Cleanup of Groundwater

DuPont Pompton Lakes Works

Introduction

- Former E. I. du Pont de Nemours and Company Pompton Lakes Works (DuPont PLW) operated from 1926 to 1994
- Ceased operation and demolished in 1995; in process of cleanup

Background

- Groundwater monitoring was initiated in the 1980s
- Existing interim remedial measure (IRM) pump & treat system -- August 1998
  - Goal: Contain groundwater contamination with potential for off-site migration

Geologic and Hydrogeologic Setting

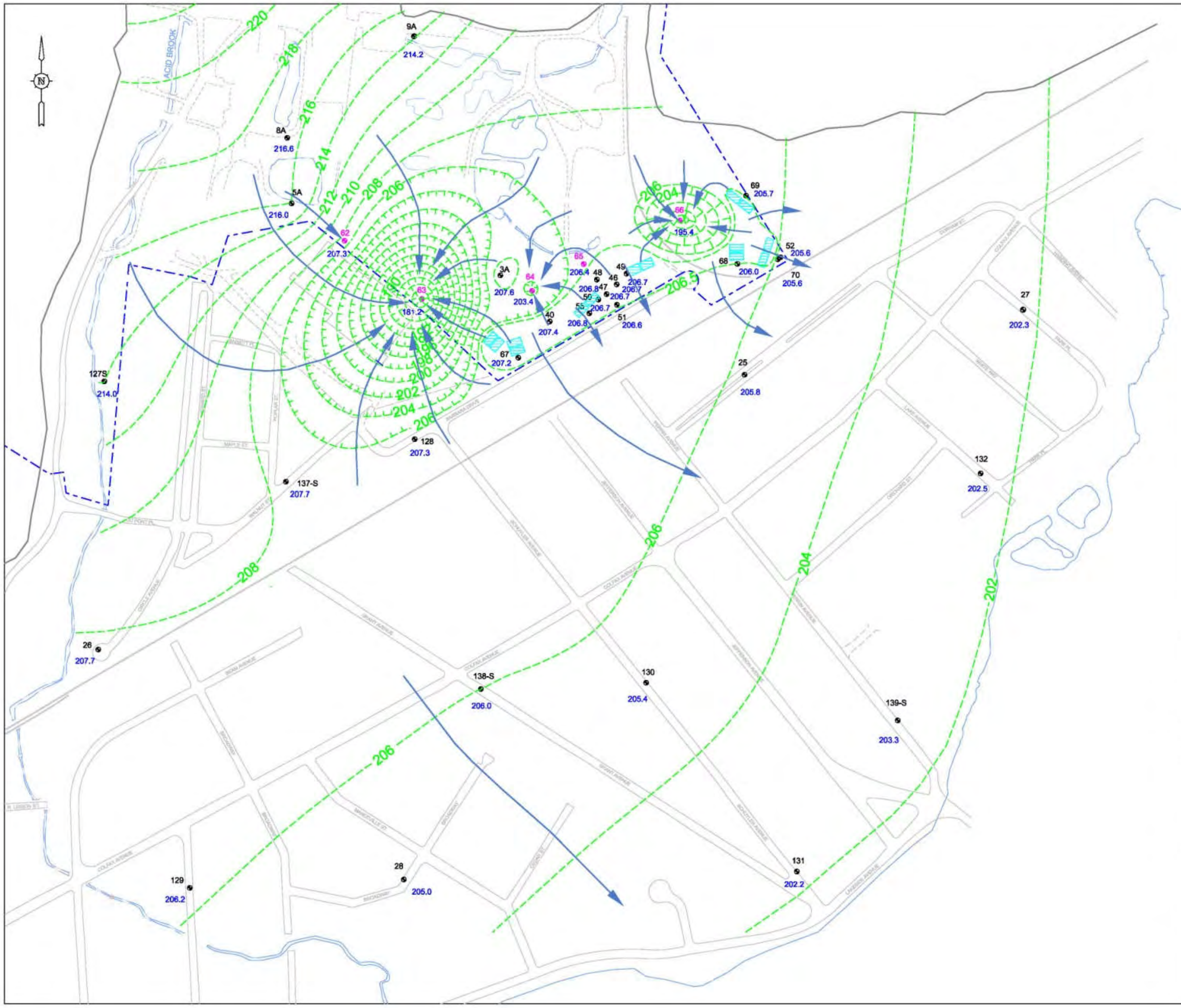
- Acid Brook flows south and discharges into Pompton Lake (created by damming the Ramapo River)
- Wanaque River flowed through Lake Inez and south through Pompton Lakes
- Two geologic units -- bedrock and alluvial deposits

LEGEND

1. Former Western Valley Manufacturing Area
2. Former Eastern Valley Manufacturing Area
3. Former Northern Manufacturing Area
4. Offsite Groundwater Area
5. Offsite Wanaque River Area
6. Pompton Lakes Delta Area

On-site Ground Water

- When groundwater was found to be contaminated, a pump and treat system was installed (think of a straw in a glass of water) to contain contaminated groundwater before it flowed off-site toward residences
- Groundwater is treated to remove chlorinated volatile organic chemicals (VOCs)
- As treated groundwater is discharged to the shallow zone, a layer of "cleaner" water will spread in the shallow zone down-gradient.



LEGEND

PROPERTY LINE

OPEN WATERS

INFILTRATION BED

WELL ID

PUMPING WELL LOCATION

WELL LOCATION

ELEVATION

GROUNDWATER ELEVATIONS ROUNDED TO NEAREST 0.1'

GROUNDWATER ELEVATION CONTOUR LINE [approximated]

Groundwater elevation contour interval is 2-Foot, except around infiltration beds where additional contours have been added to show better detail.

Direction of groundwater flow

GRAPHIC SCALE

170 0 85 170 340 680

1 inch = 170 feet

SCALE	DESIGNED BY	DRAWN BY	CAD FILE
1-in = 170-ft	MEV	MEV	GW RASR Figs 4-10.dgn
DATE	CHECKED	APPROVED	PROJECT NO
22-Jan-10			445499.01001

PARSONS

200 Cottontail Lane
Somerset, New Jersey 08873

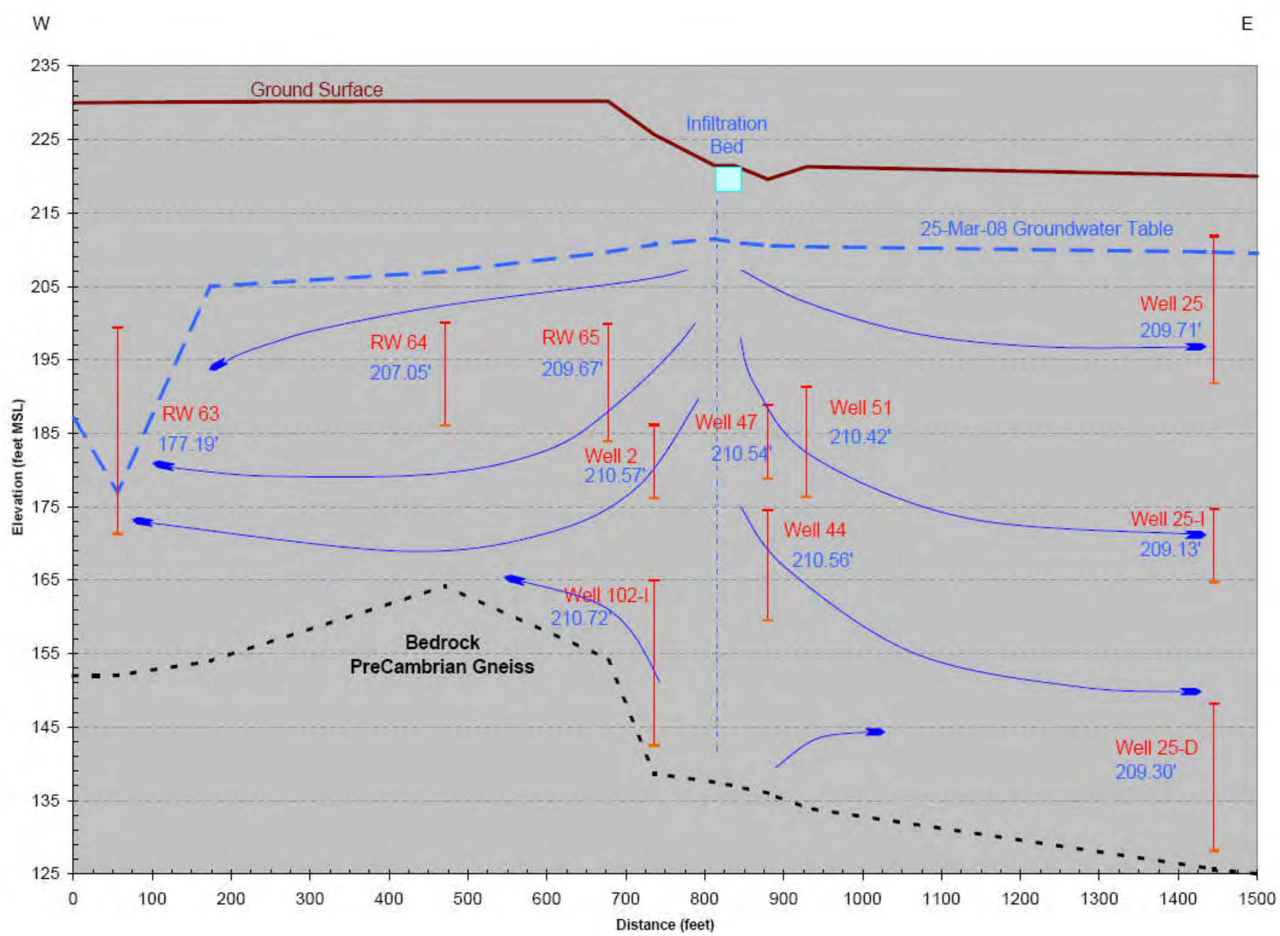
Groundwater Potentiometric Surface
Shallow Alluvial Zone, November 2008

DUPONT POMPTON LAKES WORKS
Pompton Lakes, New Jersey

2000 Cannonball Road
Pompton Lakes, New Jersey 07442

Figure 4

[redacted]



W
E
235
225
215
205
195
185
175
165
155
145
135
125
Elevation (feet MSL)
Ground Surface
Infiltration
Bed
25-Mar-08 Groundwater Table
Well 25
209.71'
RW 64
207.05'
RW 65
209.67'
RW 63
177.19'
Well 51
210.42'
Well 47
210.54'
Well 2
210.57'
Well 25-I
209.13'
Well 44
210.56'
Well 102-I
210.72'
Bedrock
PreCambrian Gneiss
Well 25-D
209.30'
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Distance (feet)

Off-site Groundwater

- An "aquifer" is a reservoir of water under the ground
- Gravity makes the groundwater flow from DuPont (a higher level) toward Pompton Lake (a lower level)
- To get from DuPont to Pompton Lake it flows under homes in Pompton Lakes

Conceptual Model

- Shallow alluvial zone: 5 to 20 feet thick. Permeable (water flows through it easily)

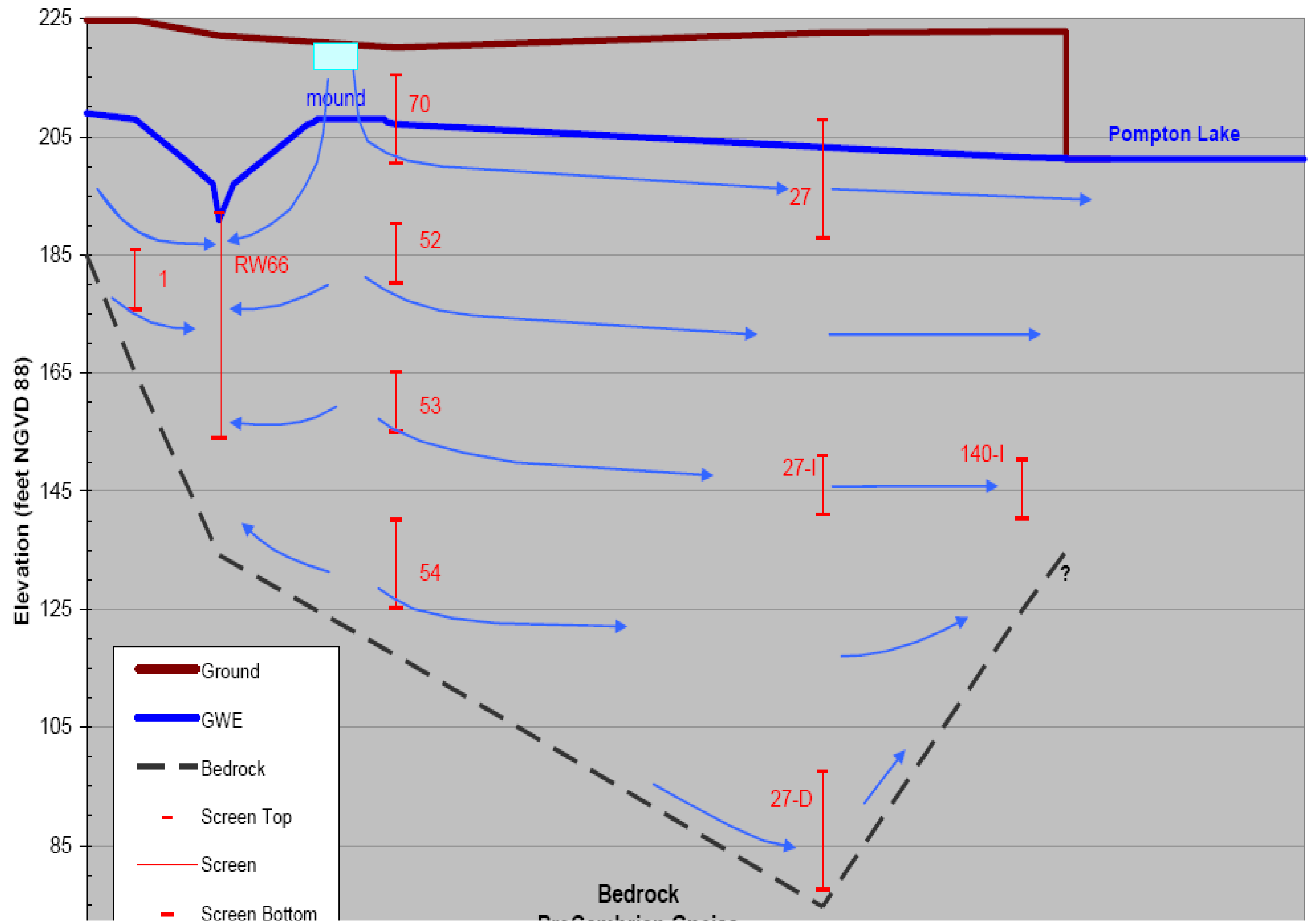
  - Intermediate alluvial zone: 15 to 80 feet thick; less permeable

  - Deep alluvial zone: 90 feet thick; least permeable

Effects of Pump and Treat on the Three Zones

- Largest decrease in contamination is in the shallow zone (highest permeability) where the clean water has the greatest affect
- Less decrease in the intermediate zone because it is less permeable and further from the clean water being flushed through basins
- Least decrease in the deep zone because it is least permeable and furthest from clean water being flushed through basins

[redacted]



225
205
185
165
145
125
105
85
Elevation (feet NGVD 88)
mound
70
27
52
RW66
1
53
27-I
140-I
54
?
27-D
Pompton Lake
Ground
GWE
Bedrock
Screen Top
Screen
Screen Bottom
Bedrock

Potential Receptors

- Shallow groundwater contaminated with VOCs flow under homes and evaporates through the slab into home.
- Residents can come into contact with groundwater if they use a contaminated drinking water well (none in vapor mitigation area).
- Residents can have direct contact with surface water and lake sediments.
- Ecological receptors have direct contact with surface water and sediment.

Vapor Intrusion Problem

VOC Constituents of Concern

- The chlorinated VOCs that came from DuPont are called constituents of concern (COCs). They include:
  - Tetrachloroethene (PCE)
  - Trichloroethene (TCE)
  - Vinyl chloride (VC)
  - Carbon Tetrachloride
- Some VOCs found in the indoor air of homes are not COCs because they were not found in the groundwater, so they didn't come from DuPont. Examples are benzene, chloroform, acetone, and toluene.
- Some VOCs in the indoor air of homes are from chemicals found in homes. Examples are dry cleaning, paints, adhesives, and cleaning products.

Why Is It Hard To Clean Up?

- No discrete source of chemicals (VOCs). The VOCs are dissolved in water.
- The VOCs are in some places and not others (heterogeneous).
- The concentrations of VOCs are relatively low.

Technology Screening

Effectiveness

- Cleans up groundwater
- Reduction in toxicity, mobility, or volume of contaminants
- Demonstrated performance history
- Long-term reliability

Previous Attempts to Clean Up Groundwater

- In-situ bioremediation pilot test was conducted in 1994 and 1995
  - Molasses, and then later yeast, were injected in the subsurface, along with nutrients
  - Large amount of maintenance was required to keep the pilot system operational
  - Injection well was fouled and had to be replaced

Criteria For Selecting Remedies

- Types of treatment depends on:
  - Chemicals to be treated
    - We know the chemicals of concern
  - Characteristics of subsurface
    - Western area of contamination plume doesn't have much oxygen (anaerobic)
    - Eastern area of the contamination plume does (aerobic)

Technology Screening

- Multiple technologies were screened
- The following technologies were eliminated:
  - Containment
  - Air Sparging/Soil Vapor Extraction
  - Targeted Extraction and Treatment

Targeted Extraction and Treatment

- Majority of the VOC is most likely stuck to the soil
- The potential for success is dependent on knowing where the VOC in soil is located
- Even if you knew where the contaminated soil was, much would be inaccessible because there are homes and streets on top

What Might Work

Enhanced Anaerobic Bioremediation (EAB)

- This might be applicable in the western part of plume where there are anaerobic (no oxygen) conditions
- Reductive dechlorination of the chlorinated VOCs
  - Microorganisms remove chlorines from the molecules, one by one, to degrade the contaminants, so that eventually no contaminants remain
- Reductive dechlorination works with PCE, TCE, VC
- Equipment that is readily available
- Requires additional site characterization

To Design an EAB System

- Small-scale laboratory treatability study
  - To make sure particular bacteria work under existing conditions
  - Making changes to injected material could make system more effective
- We know EAB technology is suitable, but we need to make sure we know enough about subsurface conditions
- Additional subsurface characterization is required
- Then, a pilot (small scale) study is required in the neighborhood

In-situ Chemical Oxidation (ISCO)

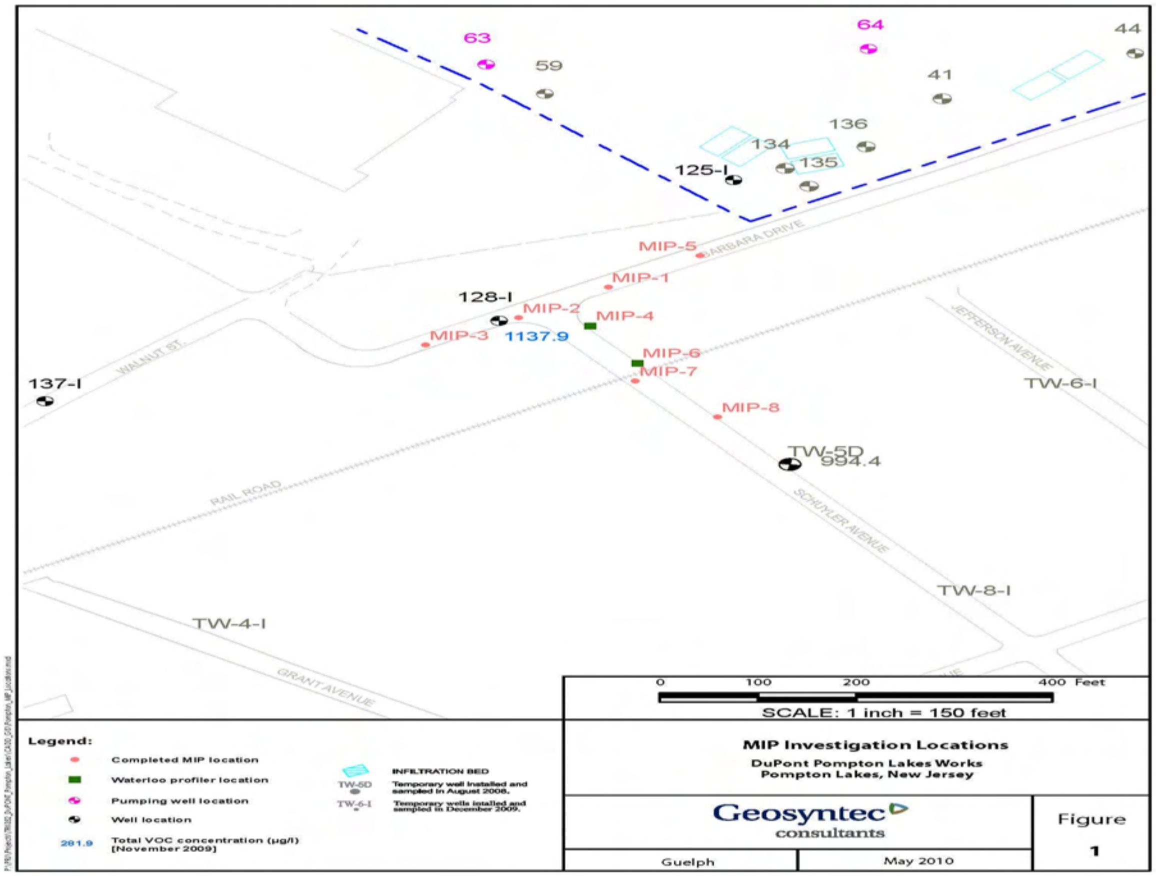
- ISCO might be applicable in the eastern part of plume and in the intermediate zone where there are aerobic (oxygen) conditions
- PCE, TCE and VC could be effectively oxidized using commercial oxidants -- hydrogen peroxide, Fenton's reagent, potassium permanganate, activated sodium persulfate, and ozone
- But which commercial oxidant and how much?

So Let’s Get It Done.
What’s Taking So Long?

What Do We Need To Know?

- Additional subsurface characterization is required to assess:
  - how much oxygen
  - what kind of soil
  - how much variation is there in the VOCs and soil
- Then, a pilot (small scale) study is required in the neighborhood to see how effective it is

Pilot Test



63
64
44
59
41
136
134
135
125-I
MIP-5
BARBARA DRIVE
MIP-1
128-I
MIP-2
MIP-4
MIP-3
1137.9
MIP-6
MIP-7
137-I
WALNUT ST
JEFFERSON AVENUE
TW-6-I
MIP-8
TW-5D
994.4
RAIL ROAD
SCHUYLER AVENUE
TW-8-I
TW-4-I
GRANT AVENUE
0
100
200
400 Feet
SCALE: 1 inch = 150 feet
Legend:
Completed MIP location
Waterloo profiler location
Pumping well location
Well location
281.9
Total VOC concentration (µg/l) [November 2009]
INFILTRATION BED
TW-5D
Temporary well installed and sampled in August 2008.
TW-6-I
Temporary wells installed and sampled in December 2009.
MIP Investigation Locations
DuPont Pompton Lakes Works
Pompton Lakes, New Jersey
Geosyntec
consultants
Figure
1
Guelph
May 2010

Conclusions and Recommendations

- We think the best approach is to:
  - Continue groundwater pump & treat to contain the contaminated groundwater on-site
  - Do additional studies on In-situ EAB and ISCO technologies which seem to be the most promising. This will require:
    - Additional characterization to determine more precisely the location and characteristics of the VOCs
    - Complete additional off-site characterization laboratory and bench scale testing if needed
    - Pilot studies to determine the effectiveness and implementability considering site access constraints
    - Assess how to most successfully proceed to large-scale remediation