CHLORINATED SOLVENT REMEDIATION DESIGN USING A HIGH DENSITY SITE CHARACTERIZATION APPROACH

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LOCATION : ANN ARBOR, MICHIGAN

U.S. EPA Region 5 States

EGLE SME

SITE HISTORY

- Developed since at least the late 1800s
- Two former dry cleaners, car wash, junkyard operations, and other commercial and residential uses
- Various environmental investigations on- and off-site
- Significant chlorinated solvent contamination to soil and groundwater
- Former pilot study failed due to environmental challenges

FORMER SITE USE

SOURCE – BROADWAY COIN LAUNDRY

- Operated from 1961 through early 2000s
- Vacant for years
- In 2002 and 2017, EGLE completed limited investigation
- Additional investigations were completed from 2004 to 2019 by private parties
- In 2017 through 2019, EGLE conducted an offsite groundwater investigation

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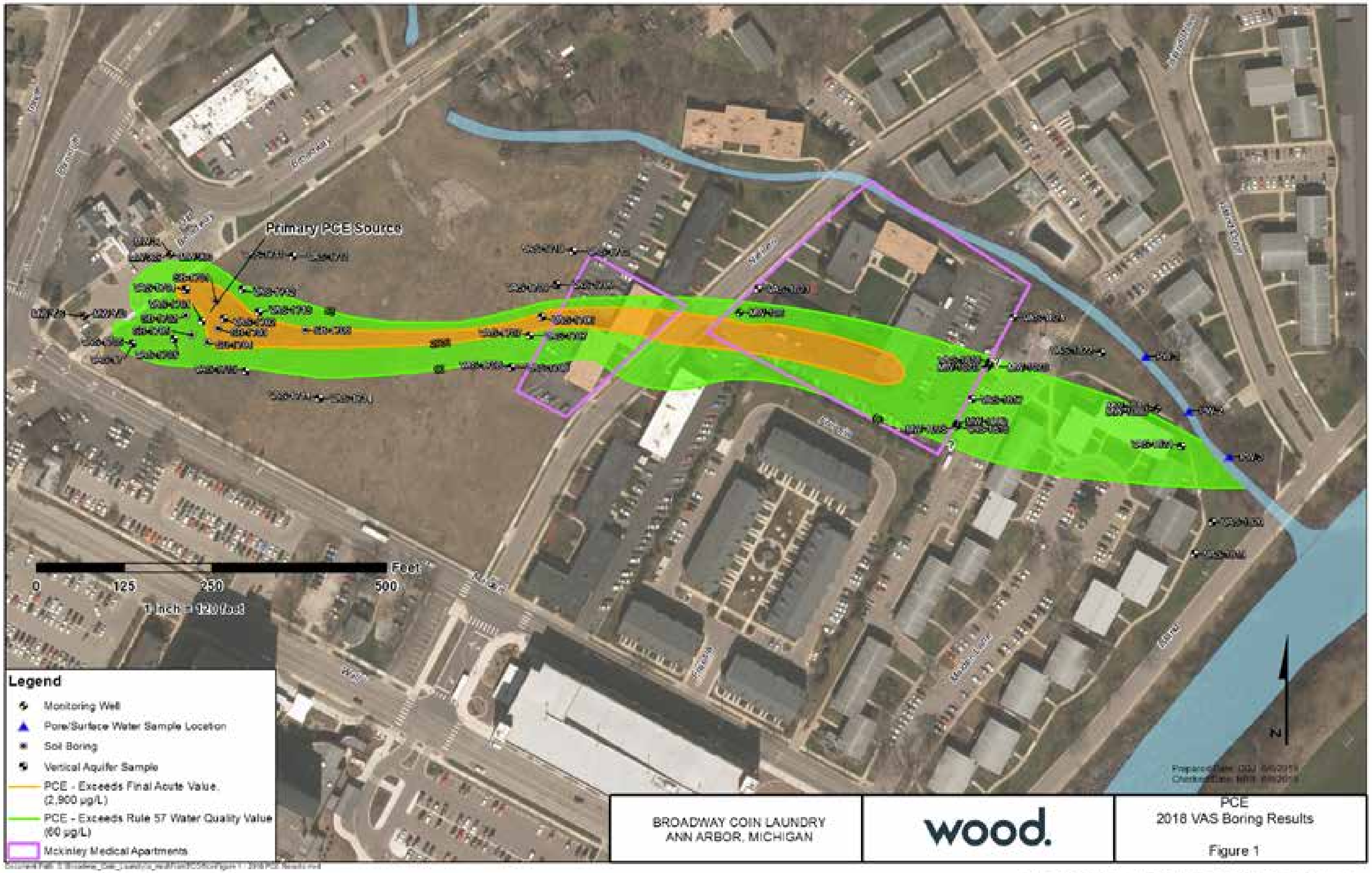
CHLORINATED VOC PLUME



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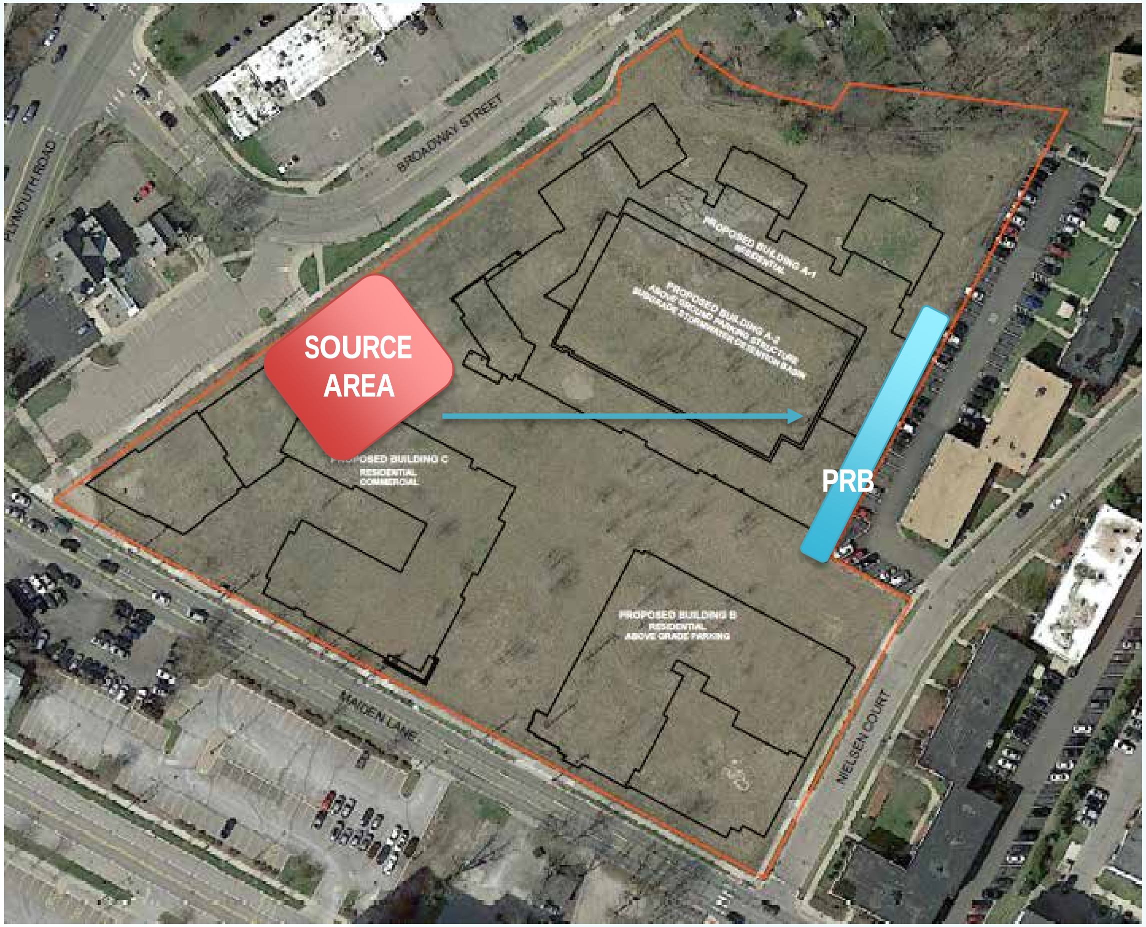
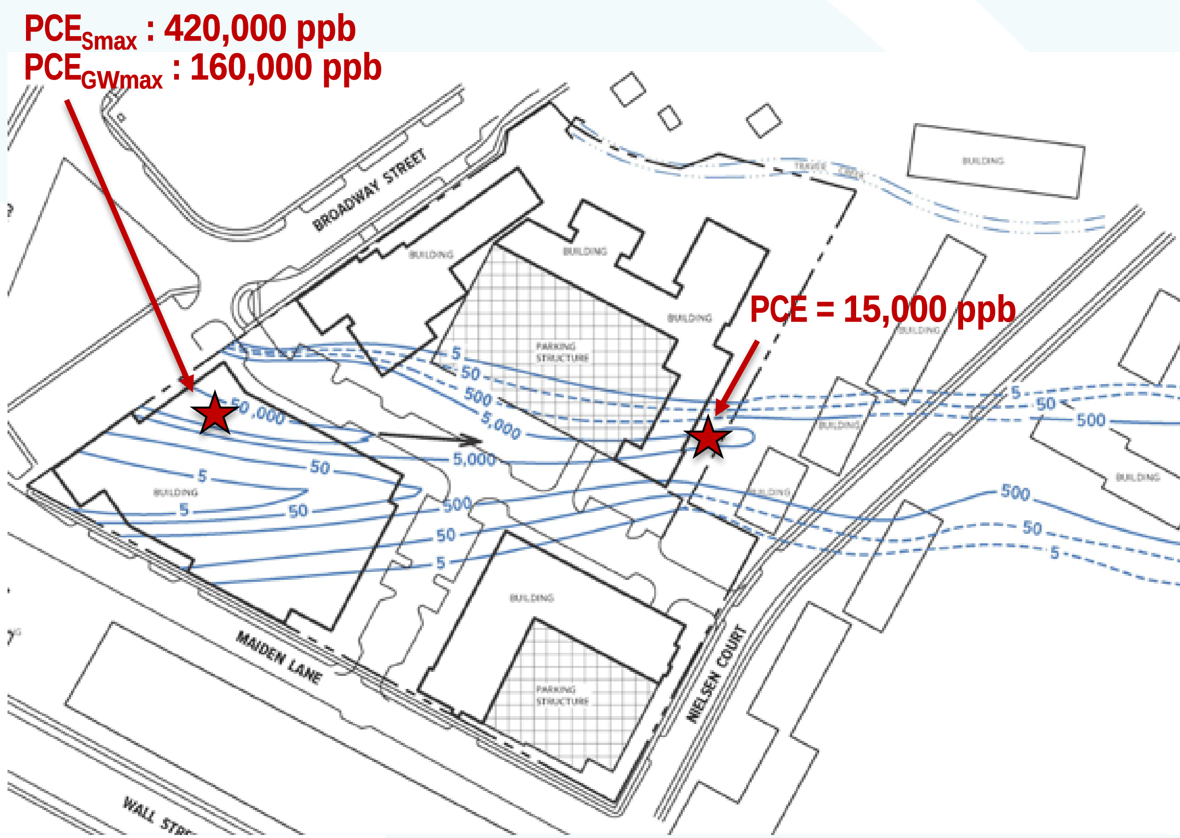
REDEVELOPMENT : THE CATALYST FOR TREATMENT

- New developer purchases site for mixed-use apartments and commercial space
- Tax incremental financing (TIF) approval required installation of PRB at downgradient (eastern) property boundary
- Goal of PRB was 80% reduction off-site migration of PCE



WHAT WE KNEW – PREVIOUS INVESTIGATIONS

- Soil profile: fill underlain by ***variable*** sand, silts, and clays
- Groundwater encountered 6-13.5 ft bgs and extended to at least 40 ft bgs
- Groundwater flow eastward
- Impact up to 33 ft bgs on west side of site and up to 16 feet on east side of site
- Location of source area
- Off-site migration occurring



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PROJECT CHALLENGES

- **Data gaps**
  - Subsurface conditions
  - Contaminant distribution and nature
  - Variable soils (sands, silts, clays)
  - Hydrogeology
    - Aquifer characteristics
    - Conflicting hydraulic conductivities

- **Project Constraints**
  - Construction limited window of opportunity
  - Development footprint left minimal room at eastern boundary
  - Relatively limited budget

- **Previous pilot study using sodium permanganate appeared to have little effect on reducing PCE concentrations in GW**
  - Who doesn't love a challenge?

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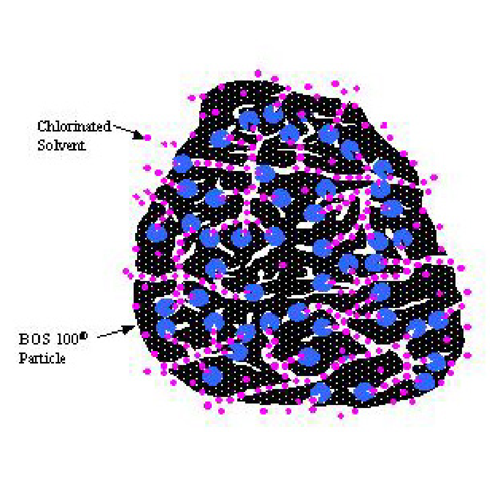
SOLUTION : DON’T GUESS, DEFINE.

...and then we had a plan

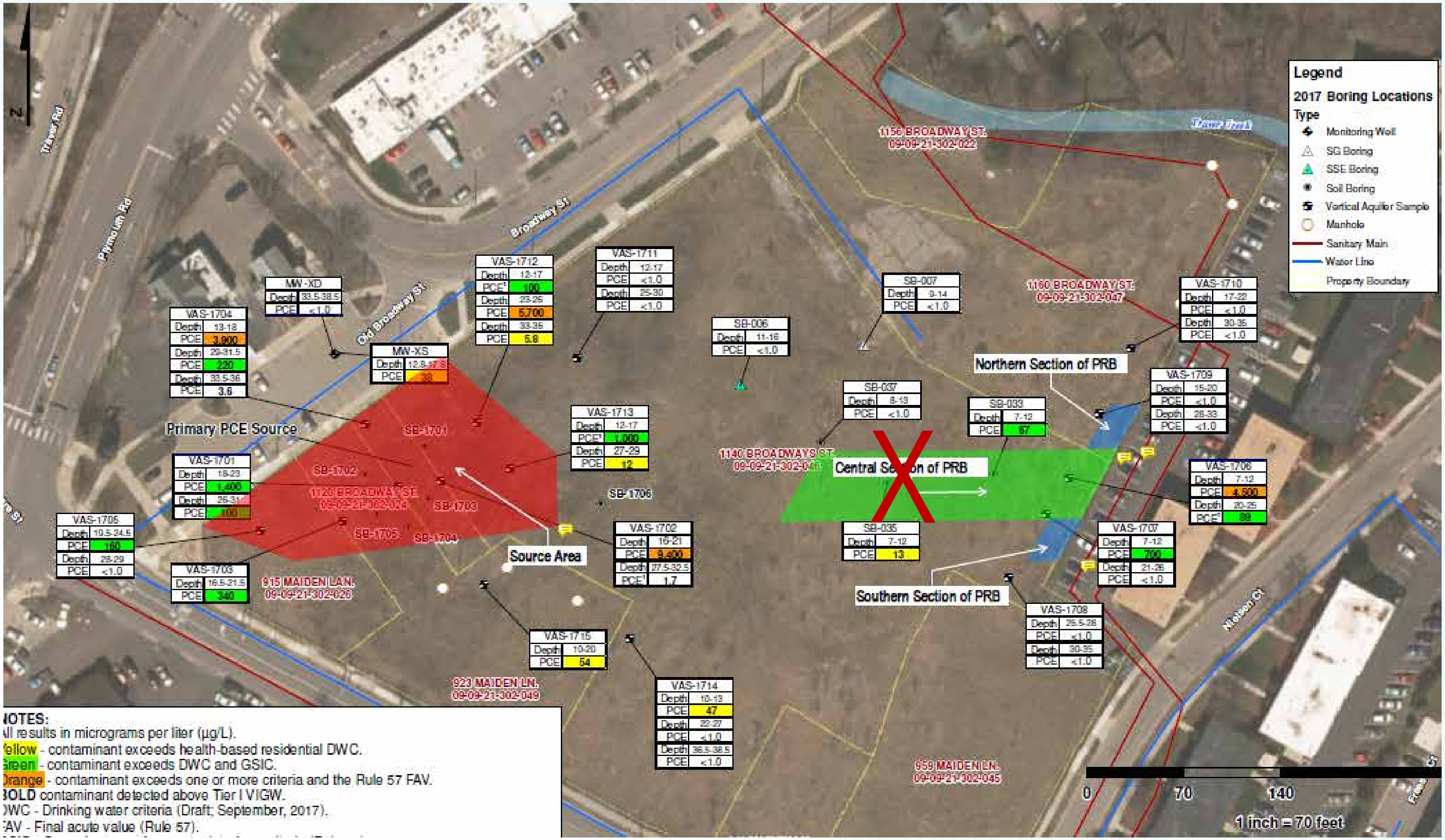
SELECTED TREATMENT MEDIA

- Evaluated various treatments
- Selected Trap & Treat® BOS 100®
    - o Granular activated carbon impregnated with metallic iron
    - o Rate of degradation and range of target compounds
        - PCE & daughter compounds
    - o End products : Dissolved iron, chloride, ethylene, methane
    - o Injected as a slurry and left in place (no trenching, special equipment applications)



- Reductive dechlorination
- Insensitive to pH, DO levels, native biota, nutrients

PRELIMINARY DESIGN #1



Base figure – Wood, PLC
Modified by – AST Environmental, Inc.

Hydraulic Conductivity$_{Shallow}$ = 257 ft/day
Hydraulic Conductivity$_{Deep}$ = 21 ft/day

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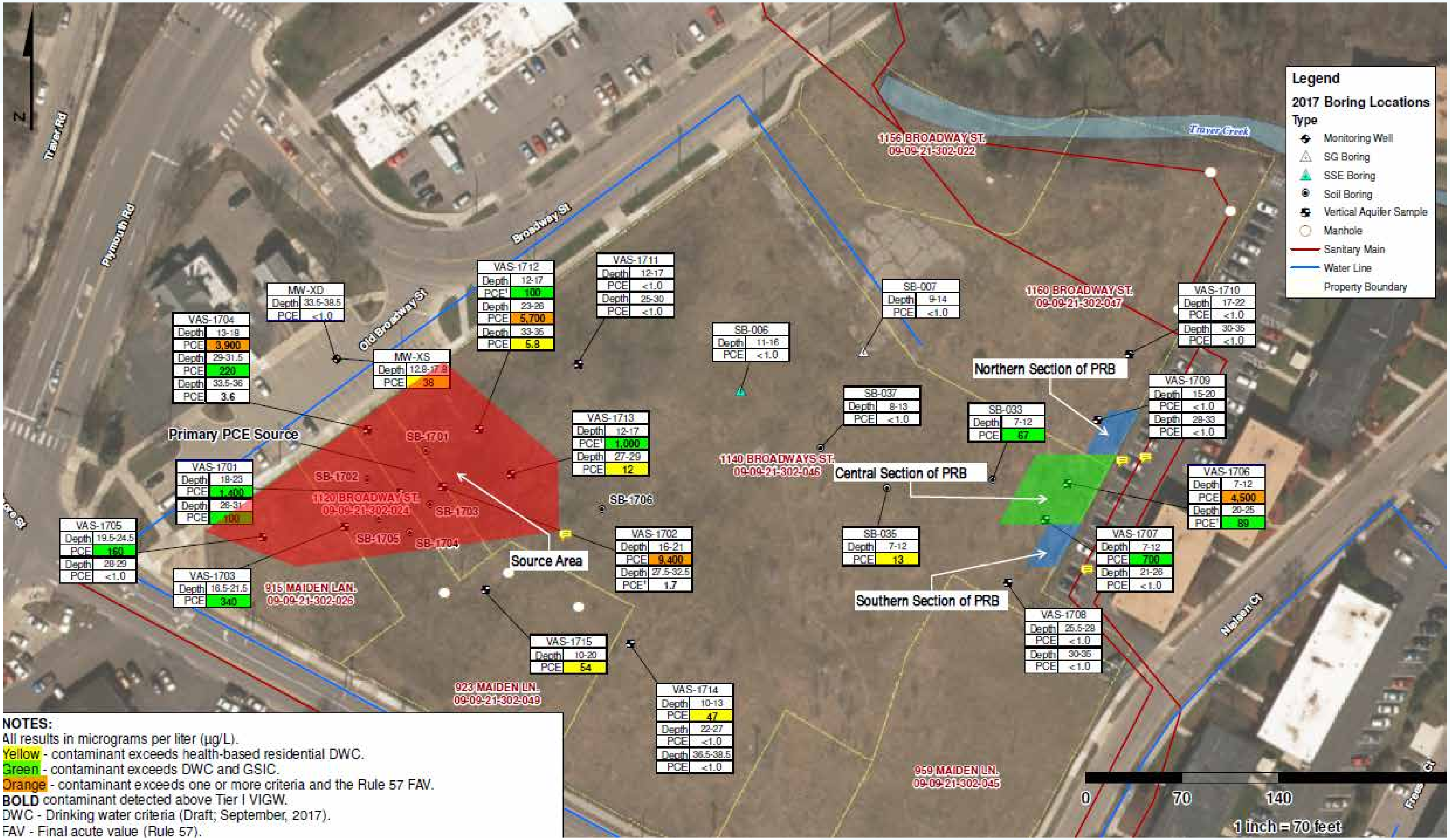
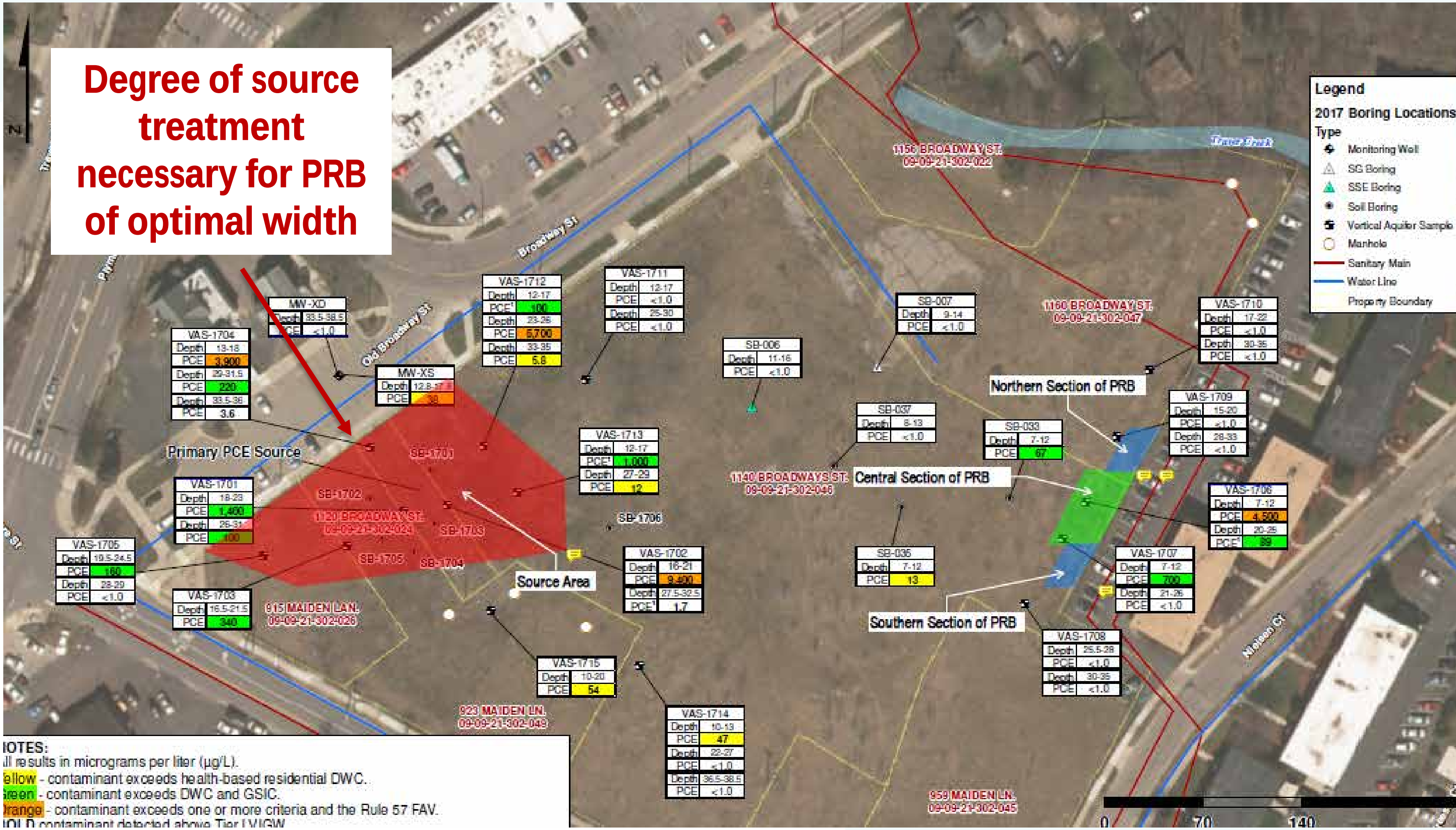
PRELIMINARY DESIGN #2



Base figure – Wood, PLC
Modified by – AST Environmental, Inc.

Hydraulic Conductivity$_{Shallow}$ = 89 ft/day
Hydraulic Conductivity$_{Deep}$ = 112 ft/day

PRELIMINARY DESIGN #3



Base figure – Wood, PLC
Modified by – AST Environmental, Inc.

Hydraulic Conductivity$_{Shallow}$ = 40 ft/day
Hydraulic Conductivity$_{Deep}$ = 40 ft/day

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EXISITING DATA VS. FILL DATA GAPS

- Limited, fragmented data set for soil, groundwater, and contaminant conditions
  - **Option 1** – Rely on existing data and model potential contaminant flux through PRB over 30 year window
    - Fills in data gaps with algorithm's best guess
    - Likely lead to the need for more soil and groundwater data
    - Iterations of the above cycle not time effective
    - *PRB design based on contaminant flux with limited site information*
  - **Option 2 –** Conduct extensive soil and groundwater study to fill in data gaps
    - Know where the cVOC mass is in soil and groundwater
    - Had a vacant site = access, access, access
    - *PRB design based on known location and character of PCE mass*

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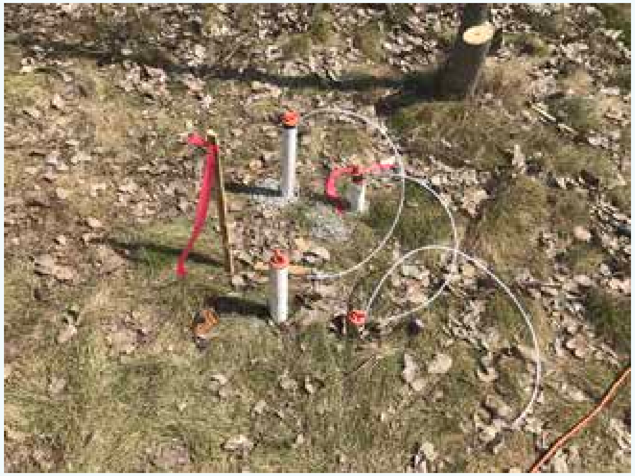
HIGH DENSITY SITE CHARACTERIZATION

- AST Environmental, recommended Option 2. Fill the data gaps with a high density soil and groundwater sampling event
    - Budget friendly (analytical at no cost)
    - Fit time frame
    - Had the access
    - Design a more accurate treatment based on the location and nature of contamination

HIGH DENSITY SITE CHARACTERIZATION

- Advanced 79 soil borings to ~40 ft bgs
  - Logged soils
  - Sampled every 2 vertical feet
- Installed 46 nested GW well clusters
  - 142 individual wells
  - Gauged and sampled all wells
  - Slug tests
- Analyzed 1,120 soil and 185 groundwater samples
  - cVOCs
  - Dissolved gases
  - Anions
- Confirmed hydraulic conductivities, calculated seepage velocities, and gradients



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SOIL BORINGS

NESTED GROUNDWATER WELLS

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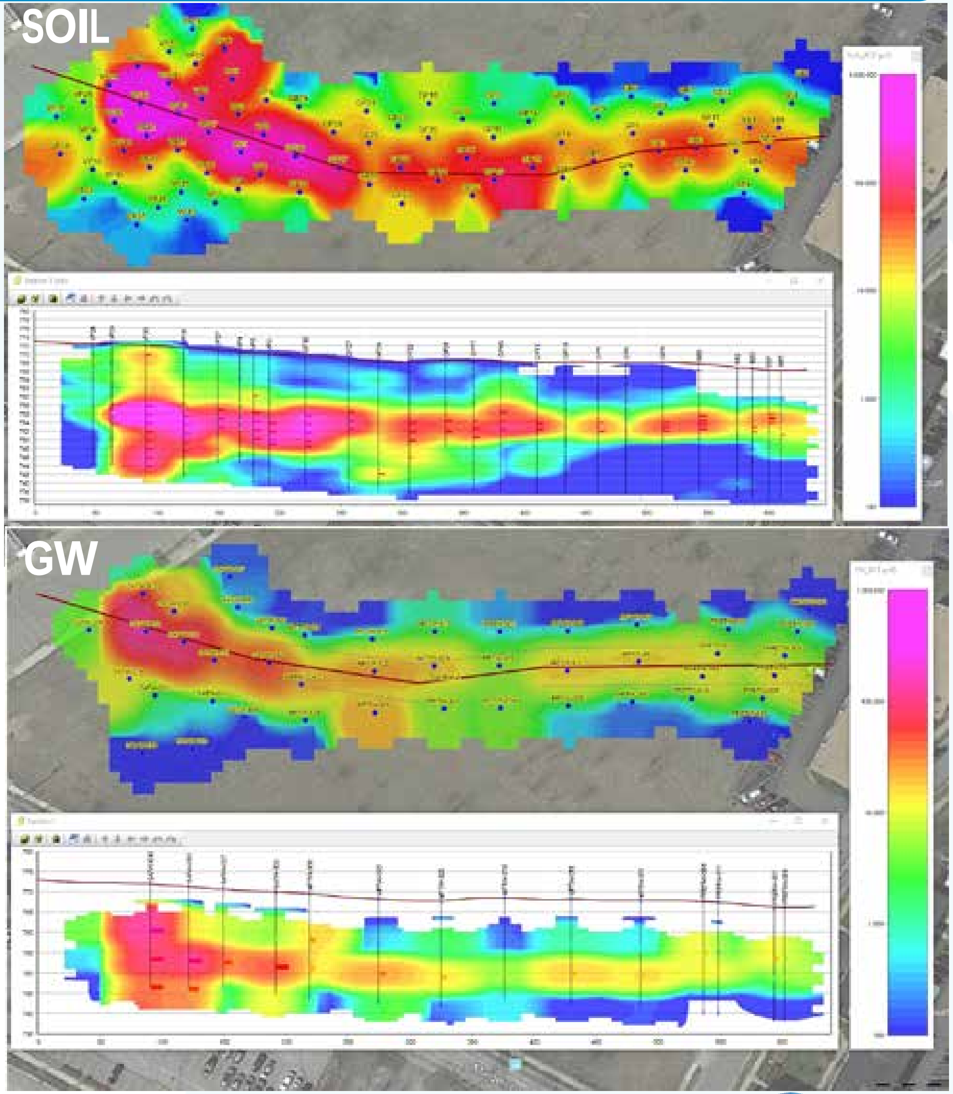
FINDINGS

- 4,125 lbs of PCE present in a 60 ft band
- Soil concentrations higher than previously measured
  - o 4,640,000 ppb – source area
- Magnitude of GW concentrations on par with previous investigations but more pervasive
  - o 137,000 ppb in source
  - o 14,000 – 27,000 ppb in axis of mid plume
- 99% of mass was PCE; *very* little natural degradation
  - o Groundwater = oxic
- Refined soil profile and hydrogeology



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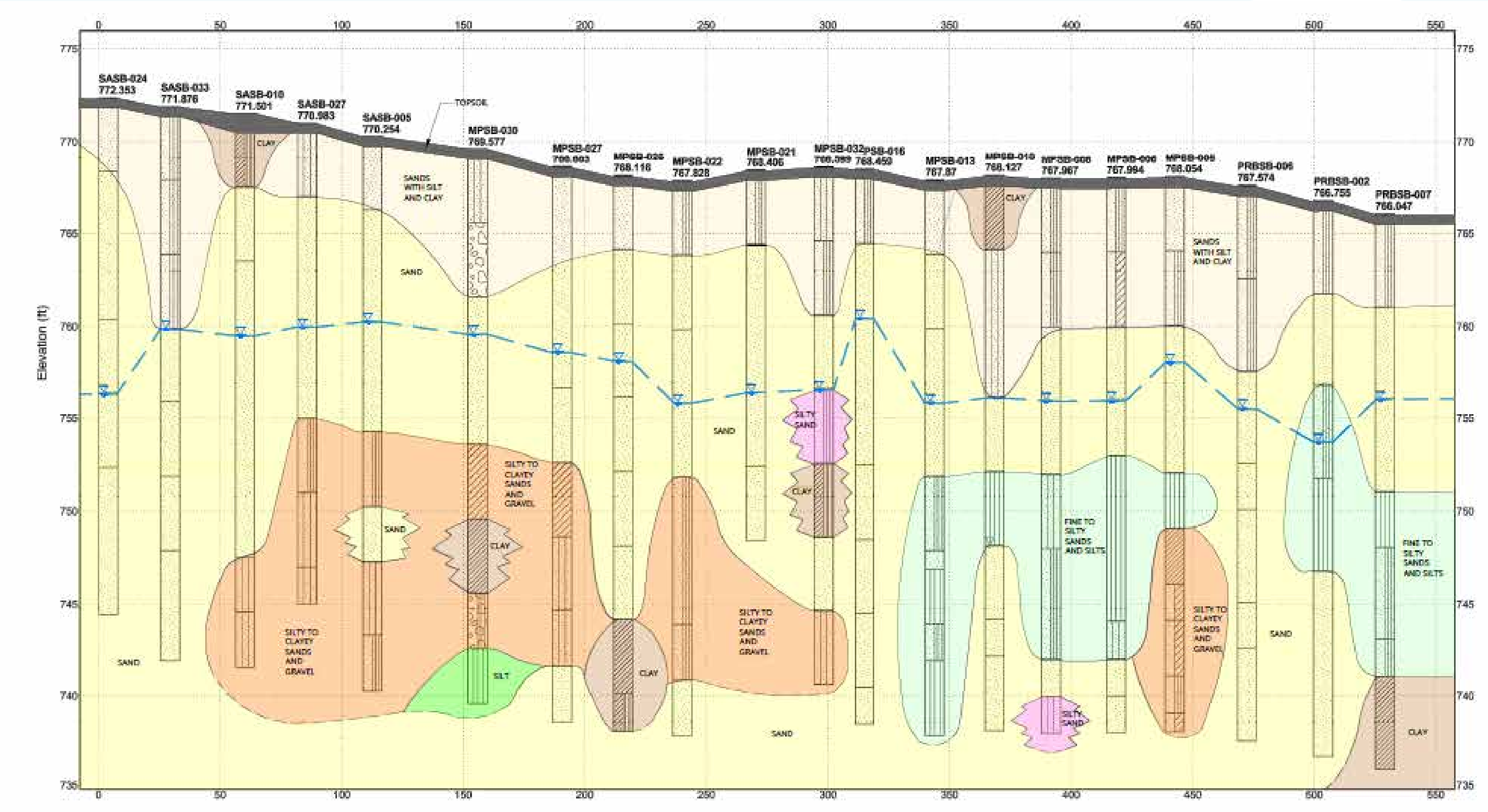
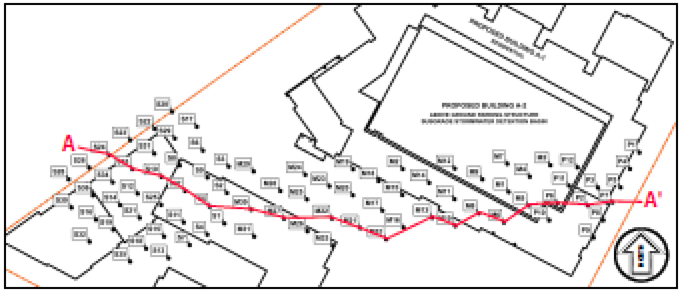
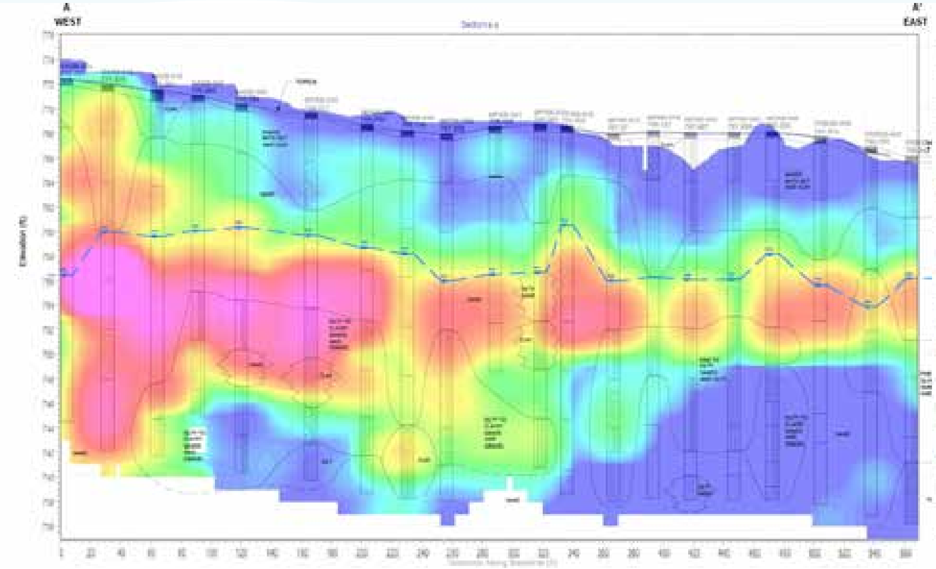
FINDINGS – ACROSS THE SITE



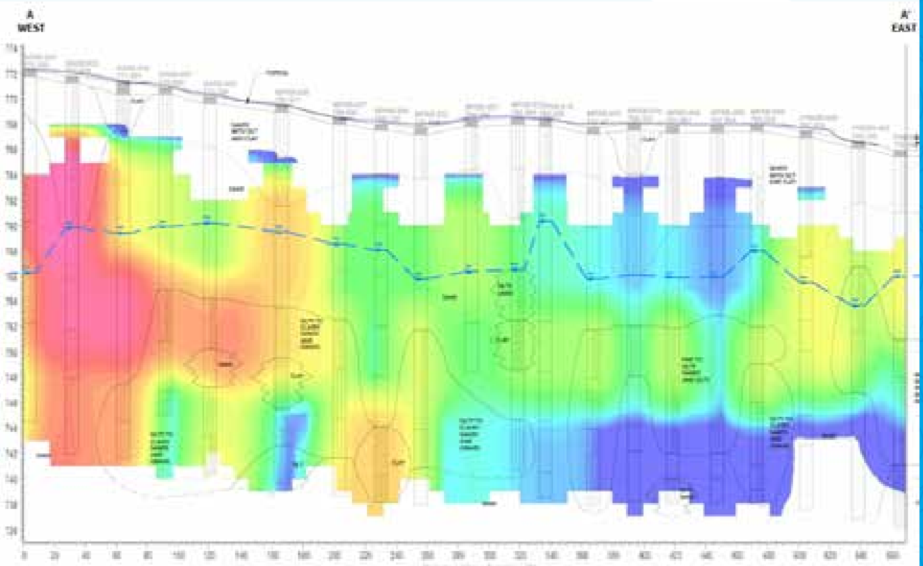


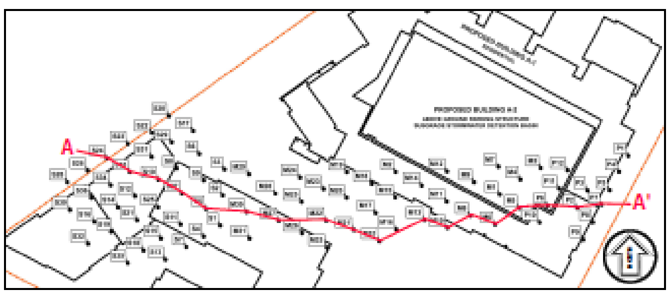
FINDINGS – ACROSS THE SITE

SOIL DATA

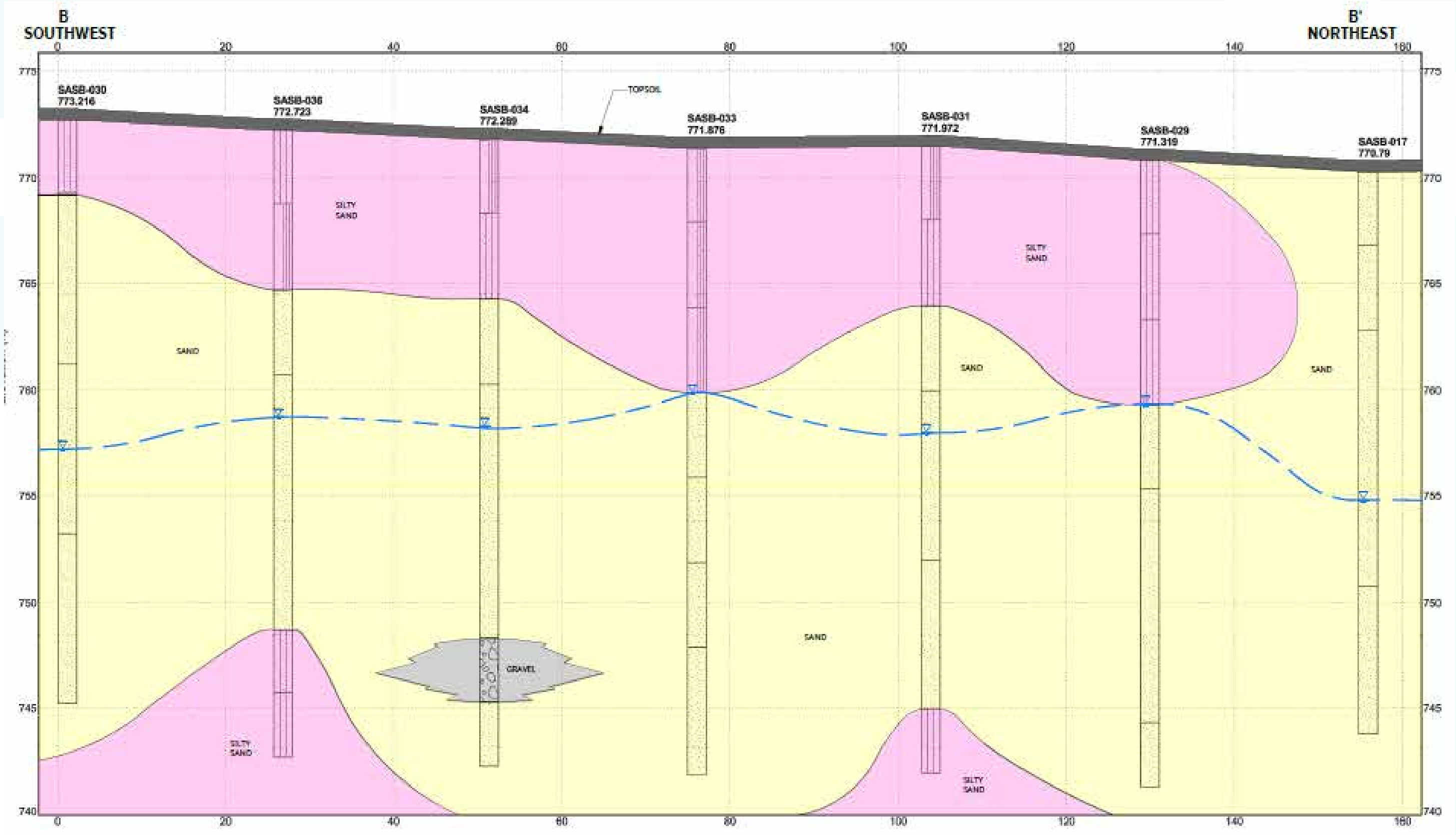


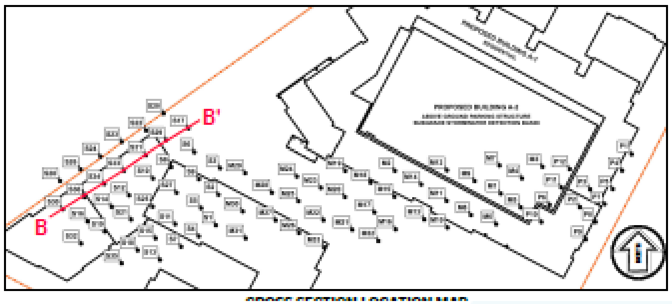
GROUNDWATER DATA





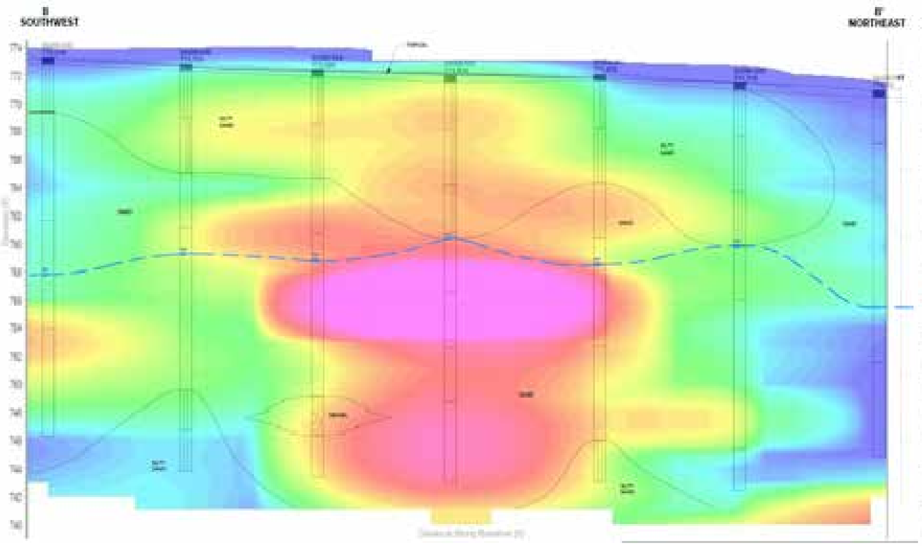
FINDINGS – SOURCE AREA



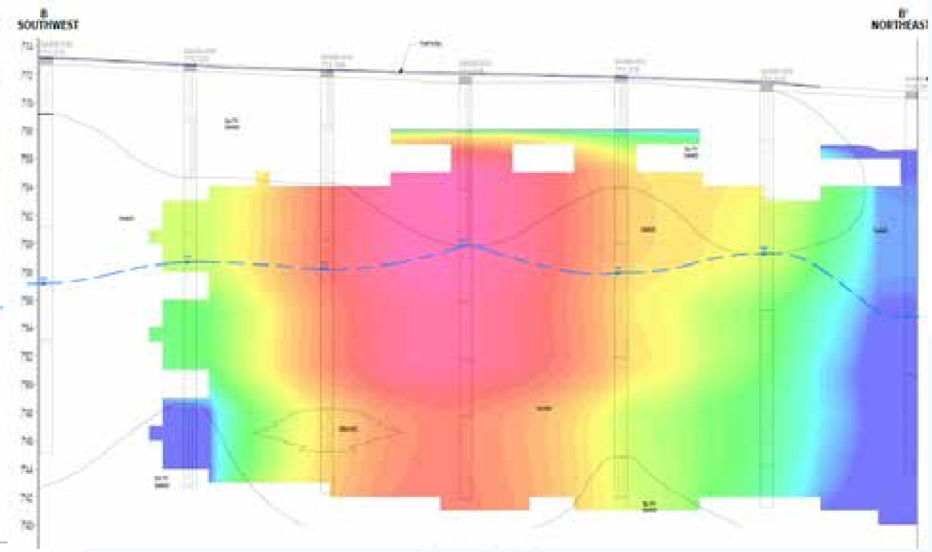


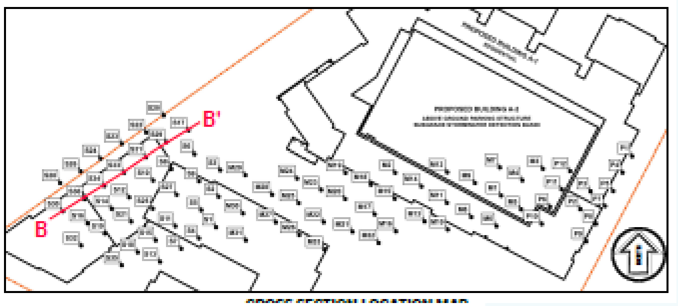
FINDINGS – SOURCE AREA

SOIL DATA

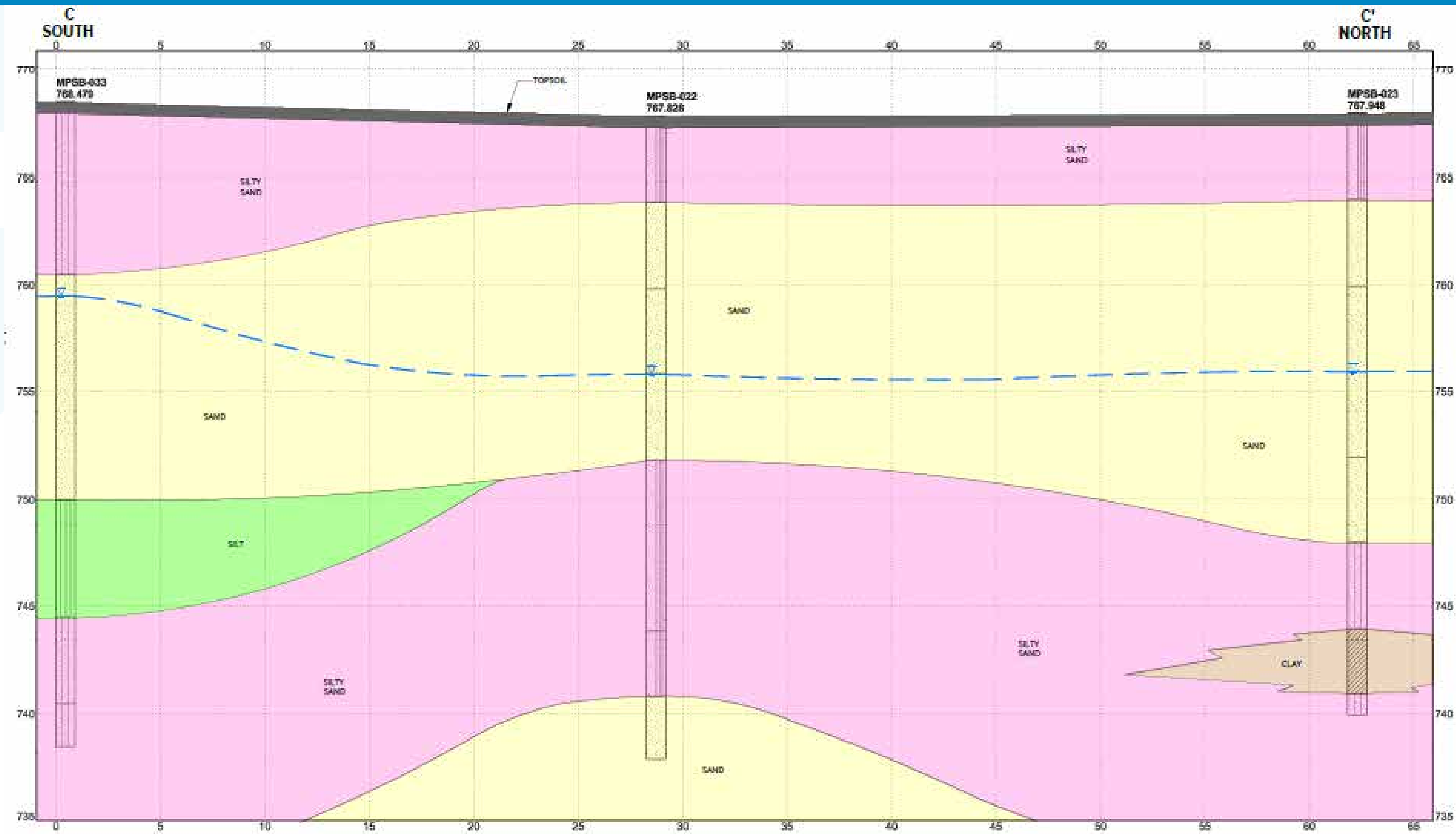


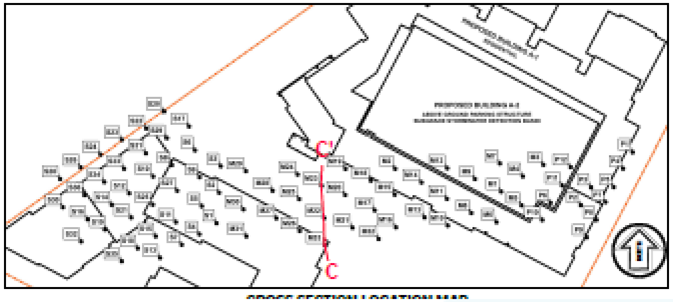
GROUNDWATER DATA





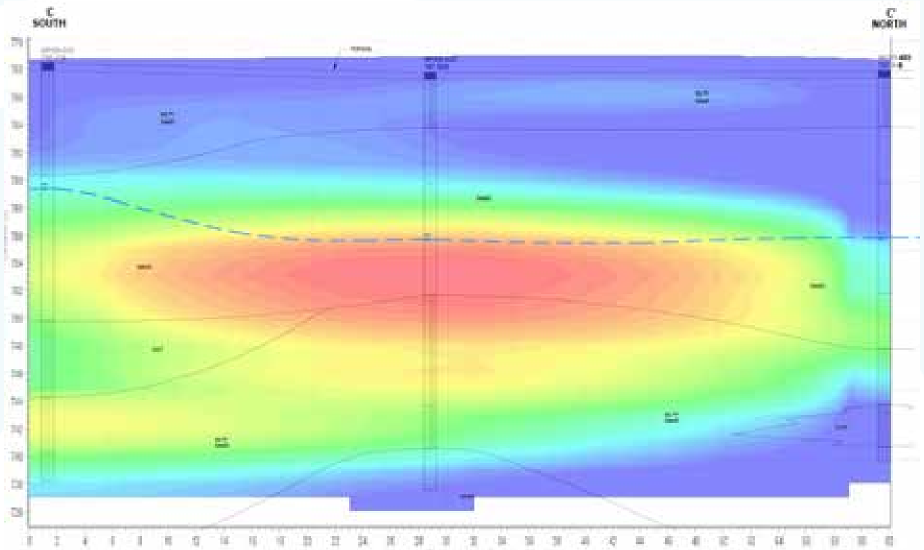
FINDINGS – MID PLUME



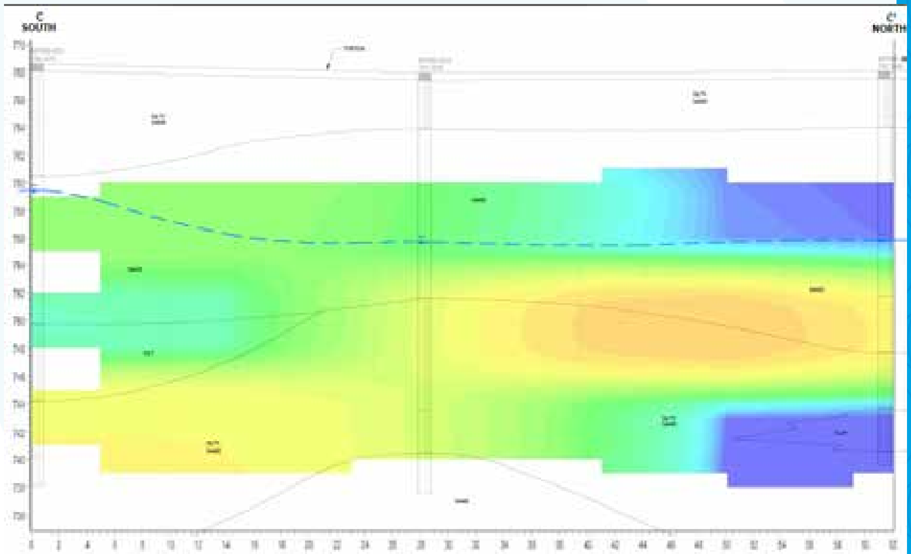


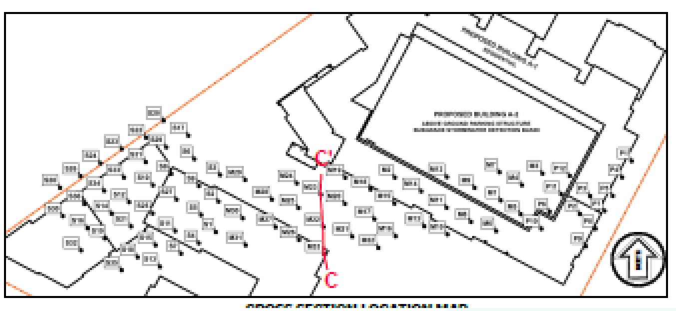
FINDINGS – MID PLUME

SOIL DATA

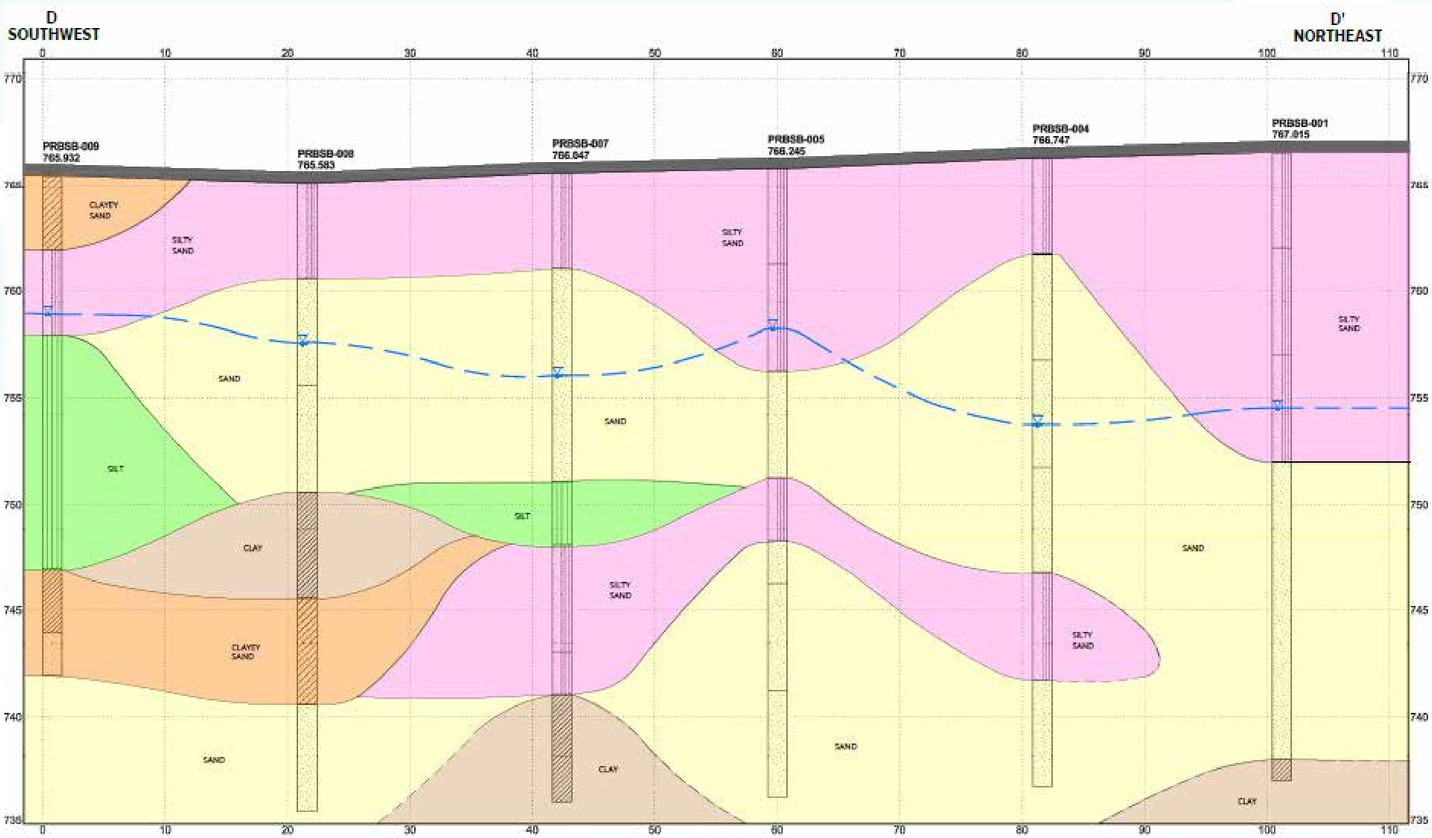


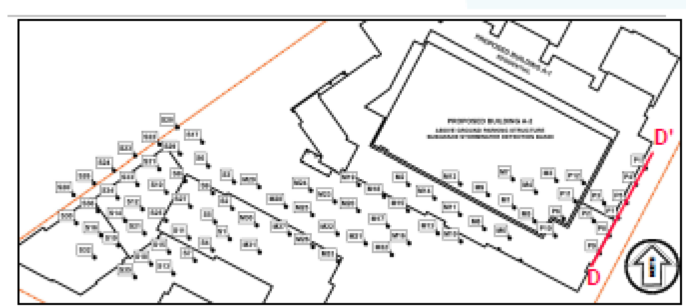
GROUNDWATER DATA





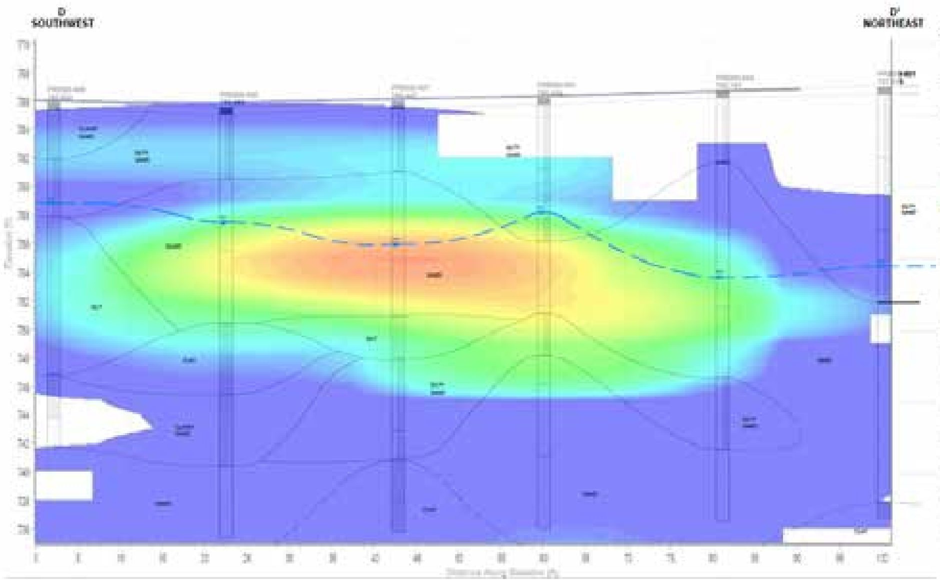
FINDINGS – PRB AREA



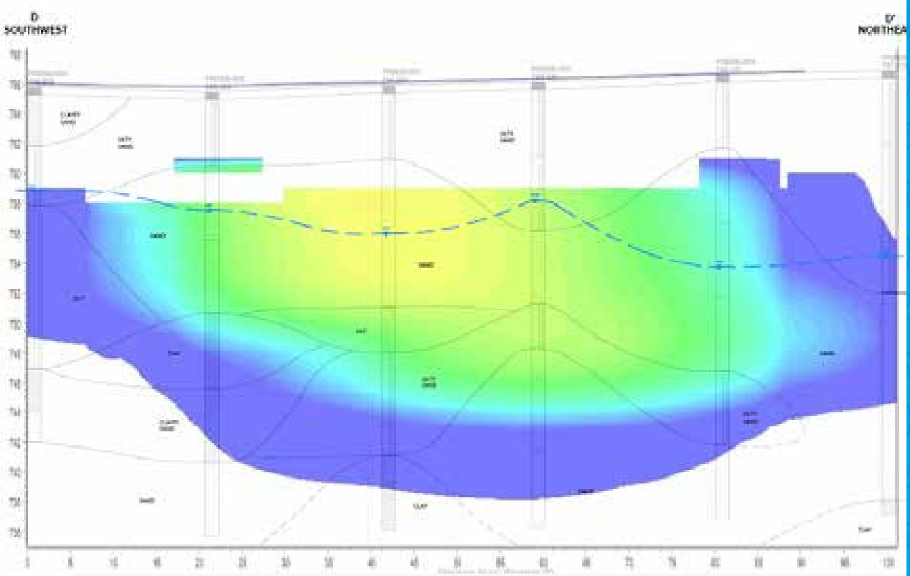


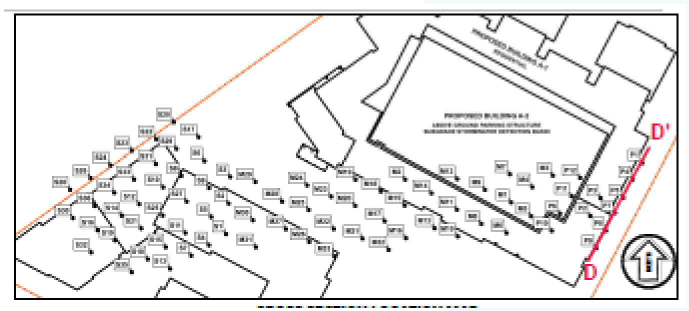
FINDINGS – PRB AREA

SOIL DATA



GROUNDWATER DATA





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IMPLICATIONS ON DESIGN

and then the plan changed...

BASED ON RDC FINDINGS

- Quantity of source and mid plume cVOC mass larger than previously estimated
  - o Insufficient space for one, adequate PRB at the eastern boundary
  - o Added a mid-plume PRB (PRB1) to knock down the cVOC concentrations prior to their arrival at the eastern boundary PRB (PRB2)
  - o Insufficient TIF funds to go after source

- Received $1 million EGLE grant
  - o Added source area treatment
  - o Decrease the concentrations = extend longevity of PRBs

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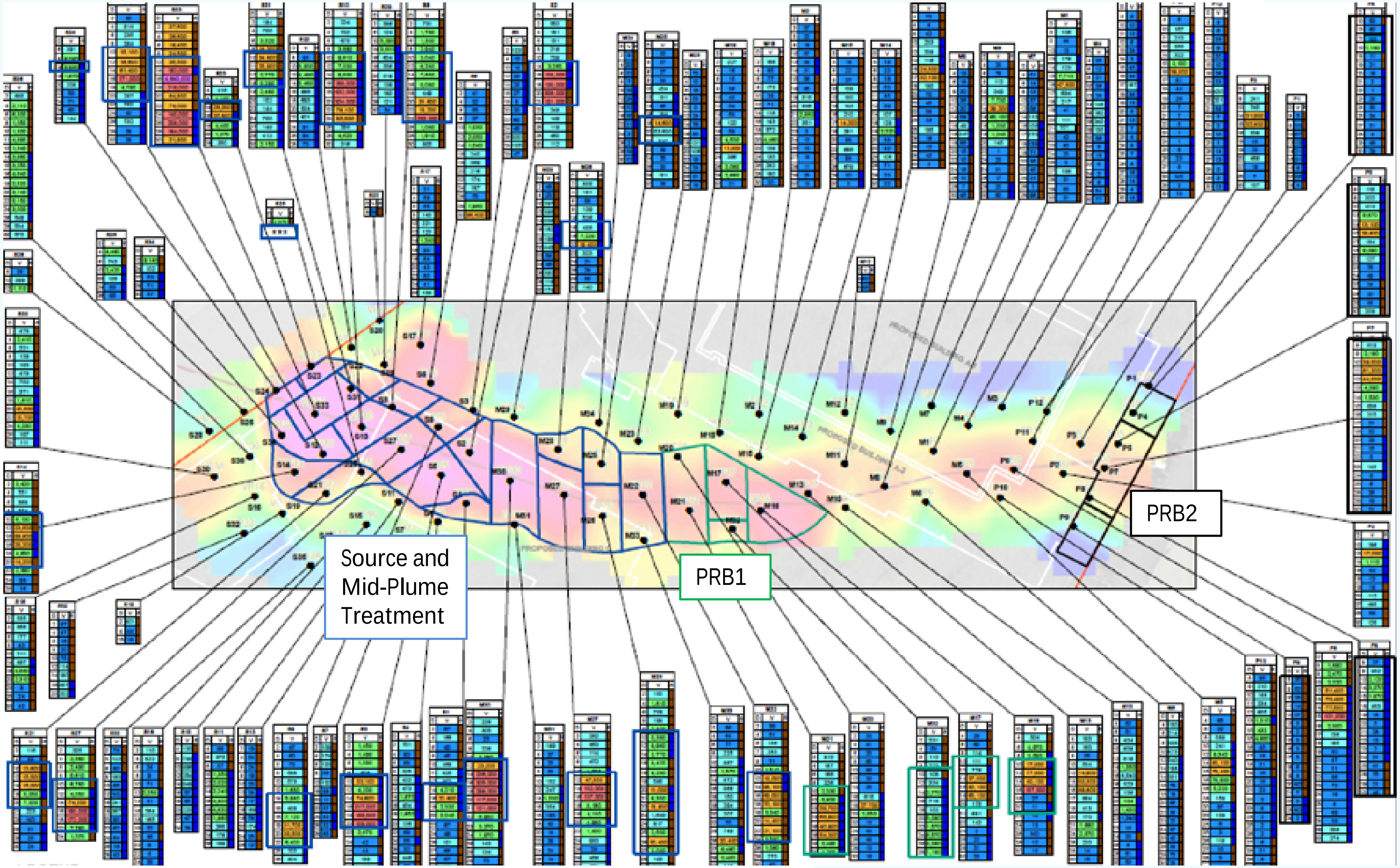
MASS-DRIVEN TREATMENT DESIGN



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APPROACH TO DESIGN – SOURCE & PRB1

- Designed remediation on spatial mass loading in saturated and unsaturated zones
  - Surgical design; using data collected every two vertical feet

- Source Area
  - CAT 100™ - BOS 100® with bacteria suite, starch, yeast
  - Loading designed on cVOC mass within source area footprint

- PRB1
  - CAT 100™
  - Loading designed on mass flux exiting source area **&** cVOC mass within PRB1 footprint
  - 5 year lifetime using seepage velocities calculated from slug tests

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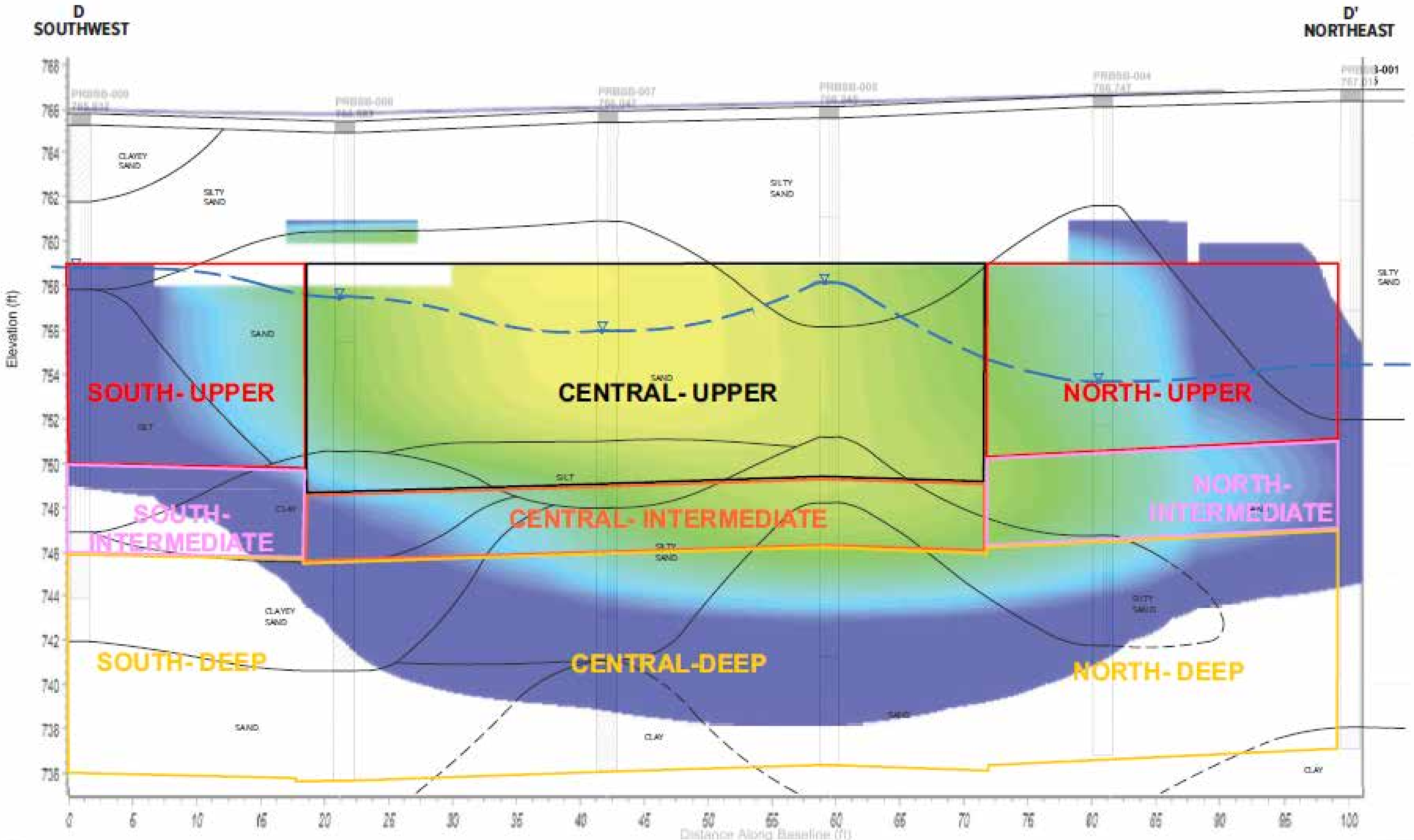
APPROACH TO DESIGN – PRB2

- PRB2
  - o BOS 100™
  - o Loading designed on…
    - Mass migrating in footprint of proposed Building A
    - Mass present within footprint of PRB2
    - 30 year lifetime using seepage velocities calculated from slug tests
  - o Majority of mass in 55 foot area from 10-17 ft bgs
    - PRB2 design broken into components
      - o Central Section [Upper, Intermediate, Deep]
      - o North Section [Upper, Intermediate, Deep]
      - o South Section [Upper, Intermediate, Deep]

APPROACH TO DESIGN – PRB2



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IMPLEMENTATION

- Approached allowed for a mass-driven design customized to the site with increased accuracy
- Conducted Pilot Study to field verify CAT 100™ as source and PRB1 treatment media in Dec 2018 through Feb 2019
- Full scale injections occurred Spring-Summer 2019; concurrent with construction
- One round of post-injection GW sampling in July 2019
  - One month following injections
  - Average PCE reduction in source and PRB1 of 68%
  - Average PCE reduction in PRB2 of 87%

Questions?