Study of Alternatives for Management of Impacted Groundwater at Bethpage (January *2012 Report) Presentation*

Naval Facilities Engineering Command Mid-Atlantic

Technical Advisory Committee Meeting

February 27, 2012

Introduction

- Study Objective: To evaluate the technical and economic feasibility of alternatives for management of impacted groundwater down gradient of NGC, Navy and other sources

- Study addresses one of the recommendations of the third-party *Remedy Optimization Team Report for the Bethpage Groundwater Plume Remedy* (June 2011)

Other Optimization Team Recommendations that Navy is Addressing

- Additional delineation in aquifer along leading edge of plume

- Additional investigation in aquifer south of the On-Site Containment System (ONCT) at OU-2 to determine its effectiveness, especially in deeper zones

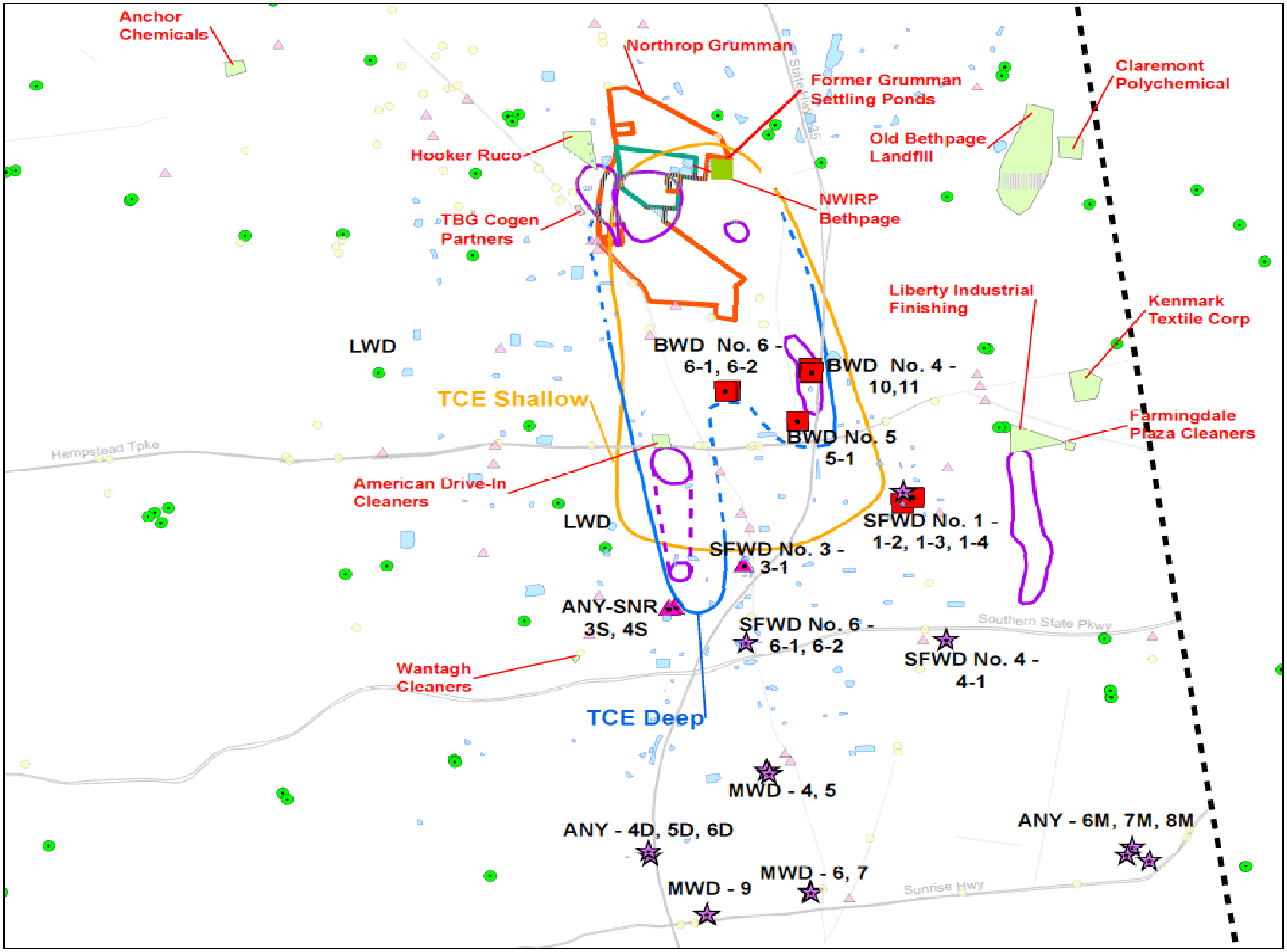
- New VPB and monitoring well cluster in the aquifer near Southern State Parkway

Scope of Study

- Integrated technical and cost evaluation of alternatives for groundwater impacts from several potential sources that collectively contribute to the “Bethpage Plume”:
  - OU-2 sources
  - OU-3 sources
  - Hooker-Ruco
  - American Drive-In Cleaners
  - Other potential sources

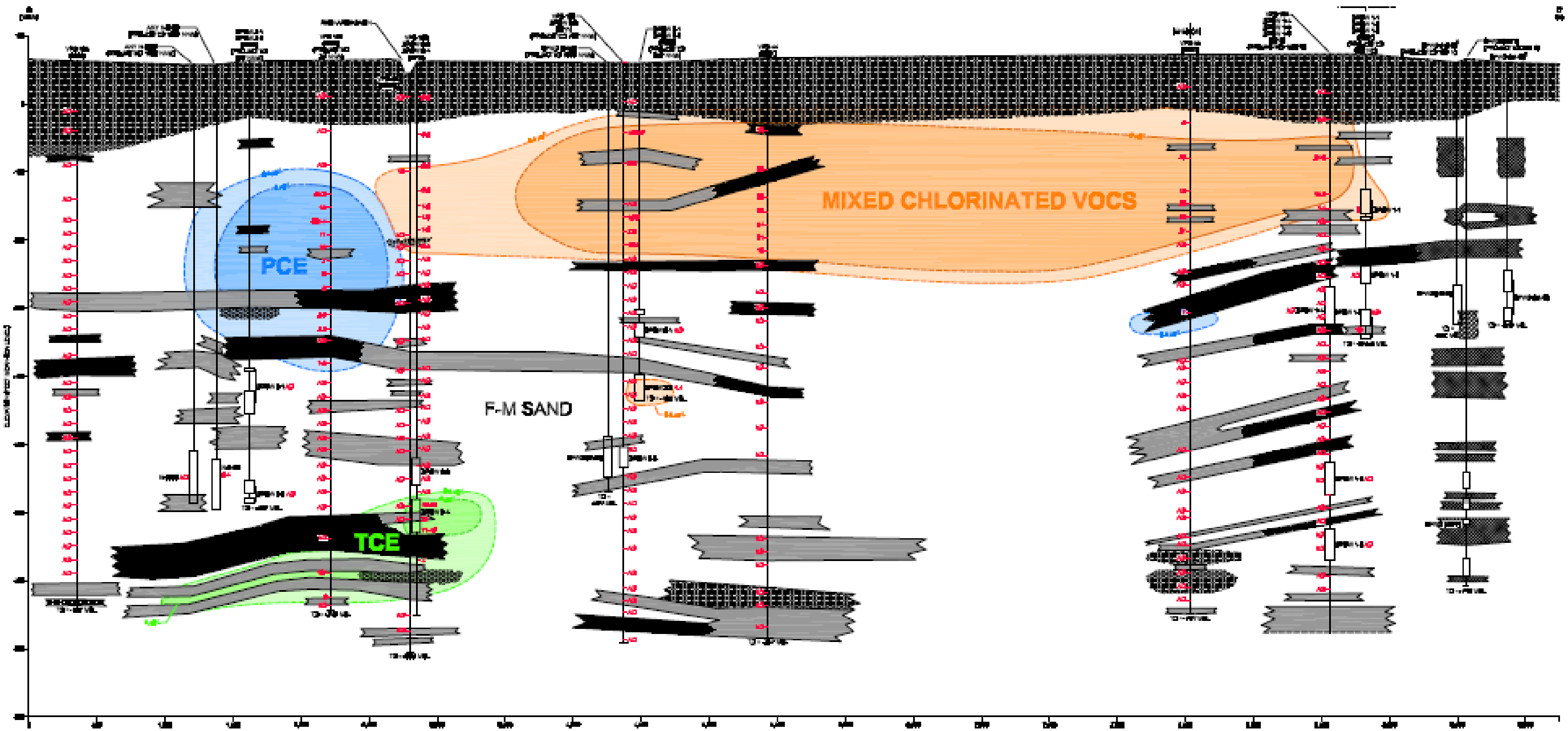
- An integrated assessment of all VOC impacts apparent at C-C’

"Bethpage Plume"
– A Collection of Plumes from Various Sources
(Adapted from Figure 1-10 in report)



Bethpage Plume - *Cross-Section C-C'*

(Adapted from Figure 1-9 in Report)



Study of Alternatives for Bethpage Plume

- Alternative 1 – Current ROD

- Alternative 2A – Sustained pumping in strategic supply wells
- Alternative 2B – New plume containment system
- Alternative 2C – New hydraulic containment system

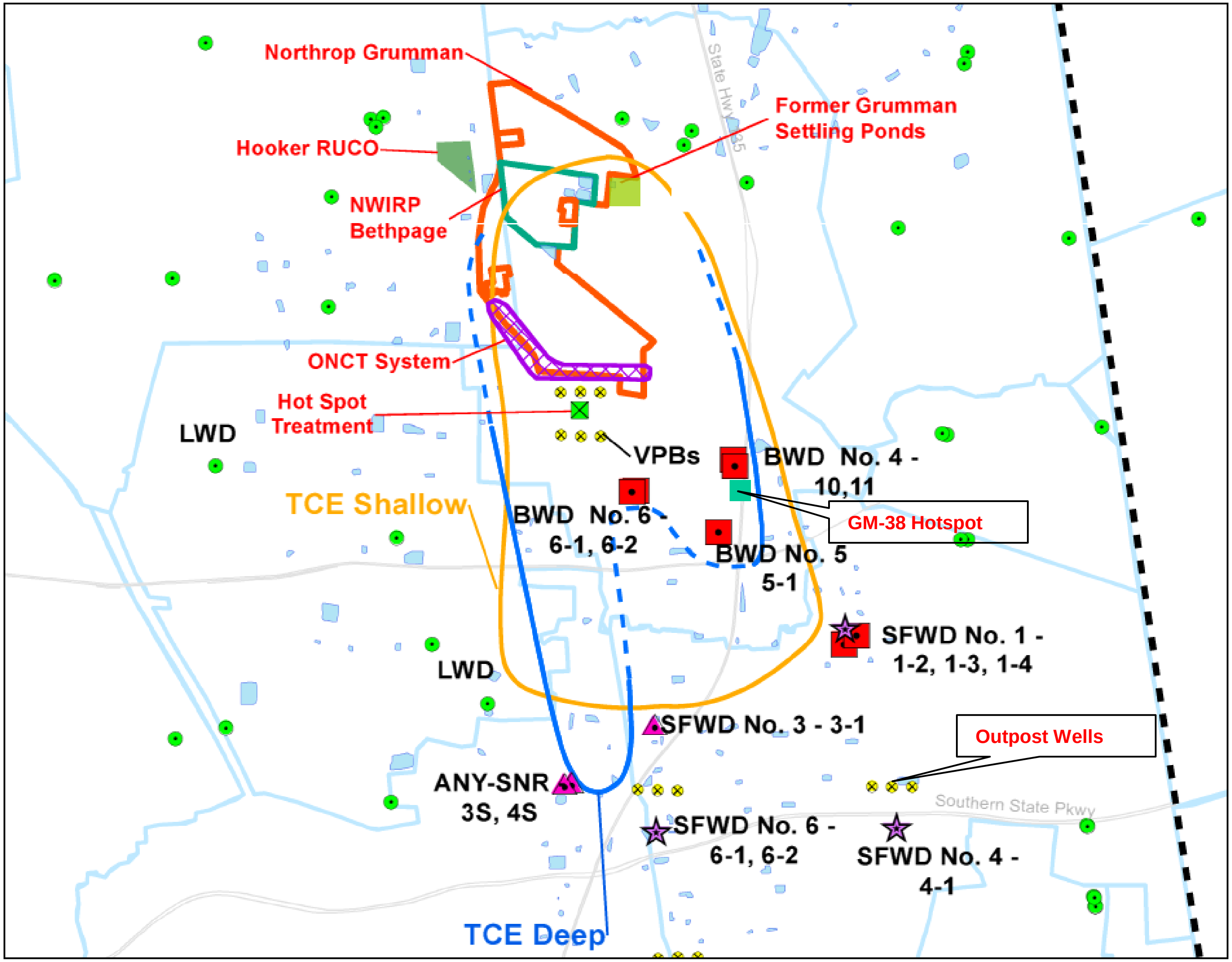
- Alternative 3 – Accelerated installation of wellhead treatment in downgradient supply wells

Alternative 1 - Description

- Current OU-2 ROD remedy (and associated measures for other sources)
  - –On-site source containment
  - –Off-site hot-spot treatment
  - –Off-site plume monitoring
  - –Wellhead treatment at impacted supply wells

  - –Fortuitous capture in impacted supply wells

Alternative 1 – Description
(Adapted from Figure 2-1 from report)

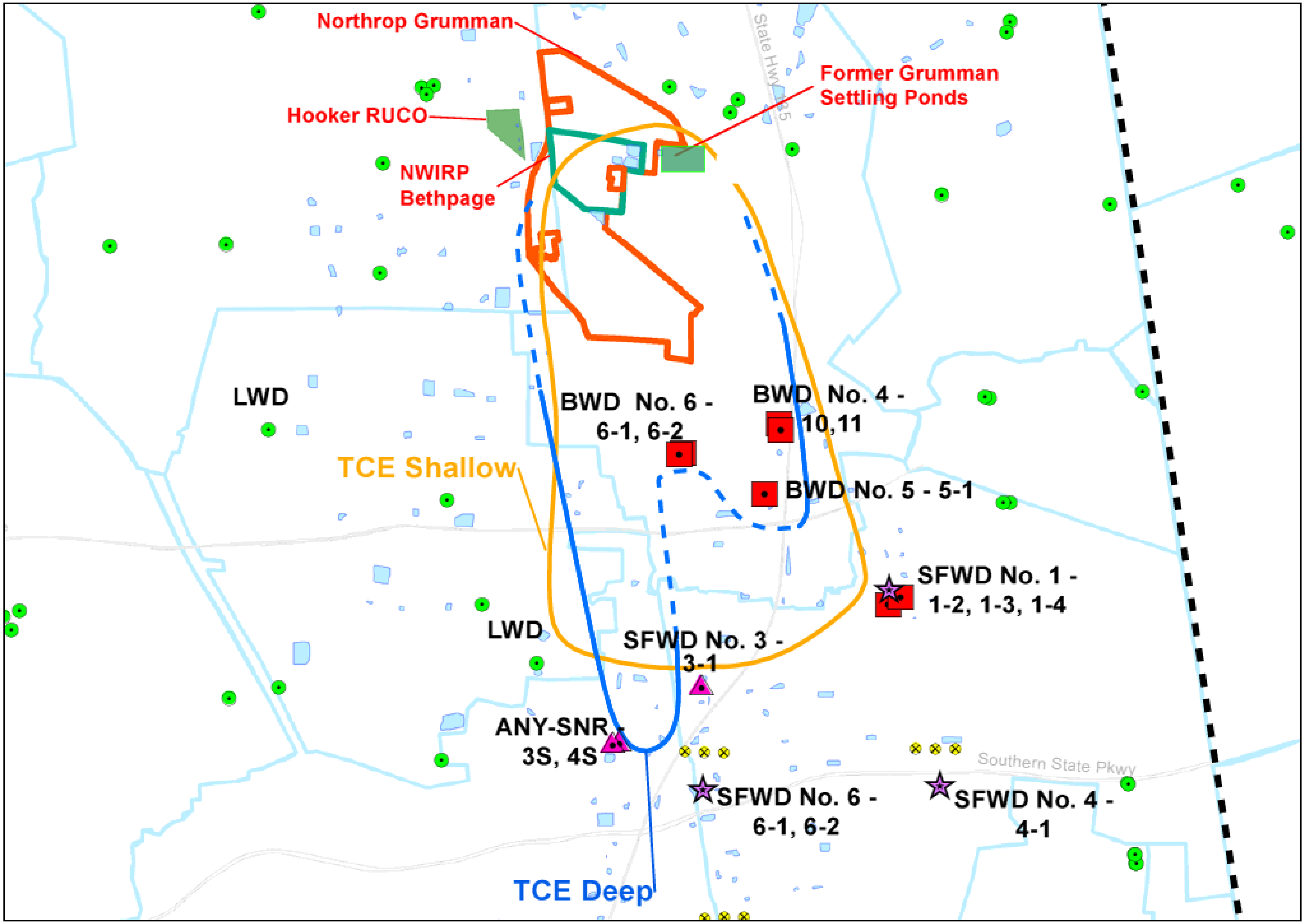


Alternative 2A - Description

- The measures in Alternative 1

- Sustained (year-round) pumping in strategic impacted supply wells, for example
  - **BWD 6-2**. 775 feet bgs, 1,200 gpm capacity. Currently estimated to operate ~ 30% of the time.
  - **ANY-SNR** (ANY #3S and 4S), approximately 650 feet bgs, with combined capacity of 4,200 gpm. Cluster is estimated to operate ~30% of its annual capacity

Alternative 2A – Description
(Adapted from Figure 2-4 from report)

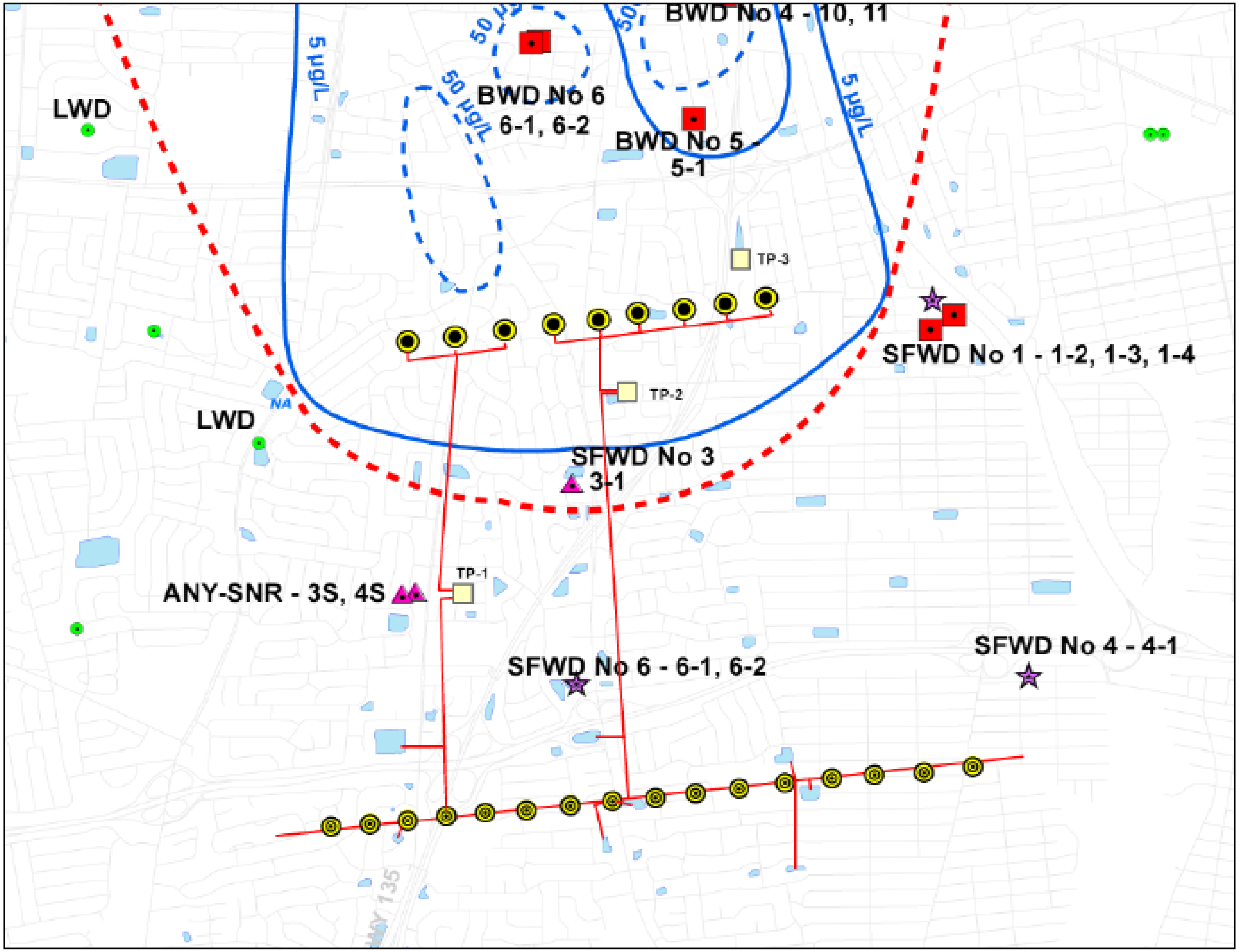


Alternative 2B – Description

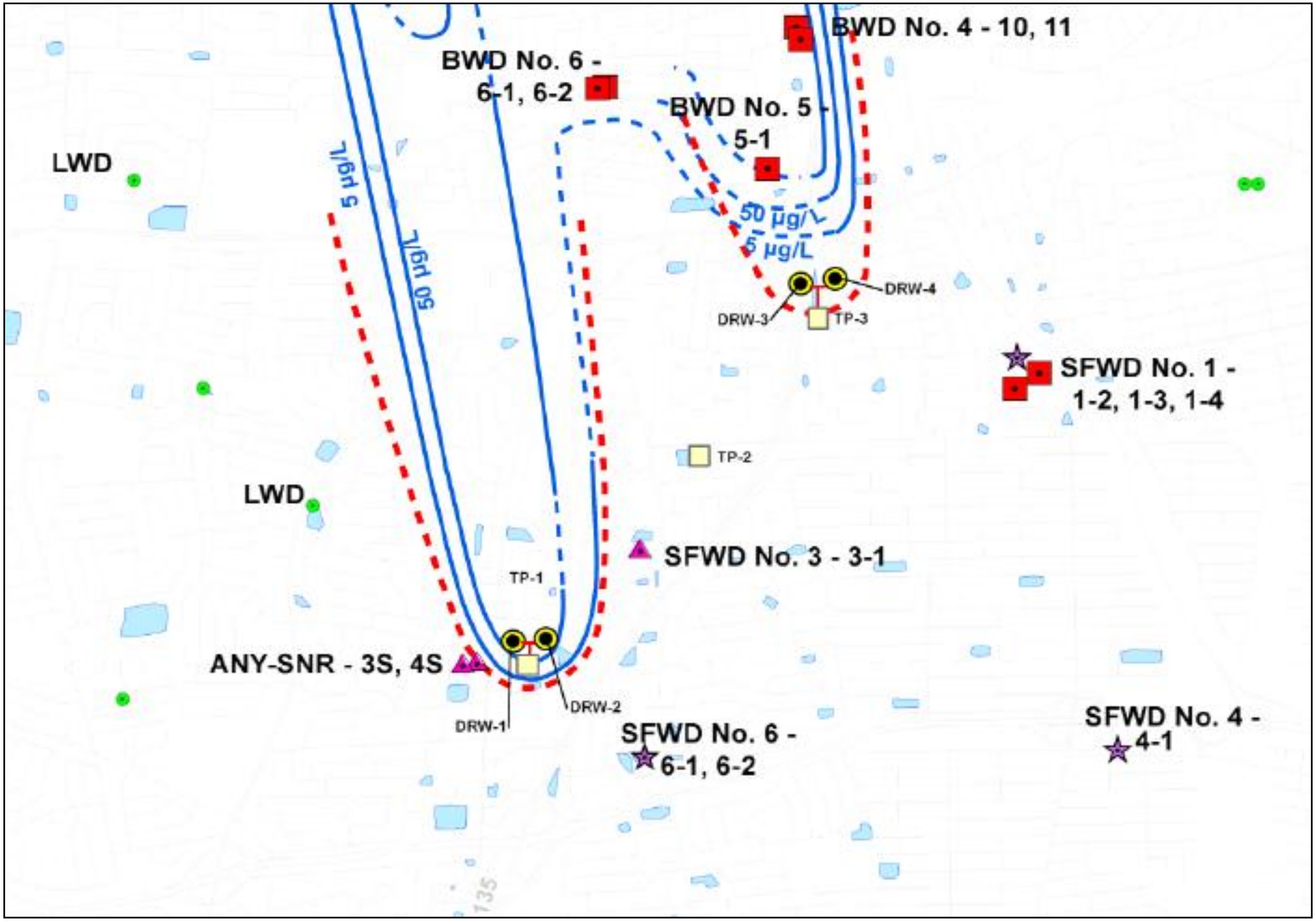
- The measures in Alternative 1

- A new plume capture system at the leading edge of the plume (assumed to be near cross-section C-C’, and ANY-SNR)

Alternative 2B – Description
(Adapted from Figure 2-5 from report)



Alternative 2B – Description
(Adapted from Figure 2-6 from report)

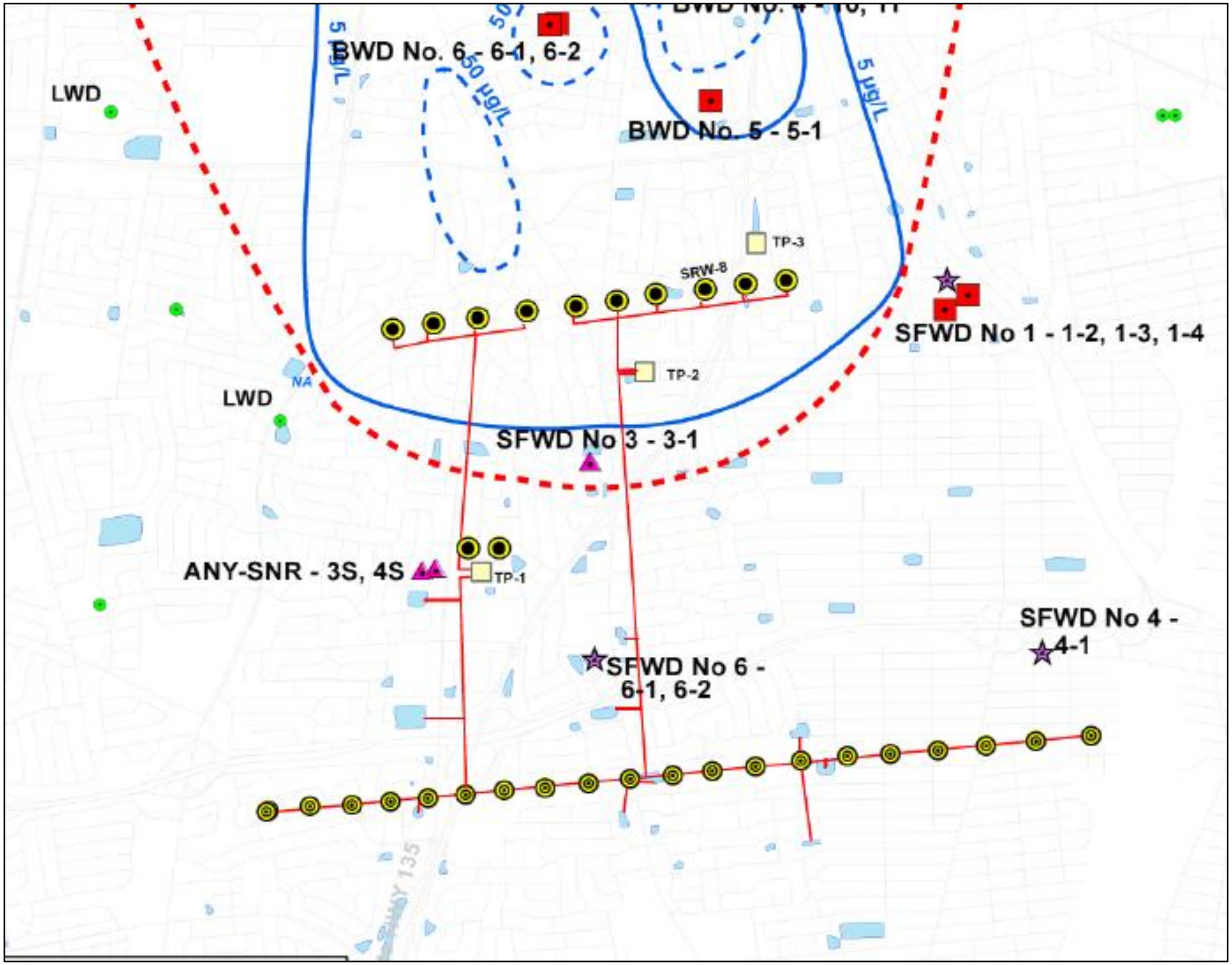


Alternative 2C – Description

- The measures in Alternative 1

- New hydraulic capture system at leading edge of plume (near cross-section C-C', near ANY-SNR)
  - –Hydraulic capture of all groundwater flowing between eastern and western boundaries of the plume

Alternative 2C – Description
(Adapted from Figure 2-11 in report)



Alternatives 2B and 2C Description
(Plume Containment and Hydraulic Containment)

- Aquifer depth, 50 feet bgs to 800 feet bgs. Based on vertical profile borings:
  - First 100 feet below water table (50-150 feet bgs) assumed to be Upper Glacial Formation, high-permeability sand and gravel (K= 250 feet/day)
  - Next 625 feet (150-775 feet bgs) assumed to be Magothy Aquifer (K = 50 feet/day)
  - Final 25 feet (775-800 feet bgs) assumed to be gravel layer identified in several borings near bottom of Magothy Aquifer (K = 200 feet/day)

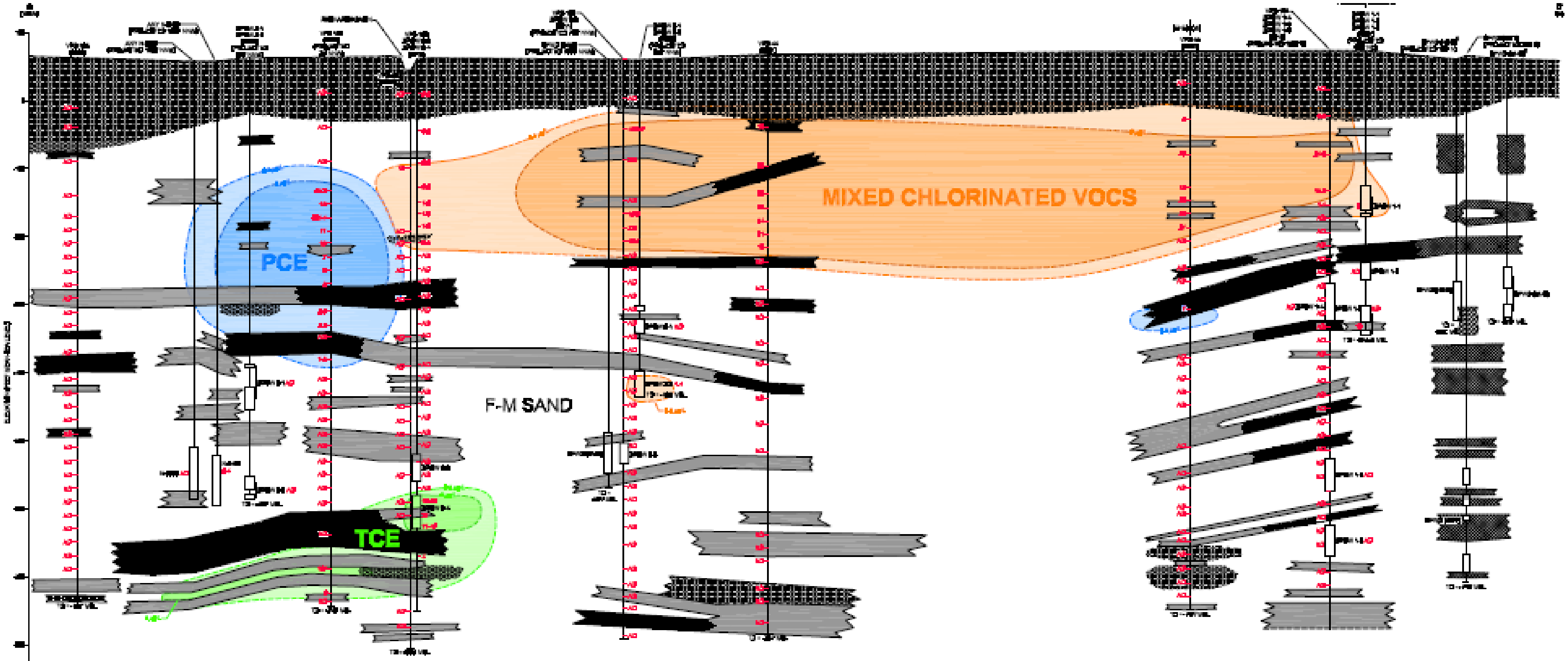
Alternative 2B Description
(Plume Containment)

- Total impacted groundwater capture would be 10,800 gpm
  - Nine shallow (400 feet bgs) extraction wells would extract 1,000 gpm each (total capture of 9,000 gpm)
  - Two deep (750 feet bgs) extraction on the west side (near ANY-SNR) and two deep extraction wells at some new location would extract 450 gpm each (1,800 gpm total deep capture)

- Driving factors for capture:
  - Large, dilute shallow plume finger
  - High groundwater flow through Upper Glacial Formation

Bethpage Plume - Cross-Section C-C’

(Adapted from Figure 1-9 in Report)



Alternative 2C Description (Hydraulic Containment)

- Plume width is estimated to be 9000 feet

- Total groundwater capture estimated to be 14,000 gpm
  - 10 shallow extraction wells would extract 1,000 gpm each (total of 10,000 gpm)
  - 10 deep extraction wells each pumping 400 gpm (total of 4,000 gpm)

- Estimate of precipitation and infiltration (~ 12,000 gpm) in the associated portion of the watershed provides a good cross-check of calculated groundwater capture requirement

Alternative 3 Description
-Accelerated Wellhead Treatment

- The measures in Alternative 1

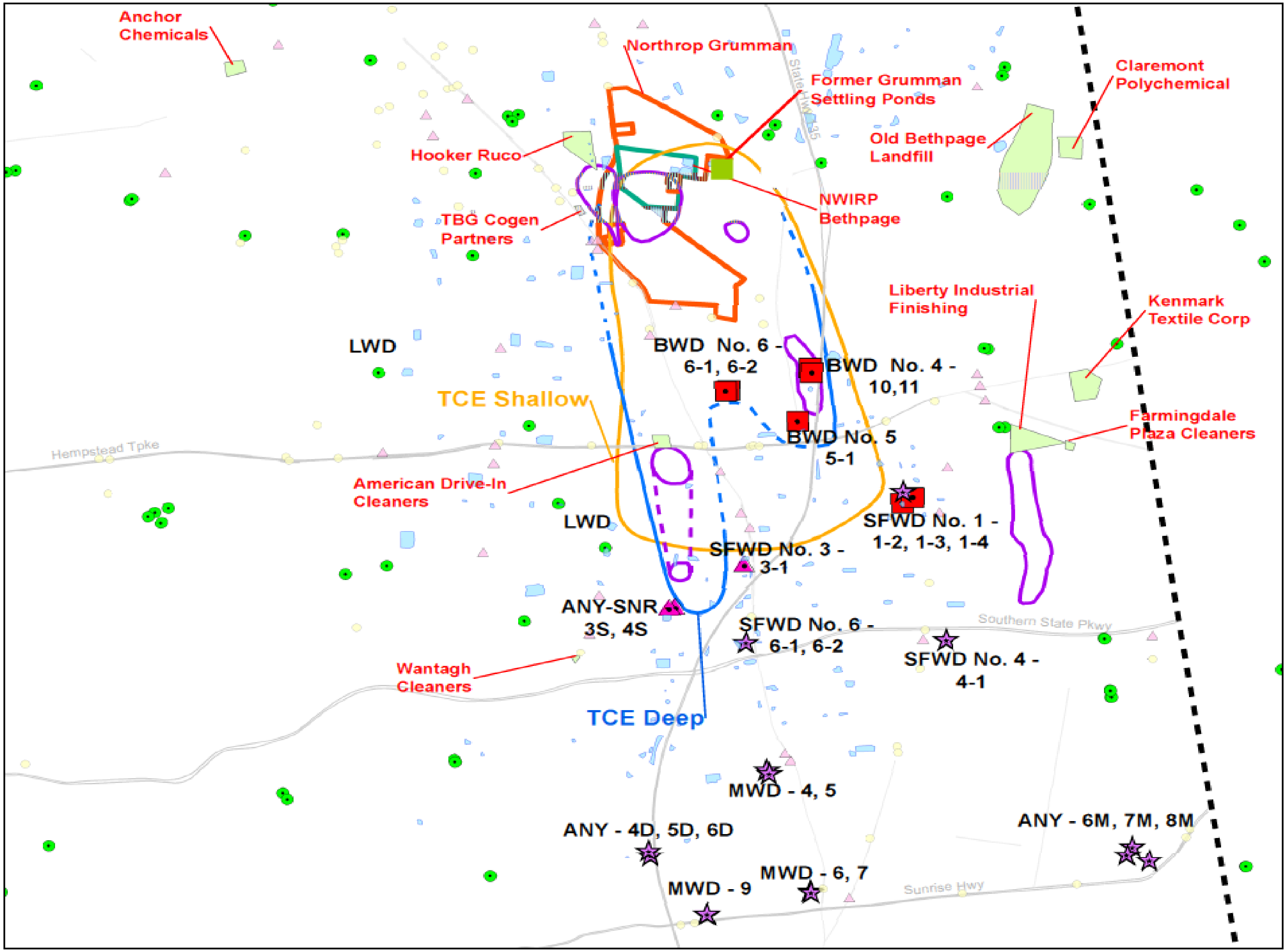
- Accelerated implementation of wellhead treatment in all downgradient supply wells
  - Wellhead treatment installed at 15 downgradient supply wells within next 10 years, regardless of degree of plume migration
  - Reduced off-site plume monitoring

Another Possible Option

- Alternative Water Supplies

- Develop alternative water supplies (outside plume footprint)
- Not apparent where alternative supplies could be located
- Potential VOC sources and other plumes evident at many locations in surrounding aquifer:
  - Liberty Industrial Finishing
  - Wantagh Cleaners
  - Old Bethpage Landfill
  - Other Superfund sites, dry cleaners, gas stations, industrial facilities

Developing Alternative Water Supplies in Surrounding Aquifer (Figure 1-10 in report)



Study of Alternatives for Bethpage Plume

- Alternative 1 – Current ROD

- Alternative 2A – Sustained pumping in strategic supply wells
- Alternative 2B – New plume containment system
- Alternative 2C – New hydraulic containment system

- Alternative 3 – Accelerated installation of wellhead treatment in downgradient supply wells

Evaluation of Alternatives

- Technical Feasibility
  - –Expected outcomes
  - –Advantages
  - –Disadvantages
  - –Experience at other similar sites with large and deep plumes in complex geology

Evaluation of Alternatives

- Cost Analysis
  - Reliable cost estimates from recent Navy expenditures on borings, wells, and wellhead treatment (e.g., GM-38, ANY-SNR)
  - Costs estimated a 50-year period as “Total Cost” and “Present Value” (PV) discounted at current OMB rate of 2.3%.
  - Both capital investment and O&M costs accounted

Evaluation of Alternatives

- Cost Analysis
  - –Containment alternatives assume capture of “plume” as defined by groundwater that exceeds MCLs and treated to the water districts’ stated goal of below detection (< 0.5 ppb)
  - –Costs incurred at the site in the past are not included in the estimates (consistent with need to support path forward decisions)
  - –Recurring costs associated with past actions not included (these costs are the same for all alternatives)

Evaluation of Alternatives
– Downgradient Wellhead Treatment Assumptions

Alternative	Wellhead Treatment at 4 Supply Wells Installed After (yrs)	Wellhead Treatment at 5 Supply Wells Installed After (yrs)	Wellhead Treatment at 6 Supply Wells Installed After (yrs)
1. Current ROD	10	15	25
2A. Sustained pumping in strategic supply wells	10	20	30
2B. Plume containment	10	20	30
2C. Hydraulic containment	15	25	35
3. Accelerated wellhead treatment in downgradient wells	5	7	10

Evaluation of Alternatives
– Total and Present Value Costs

Alternative	Total Cost (50 years)	Present Value (50 years)
1. Current ROD	$254,000,000	$151,000,000
2A. Sustained pumping in strategic supply wells	$229,000,000	$130,000,000
2B. Plume containment	$458,000,000	$296,000,000
2C. Hydraulic containment	$484,000,000	$309,000,000
3. Accelerated wellhead treatment in downgradient wells	$277,000,000	$177,000,000

Evaluation of Alternatives
–Capital and O&M Costs

Alternative	Total Cost (50 years)	Capital	O&M (50 years)
1. Current ROD	$254,000,000	$103,000,000	$151,000,000
2A. Sustained pumping in strategic supply wells	$229,000,000	$79,000,000	$150,000,000
2B. Plume containment	$458,000,000	$160,000,000	$298,000,000
2C. Hydraulic containment	$484,000,000	$167,000,000	$317,000,000
3. Accelerated wellhead treatment in downgradient wells	$277,000,000	$98,000,000	$179,000,000

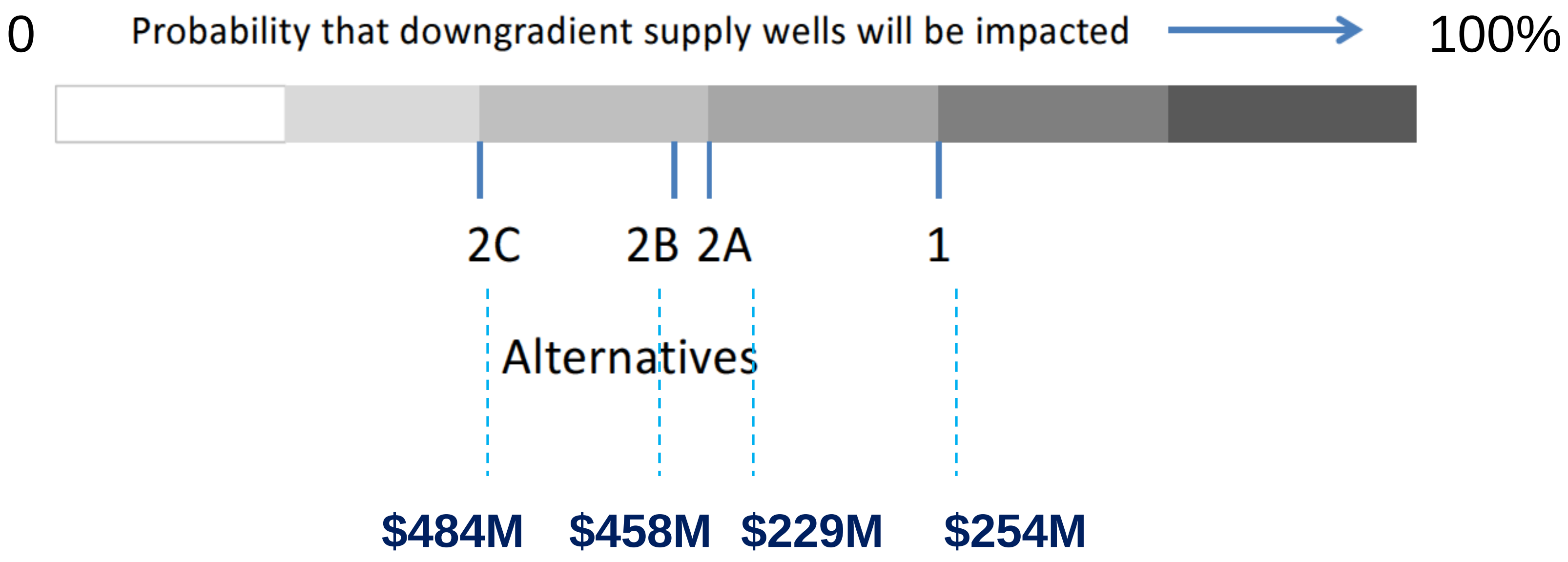
Technical Evaluation of Alternatives

- Protectiveness of alternatives in terms of probability of impacts to downgradient supply wells

- None of the alternatives reduce the probability of impacts to down gradient supply wells to zero. Therefore, wellhead treatment remains a component of all the alternatives.

- Alternative 1 already contains several plume containment mechanisms (probability of impacts to downgradient wells is not 100%)
  - On-site containment systems
  - Off-site hot-spot containment
  - Fortuitous capture in impacted supply wells

Technical Evaluation of Alternatives
– Probability of Impact to Downgradient Supply Wells



Evaluation of Alternatives
– Sensitivity of Total Cost Estimates to Supply Wells Impacted

Alternative	100% of Downgradient Supply Wells are Impacted	50% of Downgradient Supply Wells are Impacted	0% of Downgradient Supply Wells are Impacted
1. Current ROD	$254,000,000	$161,000,000	$67,000,000
2A. Sustained pumping in strategic supply wells	$229,000,000	$141,000,000	$78,000,000
2B. Plume containment	$458,000,000	$382,000,000	$306,000,000
2C. Hydraulic containment	$484,000,000	$416,000,000	$347,000,000

Technical Evaluation of Alternatives 1 and 2A

- Alternative 1 already incorporates several containment mechanisms.

- Alternative 2A would cost-effectively enhance Alternative 1 containment by leveraging investments that have already been made in impacted supply wells (e.g., BWD 6-2 and ANY-SNR under current RODs.

- Alternative 2A would enhance capture of deeper plumes. All (except one) downgradient water supply wells are screened in the deeper aquifer.

Technical Evaluation of Alternative 2B
- Plume Containment

- It is unclear whether or not Alternative 2B would provide substantially greater containment than Alternative 2A.
  - Additional characterization along the leading edge of the plume may be unable to identify all existing plume fingers
  - New plume fingers could develop over time and could be discovered only after they are well past the containment system
  - Alternative 2B costs substantially more than Alternatives 1 and 2A. Cost-benefit tradeoff between Alternative 2A and 2B unclear.

Technical Evaluation of Alternative 2C
- Hydraulic Containment

- Alternative 2C would probably provide more effective containment than Alternative 2B, with similar costs
  - Less reliance on limitations of plume characterization between eastern and western boundaries

Technical Evaluation of Alternative 2C

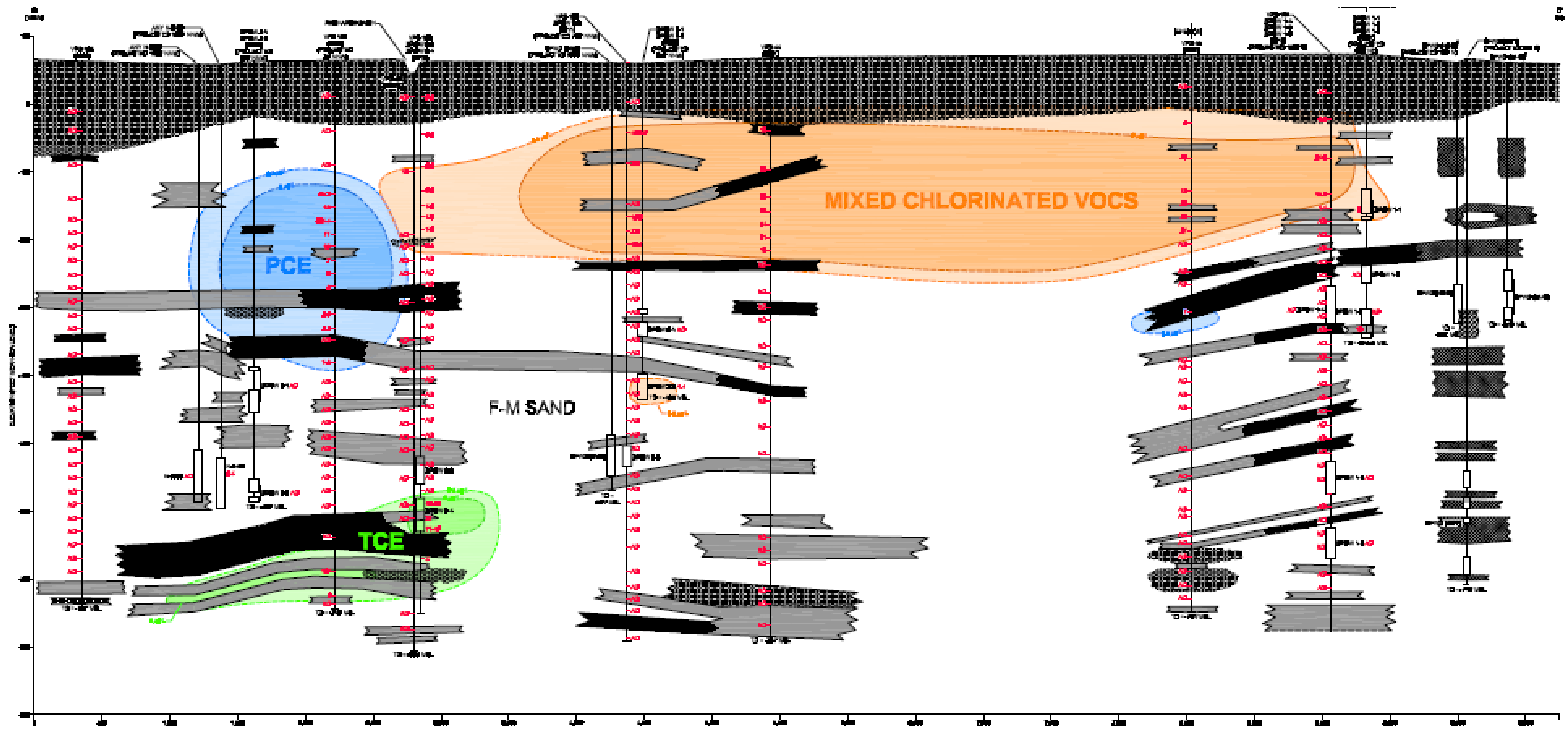
- Plume could still break through (or around) the containment, as it has at other sites (see site examples in report)
  - Heterogeneities, such as the intermittent clay layers could impact capture
  - Performance monitoring uncovers bypass only after it has happened
  - At several sites, initial hydraulic containment had to be supplemented several times to address plume bypass
  - Study targets plume defined by MCLs. If plume is defined by detection limit, considerable additional investment would be required both for capture and for treatment of <MCL portions of the plume. At such low levels there could be uncertainty regarding where the "Bethpage Plume" ends and other neighboring plumes begin.
  - Wellhead treatment in downgradient supply wells would perhaps be deferred, but not eliminated

Technical Evaluation of Alternatives 2B and 2C

- Majority of groundwater capture (and cost) would be directed towards **shallow** aquifer, whereas most downgradient supply wells are screened in **deeper** aquifer.
  - Spatially, the large shallow plume finger with relatively low VOC concentrations accounts for much of cross-section C-C'.
  - Most of the aquifer flow occurs through the shallow high-permeability sands and gravels of the Upper Glacial formation.

Bethpage Plume - Cross-Section CC'

(Figure 1-9 in Report)



Downgradient Supply Well Depths

- Adapted from Table 1-2 from report

Well ID	Well Depth (feet bgs)	Rated Well Capacity (gpm)	Status of VOC Treatment at Wellhead
ANY # 4D (5767)	385	1,935	No
ANY # 6M (7414)	530	1,667	No
ANY # 7M (8603)	893	1,607	No
ANY # 5D (8837)	680	1,154	No
ANY # 6D (9910)	780	1,667	No
ANY # 8M (10,863)	685	1,879	No
Well # 4 (MWD-6442	618	1,400	No
Well # 5 (MWD-6443)	825	1,400	No
Well # 6 (MWD-6866)	626	1,400	No
Well # 7 (MWD-6867)	492	1,400	No
Well # 9 (MWD-13,338)	645	1,400	No
Well # 1-4 (SFWD-7377)	758	1,400	No
Well # 4-1 (SFWD-6148)	566	1,200	No
Well # 6-1 (SFWD-8664)	610	1,400	No
Well # 6-2 (SFWD-8665)	560	1,400	No

Technical Evaluation of Alternatives 2B and 2C

- There could be sizeable local water table impacts
- At such high extraction rates, neighboring plumes could get pulled into the containment system in Alternatives 2B and 2C
- 5-year lead time likely from time of decision to operation
- Location of central treatment facilities unclear
- Alternatives 2B and 2C are much higher in cost than Alternatives 1 and 2A. Corresponding benefits in terms of significantly reducing or eliminating impacts to downgradient supply wells are unclear

Technical Evaluation of Alternatives 2B and 2C
- Experience at Other Similar Sites

- Section 3.2 of the report describes the experiences at several Superfund sites with sufficient history of dealing with deeper plumes (EPA 5-Year Review Reports are a good source).

- None of these sites are as deep as Bethpage

- At many sites, the initial hydraulic containment system deployed had to be supplemented several times with more wells and treatment plants, as plume breakthrough and bypass became evident

Experience at Other Similar Sites
(with large, deep plume in complex geology)

- At all these sites the capture goal and treatment goal were MCLs.
  - At least one site explored the possibility of capturing and treating the plume down to 0.8 ppb, but abandoned it due to difficulties in tracking the plume at such low levels in complex geology, cost of more extraction wells and associated infrastructure, difficulty in obtaining required easements, etc.

- At several of the sites, supply wells were used for the dual purpose of containing the plume and providing water supply. At some sites, capture in supply wells (and monitoring) was the only remedy for the off-site portion of the plume.

Summary

- Based on this study, Alternative 1 (current OU-2 ROD) remains protective through a combination of:
  - –On-site containment
  - –Hot-spot treatment
  - –Fortuitous capture in impacted supply wells
  - –Wellhead treatment.

- Alternative 2A (sustained capture in strategic supply wells) has the potential to enhance the protective measures in the ROD by capturing deeper portions of the plume at strategic locations. It would do so in a cost-effective manner, leveraging investments that have already been made.

- Alternatives 1 and 2A are consistent with the approach followed by other similar sites with large and deep plumes in complex geology

Questions

- Questions