

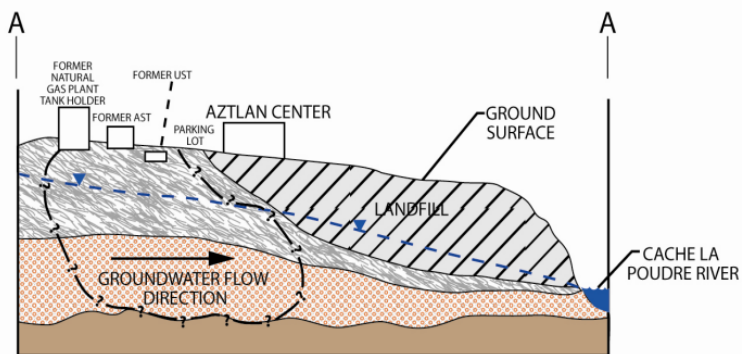


The Evolving Conceptual Site Model and Remedial Technology Selection

Examples from EPA Region 2 Superfund Sites

Kathryn Flynn

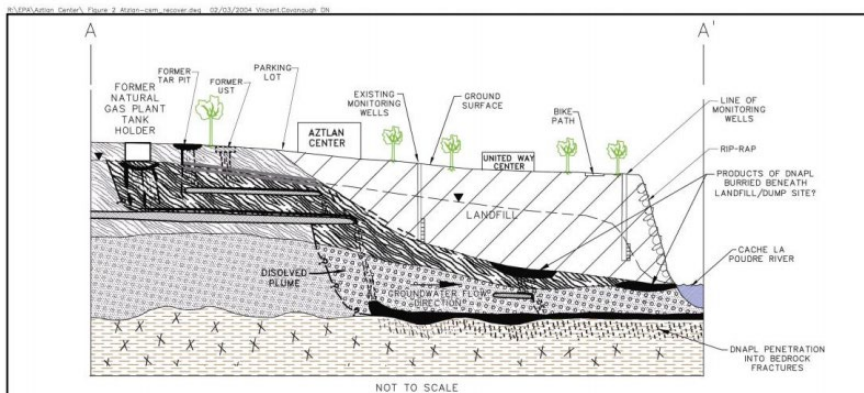
U.S. Environmental Protection Agency
Region 2 Technical Support Section



- LEGEND** NOT TO SCALE
- ▼ WATER TABLE (APPROXIMATE)
 - ?— BENZENE AND NAPHTHALENE PLUME BOUNDARY
 - ▨ POST-PINEY CREEK ALLUVIUM (UPPER HOLOCENE)
 - ▨ BROADWAY ALLUVIUM (PLEISTOCENE)
 - ▨ BROADWAY ALLUVIUM (PLEISTOCENE)
 - ▨ PIERRE SHALE
 - ▨ LANDFILL
 - ▨ CACHE LA POUDE RIVER

Preliminary CSM

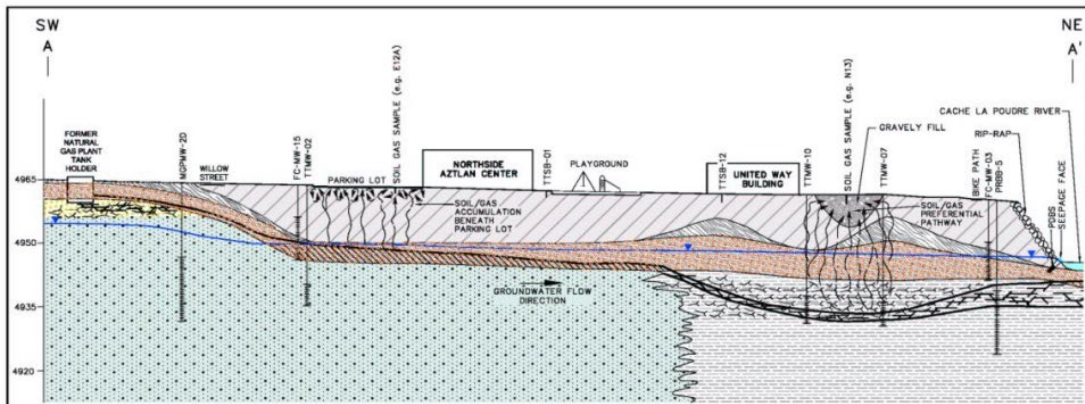
U.S. EPA REGION VIII
IN COOPERATION WITH
BROWNFIELDS TECHNOLOGY SUPPORT CENTER



- LEGEND**
- ▨ POST-PINEY CREEK ALLUVIUM (UPPER HOLOCENE)
 - ▨ BROADWAY ALLUVIUM (PLEISTOCENE)
 - ▨ WEATHERED AND FRACTURED PIERRE SHALE
 - ▨ LANDFILL
 - ▨ INTERBEDDED CALICHE/CEMENTED SANDSTONE LAYERS
 - ▨ PETROLEUM HYDROCARBONS AND NAPHTHALENE DISOLVED PLUME BOUNDARY
 - ?— NON-AQUEOUS PHASE LIQUIDS (DNAPL)
 - ?— LIGHT NON-AQUEOUS PHASE LIQUIDS (LNAPL)

Characterization CSM

CONCEPTUAL SITE MODEL DIAGRAM AND GEOLOGIC CROSS-SECTION
U.S. EPA REGION VIII
IN COOPERATION WITH
BROWNFIELDS TECHNOLOGY SUPPORT CENTER



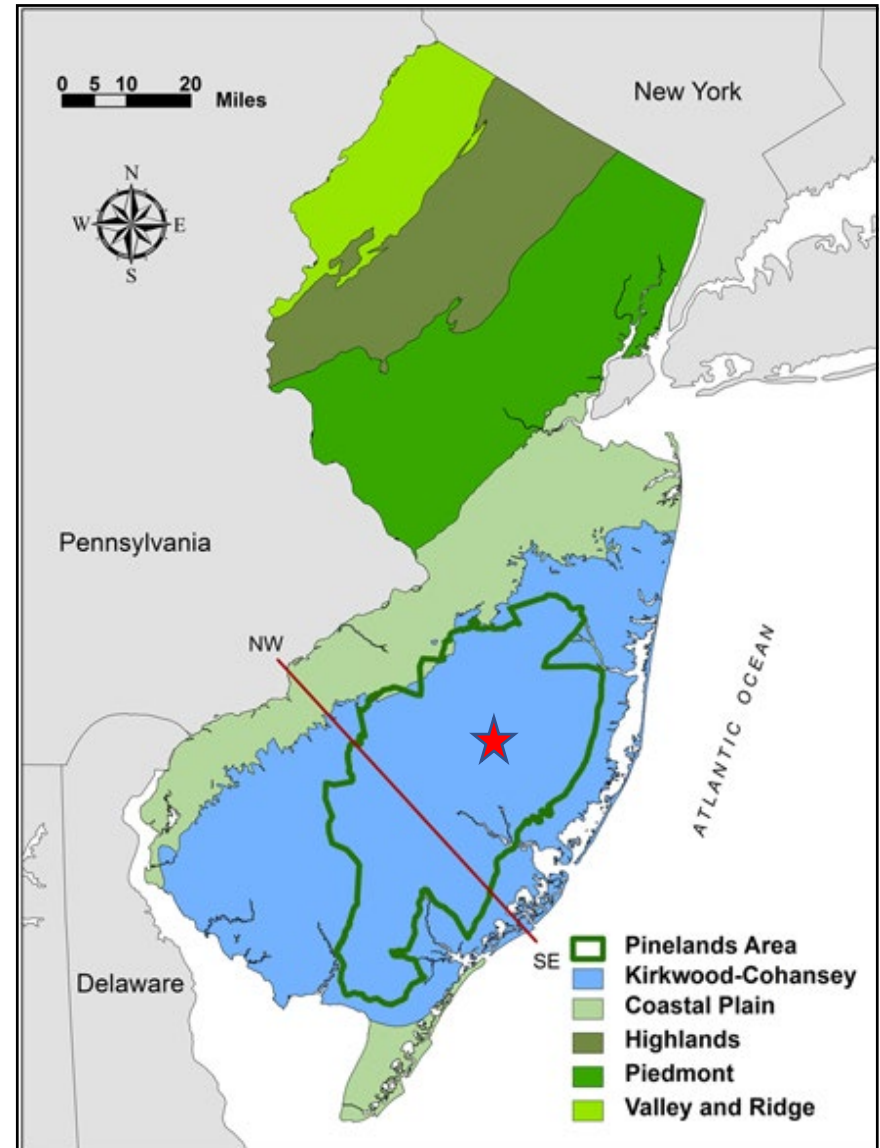
- LEGEND**
- ▼ WATER TABLE (APPROXIMATE)
 - ▨ POST-PINEY CREEK ALLUVIUM (UPPER HOLOCENE)
 - ▨ BROADWAY ALLUVIUM (PLEISTOCENE)
 - ▨ MASSIVE GLAUCANTIC SANDSTONE (PIERRE SHALE)
 - ▨ LAMINATED SILTY SANDSTONE/SILTSTONE (PIERRE SHALE)
 - ▨ LAMINATED, FRACTURED SILTY SANDSTONE (PIERRE SHALE)
 - ▨ LANDFILL MATERIAL
 - ▨ DNAPL-COAL TAR
 - ▨ HIGHLY WEATHERED FRACTURED SANDSTONE (PIERRE SHALE)
 - ▨ DENSE NON-AQUEOUS PHASE LIQUID (DNAPL)
 - ?— PASSIVE DIFFUSION BAG SAMPLER
 - ?— WELL SCREEN INTERVAL
 - ?— COAL TAR

Design CSM

NO SCALE
HORIZONTAL VERTICAL
1:5 APPROXIMATE VERTICAL EXAGGERATION
POUDRE RIVER SITE
FORT COLLINS, COLORADO
FINAL CONCEPTUAL SITE MODEL AND CROSS-SECTION
U.S. EPA REGION VIII
IN COOPERATION WITH
BROWNFIELDS TECHNOLOGY SUPPORT CENTER

Woodland Rt 72 Site

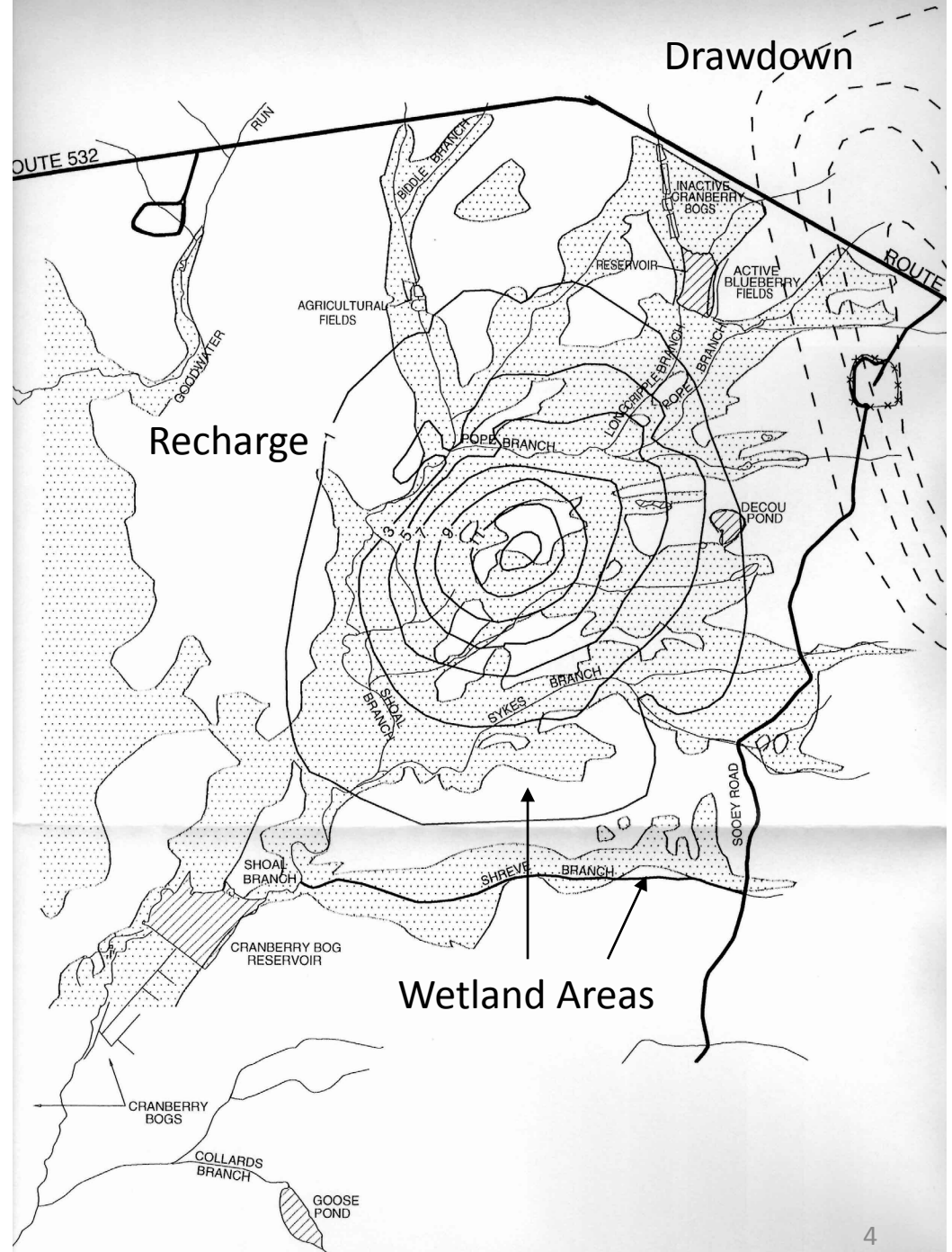
- NPL 1984
- Contaminants 1,2-DCA and BTEX
- Pinelands Preservation Area
- Kirkwood-Cohansey Aquifer



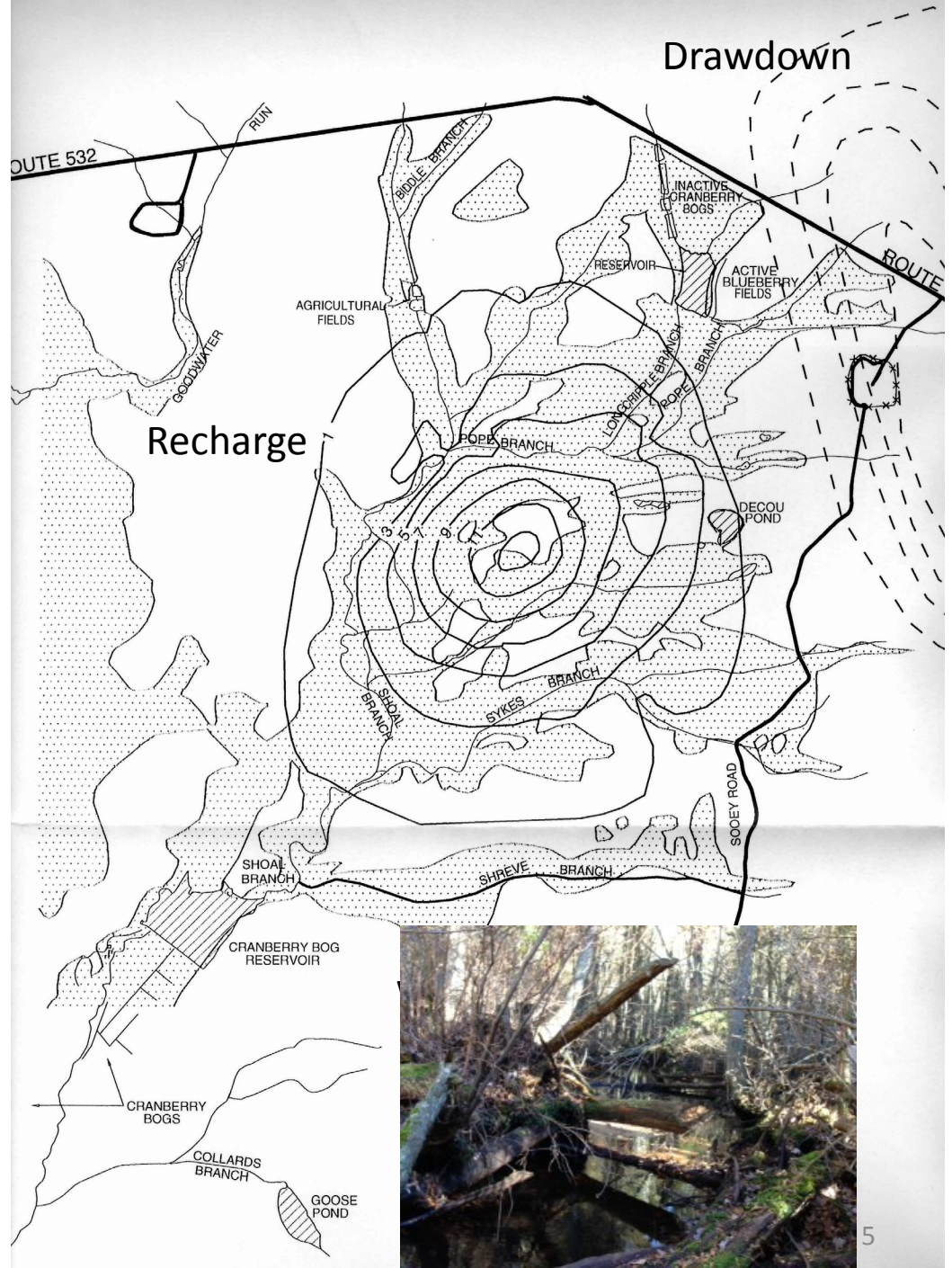
Woodland Rt 72 Site

1990 Remedy Pump and Treat

- ROD estimate was 1.2 Mgd for plume capture
- Groundwater model showed 10 Mgd required
- 1 – 12 feet of drawdown in plume
- 5 feet of recharge over 2 square miles
- Drastic consequences for ecology of Pinelands



Woodland Rt 72 Site



Woodland Rt 72 Site



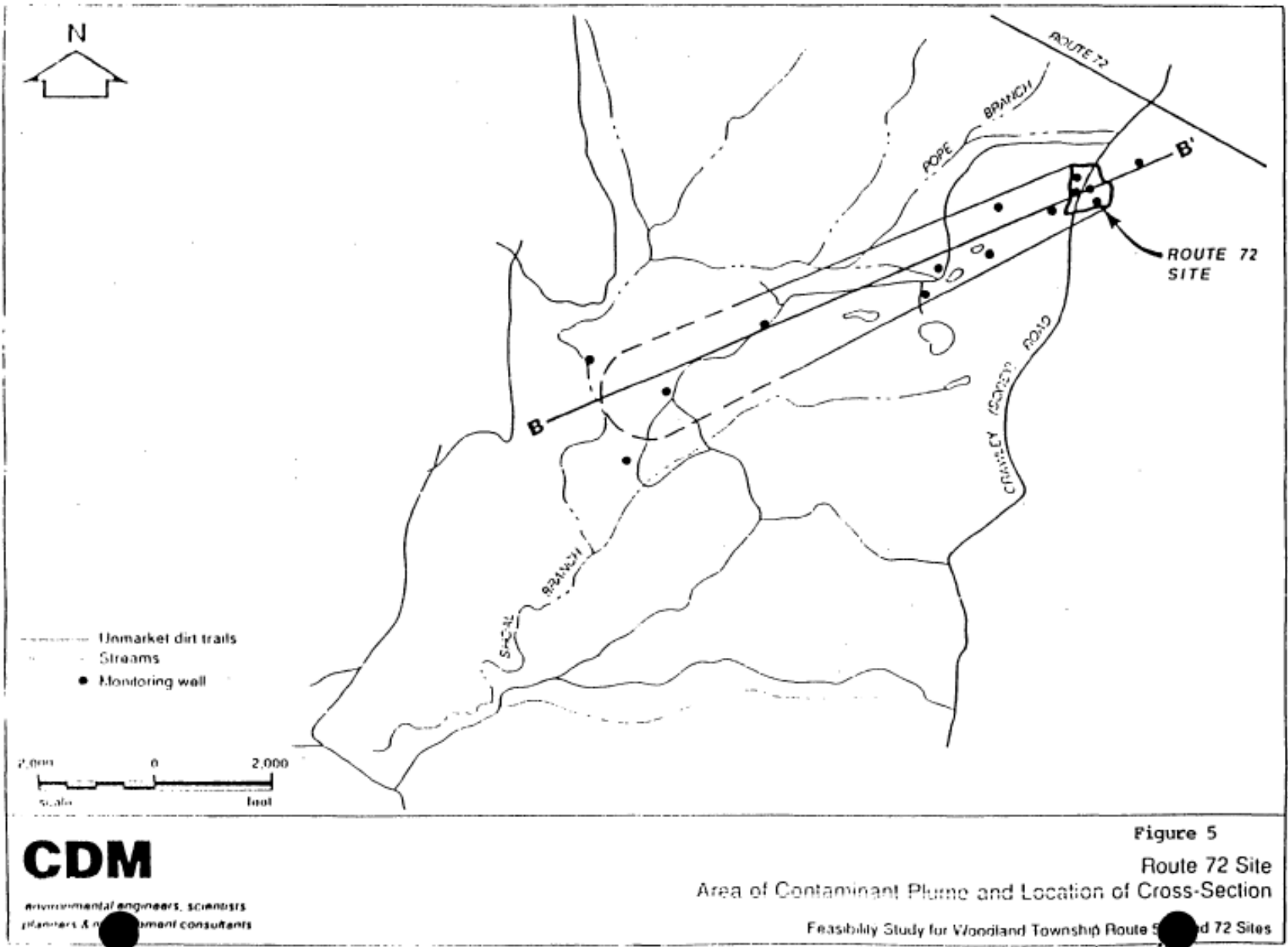
1999 ROD Amendment
AS/SVE with Pump and Treat
Contingency



Woodland Rt 72 Site

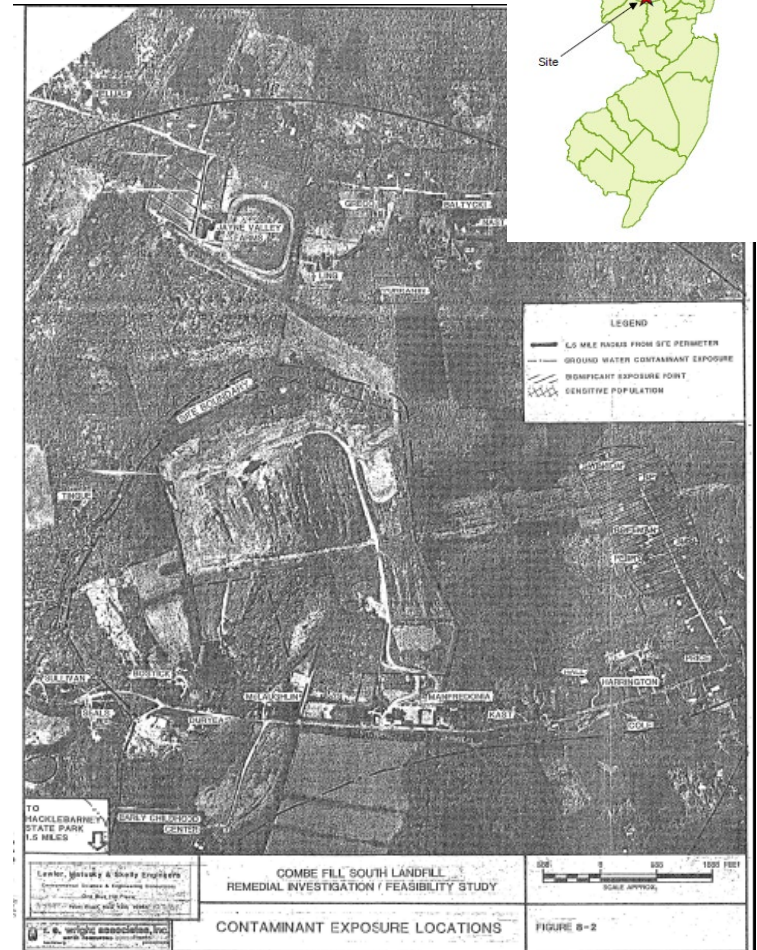
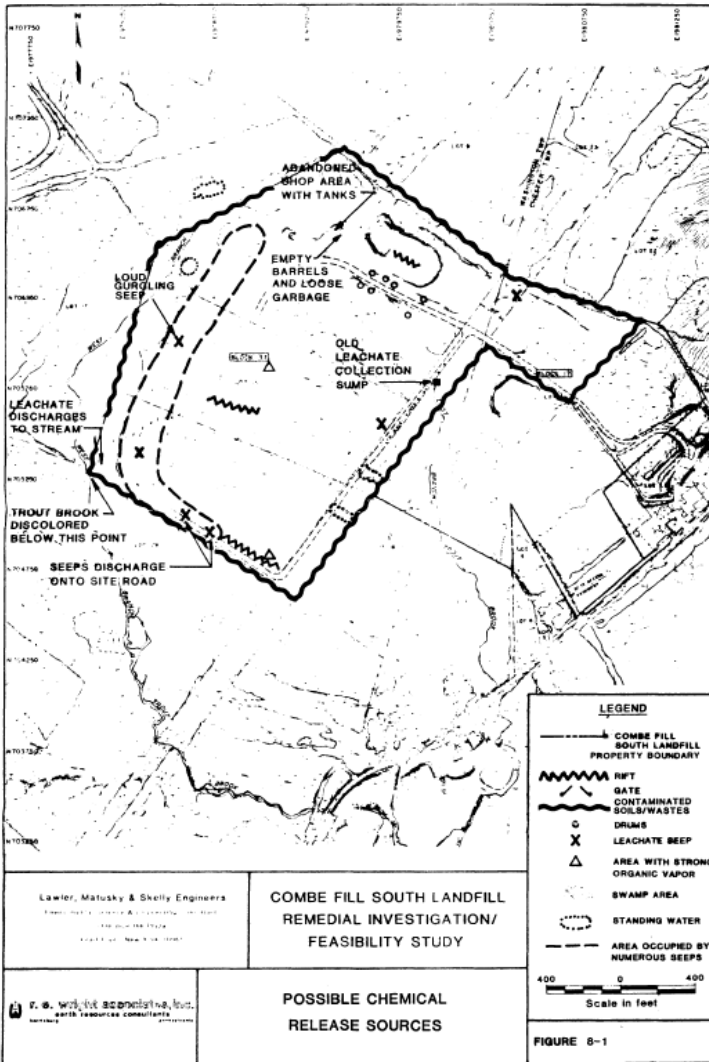


Woodland Rt 72 Site



1990 Record of Decision Plume Map

Combe Fill South Site

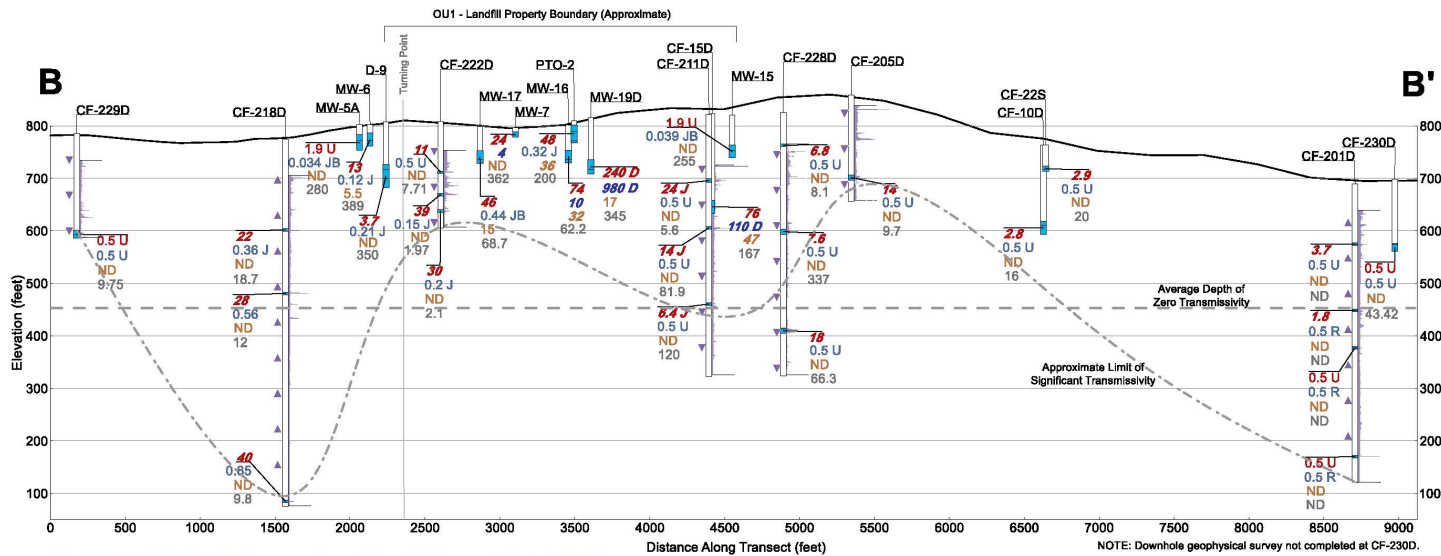


CSM Remedial Investigation 1986

NPL 1983

ROD 1986: Water supply + pump and treat

Combe Fill South Site



Legend (Inset Map)

- Well Location On Section
- Other Well Location
- OU1 - Landfill Property Boundary

Cross Section Legend

- 1,4-Dioxane
- Benzene
- Total Carcinogenic TICs
- Total Non-Carcinogenic TICs
- Well Casing
- Borehole Caliper Reading (Relative Width of Hole)
- Well Screen or Sample Port Zone
- Spikes indicate potential fracture zones.

Notes:
 Constituents are presented in the same order adjacent to the sample location.
 Concentrations shown in ug/L.
 Bold Italics indicates exceedance of applicable NJGWQS.

Constituent	GWQS
1,4-Dioxane	0.4
Benzene	1
Total Carcinogenic SOCs *	25
Total Non-Carcinogenic SOCs *	500

NJAC 7:9C Ground Water Quality Standards, Tables 1 & 2
 * *Interim Generic Criteria for Synthetic Organic Chemicals*

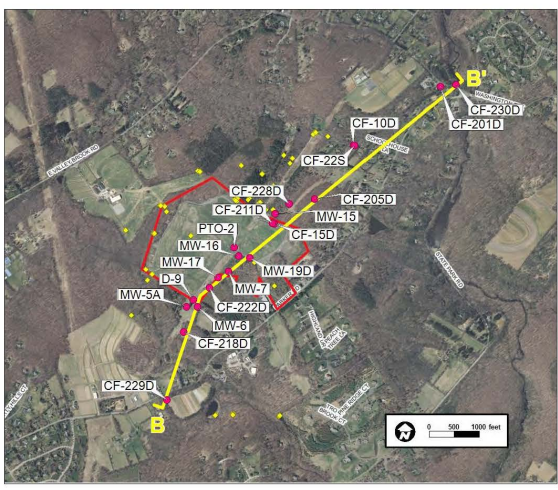
Synthetic Organic Chemicals (SOCs) are purposefully produced organic chemical compounds defined in NJAC 7:9C-1.4. SOCs do not have a specific groundwater quality criterion. Criteria for individual carcinogenic and non-carcinogenic are 5 ug/L and 100 ug/L respectively. The criteria for totals of each are 25 ug/L and 500 ug/L respectively.

Tentatively Identified Compounds (TICs) are non-target analytes for which there is presumptive evidence of their presence. Some TICs are unidentifiable and reported as unknowns. SOC TICs were grouped based on their carcinogenicity listed by the International Agency for Research on Cancer (IARC, March 2018).

Unknown TICs, non-SOCs, and TICs for which there is a promulgated standard in Table 1 of NJAC 7:9C are excluded from summations.

Maximum detected concentration occurring within the study duration is shown. Sample dates range from 4th Quarter 2011 through 4th Quarter 2015; and 1st Quarter 2017 (CF-209D and CF-209R-R). Samples collected by NJDEP and HDR.

CROSS SECTION B - B' **Figure 3-5**
June, 2018



Analytical Data Sources:
 HDR OU2 Remedial Investigation Groundwater Samples (2011 to 2015, 2017)
 NJDEP Post-Construction Environmental Monitoring (PCEM) Program Samples (Q4 2011 to Q4 2015)

Average site-wide depth of zero transmissivity calculated using OU2 RI geophysical data.

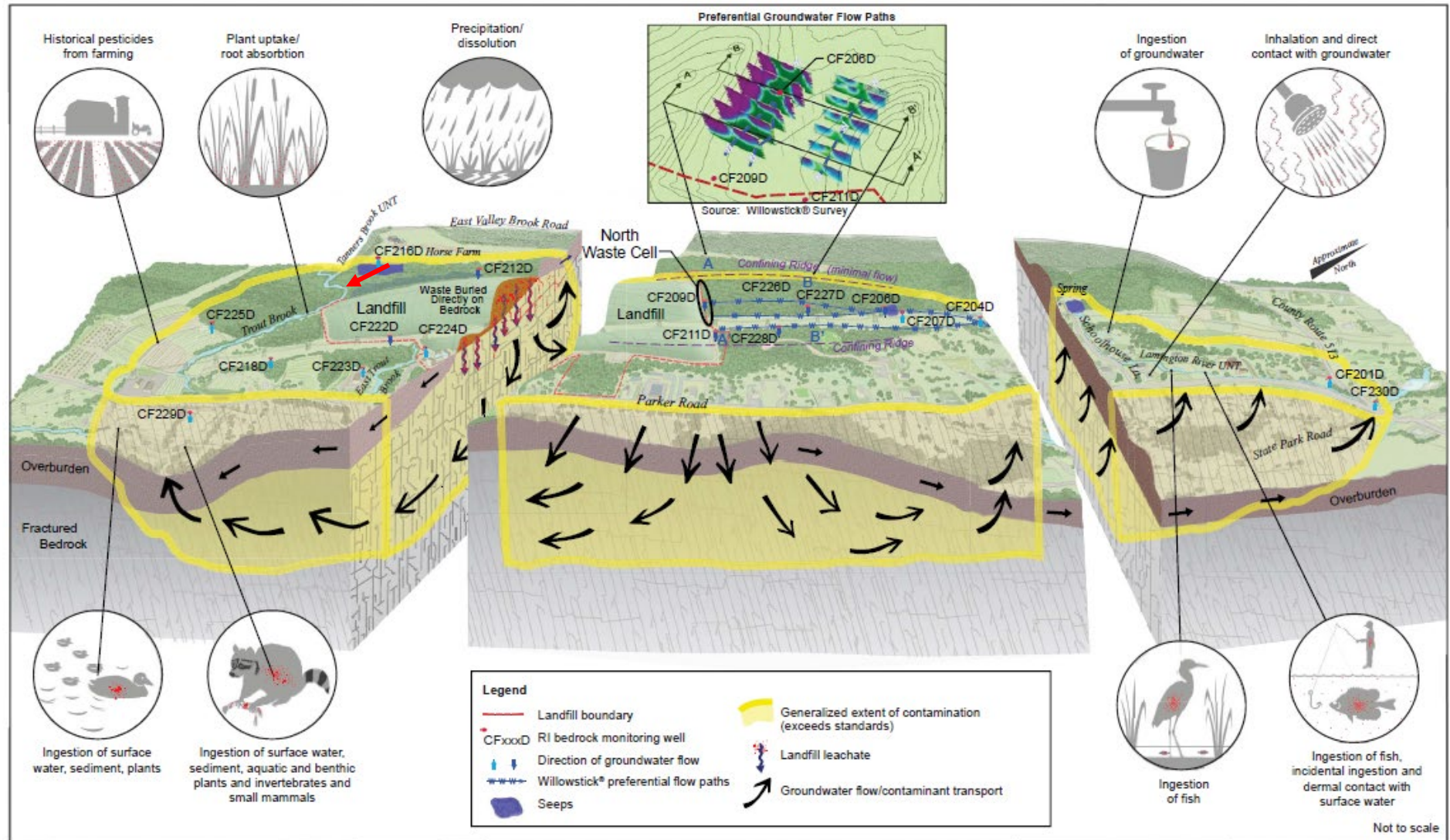
Geophysical Data Source:
 Downhole Geophysical Report (see RI Appendix K)
 (NOTE: Downhole geophysical survey not completed at CF-230D.)

Transmissivity Data Source:
 FLUTE Hydraulic Profiling Report (see RI Table 4-1 and RI Appendix T)

Well	Total Depth (ft bgs)	Depth to Competent Rock (ft bgs)	Maximum Depth of Liner Eversion (ft bgs)	Vertical Flow Direction
CF-201D	571	30	570	Upwards
CF-205D	198	6	173	Down or none
CF-211D	499	87	359	Down or none
CF-218D	700	67	698	Upwards
CF-222D	200	60	200	Down or none
CF-228D	499	35	428	Down or none
CF-229D	197	35	197	Down or none

1,4-Dioxane Results from Remedial Investigation 2015

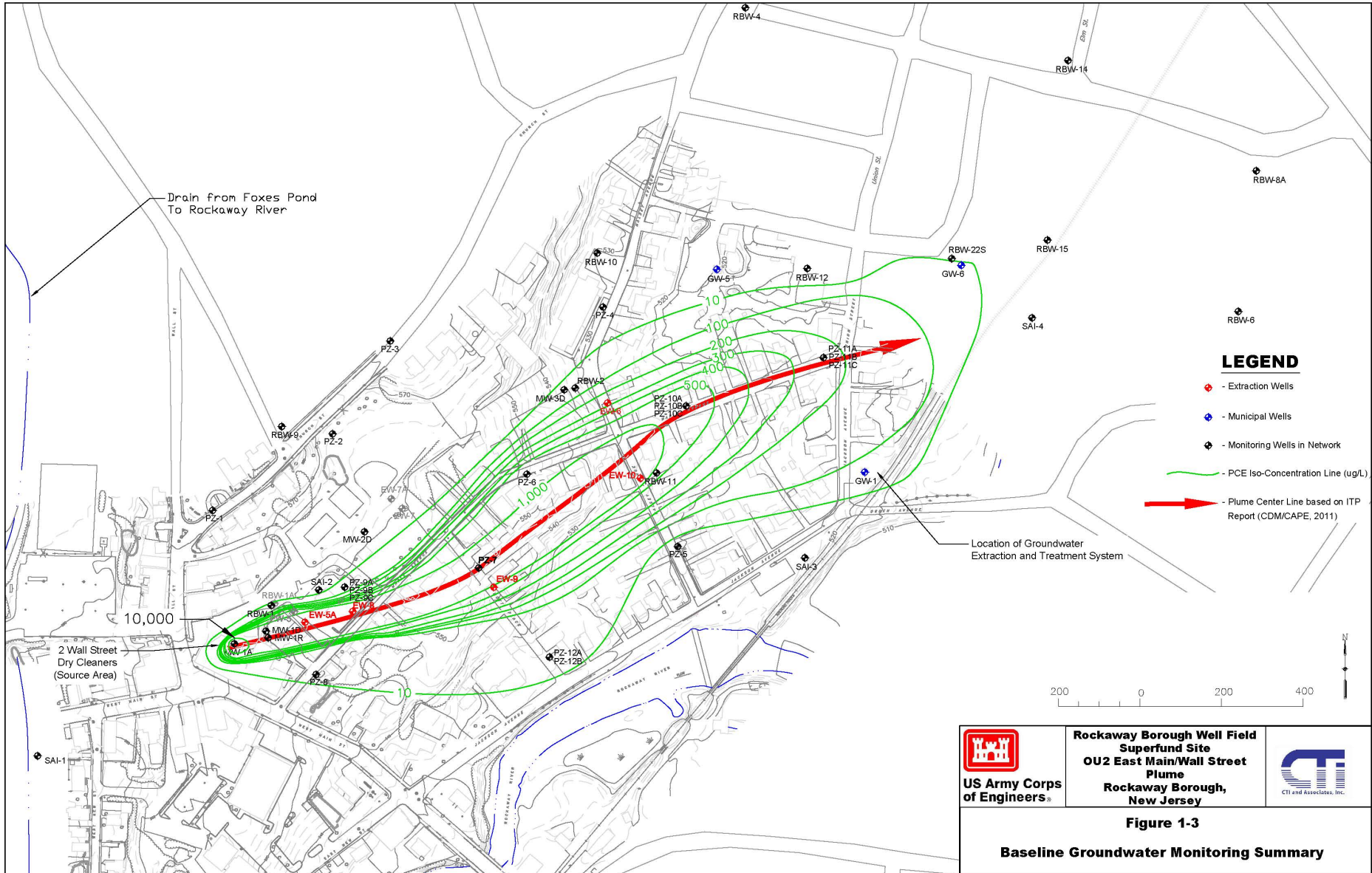
Combe Fill South Site



HR U.S. Environmental Protection Agency
Combe Fill South Landfill RI/FS
Chester & Washington Townships, New Jersey

Figure 3-8
Conceptual Site Model Illustration
August 2018

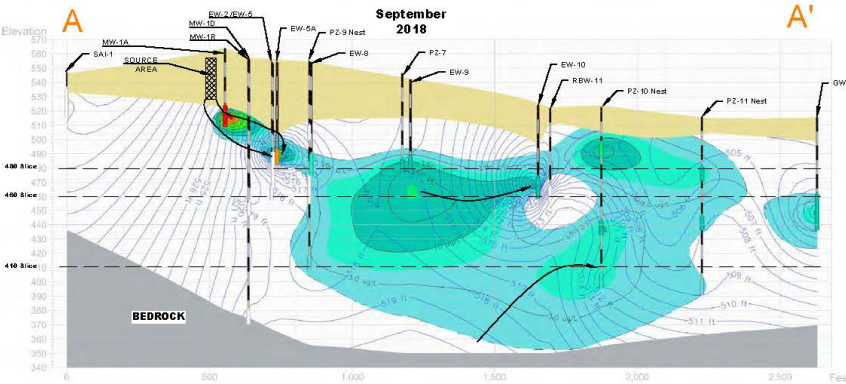
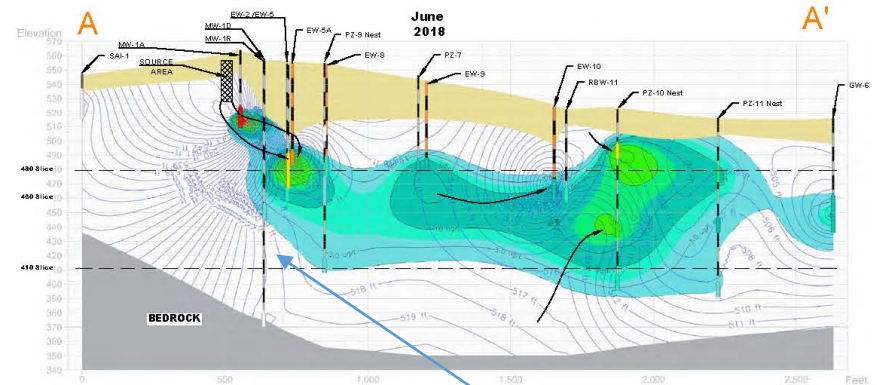
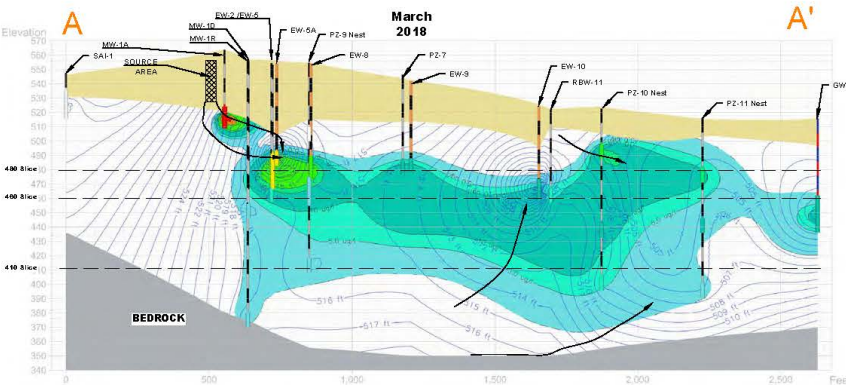
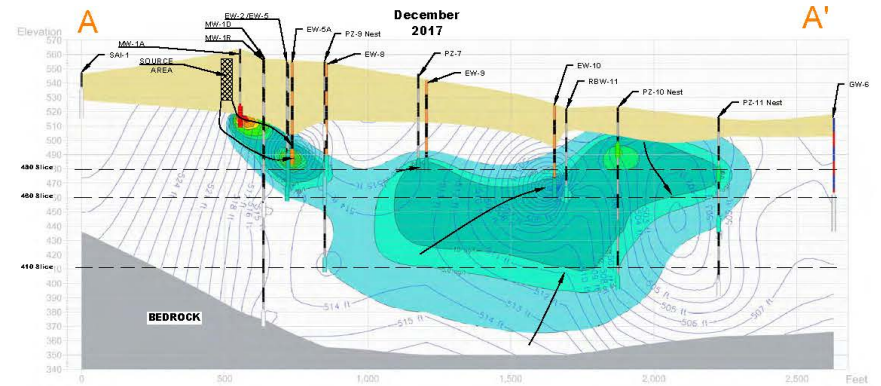
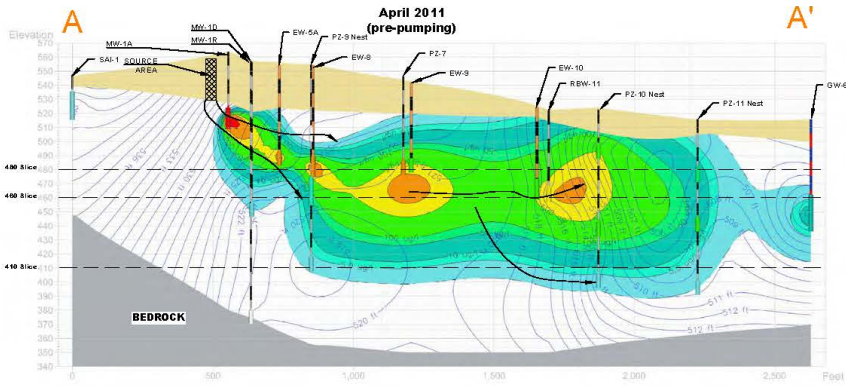
Rockaway Borough Site



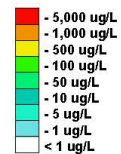
NPL 1983

Source removal and SVE system 2008
 Pump and treat system start up November 2011

Rockaway Borough Site



PCE LEGEND



LEGEND

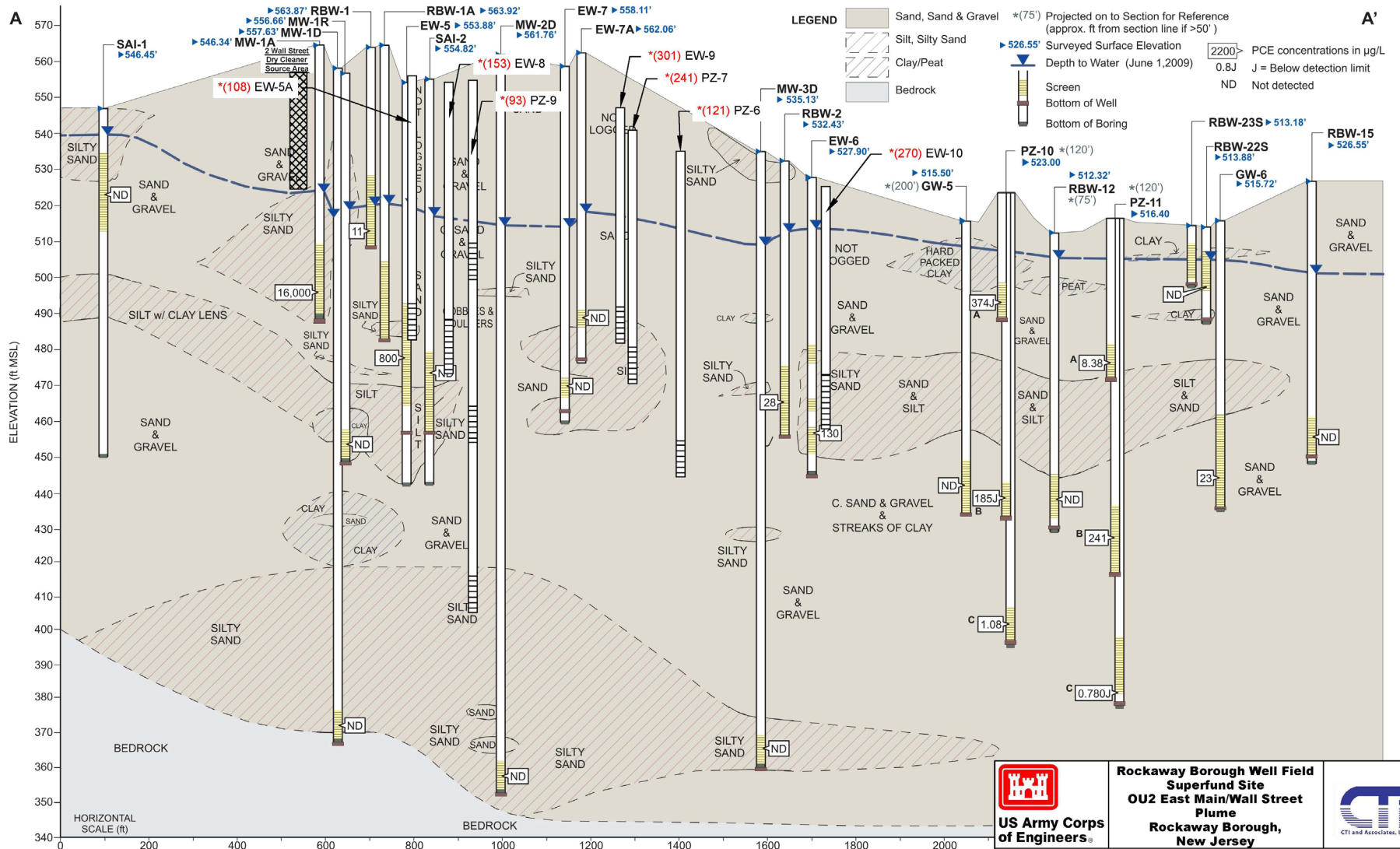
- Groundwater Flow Direction
- Hydraulic Equipotential Line

MW - 1A (509-524ft)
06/09 - 16,000
04/11 - 170,000
09/15 - 210,000
12/15 - 480,000
03/16 - 410,000
06/16 - 200,000
09/16 - 180,000
03/17 - 200,000
06/17 - 91,000
09/17 - 170,000
12/17 - 130,000
03/18 - 157,360 J
06/18 - 153,000
09/17 - 161,000

EW - 5A (483-493ft)
04/11 - 2,300
03/16 - 850
06/16 - 800
09/16 - 790
12/16 - 810
03/17 - 1,200
06/17 - 1,600
09/17 - 850
12/17 - 1,100
03/18 - 815
06/18 - 1,660 / 2,120 J
09/18 - 1240


April 2011 and 2017-2018 Flow Nets Showing PCE Plume

Rockaway Borough Site




Note: PCE concentrations in $\mu\text{g/L}$ and groundwater elevations from June 2009 Sample Event. Wells EW-5A, EW-8, PZ-9A/B/C, EW-9, PZ-7, PZ-6, and EW-10 were projected to the geological cross section for reference. *(153) indicates approximate feet from section line.

Base Figure Source: Predesign Investigation Report (HDR/OBG, 2010)



US Army Corps of Engineers

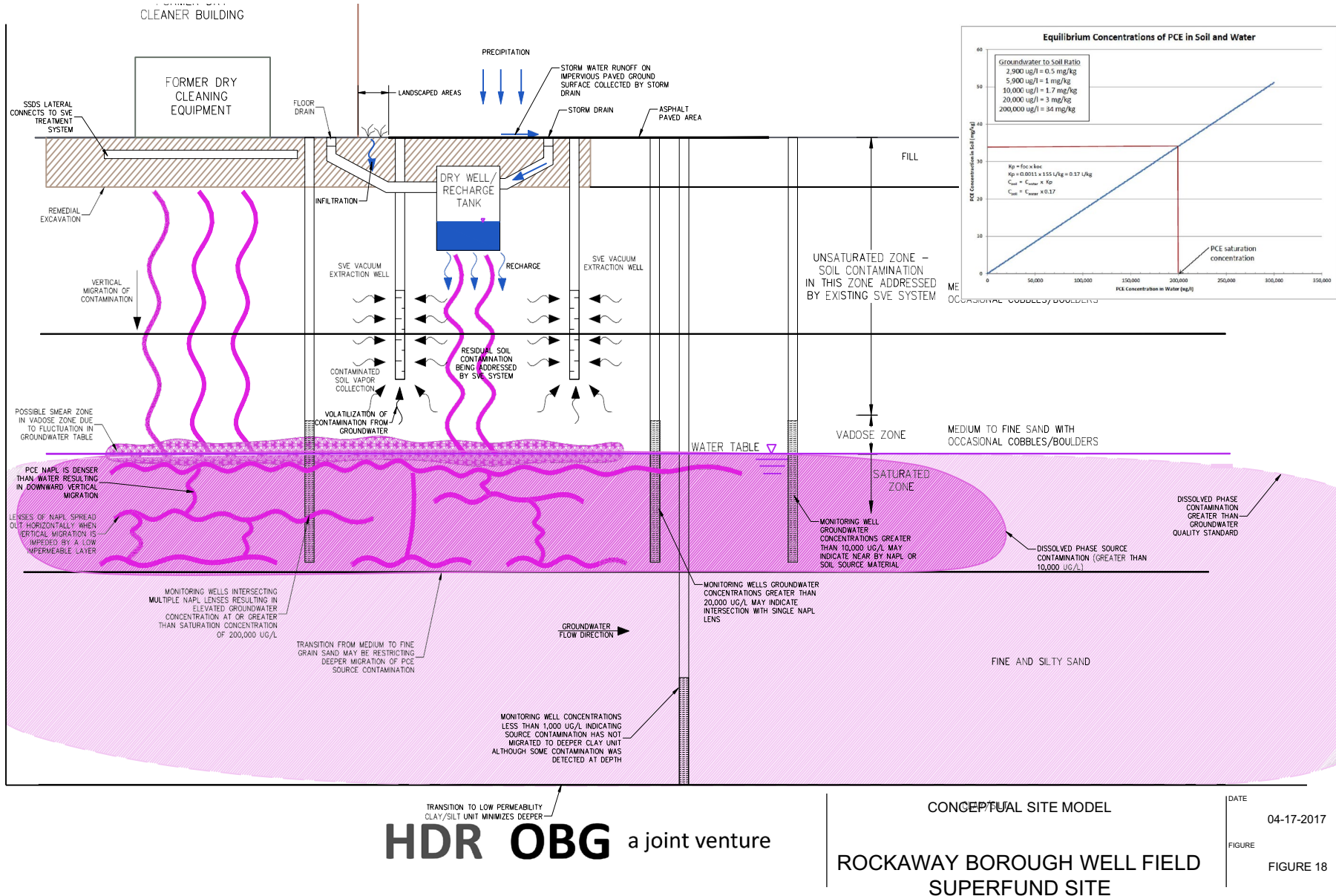
Rockaway Borough Well Field Superfund Site
OU2 East Main/Wall Street Plume
Rockaway Borough, New Jersey



CTI and Associates, Inc.

Figure 1-5
Geologic Cross Section A-A'
Along East Main/Wall Street Plume Axis

Rockaway Borough Site

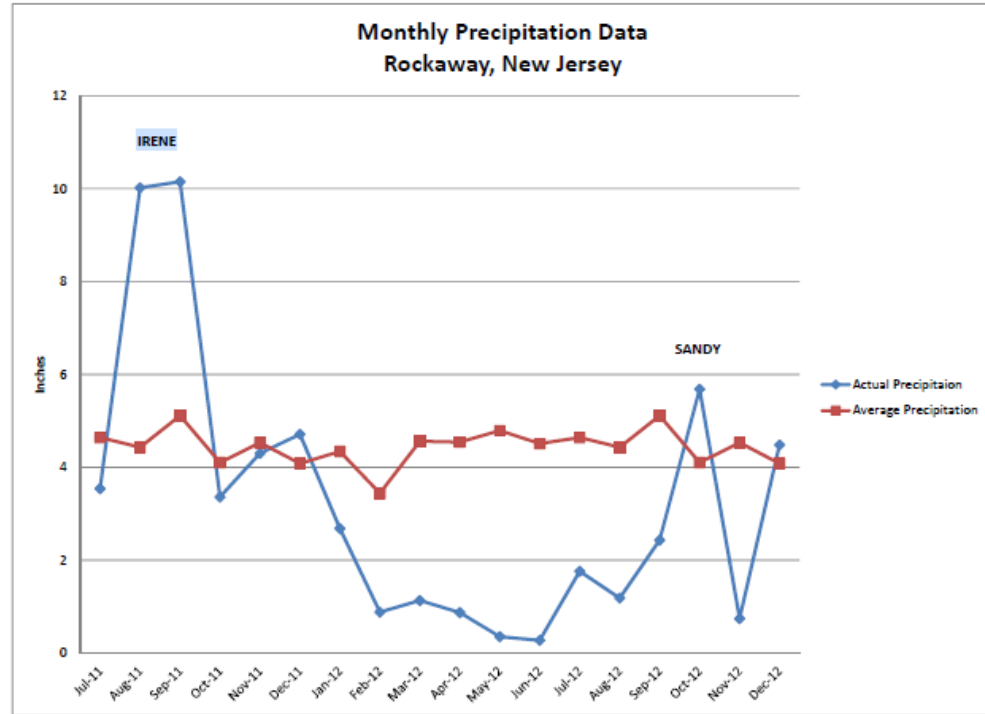
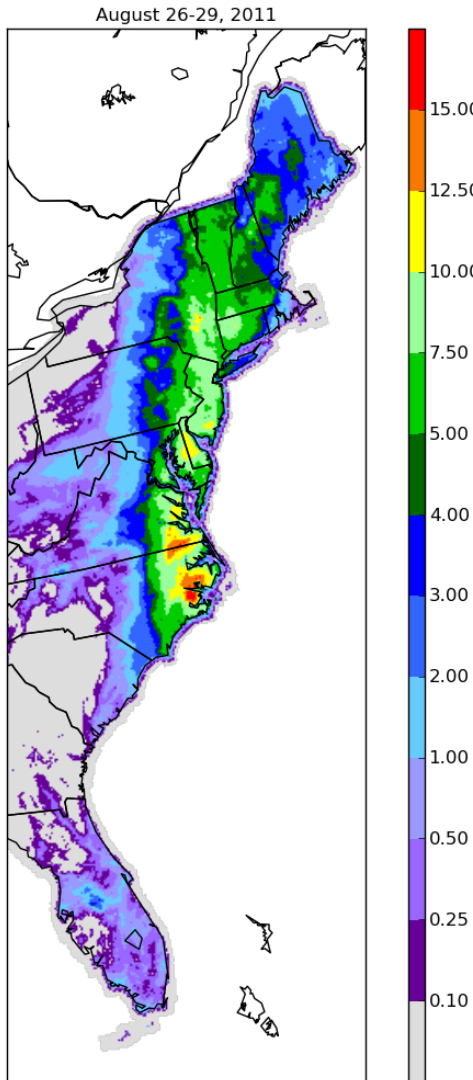


HDR OBG a joint venture

ROCKAWAY BOROUGH WELL FIELD
SUPERFUND SITE

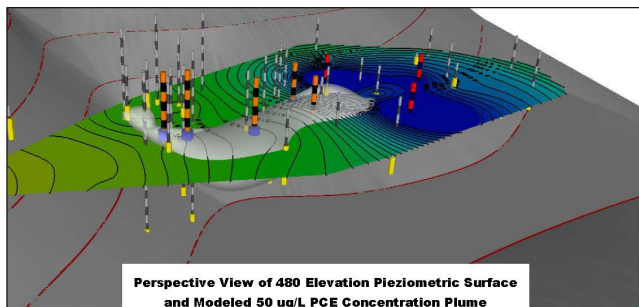
Rockaway Borough Site

Total Radar Estimated Precipitation



Hurricane Irene August 2011

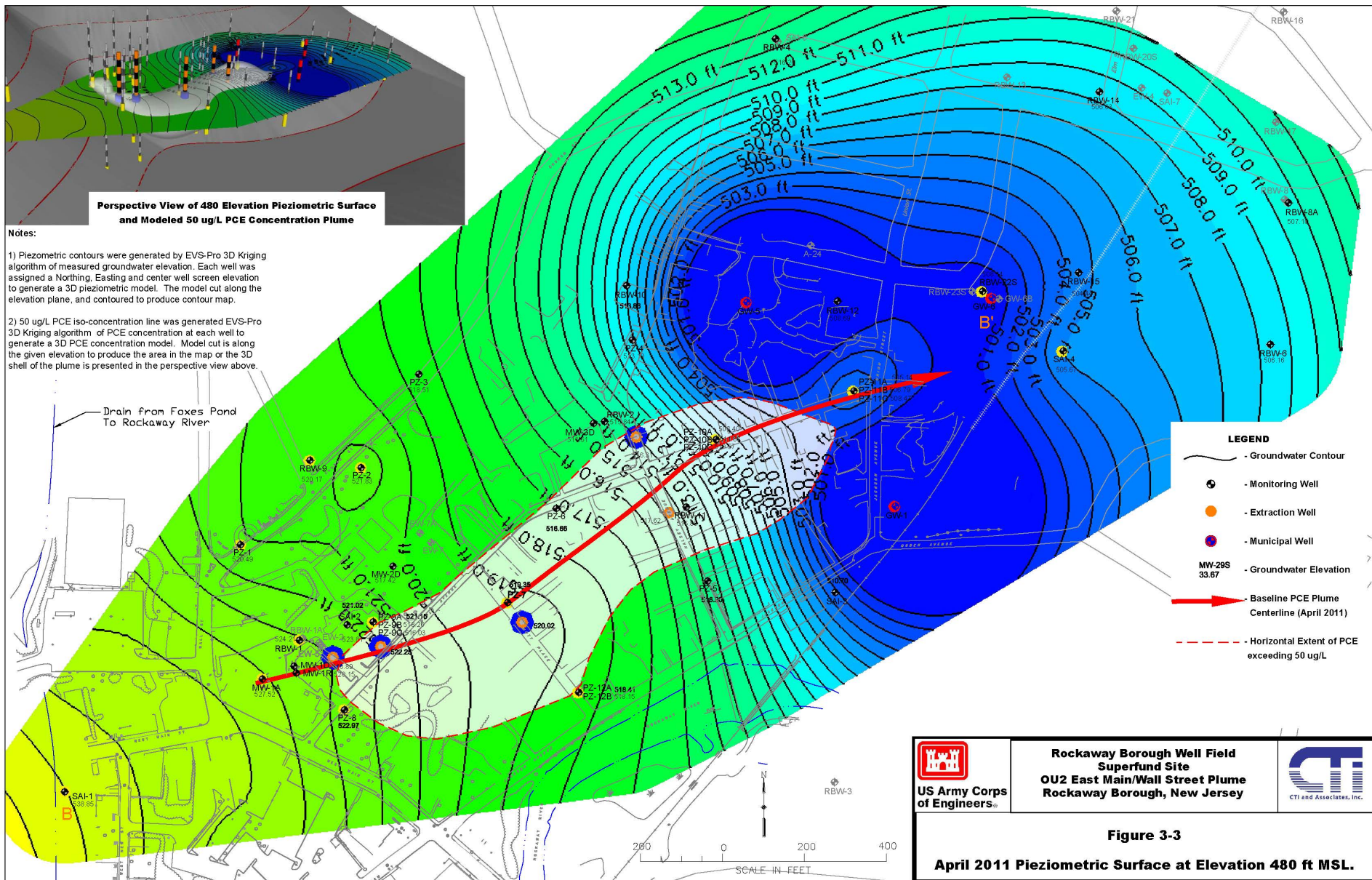
Rockaway Borough Site



Perspective View of 480 Elevation Piezometric Surface and Modeled 50 ug/L PCE Concentration Plume

Notes:

- 1) Piezometric contours were generated by EVS-Pro 3D Kriging algorithm of measured groundwater elevation. Each well was assigned a Northing, Easting and center well screen elevation to generate a 3D piezometric model. The model cut along the elevation plane, and contoured to produce contour map.
- 2) 50 ug/L PCE iso-concentration line was generated EVS-Pro 3D Kriging algorithm of PCE concentration at each well to generate a 3D PCE concentration model. Model cut is along the given elevation to produce the area in the map or the 3D shell of the plume is presented in the perspective view above.

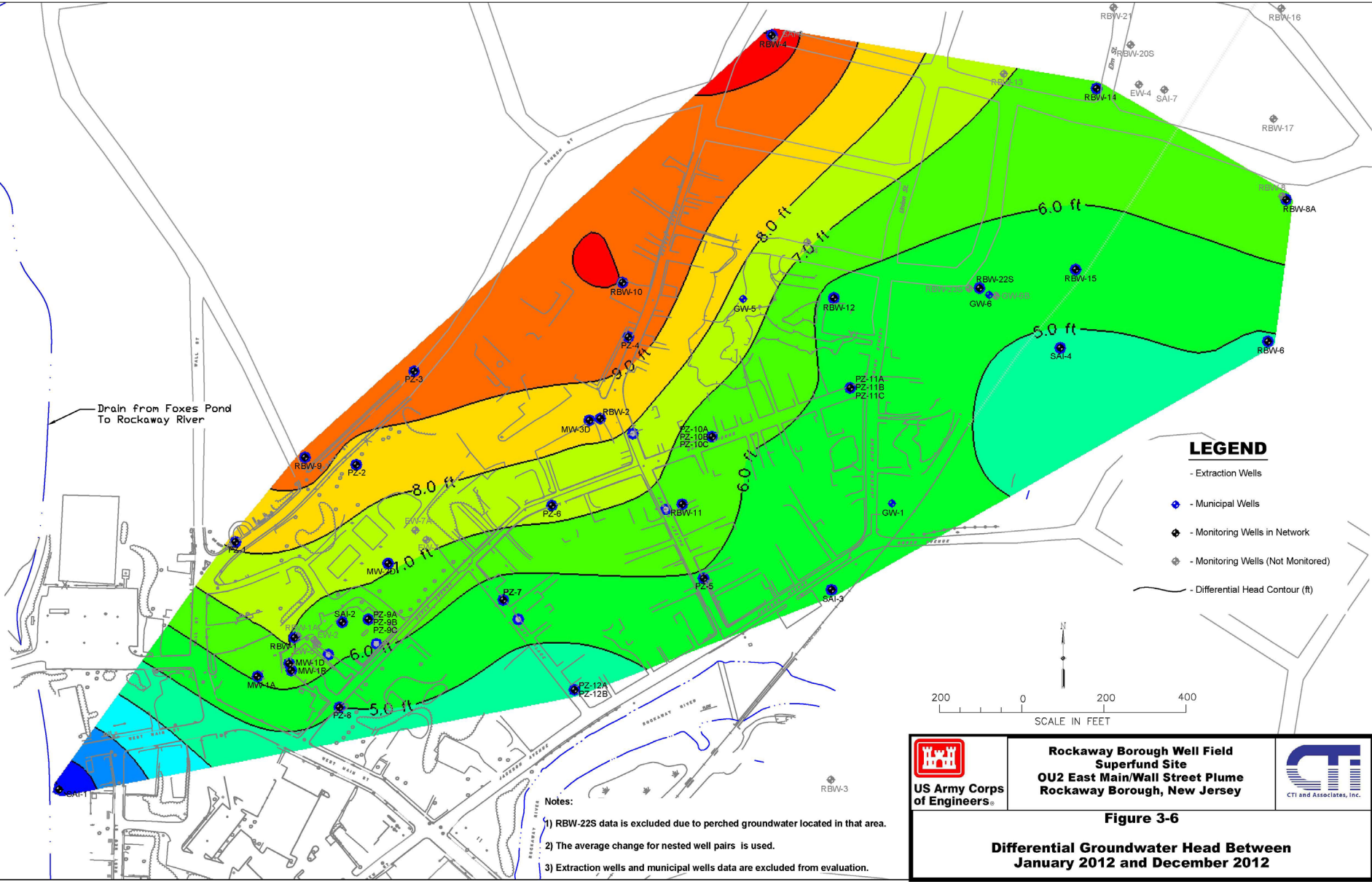


LEGEND

- Groundwater Contour
- Monitoring Well
- Extraction Well
- Municipal Well
- MW-29S
33.67
- Baseline PCE Plume
Centerline (April 2011)
- Horizontal Extent of PCE
exceeding 50 ug/L

<p>US Army Corps of Engineers</p>	<p>Rockaway Borough Well Field Superfund Site OU2 East Main/Wall Street Plume Rockaway Borough, New Jersey</p>	<p>CTI and Associates, Inc.</p>
	<p>Figure 3-3</p> <p>April 2011 Piezometric Surface at Elevation 480 ft MSL.</p>	

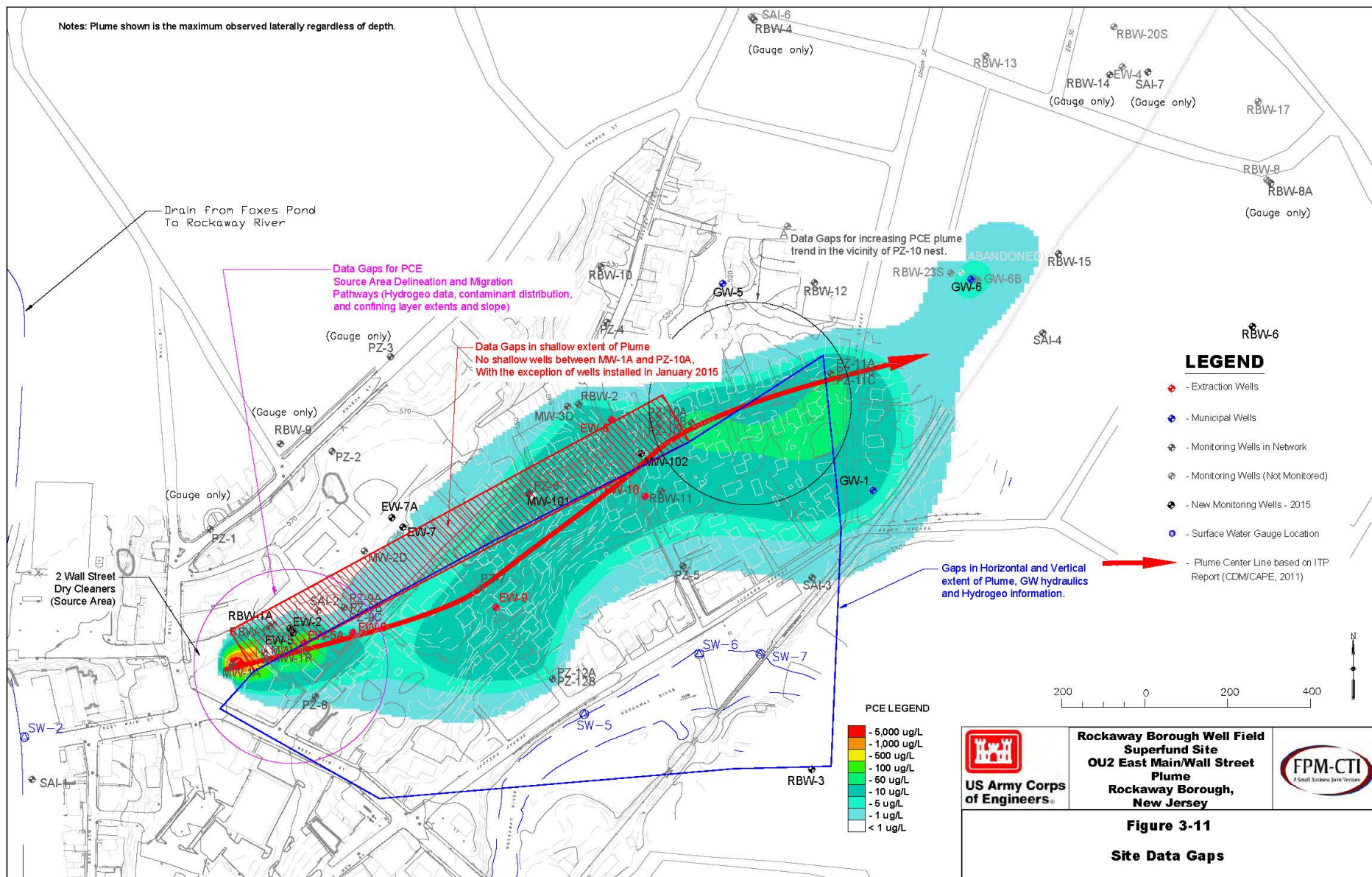
Rockaway Borough Site



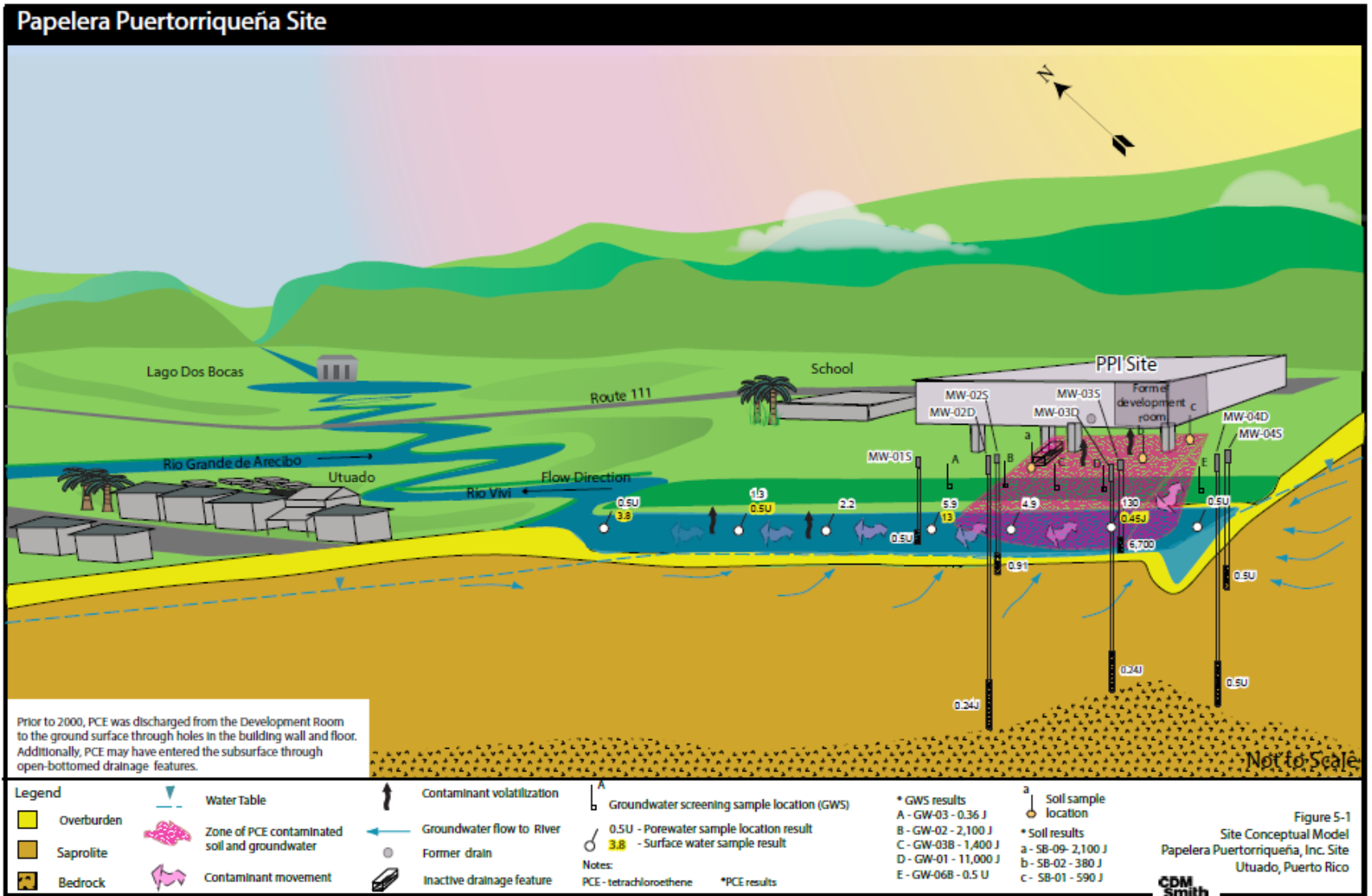
<p>US Army Corps of Engineers</p>	<p>Rockaway Borough Well Field Superfund Site OU2 East Main/Wall Street Plume Rockaway Borough, New Jersey</p>	<p>CTI and Associates, Inc.</p>
<p>Figure 3-6</p>		
<p>Differential Groundwater Head Between January 2012 and December 2012</p>		

Rockaway Borough Site

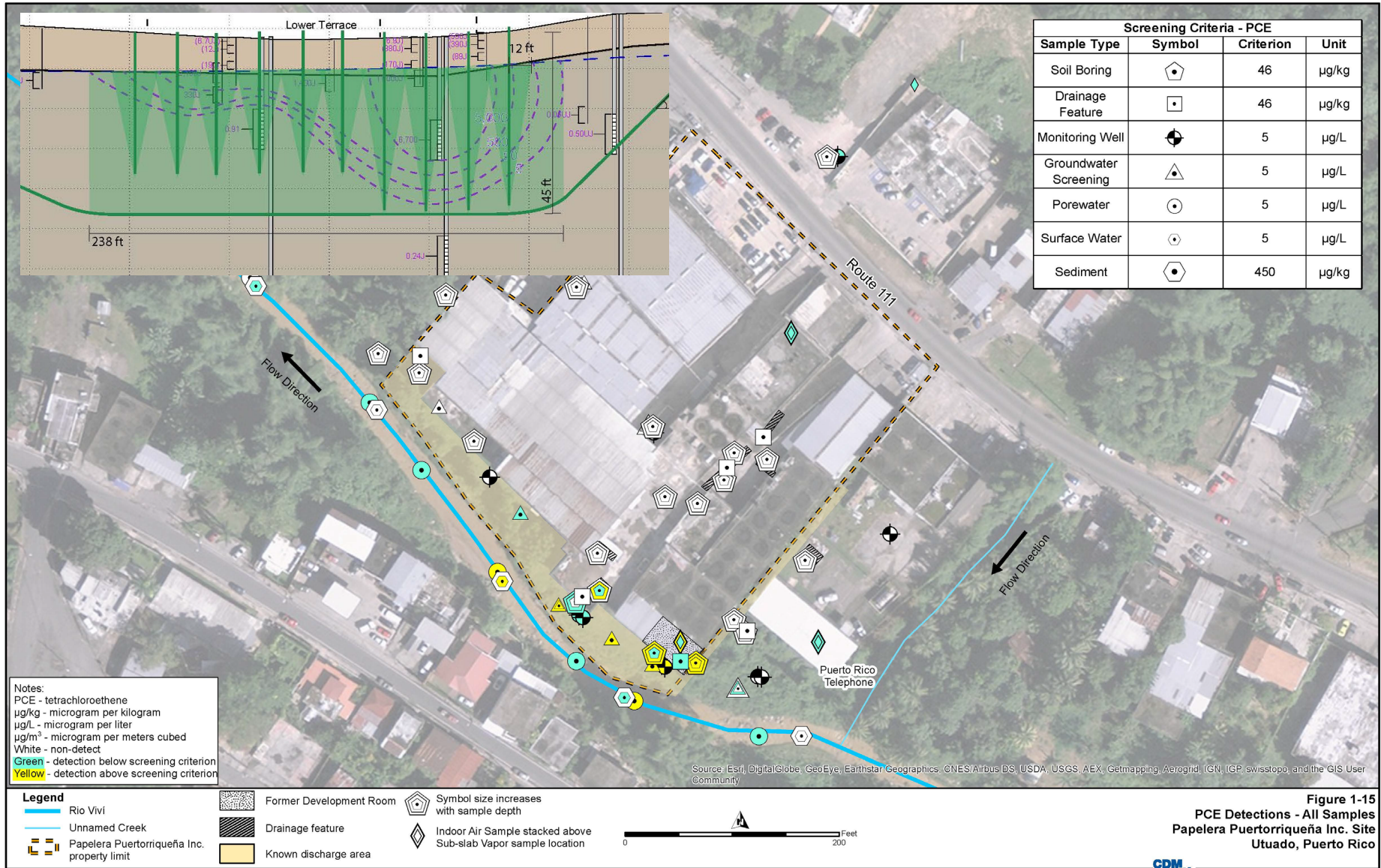
Notes: Plume shown is the maximum observed laterally regardless of depth.



Papelera Puertorriqueña Site

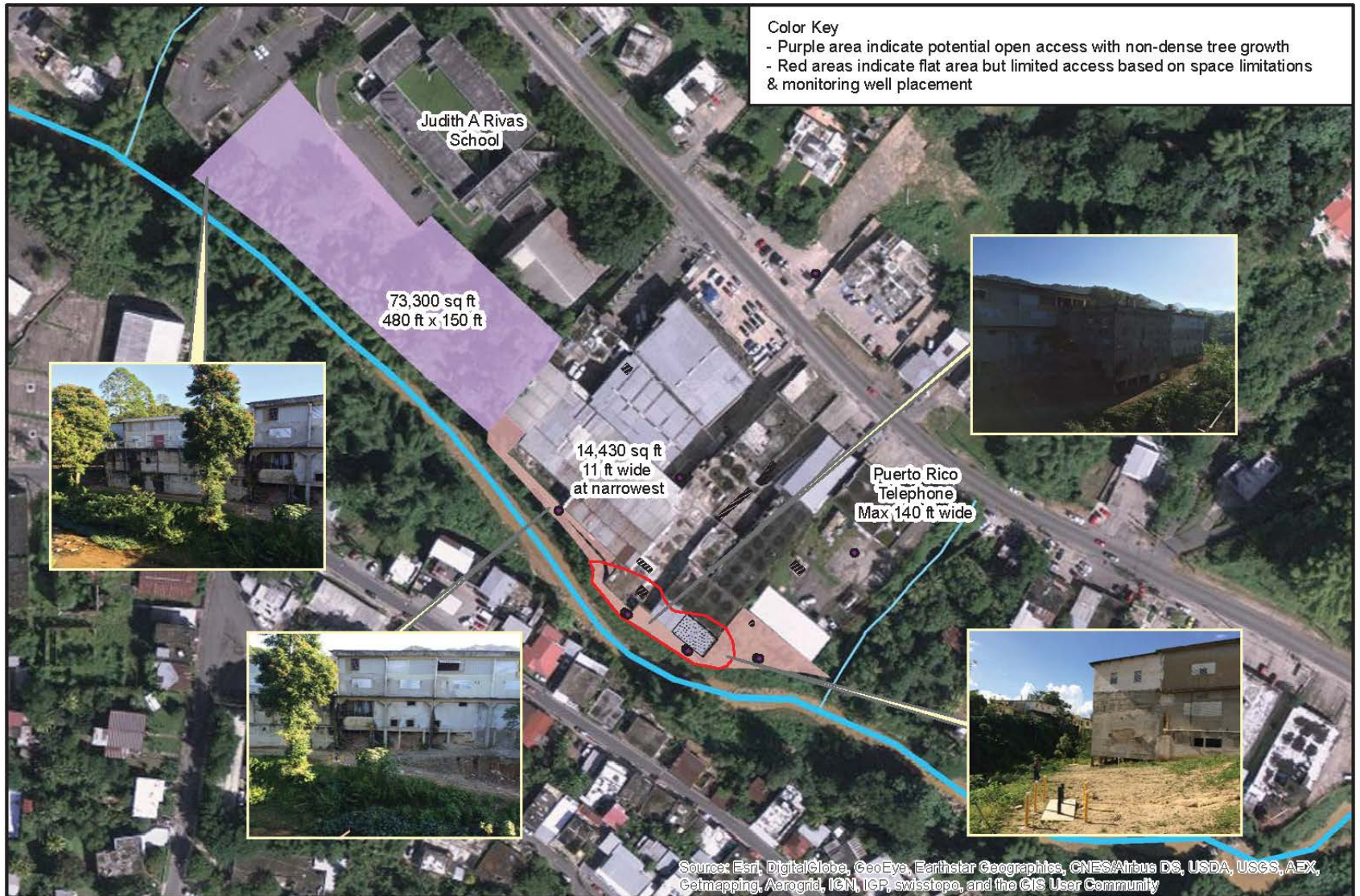


Papelera Puertorriqueña Site



2017 ROD selected AS/SVE

Papelera Puertorriqueña Site



Color Key
 - Purple area indicate potential open access with non-dense tree growth
 - Red areas indicate flat area but limited access based on space limitations & monitoring well placement

Legend
 Rio Viví
 Unnamed Creek

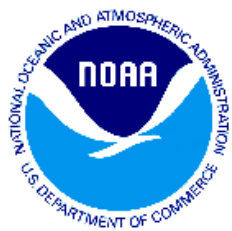
Former Development Room
 Drainage feature



Figure 3-1
Site Accessibility
 Papelera Puertorriqueña, Inc. Site
 Utuado, Puerto Rico



Papelera Puertorriqueña Site



Hurricane María Estimated Rainfall

National Weather Service WFO San Juan

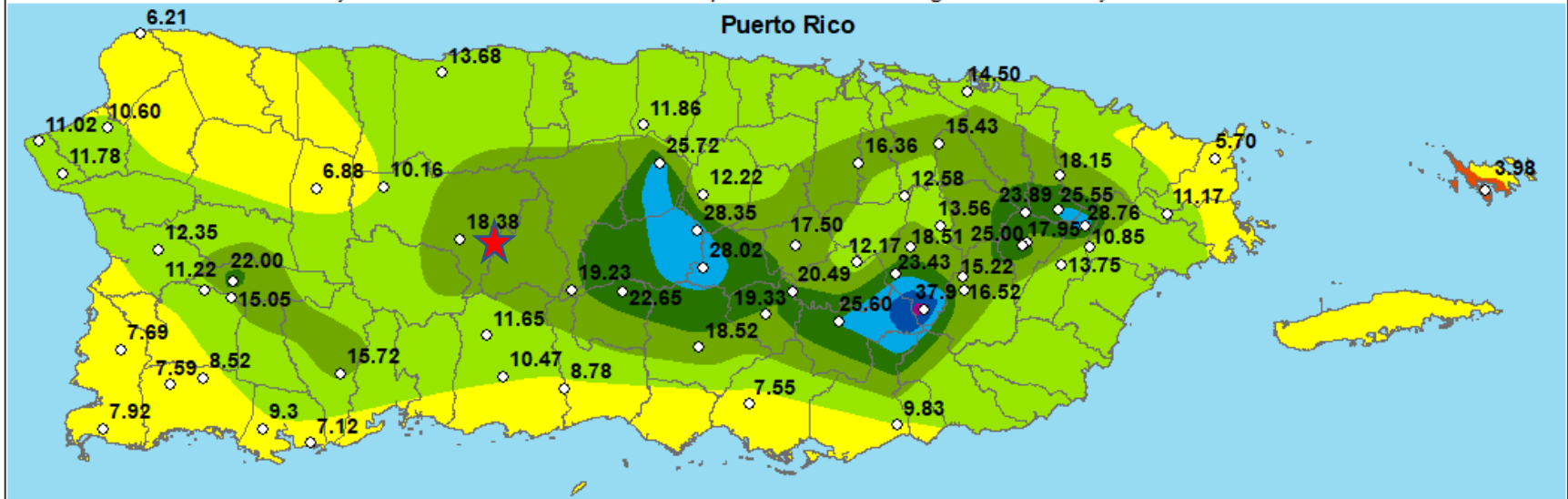
Data Source: USGS, COOP, RAWS

48-hr Total Sept. 19 to Sept. 21, 2017

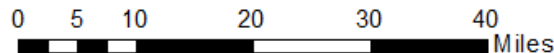
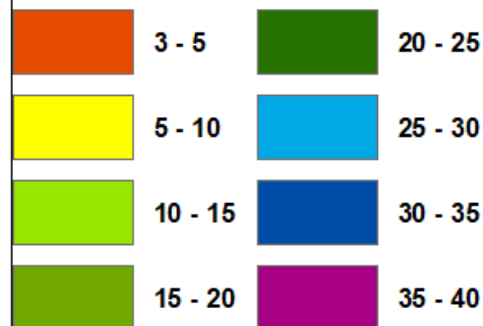
Data is Preliminary



*Many of our stations were not able to report due to the damages sustained by Hurricane María.



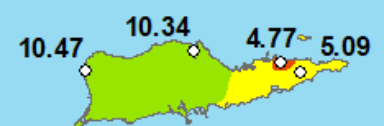
Rainfall (inches)



Saint Thomas / Saint John



Saint Croix



Papelera Puertorriqueña Site



2006



2016



2018

Papelera Puertorriqueña Site



2006

- Significant deposition in riverbed
- Collapsed retaining wall on opposite side of the river



March 2010

Papelera Puertorriqueña Site



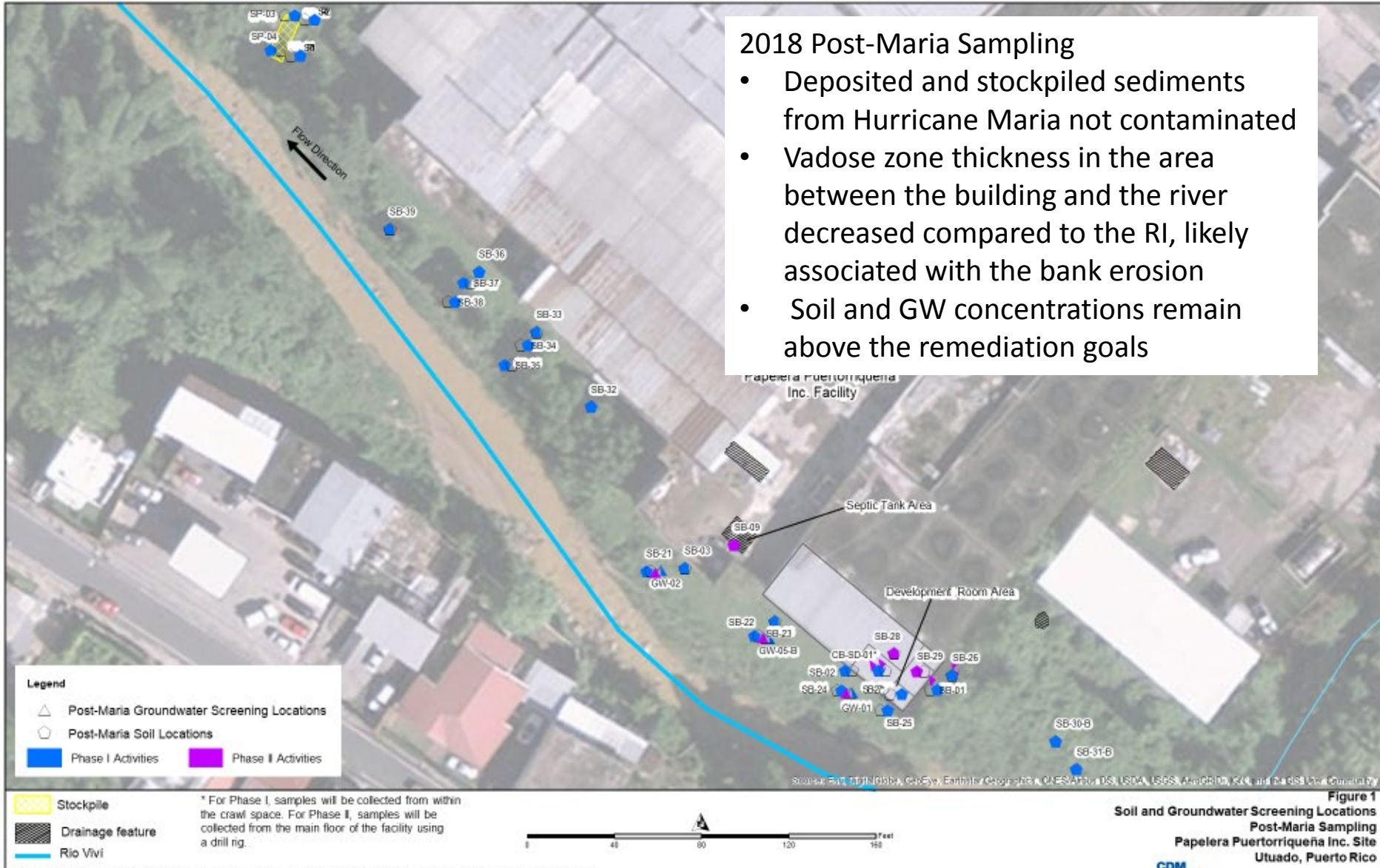
2016



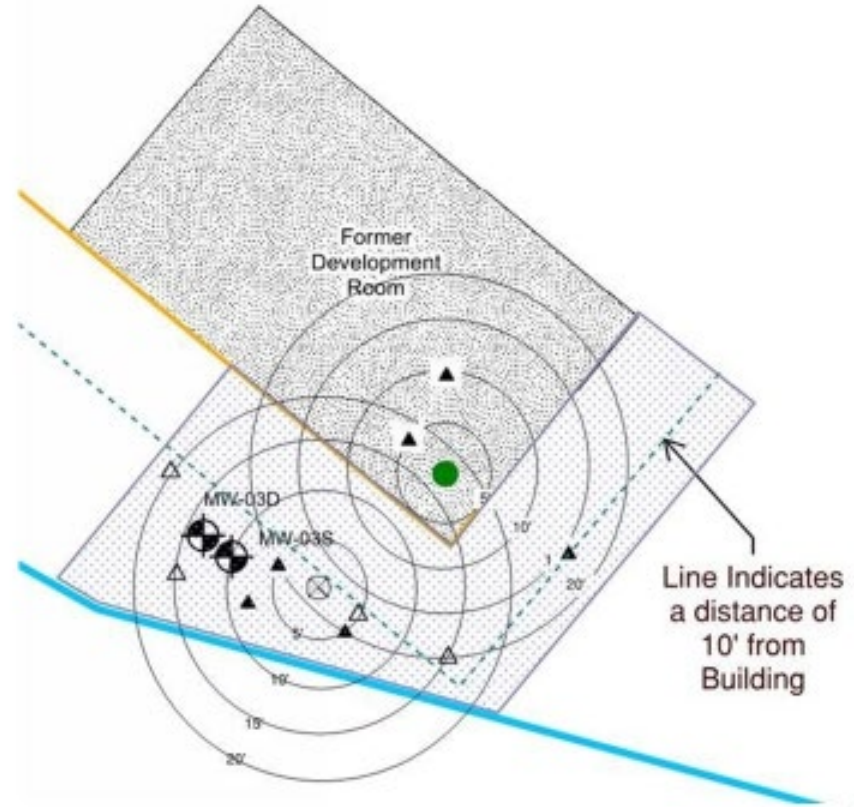
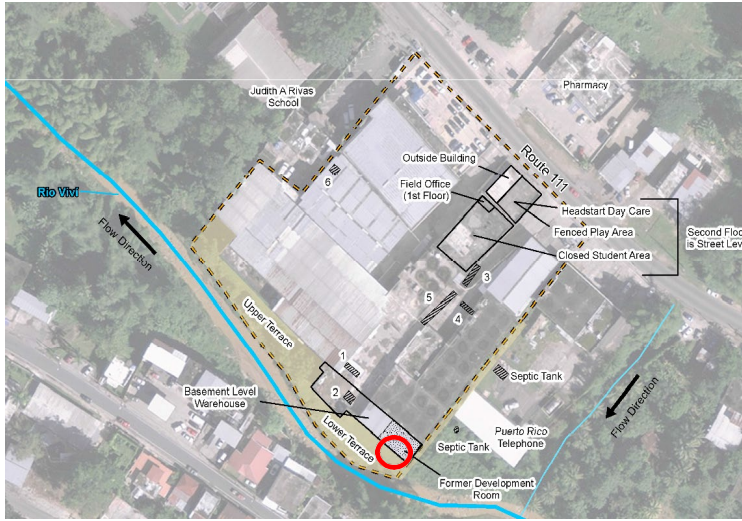
March 2018

- Significant erosion along back of building
- Exposed foundation
- Damaged wells

Papelera Puertorriqueña Site



Papelera Puertorriqueña Site



LEGEND

- EXISTING MONITORING WELL
- PROPOSED VADOSE ZONE MONITORING POINT
- PROPOSED GROUNDWATER MONITORING POINT
- PROPOSED AIR SPARGE LOCATION
- PROPOSED SOIL VAPOR EXTRACTION POINT

2020 Pilot Study Issues

- Site improvement will be required to construct the remedy and protect equipment
- Design will need to account for the shallow vadose zone
- Protection against flooding and coordination with the retaining wall will need to be considered

Papelera Puertorriqueña Site

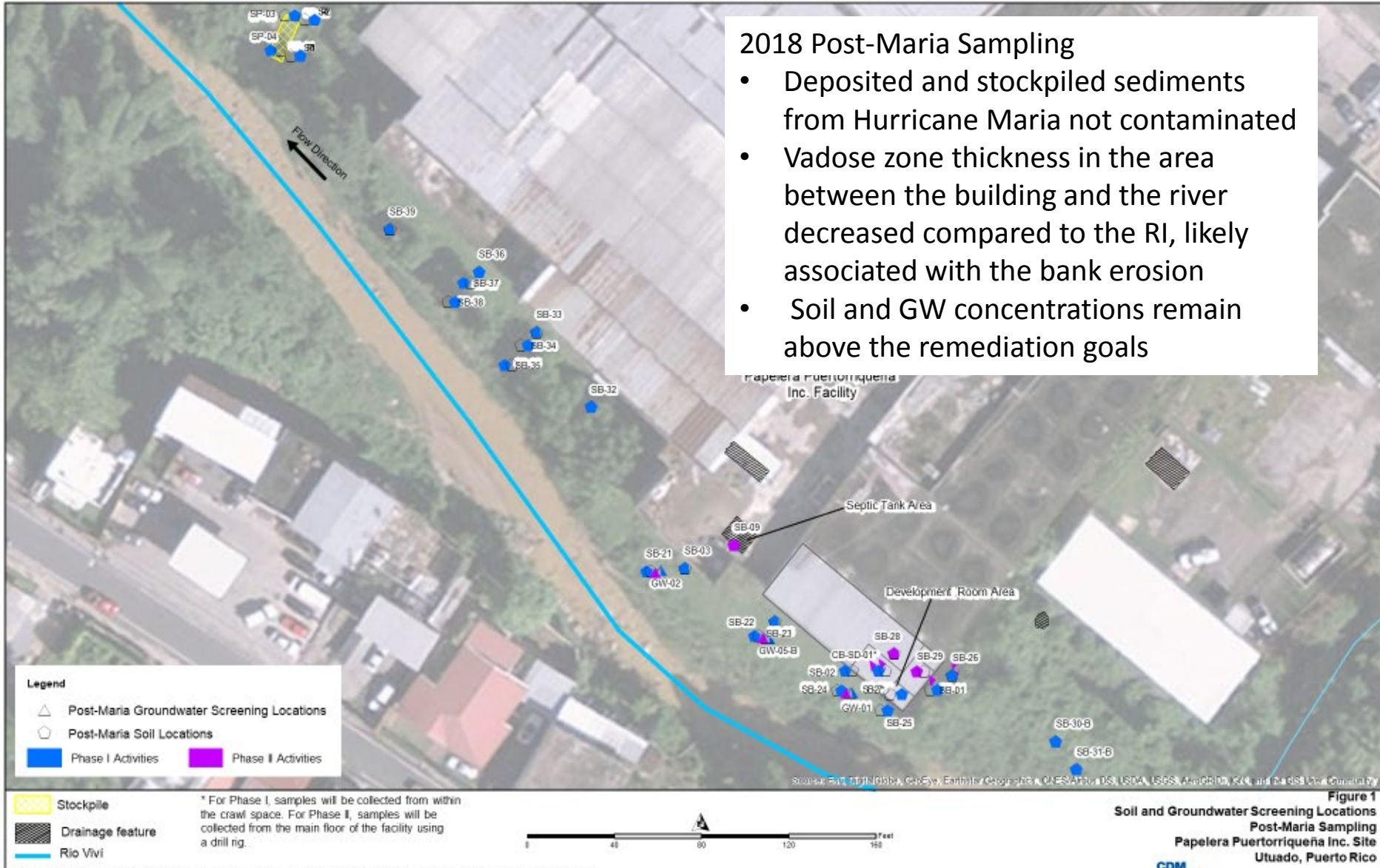


Figure 1
Soil and Groundwater Screening Locations
Post-Maria Sampling
Papelera Puertorriqueña Inc. Site
Utua, Puerto Rico

