-2017-22
MIHPT-2017-2
MIHPT-2017-13
MIHPT-2017-1
MIHPT-2017-24
MIHPT-2017-12
MIHPT-2017-4
MIHPT-2017-5
MIHPT-2017-11
MIHPT-2017-6
MIHPT-2017-7
MIHPT-2017-10
MIHPT-2017-8
MIHPT-2017-9
MIHPT-2017-31
XSD
HORIZONTAL SLICE
7 FEET AMSL



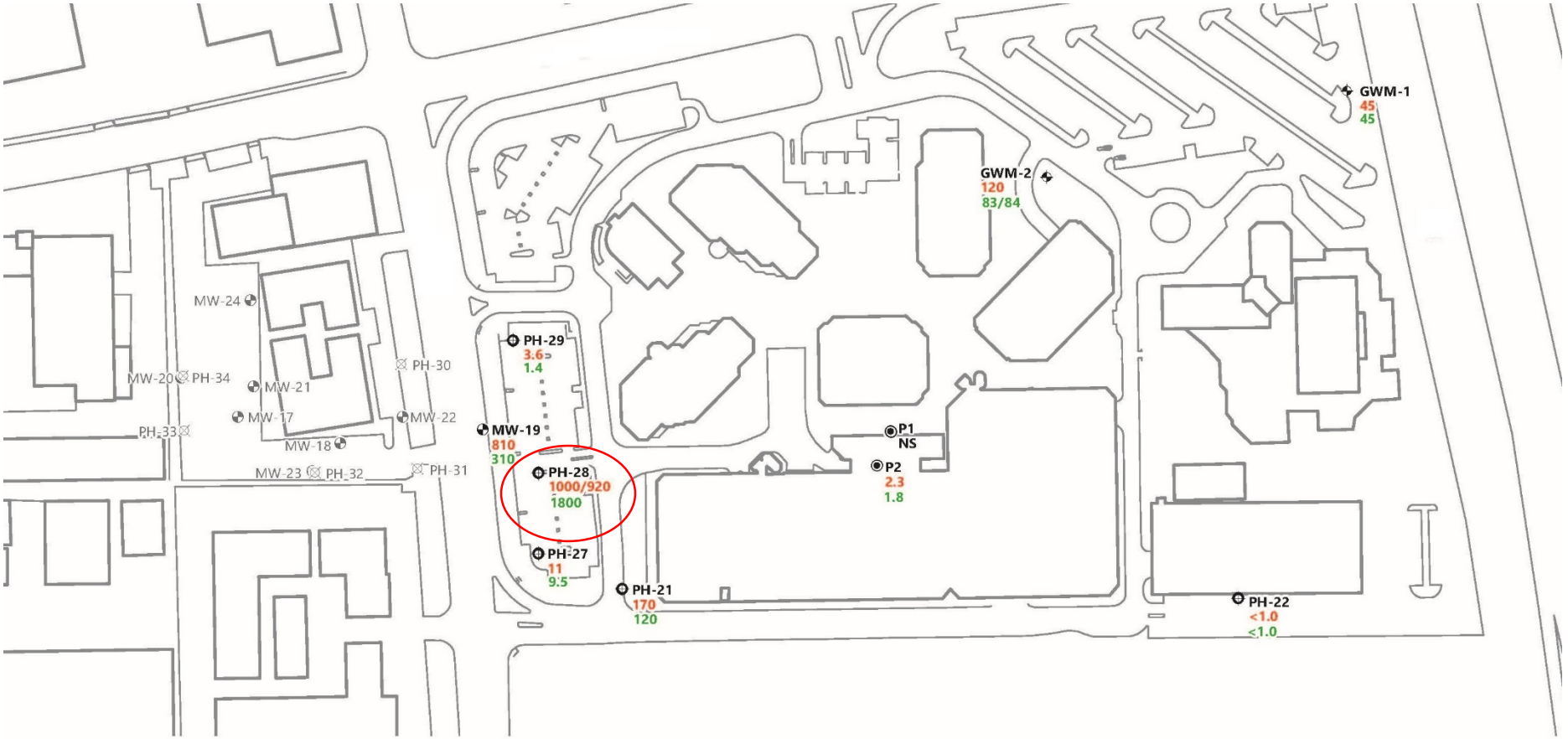
*HC INTERPOLATION NOT TO SCALE

NEXT STEPS

- Enhanced Bioremediation Pilot Test 2020
- Install transects of multi-depth groundwater wells on Site and on the adjacent property
- Investigate the deeper water bearing zone
- Complete VI Assessments
- Update CSM
- Interim Remedial Action Plan



Areas tentatively targeted for well installations during the next phase of investigation



Explanation

GWM-2 Groundwater monitoring well 2011)

PH-29 Groundwater monitoring well (1990, 1997, and 1998)

MW-19 Groundwater monitoring well (2002 and 2016)

P2 Piezometer

PH-30 Groundwater monitoring well destroyed (1998)

1000 Trichloroethene (TCE) concentration in micrograms per liter (µg/L), September 2019

1800 TCE concentration in µg/L, November 2019

1000/920 Primary sample results/duplicate sample result

<1.0 Not detected at or above the laboratory reporting limit shown

NS Not sampled

N

0 75 150

Approximate Scale in Feet

DISTRIBUTION OF TCE IN GROUNDWATER
SEPTEMBER AND NOVEMBER 2019

Water Boards

- Shorten assessment phase
- Complete CSMs
- Targeted remediation
- Shorter remediation timeframe
- Lower remediation costs
- Lower long-term monitoring costs

HRSC CAN REDUCE REMEDIATION TIME AND COST

Water Boards

TECHNOLOGY RESOURCES

Interstate Technology & Regulatory Council (ITRC) Integrated DNAPL Site Characterization Tools

- 2015 Guidance document
- https://www.itrcweb.org/guidance/ListDocuments?topicID=5&subTopicID=10

ITRC Implementing Advanced Site Characterization Tools

- Nov. 2019 Guidance Document
- Training videos in development
- Evening Workshop at AEHS Conference on March 18, 2020
- https://www.itrcweb.org/team/public?teamid=79

Clu-in.org Website

- https://cluin.org/characterization/technologies/hrsc/hrscintro.cfm