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Remedial Investigation Report (Study Area Groundwater)

Operable Unit 3 (Former Grumman Settling Ponds),

Bethpage, New York

Revised: February 7, 2011

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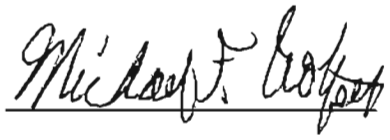
Certification

Pursuant to Section II.D.1 of the Order On Consent (Index #W1-0018-04-01) between the New York State Department of Environmental Conservation and Northrop Grumman Systems Corporation, Integrated Systems Sector, all requirements of the Remedial Investigation/Feasibility Study Work Plan, Former Grumman Settling Ponds (Operable Unit 3 – Bethpage Community Park), Bethpage, New York, NYSDEC Site # 1-30-003A, Revised: March 8, 2006 (including all addenda) have been complied with and all activities have been performed in full accordance with the Work Plan.

By:



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E-1 Executive Summary

This RI Report addresses the "Study Area", which is defined as VOC-impacted groundwater south/southeast of the Site Area, plus the peripheral area. This report was prepared to achieve the following Study Area objectives: characterize the geology and hydrogeology; determine the nature and extent of groundwater contamination; update the groundwater portion of the CSM; determine if any additional investigation is warranted to meet RI objectives; and evaluate the need for an IRM(s).

The RI consisted of drilling and sampling of VPBs, installation of monitoring wells, water-level measurements, and groundwater sampling. A total of 20 VPBs were drilled and sampled in the Study Area, with depths ranging from 120 to 890 ft bls. VPB groundwater samples were analyzed for VOCs and selected samples for perchlorate. A total of 15 monitoring wells were installed. Water levels were measured and groundwater samples were collected from new and selected existing wells.

Geology consists primarily of sand with interbedded lenses of silts, clays, and gravels. The direction of groundwater flow is horizontally to the south-southeast and vertically, slightly downward and consistent with the regional flow direction. Remedial well and supply well pumping locally influences groundwater flow. Groundwater velocity in the Study Area ranges from approximately 0.85 to 2.56 ft/day. The Study Area is a part of the larger region of VOC-impacted groundwater. BWD operates three public supply well fields (Plants 4, 5, and 6) that lie within the Study Area. VOCs have been detected in untreated water in several BWD wells; however, Plants 4, 5, and 6 have treatment systems to meet BWD's goal of no detectable VOCs in the delivered water.

The regional downward flow has been accentuated by industrial pumping and recharge on the former Grumman, NWIRP, and OCC properties, and public supply well pumpage. As a result, regional VOC-impacted groundwater descends in the aquifer as it migrates south-southeast. VOCs in groundwater beneath and downgradient of the above properties were influenced by groundwater withdrawals for industrial use and recharge (through recharge basins) from the above properties, with the result being a mixed-source region of VOC-impacted groundwater. The constituents in the region of VOC-impacted groundwater include TCE; PCE; 1,1,1-TCA; 1,2-DCE (cis/trans); 1,2-DCA; Freon 113; 1,1-DCE; and 1,1-DCA, and VC. The maximum extent of the regional area of VOC-impacted groundwater is approximately 3.5 miles in length by 1.6 miles in width, with a maximum depth of 790 ft bls and a maximum thickness of 430 ft.

VOCs were determined to be the COCs in Study Area groundwater. The Study Area VOC-impacted groundwater is part of and comprises approximately 11 percent of the region of VOC-impacted groundwater previously identified. The maximum extent of VOC-impacted groundwater identified in the RI is approximately 8,300 ft in length and 2,100 ft in width, with a maximum depth of 670 ft bls and a maximum thickness of 430 ft. The highest total VOC levels are predominantly located in the Study Area and north of Northrop Grumman Remedial Wells 1 and 3. The highest total VOC levels observed in the Study Area were at depths ranging from approximately 75 ft bls (northern portion) to 590 ft bls (southern portion VP-111 exhibited the maximum level of total VOCs (10,500 µg/L at a depth of 451 ft bls). The highest total VOC levels observed outside the Study Area were around Northrop Grumman Remedial Wells 1 and 3, which are screened at depths of approximately 480 to 570 ft bls. The composition of the Study Area VOC impacted groundwater changes with distance downgradient from the Site. The leading edge of the impacted groundwater (oldest portion) consists predominantly of TCE, the intermediate section consists of TCE and cis- 1,2- DCE in relatively equal proportions, and the portion nearest the Site (youngest portion) consists predominantly of cis- 1,2- DCE. The distribution and levels of chromium and perchlorate in the Study Area indicate that these constituents are not Site-related.

A conceptual site model for groundwater was developed and is summarized as follows:

- VOCs from Site Area source areas and industrial releases to properties west and adjacent to the Site resulted in VOC impacts to groundwater.
- Historical pumping and recharge on the former Grumman, NWIRP, and OCC properties caused mixing of VOCs and accentuated downward movement of VOC-impacted groundwater, resulting in impacts at depths greater than 500 ft bls. The VOC-impacted groundwater that migrated south of the above properties and the Site was further influenced by the pumping of public supply wells.
- Several downgradient public supply wells are presently affected by VOC-impacted groundwater.
- Current wellhead treatment of public supply wells for VOCs results in no human exposure to VOCs in groundwater above applicable drinking water standards.

A recommendation for additional action includes preparing a focused FS to address VOCs in Study Area groundwater.

Acronyms and Abbreviations

Access Road	Former Grumman Plant 24 Access Road
AOC	Administrative Order on Consent
ARCADIS	ARCADIS U.S. Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
bls	below land surface
BTEX	benzene, toluene, ethyl benzene, and xylene
BWD	Bethpage Water District
Cd	cadmium
CAMP	Community Air Monitoring Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cr	Chromium
COC	Constituent of Concern
CSM	Conceptual Site Model
DCA	Dichloroethane
DCE	Dichloroethene
DUSR	Data Usability Summary Report
EVS	Environmental Visualization System
Freon 22	Chlorodifluoromethane
Freon 12	Dichlorodifluoromethane
FS	Feasibility Study
ft	feet

ft/d	feet per day
Grumman	Grumman Aerospace Corporation
HASP	Health and Safety Plan
IDW	investigation derived waste
IRM	Interim Remedial Measure
K_H	horizontal hydraulic conductivity
K_{oc}	organic carbon partitioning coefficient
K_{ow}	octanol-water partitioning coefficient
mg/L	milligrams per liter
msl	mean sea level
NAD	North American Datum
Navy	United States Navy
NCDOH	Nassau County Department of Health
NCDPW	Nassau County Department of Public Works
Northrop Grumman	Northrop Grumman Systems Corporation
NWIRP	Naval Weapons Industrial Reserve Plant
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
OCC	Occidental Chemical Corporation

OM&M	Operation, Maintenance, and Monitoring
OU	Operable Unit
Park	Bethpage Community Park
PCE	Tetrachloroethene (aka Perchloroethene)
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QA/QC	Quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SCGs	Standards, Criteria and Guidance Values
Site	Bethpage Community Park and Former Grumman Plant 24 Access Road
Site Area	Bethpage Community Park and Former Grumman Plant 24 Access Road, plus rights of way along portions of Stewart Avenue and Sycamore Avenues that abut the Site to the east and south, respectively.
TAGM	Technical and Administrative Guidance Memorandum
TCA	Trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TICs	Tentatively Identified Compounds
TOGs	Technical and Operational Guidance Series
Town	Town of Oyster Bay
USGS	United States Geological Survey
µg/L	micrograms per liter

USEPA	United States Environmental Protection Agency
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
VPB	Vertical Profile Boring

1. Introduction

This Remedial Investigation (RI) Report (RI Report) (Study Area Groundwater) has been prepared by ARCADIS U.S., Inc. (ARCADIS) on behalf of Northrop Grumman Systems Corporation (Northrop Grumman), and is submitted pursuant to the Administrative Order on Consent (AOC) between the New York State Department of Environmental Conservation (NYSDEC) and Northrop Grumman, effective July 4, 2005 (NYSDEC 2005a).

The "Site" is defined as the Bethpage Community Park (Park), termed the "Former Grumman Settling Ponds Area" and designated as Operable Unit 3 (OU3) by the NYSDEC, and the Former Grumman Plant 24 Access Road Property (Access Road). The "Site Area" is defined as the Site, plus the residential properties on the north side of Sycamore Avenue. Generally, the "Study Area" is defined as volatile organic compound (VOC)-impacted groundwater hydraulically downgradient (i.e., south and southeast) of the Site Area, plus the peripheral area that was used to delineate the impacted groundwater (Figure 1).

On February 1, 2008, the Site Area RI Report was submitted to the NYSDEC. The Site Area RI Report characterized soil, soil gas, perched water, and groundwater in the Site Area. For the reasons stated in Section 1.3.1 of this report, groundwater is the sole medium investigated during the Study Area RI.

As agreed to by the NYSDEC, this report is the second of two documents that collectively form the RI Report for OU3.

1.1 Objectives of Report

The purpose of this RI Report is to discuss groundwater impacts in the Study Area. Accordingly, this report was prepared to achieve the following objectives:

- Characterize the geology and hydrogeology in the Study Area.
- Determine the nature and extent of groundwater contamination in the Study Area.
- Update the portion of the Conceptual Site Model for Study Area groundwater.
- Determine if any additional investigation is warranted to meet the RI objectives.

- Evaluate the need for an Interim Remedial Measure (IRM).

1.2 Site History

The Site history is provided in the Site Area RI Report (ARCADIS 2008a; 2009a).

1.3 Previous/Other Investigations

1.3.1 Soil Gas

Investigation into the nature and extent of Site-related impacts to soil gas as well as potential vapor intrusion (VI) were completed as part of the OU3 Site Area RI. Samples were collected from soil gas points, subslab soil gas, indoor and outdoor air. The analytical results are documented in the Site Area RI Report (ARCADIS 2008a), and indicate that soil gas impacts were limited to the Site Area and do not extend into the Study Area. Additionally, based on soil gas data from the Site Area, it was determined that a Soil Gas IRM was necessary. The Soil Gas IRM was constructed on the Site and started up on February 18, 2008. Routine performance monitoring has indicated that the IRM effectively prevents off-site migration of VOCs in soil gas and that additional off-site soil gas investigation is not required (NYSDOH 2008).

1.3.2 Groundwater

The Study Area is part of the larger region of VOC-impacted groundwater, located downgradient of the former Grumman, Naval Weapons Industrial Reserve Plant (NWIRP), and Occidental Chemical Corporation (OCC) properties. The regional groundwater impacts have been previously investigated and documented by the U.S. Geological Survey (USGS), and subsequently investigated and remediated by Northrop Grumman, the US Navy, and OCC (Figure 1). Based on the findings of Northrop Grumman and the Navy, the plan for remediation for the regional VOC-impacted groundwater was developed and implemented with approval from the NYSDEC. The Operable Unit 2 (OU2) Record of Decision (ROD)-required components of the regional VOC-impacted groundwater remedy include:

- On-site containment (via pump and treat) of VOC-impacted groundwater attributable to the former Grumman Aerospace Corporation (Grumman) and Naval Weapons Industrial Reserve Plant (NWIRP) properties.

- VOC mass removal from groundwater (via pump and treat) in an area of elevated VOC concentrations in the GM-38 Area (near Wells GM-38D/D2 – See Figure 1).

- Further study of elevated VOC concentrations in the GM-75D2 area (see Figure 1).

- Implementation of a public water supply protection program consisting of installing and monitoring outpost wells and providing funding for potentially affected downgradient water suppliers.

- Ongoing groundwater monitoring and reporting.

The USGS performed investigations into former industrial areas throughout the Bethpage, Hicksville, Levittown, Plainview, Plainedge, and Farmingdale region in 1986 and 1987. The USGS area of investigation encompassed approximately 11.4 square miles, which includes the Study Area. Analytical results indicated widespread regional groundwater impacts from VOCs (primarily trichloroethene [TCE]; tetrachloroethene [PCE]; 1,1,1-trichloroethane [1,1,1-TCA]; cis- and trans-1,2-dichloroethene [1,2 DCE]; 1,1-dichloroethane [1,1-DCA], and vinyl chloride [VC]). The USGS concluded that the distribution of VOCs detected was greatly influenced by withdrawals for industrial non-contact cooling water purposes. Also, subsequent routing of pumped water into recharge basins altered the natural hydraulic gradients and increased the vertical component of groundwater flow within this industrialized area, resulting in an area of contaminated groundwater greater than 500 ft thick(USGS 1992).

Northrop Grumman performed several groundwater investigation activities on and in the area south and southeast of the Grumman facility from 1989 through 1995. VOCs attributed to the Grumman facility primarily include TCE and Freon 113. The investigations generally consisted of drilling and sampling of monitoring wells to characterize and delineate site-related VOC impacts in groundwater. In general, four areas of contamination (i.e., western, central, and northwestern portions of the main facility, and off-site) were detected, which collectively contributed to a regional area of VOC-impacted groundwater. Consistent with the USGS' findings, the main mechanism for the distribution of VOCs within the aquifer was on-site deep pumpage and shallow recharge of non-contact cooling water. Although not fully delineated, it was concluded in the RI Report for the main facility that sources of VOCs likely originated from one or more sources on the NWIRP, OCC, and Grumman properties (Geraghty & Miller 1994). Additionally, ongoing groundwater monitoring has been performed by Northrop Grumman since 1997 in varying subsets of wells in the area.

The Navy performed groundwater investigation activities on and in the area south, southeast, and southwest of their NWIRP Bethpage facility between 1986 and 2009. VOCs attributed to the NWIRP site include TCE; PCE;1,1,1-TCA; 1,2 DCE; 1,1-dichlorethene (1,1-DCE), and 1,1-DCA. VOC sources identified on the NWIRP Bethpage facility included Site 1 (Former Drum Marshalling Area, located east of Former Plant 3), Site 2 (Recharge Basin Area, located immediately west of the Park), Well HN-24 Area (located immediately southwest of Former Plant 3), and Site 3 (Former Salvage Storage Area, located north of Former Plant 3 and west of the recharge basins) (Halliburton NUS 1993).

OCC performed groundwater investigation activities since the late 1980s for VOCs on and downgradient of their former Hicksville property (i.e., the Oxy Hooker RUCO National Priorities List [NPL] site), located immediately west of the former Grumman facility. VOCs attributed to the OCC site included TCE; PCE; VC; 1,1,1-TCA; 1,2 DCE, 1,1-DCE; 1,2 DCA; 1,1-DCA andseveral tentatively identified compounds (TICs) (Geraghty & Miller 1994). VOC sources on the OCC site included the discharge of process water to on-site recharge basins, located in the southern portion of the OCC property. Pumpage on the Grumman and NWIRP properties caused impacted water beneath the OCC property to migrate beneath the Grumman/NWIRP properties (Conestoga Rovers Associates, Inc. 1996).

The nature and extent of impacted groundwater in the Study Area is discussed in Section 5 of this report.

1.4 Interim Remedial Measures in Place

On the Northrop Grumman property, a groundwater remedy has been in place since 1998 to contain and treat on-site VOC-impacted groundwater associated with the former Grumman and NWIRP properties. OCC relies, in part, on this system to capture VOC-impacted groundwater associated with their former Hicksville property. Formerly an IRM, the remedy consists of five remedial wells (Wells, 1, 3, 17, 18, and 19 that pump nearly 5.5 million gallons per day), two air stripping towers, off-gas vapor treatment, and two sets of recharge basins on Northrop Grumman property. The Northrop Grumman/NWIRP IRM, with the approval of NYSDEC, became part of the final OU2 ROD-required remedy (as describe in Section 1.3.2) for regional VOC-impacted groundwater in 2001.

As part of the OU3 Site Area RI, Northrop Grumman performed an evaluation of the need for IRMs. Based on this evaluation Northrop Grumman implemented two IRMs

one for soil gas (see Section 1.3.1), the second for groundwater. Based on data in the Site Area, it was determined that a groundwater IRM was necessary. The groundwater IRM was started up on July 21, 2009, and is meeting its design goal of containing on-Site VOC-impacted groundwater. Details on the scope and purpose of the IRMs are provided in the associated design reports (ARCADIS 2007a; 2008b).

2. Physical Setting

2.1 Surface Features and Land Use

The Study Area land surface elevation ranges from approximately 120 feet above mean sea level (ft msl) to 85 ft msl and, topographically, is generally flat. Land usage is primarily residential with some commercial and industrial development; surface features are shown on Figure 1.

2.2 Surface Water Hydrology and Drainage

Natural surface water features do not exist in the Study Area, although man-made stormwater recharge basins are present, which receive runoff from paved surfaces and recharge the groundwater system (Figure 1).

2.3 Regional Hydrogeology

In general, regional geology, from land surface downward to the basal Magothy Formation, consists primarily of sand with interbedded lenses of silts, clays, and gravels. The uppermost sequence of these sediments is part of the Upper Glacial Pleistocene-age outwash deposits, while the lower geologic sequence comprises the Cretaceous-age Magothy Formation. The Upper Glacial deposits in this area of Long Island tend to be coarser than the underlying upper portion of the Magothy Formation, whose the deposits tend to become finer with depth, except for the basal Magothy, where sand and gravel deposits are more prevalent. The saturated Upper Glacial deposits tend to thin toward the north and are relatively thin beneath the Study Area. Regional geologic cross sections indicate a high degree of stratification of these deposits with stratification increasing with depth in the Magothy Formation (ARCADIS Geraghty & Miller, Inc., 2000).

The principal aquifers are the Upper Glacial and the Magothy, which are in direct hydraulic connection with each other. Groundwater in the Upper Glacial and Magothy aquifers occurs under unconfined conditions, with the Magothy aquifer exhibiting semi-

confined to confined conditions with increasing depth. The average horizontal hydraulic conductivity of the Upper Glacial aquifer is approximately 270 feet per day (ft/d); with an anisotropy of approximately 10:1 (horizontal to vertical hydraulic conductivity, respectively). The average horizontal hydraulic conductivity of the Magothy aquifer is approximately 50 ft/d, with an anisotropy ratio of approximately 100:1. The regional direction of groundwater flow is to the south-southeast (Geraghty & Miller, Inc. 1994).

3. Remedial Investigation Activities

Study Area RI activities were conducted in accordance with the approved RI/FS Work Plan and approved addenda (ARCADIS 2006; ARCADIS 2007b; ARCADIS 2007c; ARCADIS 2008c; ARCADIS 2008d; ARCADIS 2009b) (hereinafter referred to as the Work Plan) that are provided in Appendix K. The scope of work is summarized in Table 1 and sample locations are shown on Figure 1. The Work Plan provided for a dynamic investigation approach consisting of systematic planning, dynamic work strategies, and rapid data turnaround in which modifications to the work scope (e.g., sampling depths, number of samples) could be implemented in real time, based on observed field conditions.

The groundwater investigation consisted of drilling and sampling of vertical profile borings (VPBs) and monitoring wells to evaluate the nature and extent of groundwater contamination in the Study Area. As the work progressed, data gaps were identified and additional work was proposed. Monitoring wells were installed to confirm VPB results in selected areas and to allow for future periodic groundwater monitoring.

3.1 Vertical Profile Borings

From June 2006 to July 2009, a total of 20 VPBs (VP-100 to VP-119) were drilled and sampled in the Study Area (Figure 1). Information obtained included lithology, geophysical data, and profiles of groundwater quality. Split-spoon soil sampling and geophysical logging of the VPB boreholes was performed to obtain hydrogeologic information, support selection of groundwater sample intervals, determine the need for monitoring wells, select monitoring well screen intervals, and determine Study Area hydrogeology.

VPB total drilled depths ranged from 120 to 890 ft bls. Depending on the anticipated depth, VPBs were drilled/groundwater was sampled using either the hollow-stem auger/temporary well (shallower VPBs) or the mud rotary/hydropunch method (deeper

VPBs) (refer to the Work Plan for details). Groundwater samples collected from VPBs were submitted for laboratory analysis of the Target Compound List (TCL) VOCs, plus Freons 12, 22, and 113. Select VPB groundwater samples were also analyzed for perchlorate. Depending on the results, either a permanent monitoring well was installed or the VPB was abandoned. VPB and well locations are shown on Figure 1. Split-spoon sample logs, geophysical logs, and VPB sampling logs are provided in Appendices A, B, and C, respectively.

3.2 Monitoring Well Installation

From March 2007 to May 2009, 15 monitoring wells were installed in the Study Area (Figure 1). Depths of the wells range from 55 to 750 ft bls. For each well location, the associated VPB water quality data and geophysical logs were reviewed to select a screen interval that would intersect permeable aquifer materials. Well screens generally were placed either in the zone with the highest observed VOC concentrations, or as guided by groundwater modeling.

Following completion, the wells were surveyed to the 1983 North American Datum (NAD 83) by a NYS-licensed surveyor.

Well construction details and survey data are summarized in Tables 2 and 3, respectively. Well locations are shown on Figure 1. Monitoring well construction logs/well development logs are provided in Appendix D.

3.3 Monitoring Well Sampling/Water-Level Measurements

Two rounds of water-level measurements were collected in July and September 2009 (Table 3).

Groundwater samples were obtained from new and select existing Study Area wells in July 2009 and were analyzed for TCL VOCs (plus Freons, 12, 22, and 113) and total/dissolved cadmium (Cd) and chromium (Cr). Additional rounds of samples were also collected from select wells for TCL VOC (plus Freons, 12, 22, and 113) analysis to develop data trends. In accordance with the Work Plan, a second round of groundwater sampling is planned for the Fourth Quarter of 2009; these data are included in the Supplement to the Remedial Investigation Report (Study Area Groundwater), which was submitted to the NYSDEC in March 2010 and is included herein as Appendix L.

Groundwater sampling logs are provided in Appendix C.

3.4 Community Air Monitoring Program

Real-time community air monitoring was performed and recorded for field activities in the Study Area. The CAMP data indicated no exceedances of CAMP action levels. The Community Air Monitoring results are provided in Appendix E.

3.5 Investigation-Derived Waste Disposal

Investigation-derived waste (IDW) consisting of personal protective equipment (PPE) as well as soil cuttings generated during the drilling program was containerized in New York State Department of Transportation (NYSDOT) 55-gallon drums, characterized as appropriate, and transported for off-site disposal. Based on analytical results obtained, IDW was disposed of as non-hazardous.

Waters generated from the drilling and sampling activities were containerized in NYSDOT 55-gallon drums and characterized prior to disposal. Based on waste characterization results, water was either discharged to the publicly-owned treatment works (POTW) intake at the Northrop Grumman property (in accordance with existing approvals granted by the Nassau County Department of Public Works) or disposed of at Ross Incineration Services, of Grafton, OH under Northrop Grumman's United States Environmental Protection Agency (USEPA) ID#NYR000058347. IDW records are provided in Appendix F.

4. Study Area Hydrogeology

4.1 Lithology

Figure 2 depicts Geologic Cross Section A-A' through the Study Area (line of section is shown on Figure 1). The cross section was developed using data from VPBs and wells installed by Northrop Grumman and others.

Split-spoon soil samples and geophysical logs obtained from VPB and monitoring well boreholes and other historical data were collectively utilized to characterize lithology. Based on these data, from land surface downward, the geologic sequence is as follows:

- Pleistocene-age (Upper Glacial) sands of varying grain size with silt, clay and gravel lenses in the unsaturated and saturated zones

- Cretaceous-age (Magothy) interbedded fine to coarse sands and silts with discontinuous zones of lower permeability clays, sandy clays, and silty clays to a depth of approximately 820 ft bls.

- The basal Magothy gravel zone was encountered in VP-104 from 820 to 880 ft bls.

- Cretaceous age clay (Raritan Confining Unit) (dense, colored gray with red mottling) was encountered at 672 ft bls during the drilling program in VP-110R (Figure 1). Although it has been documented in the literature that regionally this unit underlies the Magothy formation and varies in depth, except for at VP-110R, all VPBs drilled deep enough to reach this unit did not encounter it.

4.2 Groundwater Use

The Bethpage Water District (BWD) operates five public supply wells in three wellfields (Plants 4, 5, and 6) (Figure 1). It is believed that all residents in the Study Area receive water supply from BWD. BWD Plants 4, 5, and 6 are equipped with treatment systems to remove VOCs.

4.3 Groundwater Flow, Hydraulic Gradients and Groundwater Velocity

Based on water levels measured in 2009, groundwater elevations in the Study Area range from approximately 51 to 74 ft above mean sea level (msl) (Table 3).

The potentiometric surface and groundwater flow directions from the July 2009 round are shown on Figure 4. Water-level elevation data indicate a resultant direction of groundwater flow that is horizontally to the south-southeast and vertically, slightly downward and overall generally consistent with the regional flow direction. The steepening hydraulic gradient and resulting increase in average groundwater flow velocity indicate the effect of well pumpage on groundwater flow within the Study Area (Figure 1).

The horizontal hydraulic gradient generally north of Central Avenue (i.e., northern portion of the Study area, distant from pumping wells) was calculated to be approximately 0.0017 ft/ft. Using the established horizontal hydraulic conductivity (K_H) value for the upper Magothy of 50 ft/day (USGS 1988)and an effective porosity value of 0.1(ARCADIS G&M, Inc. 2003) that was utilized in the NYSDEC-accepted regional model, the average horizontal groundwater velocity in this area was calculated to be approximately 0.85 ft/day.

The horizontal hydraulic gradient generally south of Central Avenue (southern portion of the Study area, closer to pumping wells) was calculated to be approximately 0.0032 ft/ft. Using the established K_H value for the middle Magothy of 80 ft/day (USGS 1988) and an effective porosity value of 0.1(ARCADIS G&M, Inc. 2003), the average horizontal groundwater velocity in this area was calculated to be 2.56 ft/day.

4.4 Historical Pumpage and Recharge

As documented by the USGS (1992), a natural vertical head difference of approximately 2 to 4 ft between the water table and the basal portion of the Magothy aquifer causes a downward component of groundwater flow. This regional downward flow has, over the years, been accentuated by industrial pumping and recharge on the former Grumman, NWIRP, and OCC properties, as well as public supply well pumpage throughout the area. As a result of this downward flow component, regional VOC-impacted groundwater descends in the aquifer as it migrates downgradient (south-southeast).

As described by the USGS (1992) and Geraghty & Miller, Inc. (1994), the distribution of VOCs in groundwater beneath and downgradient of the former Grumman, NWIRP and OCC properties was greatly influenced by the concentrated on-site withdrawals (for industrial non-contact cooling water purposes; 14 industrial wells pumping 11 million gallons per day peak) and recharge (via four sets of recharge basins). Specifically, this pumpage and recharge altered the natural hydraulic gradients and increased the horizontal and vertical components of groundwater flow. The effect of this pumpage/recharge was twofold: Near the basins, mounding of the water table created radial horizontal flow and accentuated downward groundwater movement. In relation to the Study Area, historical data (Geraghty & Miller, Inc. 1994) and Navy modeling (Halliburton NUS 1993) indicate that mounding of the water table beneath the former NWIRP Plant 3 basins resulted in an easterly component of flow underneath the Park. South of the Park, the eastern flow component was re-directed to the south-southeast, consistent with the regional flow direction. Second, deep production well pumpage pulled contaminated groundwater locally to depths that it would not naturally occur. The combined result was a mixed-source region of contaminated groundwater.

5. Nature and Extent of Constituents in Groundwater

5.1 Standards, Criteria, and Guidance Values

Standards, Criteria, and Guidance Values (SCGs) have been identified for the Study Area that pertain to meeting applicable regulations and RI objectives.

The groundwater SCGs for VOCs and metals utilized in this report, consist of the New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, as provided by the Division of Water Technical and Operational Guidance Series (TOGs 1.1.1) and addenda (NYSDEC 1998) (SCGs are provided in Tables 4, to 7). The guidance value for perchlorate utilized in this report is that which has been adopted by Nassau County for water purveyors (see Table 8).

5.2 Data Analysis Methods and Usability Assessment

Analytical data collected as part of the Study Area RI are summarized in Tables 4 to 9. Data were validated following RI/FS Work Plan protocols. Specifically, the Data Validation Checklist associated with sampling conducted for the Study Area RI was reviewed for thoroughness and accuracy. The analytical data underwent an independent review process following NYSDEC data usability summary report (DUSR) guidelines. Analytical methods utilized followed acceptable NYSDEC or USEPA methods, as specified in the RI/FS Work Plan. The DUSRs are provided in Appendix H. NYSDEC Category A and B laboratory data package deliverables are provided as Appendix I. It is the opinion of the data reviewers that the analytical data generated from samples collected and analyzed as part the Study Area RI Report underwent a thorough data review process in accordance with Quality Assurance Project Plan (QAPP) requirements. Based on the data validation, the data are considered acceptable for the intended purpose.

The Study Area RI data were supplemented, as appropriate, by data collected by Northrop Grumman and others as part of ongoing investigations/monitoring in the region. The data were obtained from final Department and agency approved reports. ARCADIS also independently reviewed the data for its suitability in determining the nature and extent of constituents in groundwater.

As part of the data usability analysis, the VOC analytical results from monitoring wells were compared to co-located VPB VOC analytical results. Based on this analysis, there was a good agreement between VPB data and monitoring well data (Table 6).

Therefore, the VPB data were considered to be representative of groundwater conditions and were used throughout this report.

5.3 Nature and Extent of Constituents in Groundwater

Analytical results of groundwater samples are provided in Tables 4 to 10 and are depicted on Figures 4 to 7; graphs showing VOC detections versus depth in VPBs are provided in Appendix G. In general, the data obtained from water quality sampling of groundwater from VPBs and monitoring wells have met the RI goal of determining the nature and extent of COCs in groundwater in the Study Area.

Where total VOC concentration contours are depicted on Figures 4 and 5, the krieging function of Environmental Visualization Software (EVS) was used initially to develop the contours. The contours were then reviewed and modified using professional judgment.

5.3.1 Volatile Organic Compounds

The areal extent of VOC-impacted groundwater in the Study Area represents about 11 percent (approximately 0.44 square miles) of the total areal extent of the regional VOC impacted groundwater (approximately 3.9 square miles). Section 1.3.2 also described investigations of VOC-impacted groundwater in the region associated with the former Grumman, NWIRP, and OCC properties.

Regionally, VOC-impacted groundwater has been documented (see Section 1.3.2 of this report) to underlie and extend downgradient (generally south) of the former Grumman, NWIRP, and OCC properties, and the Site. The maximum horizontal extent (irrespective of depth) of total VOCs in the regional area of VOC-impacted groundwater is shown on Figure 4, and the vertical extent is shown on Figure 5. The extent of impacted groundwater shown on these figures is based on the 5 microgram per liter (µg/L) contour; although there is no SCG for total VOCs, this contour was selected because many of the VOCs have an SCG of 5µg/L. From review of Figures 4 and 5, the overall maximum extent of the regional area of VOC-impacted groundwater is approximately 3.5 miles in length by 1.6 miles in width, with a depth and thickness of 790 ft bls and 430 ft, respectively.

As depicted on Figure 5, Cross Sections A-A' and B-B' are transects of the regional area of total VOC-impacted groundwater and indicate that the impacts are present at similar depths along these sections. In the Study Area (Cross Section A-A'), the

maximum extent of VOC-impacted groundwater identified is approximately 8,300 feet in length and 2,100 ft in width, with a depth and thickness of approximately 670 ft bls and 430 ft, respectively. As depicted on Cross Section A-A', a segment of VOC-impacted groundwater was identified at depths of approximately 100 to 330 ft bls between VPBs VP-111 and VP-119. This shallower segment of VOC-impacted groundwater is not consistent with the depth of the Study Area VOC-impacted groundwater originating from the Site and therefore is not Site-related.

As shown on Figure 6 and summarized in Table 10, public supply wells at Bethpage Water District Plants 4, 5, and 6, have detections of VOCs in the untreated water, water from these wells is treated to meet the BWD's policy of zero detections in water delivered to the public.

As shown on Figure 4, the highest total VOC concentrations (i.e., greater than 1,000 µg/L) are predominantly located in the Study Area and also more locally near and north of Northrop Grumman Remedial Wells 1 and 3. Regionally, the VOC-impacted groundwater descends in the aquifer as it migrates, generally consistent with regional groundwater flow and hydraulic gradient (Figure 5). The highest total VOC concentrations (i.e., greater than 1,000 µg/L) are predominantly observed in the Study Area at depths ranging from approximately 75 ft bls (northern portion) to 590 ft bls (southern portion) and also near and north of Northrop Grumman Remedial Wells 1 and 3, which are at depths of approximately 480 to 570 ft bls. The highest total VOC concentrations were detected in the Study Area and were found in VP-104; VP-109; VP-111; and VP-116. VP-111 exhibited the maximum concentration of total VOCs (10,500 µg/L at a depth of 451 ft bls). Concentrations of total VOCs in Remedial Wells 1 and 3 were 740 µg/L and 3,529 µg/L, respectively.

The constituents in the regional area of VOC-impacted groundwater generally are TCE; PCE; 1,1,1-TCA; 1,2-DCE (cis/trans); 1,2-DCA; Freon 113; 1,1-DCE; and 1,1-DCA, and to a more localized extent VC. For detailed information on VOCs detected, see Tables 4 and 5, as well as previous reports prepared for the region Geraghty & Miller, Inc. (1994); TTNUS (1993); and Conestoga Rovers (1996).

Additionally, Freons 12 and 22 were sporadically detected in groundwater in the Study Area. The extent of these compounds off-site was not delineated, as the source of these compounds was attributed to the Town in the Site Area RI Report (ARCADIS 2008a).

Figure 6 depicts the percentage of individual VOCs relative to the total VOCs detected in select wells/VPBs and primarily illustrates the widespread nature of the TCE distribution in the region of VOC-impacted groundwater. For Figure 6, the maximum total VOC concentration detected over the period of record for each location was used. Data from the Study Area depicted on Figure 6, and provided in Tables 4 and 5 and Appendix G confirm the regional nature of the VOC impacts. In addition, this figure generally illustrates that constituents comprising the regional area of VOC-impacted groundwater are present in the Study Area (e.g., as evidenced by various VOCs detected in Wells GM-15I and GM-36D2).

As illustrated on Figure 6, the composition of the Study Area VOC-impacted groundwater changes with distance downgradient from the Site, from predominantly cis-1,2-DCE to TCE. Although the details of the historical daily operations at the Site are not known, one possible explanation for this off-site VOC distribution is that TCE was initially introduced to the subsurface, followed by the introduction of toluene at the site at some later date (see VP-27 and Site Area RI Report [ARCADIS 2008a]). In this scenario, toluene provided the source of organic carbon that allowed for the creation of an anaerobic environment amenable to the biodegradation of TCE on-site (as supported by biogeochemical data included in the Site Area RI Report [ARCADIS 2008a]). As is well documented in the literature, this biodegradation process then transformed TCE to cis-1,2DCE (as well as other degradation products) (Suthersan 1997). This process is a possible explanation of the change in VOC-impacted groundwater composition with distance from the Site and is supported by the data (i.e., the leading edge of the impacted groundwater [oldest portion] consists predominantly of TCE, the intermediate section consists of both VOCs in relatively equal proportions, and the portion nearest the Site consists predominantly of cis- 1,2- DCE). As described in Section 4.4., the historical discharge of VOC-impacted water (non-contact cooling water) to the Former NWIRP Plant 3 recharge basins (assuming it primarily contained TCE) and subsequent groundwater flow beneath and downgradient of the Site, (consistent with Northrop Grumman historical data and US Navy modeling), could also explain the Study Area distribution of TCE and cis-1,2,-DCE (Halliburton NUS 1993).

5.3.2 Metals

The results of metals analysis (total/dissolved) are provided in Table 7 and the single SCG exceedance is depicted on Figure 7; only chromium was detected in exceedance of its SCG. In general, dissolved concentrations are more representative of groundwater quality because total sample analytical results may include metals

adsorbed onto particulate matter in the sample and yield results that are biased high, and therefore only dissolved results are discussed. Based on the Site Area RI Report findings, chromium was determined to not be a COC in groundwater. The single, isolated, dissolved-phase exceedance of chromium in Monitoring Well MW111-4, it is not Site-related. An additional round of groundwater sampling is planned; this second round will include re-sampling of these wells for metals.

5.3.3 Perchlorate

The analytical results of perchlorate are provided in Table 8. Based on the findings of the Site Area RI Report (ARCADIS 2008a), no on-Site source of perchlorate to groundwater was identified and overall, the Study Area data verify that perchlorate is not Site related, with no trends apparent.

5.4 Tentatively Identified Compounds

This section of the RI Report discusses the results of analysis for TICs in groundwater samples collected during the RI. The results of TIC sample analysis are provided in Table 9. Two TICs, identified as 2-methyl 1-propene and propene, were detected in 30 and 29 percent of samples, respectively. The results from subsequent rounds of groundwater sampling will be evaluated to determine if any TICs need to be added to the list of quantified analytes.

6. Fate and Transport

This section of the RI Report provides a discussion of the environmental processes that control the movement and distribution of the COCs related to the Study Area. In general, after a chemical is released to the environment, it may be transported; transformed physically, chemically, or biologically; or accumulated in one or more media. The evaluation of the fate and transport of the COCs identified for the Study Area will aid in predicting future potential risks by identifying the substance's persistence and potential for migration in the environment.

6.1 Constituents of Concern

Chlorinated VOCs and toluene are identified as the COCs for the Study Area based on their concentrations and frequency of detection in groundwater samples collected in VPBs and monitoring wells. TCE and cis-1,2-DCE were determined to be the predominant VOCs detected in groundwater above SCGs, followed by (in order of

decreasing frequency of exceedance) 1,1-DCA; PCE; 1,1-DCE; VC; 1,2-DCA; Freon 113; toluene , chloroform, 1,1,1-TCA; and trans-1,2-DCE. Table 11 summarizes the chemical properties relevant to fate and transport of the COCs and Appendix J provides a general discussion of the various fate and transport processes applicable to the COCs.

6.2 Environmental Fate

The medium of concern for the Study Area is groundwater and the COCs are chlorinated VOCs and toluene. The COCs are relatively mobile in groundwater, having moderate to high solubilities and/or low organic carbon partition coefficients (K_{oc}) and octanol-water partition coefficients (K_{ow}). Accordingly, these COCs are considered to have medium-to-high mobility in groundwater, with relatively low sorption to soils. The predominant degradation processes for the COCs are hydrolysis and biodegradation. As discussed in Section 5, a number of biodegradation processes may have occurred in the Site Area. Further degradation of these breakdown products in the subsurface environment is expected to be slow; therefore, these constituents may persist for some time.

6.3 Transport Mechanisms

Transport mechanisms are physical processes governing the movement of constituents from points of origin (i.e., sources) through environmental media. The primary transport mechanism for the COCs is advection, which is chemical movement via groundwater flow due to the groundwater hydraulic gradient. The primary influences on groundwater movement are subsurface lithology and structure and local groundwater pumpage and recharge. As discussed in Section 4, downward regional groundwater flow has caused the VOC-impacted groundwater to descend in the aquifer as it migrates downgradient (south-southeast). As a result, the distal edge of the impacted groundwater exists at depths close to the basal portion of the Magothy aquifer, approximately 800 ft bls.

7. Conceptual Site Model

Previous sections of this RI Report summarized relevant Study Area conditions, consisting of hydrogeology (Study Area and regional), and distribution of COCs in groundwater. The groundwater portion of the conceptual site model (CSM) relates current conditions to apparent historical sources (to the extent possible with available data). The purpose of the CSM is to more specifically explain the source(s) of COCs,

migration mechanisms of COCs in groundwater, as well as potential receptors. The portion of the CSM related to groundwater is shown on Figure 8.

7.1 Sources

VOCs present in source areas in the Site Area, as well as industrial releases to properties west and adjacent to the Site, migrated via percolation through the unsaturated zone to groundwater.

7.2 Migration Mechanisms

Prior to startup of the groundwater remedy on the Northrop Grumman property, local recharge via basins and operation of industrial supply wells on the former Grumman, NWIRP, and OCC facilities caused the VOC-impacted groundwater to migrate downward, resulting in a zone of impacted groundwater greater than 500 ft deep on the Grumman facility (USGS 1992). This pumpage/recharge also laterally and vertically mixed VOCs from multiple on-site sources. A portion of the VOC-impacted groundwater migrated off-site via advection, where it was further influenced by the pumping of public supply wells in the area. VOCs have been detected in several downgradient public supply wells.

VOC-impacted groundwater at the Site descended in the aquifer as it migrated via advection off-site and downgradient in the Study Area to the south/southeast, along the regional flow path. Further downgradient of the Site, local pumpage (i.e., Remedial Well 19 and downgradient public supply wells) accentuated the descent of the impacted groundwater in the aquifer.

The result of this pumpage, recharge, and migration is a regional area of VOC-impacted groundwater that is approximately 3.5 miles in length by 1.6 miles in width, with a depth and thickness of 790 ft bls and 430 ft, respectively

7.3 Potential Receptors

Off-Site wellhead treatment of public supply wells for VOCs, supplemented by the OU3 Groundwater IRM and the Northrop Grumman main facility groundwater remedy, results in no human exposure to VOCs in groundwater.

8. Conclusions

- The horizontal groundwater flow direction is south-southeast and in the vertical direction, flow is slightly downward. Supply well pumping and recharge via basins exhibit local influences on groundwater flow directions (vertically/horizontally).

- Regionally, VOC-impacted groundwater has been documented to underlie and extend downgradient (generally south) of the former Grumman facility, the NWIRP, and OCC properties, and the Site. The constituents in the regional VOC-impacted groundwater generally are TCE; PCE; 1,1,1-TCA; 1,2-DCE (cis/trans); 1,2-DCA; Freon 113; 1,1-DCE; and 1,1-DCA, and to a more localized extent VC. In general, the highest total VOC concentrations (i.e., greater than 1,000 µg/L) are predominantly observed in the Study Area and near and north of Northrop Grumman Remedial Wells 1 and 3.

- In the Study Area, chlorinated VOCs and toluene were determined to be the COCs in groundwater. Of these COCs, TCE and cis-1,2 DCE, were the predominant VOCs. Other VOCs detected above SCGs include the regional VOCs, plus chloroform.

- The maximum extent of the regional area of VOC-impacted groundwater is approximately 3.5 miles in length by approximately 1.6 miles in width, with a maximum depth/ thickness of 790 ft bls and 430 ft, respectively. In the Study Area, the VOC-impacted groundwater (downgradient of the Site) extends over a maximum area of approximately 8,300 feet in length by 2,100 ft in width. This impacted groundwater descends in the aquifer as it migrates generally to the south (consistent with regional groundwater flow) and reaches a maximum depth/thickness of approximately 670 ft bls, and 430 ft, respectively.

- The analytical data collected in the Study Area from VPBs and monitoring wells show good agreement. Therefore, VPB data were considered representative of aquifer conditions and were used throughout this Report.

- The composition of the Study Area VOC-impacted groundwater changes from predominantly cis-1,2-DCE to TCE with distance downgradient from the Site. One possible explanation is that TCE was initially introduced to the subsurface, followed by the introduction of toluene, which facilitated the biodegradation of TCE to cis-1,2DCE. Also, the historical discharge of VOC-impacted water (assuming water contained predominantly TCE) to the Former NWIRP Plant 3 recharge basins and

subsequent groundwater flow beneath and downgradient of the Site is another possible explanation.

- The shallower segment of VOC-impacted groundwater identified between VP-111 and VP-119 is not consistent with the depth of the Study Area VOC-impacted groundwater originating from the Site and therefore is not Site-related.

- Freons 12 and 22 were identified in the Study Area. The source of these compounds has been attributed to the Town.

- Based on the findings of the Site Area and Study Area RIs, Site-related metals in groundwater are limited in extent to the Site and are not COCs in Study Area groundwater.

- Based on the findings of the Site Area RI Report, no on-Site source of perchlorate was identified and overall, the Study Area data verify that perchlorate is not a COC in groundwater.

- Primary mechanism for transport of VOCs in groundwater is advection.

- The CSM for groundwater is as follows:

    - VOCs in source areas in the Site Area and industrial releases to properties west and adjacent to the Site resulted in VOC impacts to groundwater. Historical pumping/recharge on the former Grumman, NWIRP, and OCC properties caused lateral and vertical mixing of VOCs and accentuated downward movement of VOC-impacted groundwater, resulting in groundwater impacts at depths greater than 500 ft bls. The VOC-impacted groundwater that migrated south of the former Grumman, NWIRP, OCC, and the Site was further influenced by the pumping of public supply wells. Several downgradient public supply wells are presently affected by VOC-impacted groundwater.

    - Wellhead treatment of public supply wells for VOCs, supplemented by the OU3 Groundwater IRM and the former Grumman main facility groundwater remedy, results in no human exposure to VOCs in groundwater.

- Additional IRMs are not appropriate and no further investigation is warranted

9. Recommendations

Prepare a feasibility study to evaluate remedial alternatives for VOCs in Study Area groundwater.

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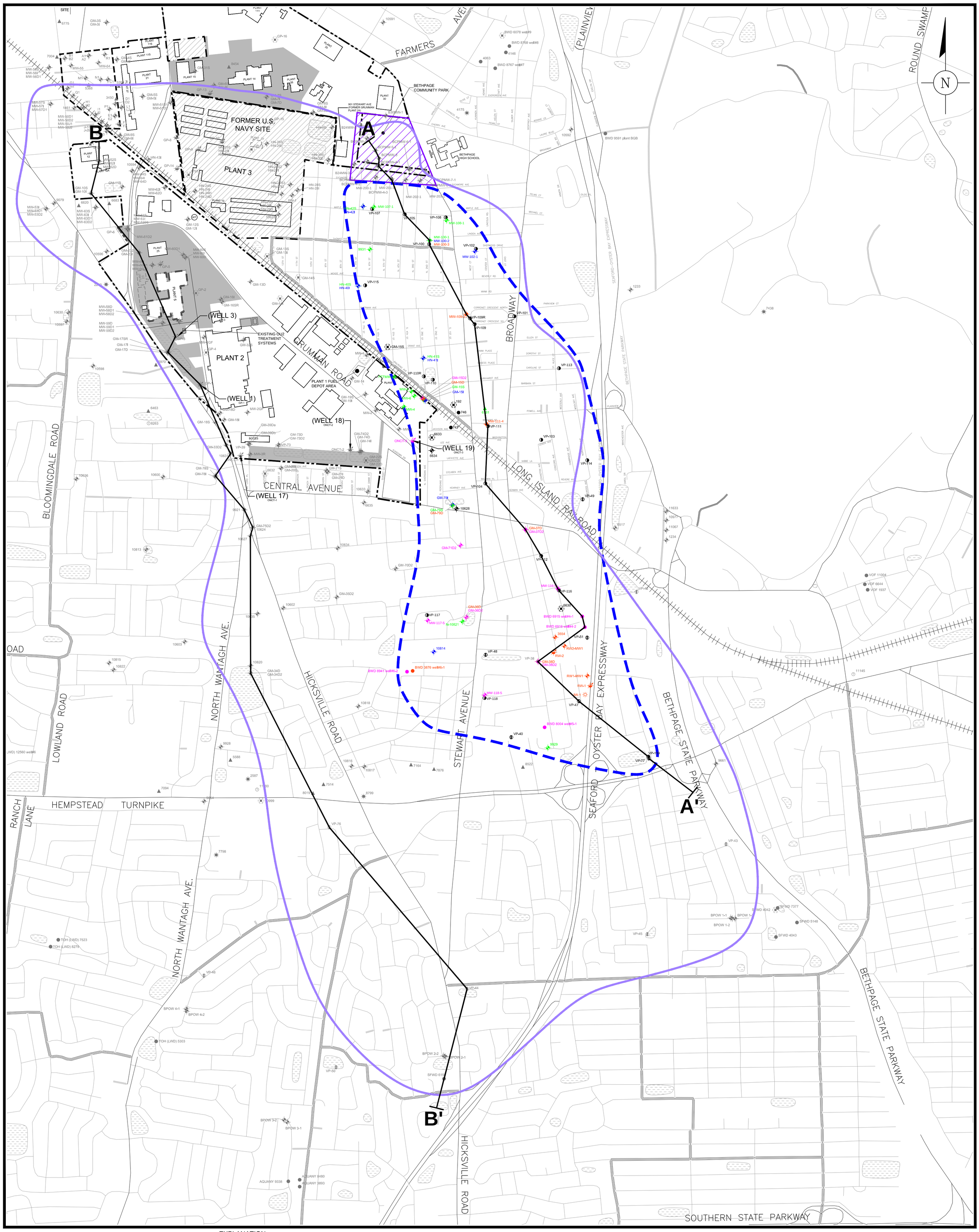


EXPLANATION:

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE PROPERTY
- PROPERTY BOUNDARY OF THE FORMER U.S. NAVY PROPERTY
- PROPERTY BOUNDARY OF THE FORMER OCC PROPERTY
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY
- DENOTES FORMER U.S. NAVY OWNED PROPERTY
- RECHARGE BASIN
- A — A' LINE OF SECTION
- SITE AREA
- STUDY AREA LIMIT (APPROXIMATE)
- APPROXIMATE LIMIT OF REGIONAL AREA OF VOC-IMPACTED GROUNDWATER (BASED ON TVOC CONCENTRATION OF 5 µg/L
- µg/L MICROGRAMS PER LITER

- OBSERVATION, MONITORING WELL
- INDUSTRIAL WELL
- PUBLIC SUPPLY WELL
- IRRIGATION WELL
- INJECTION WELL
- NORTHROP GRUMMAN OR NAVY PRODUCTION WELL
- OU2 VERTICAL PROFILE BORING
- OU3 VERTICAL PROFILE BORING
- ABANDONED WELL

DESIGNATION OF HYDROGEOLOGIC ZONE FOR MONITORING WELL SCREENED INTERVALS (ARCADIS 2003)

- SHALLOW
- INTERMEDIATE
- DEEP
- DEEP2

NOTES:

1. VERTICAL PROFILE BORING LOCATIONS BASED ON FIELD MEASUREMENTS.
2. HYDROGEOLOGIC ZONE BASED ON MODEL LAYER ELEVATIONS PRESENTED IN COMPREHENSIVE GROUNDWATER MODEL (ARCADIS 2003).

0 800' 1600'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

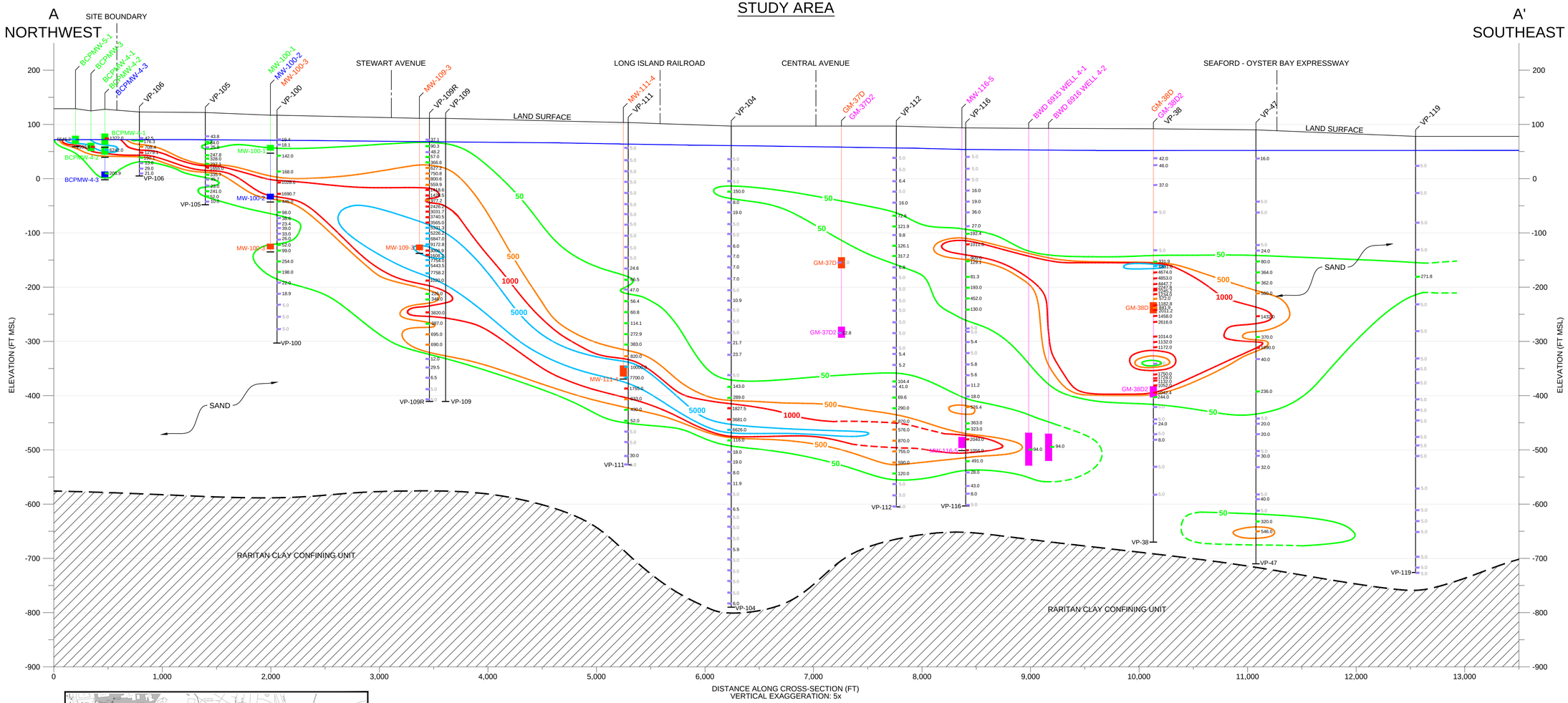
STUDY AREA SHOWING WELL AND VERTICAL PROFILE BORING LOCATIONS AND LINES OF SECTION

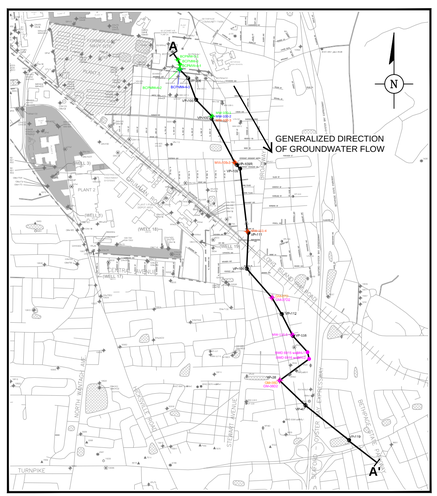
ARCADIS

FIGURE
1

STUDY AREA

A NORTHWEST — A' SOUTHEAST





PLAN VIEW SHOWING LINE OF SECTION A-A'

0 2000' 4000'

SCALE IN FEET

EXPLANATION

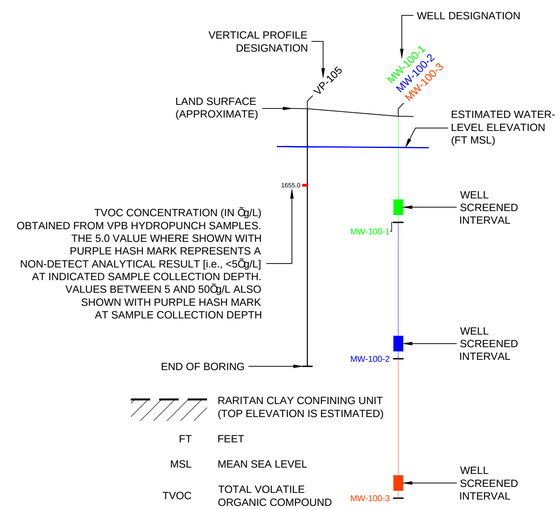
- OBSERVATION, MONITORING WELL
- PUBLIC SUPPLY WELL
- OU2 VERTICAL PROFILE BORING
- OU3 VERTICAL PROFILE BORING
- A — A' LINE OF SECTION

DESIGNATION OF HYDROGEOLOGIC ZONE FOR MONITORING WELL SCREENED INTERVALS (ARCADIS 2003)

- SHALLOW
- INTERMEDIATE
- DEEP
- DEEP2

TVOC CONTOURS

- 50 — 50 µg/L
- 500 — 500 µg/L
- 1000 — 1000 µg/L
- 5000 — 5000 µg/L



NOTES:

1. HYDROGEOLOGIC ZONE BASED ON MODEL LAYER ELEVATIONS PRESENTED IN COMPREHENSIVE GROUNDWATER MODEL (ARCADIS 2003).
2. VERTICAL PROFILE BORING LOCATIONS ARE BASED ON FIELD MEASUREMENTS.
3. MONITORING WELLS SURVEYED TO NAD 1983.
4. LAND SURFACE ESTIMATED FROM USGS QUADRANGLES (AMITYVILLE, HUNTINGTON, FREEPORT, AND HICKSVILLE)
5. THE GEOLOGICAL TERM "SAND" REFERENCED ABOVE IS DEFINED IN DETAIL IN THE STUDY AREA REMEDIAL INVESTIGATION REPORT. LOCALIZED LENSES OF LOWER PERMEABILITY NOT SHOWN. REFER TO STUDY AREA REMEDIAL INVESTIGATION REPORT FOR THIS INFORMATION (ARCADIS 2009).

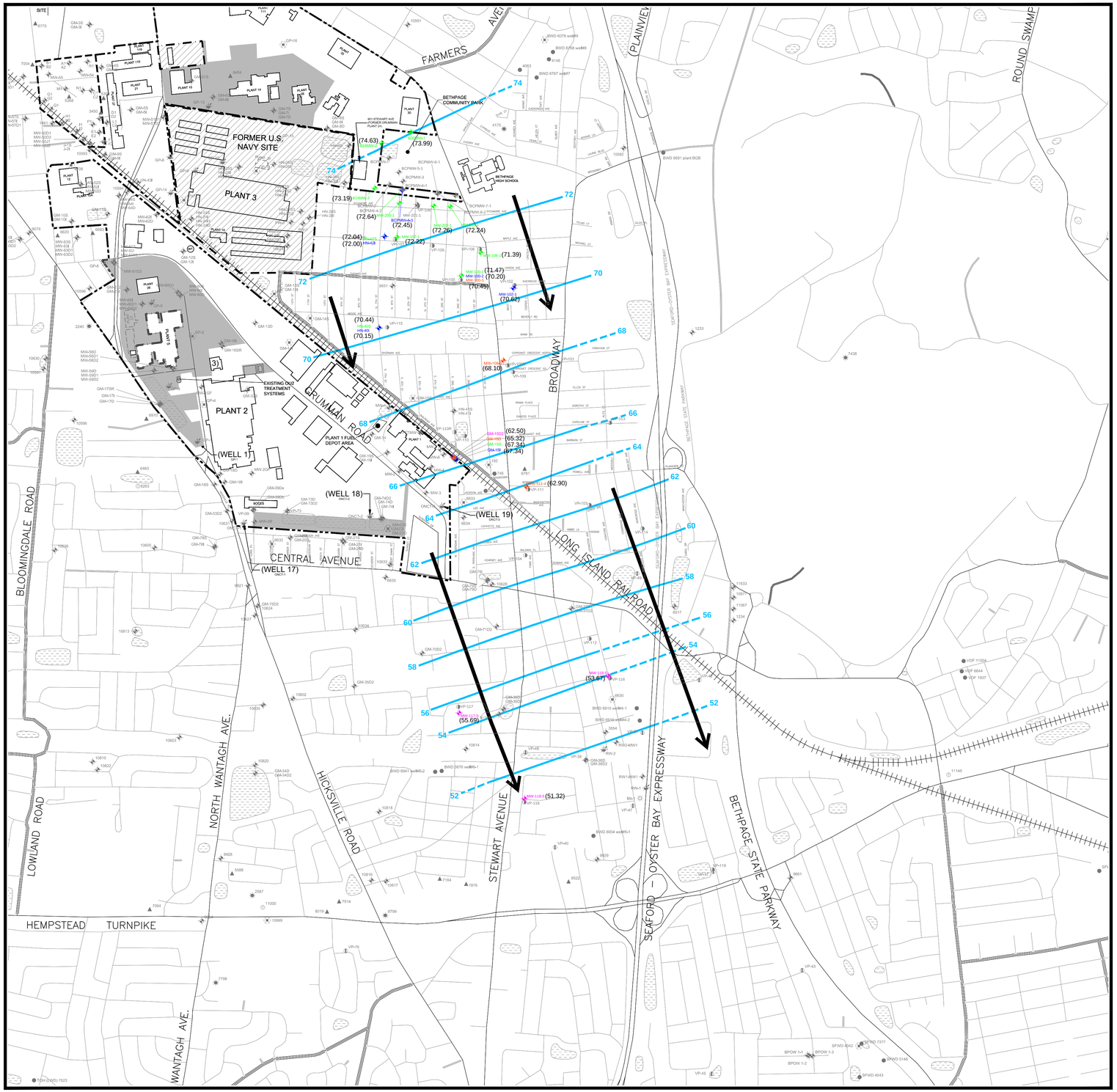
ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

CONCENTRATIONS OF TVOCs IN GROUNDWATER (CROSS SECTION A-A')

ARCADIS

FIGURE 2



EXPLANATION:

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE PROPERTY
- PROPERTY BOUNDARY OF THE FORMER U.S. NAVY PROPERTY
- PROPERTY BOUNDARY OF THE FORMER OCC PROPERTY
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY
- DENOTES FORMER U.S. NAVY OWNED PROPERTY
- RECHARGE BASIN
- OBSERVATION, MONITORING WELL
- INDUSTRIAL WELL
- PUBLIC SUPPLY WELL
- IRRIGATION WELL
- INJECTION WELL
- NORTHROP GRUMMAN OR NAVY PRODUCTION WELL
- OU2 VERTICAL PROFILE BORING
- OU3 VERTICAL PROFILE BORING
- ABANDONED WELL
- BWD — BETHPAGE WATER DISTRICT
- VPB — VERTICAL PROFILE BORING
- RI — REMEDIAL INVESTIGATION
- OU2 — OPERABLE UNIT 2
- OU3 — OPERABLE UNIT 3
- 66 — LINE OF EQUAL POTENTIOMETRIC SURFACE ELEVATION IN FEET RELATIVE TO MEAN SEA LEVEL (DASHED WHERE INFERRED)
- HORIZONTAL COMPONENT OF GROUNDWATER FLOW

DESIGNATION OF HYDROGEOLOGIC ZONE FOR MONITORING WELL SCREENED INTERVALS (ARCADIS 2003)

- SHALLOW
- INTERMEDIATE
- DEEP
- DEEP2

NOTES:

1. HYDROGEOLOGIC ZONE BASED ON MODEL LAYER ELEVATIONS PRESENTED IN COMPREHENSIVE GROUNDWATER MODEL (ARCADIS 2003).
2. WELL CLUSTERS, SHALLOWEST WATER ELEVATIONS USED. DEEPER WELLS IN CLUSTERS ARE USED TO GUIDE CONTOURS BUT WERE NOT EXCLUSIVELY RELIED ON.

0 800' 1600'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTION JULY 2009

ARCADIS

FIGURE 3

CITY:Melville-NY DIV/GROUP:SER1 DB:A.Sanchez LD: PIC: PM:C.S.Giovanni TM:D.Stern LYR:ON=*;OFF=*REF*
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PROJECTNAME: NY001493.0809.00008

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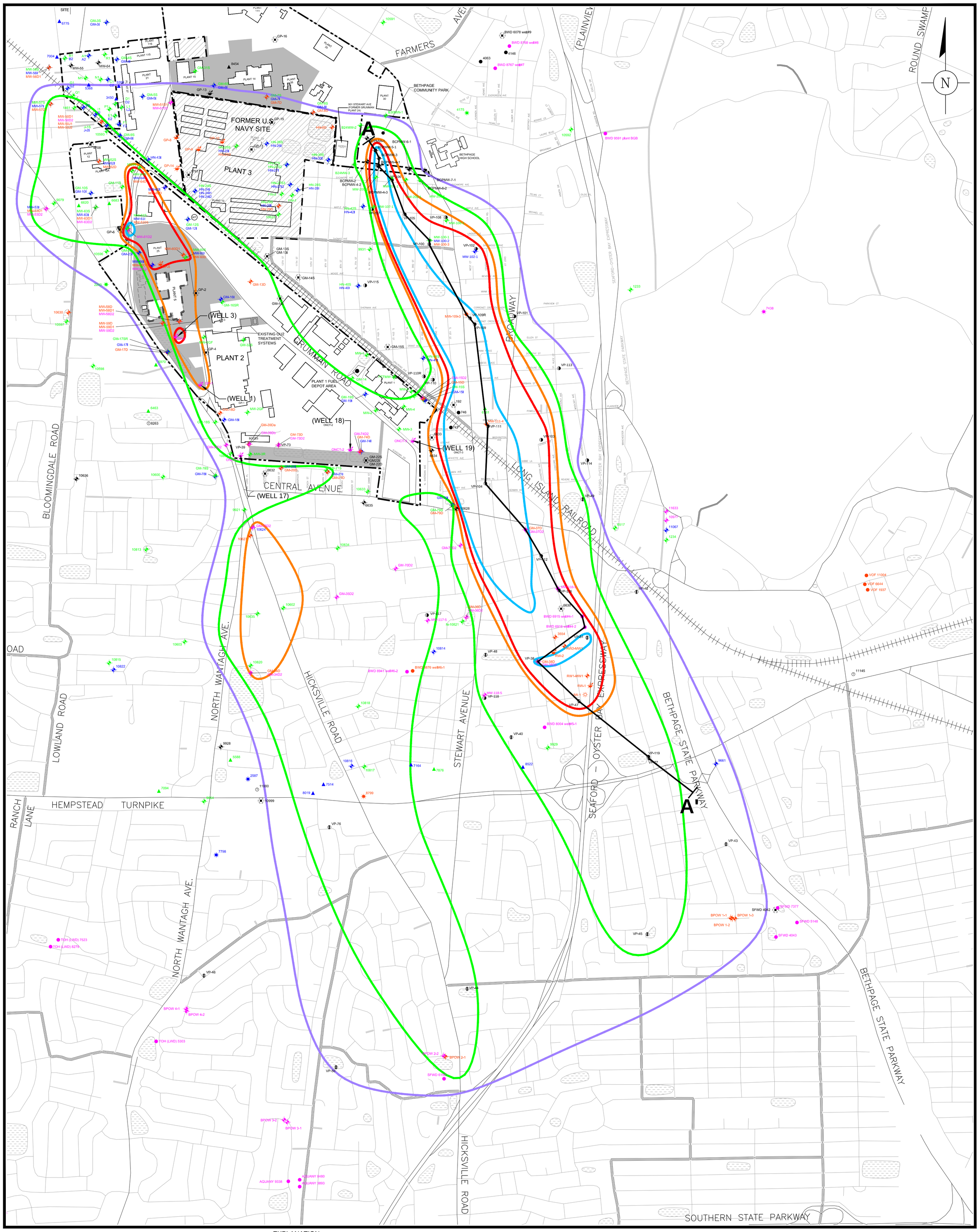


EXPLANATION:

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE PROPERTY
- PROPERTY BOUNDARY OF THE FORMER U.S. NAVY PROPERTY
- PROPERTY BOUNDARY OF THE FORMER OCC PROPERTY
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY
- DENOTES FORMER U.S. NAVY OWNED PROPERTY
- RECHARGE BASIN
- A — A' LINE OF TVOC CROSS-SECTION
- OBSERVATION, MONITORING WELL
- INDUSTRIAL WELL
- PUBLIC SUPPLY WELL
- IRRIGATION WELL
- INJECTION WELL
- NORTHROP GRUMMAN OR NAVY PRODUCTION WELL
- OU2 VERTICAL PROFILE BORING
- OU3 VERTICAL PROFILE BORING
- ABANDONED WELL

TVOC	TOTAL VOLATILE ORGANIC COMPOUND
Õg/L	MICROGRAMS PER LITER
VPB	VERTICAL PROFILE BORING
BPOW	BETHPAGE OUTPOST WELL
RW	REMEDIAL WELL
BWD	BETHPAGE WATER DISTRICT
SFWD	SOUTH FARMINGDALE WATER DISTRICT
VOF	VILLAGE OF FARMINGDALE
TOH (LWD)	TOWN OF HEMPSTEAD (LEVITTOWN WATER DISTRICT)

DEFINITIONS OF TVOC CONCENTRATION CONTOURS IN GROUNDWATER

- 5 — 5 Õg/L
- 50 — 50 Õg/L
- 500 — 500 Õg/L
- 1000 — 1000 Õg/L
- 5000 — 5000 Õg/L

TVOC DATA DISPLAYED CONSISTS OF:

- AVERAGE OF MONITORING WELL AND PUBLIC SUPPLY WELL DATA FROM 2004 THROUGH 2007
- NORTHROP GRUMMAN AND NAVY VERTICAL PROFILE BORING INFORMATION

0 800' 1600'
SCALE IN FEET

NOTE:

1. VPB LOCATIONS BASED ON FIELD MEASURMENTS.

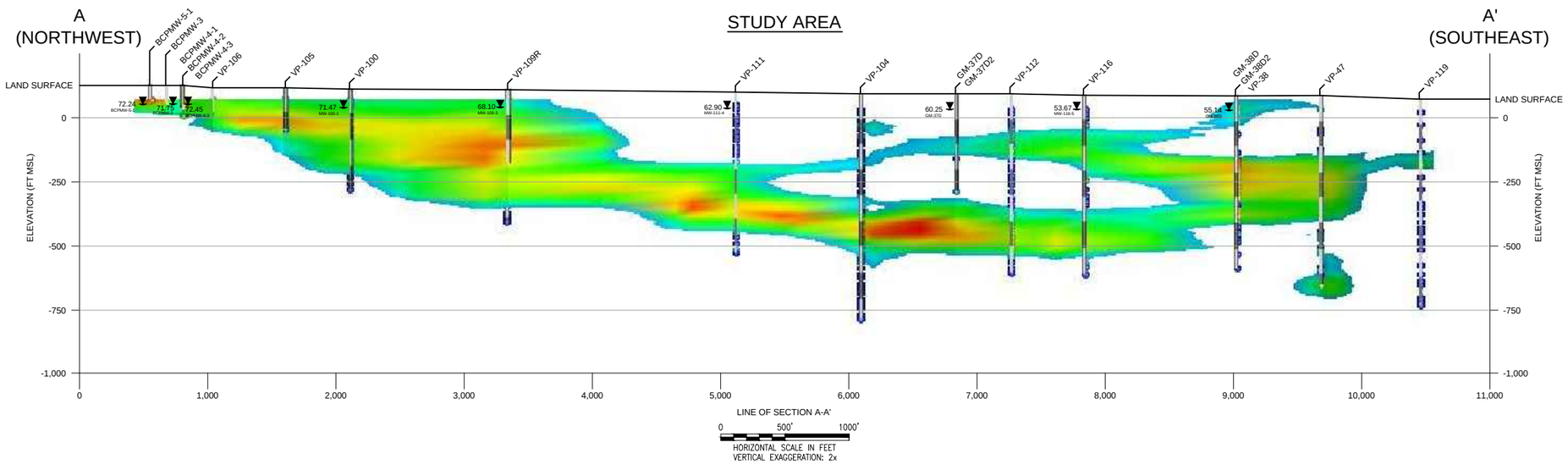
ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

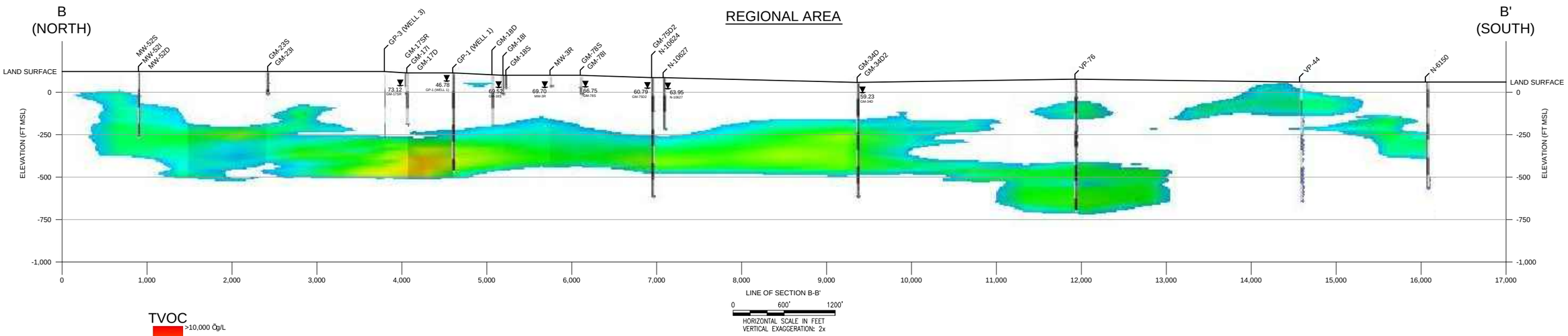
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

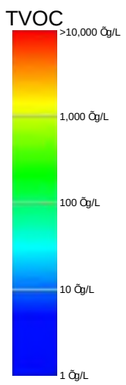
CONCENTRATIONS OF TVOCs IN REGIONAL AREA GROUNDWATER - PLAN VIEW

ARCADIS

FIGURE
4







NOTES:

1. CROSS SECTION BASED ON A PROJECTED VIEW OF SECTION LINES A-A' AND B-B' SHOWN ON FIGURE 1.
2. TVOC PLUME GENERATED IN "EVS".
3. VPB LOCATIONS ARE ESTIMATED.
4. MONITORING WELL SURVEYED TO NAD 83.
5. WATER-LEVEL ELEVATIONS FROM SHALLOW WELLS ESTIMATED BASED ON MOST RECENT ROUNDS OF WATER LEVEL MEASUREMENTS FOR THAT WELL.
6. LAND SURFACE ELEVATION IS APPROXIMATE.

DEFINITIONS:

TVOC	TOTAL VOLATILE ORGANIC COMPOUND
Ūg/L	MICROGRAMS PER LITER
FT MSL	FEET RELATIVE TO MEAN SEA LEVEL
VPB	VERTICAL PROFILE BORING
EVS	ENVIRONMENTAL VISUALIZATION SYSTEM
72.24 BCPMW-5-1	WATER-LEVEL ELEVATION (FT MSL)

DATA DISPLAYED CONSISTS OF:

- AVERAGE OF MONITORING WELL AND PUBLIC SUPPLY WELL DATA FROM 2004 THROUGH 2007
- NORTHROP GRUMMAN AND NAVY VERTICAL PROFILE BORING INFORMATION

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

CROSS SECTIONS A-A' AND B-B' SHOWING TVOC CONCENTRATIONS GREATER THAN 5Ūg/L

ARCADIS

FIGURE
5

CITY:Melville-NY DIV/GROUP:SER1 DB:A.Sanchez LD:AS PIC: PM:C.S.Giovanni TM:M.Reindl LYR:(Opt)ON=*;OFF=*REF*
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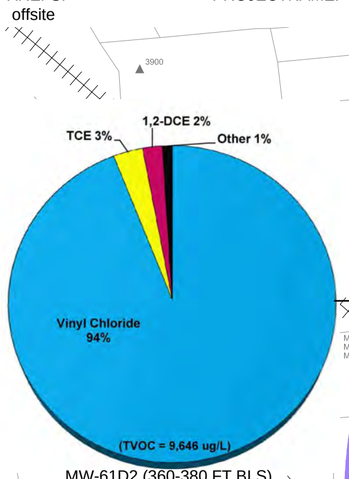
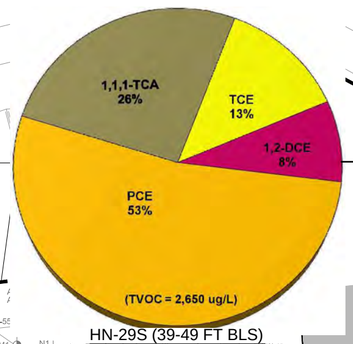
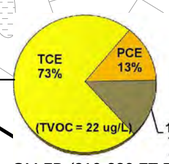


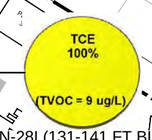
MW-61D2 (360-380 FT BLS)



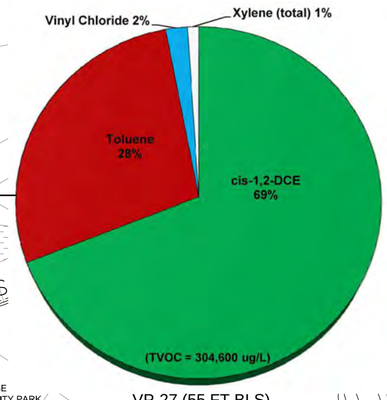
HN-29S (39-49 FT BLS)



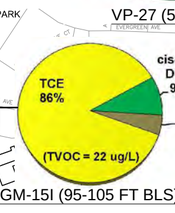
GM-7D (210-220 FT BLS)



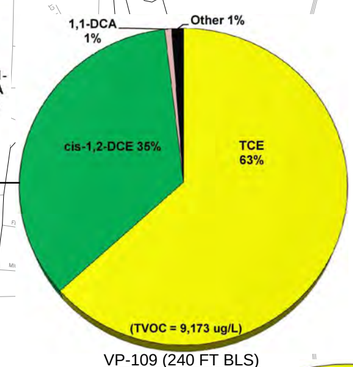
HN-28I (131-141 FT BLS)



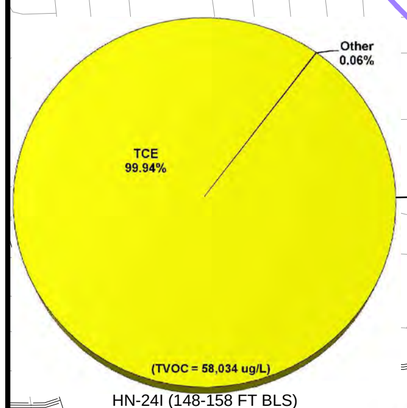
VP-27 (55 FT BLS)



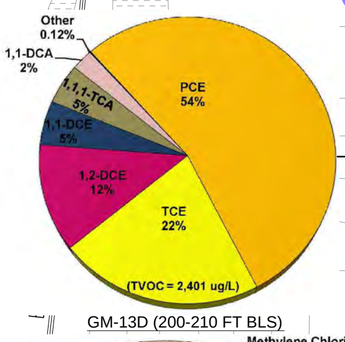
GM-15I (95-105 FT BLS)



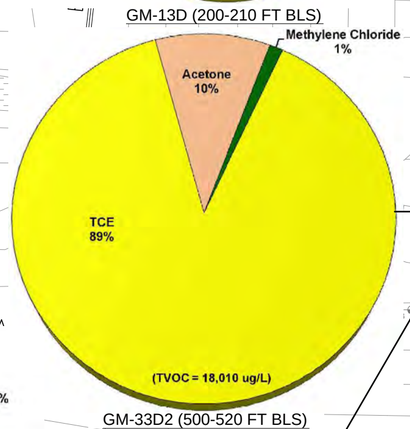
VP-109 (240 FT BLS)



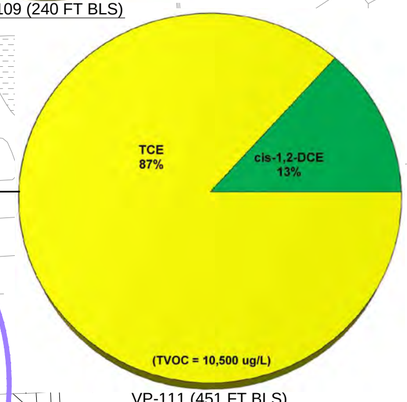
HN-24I (148-158 FT BLS)



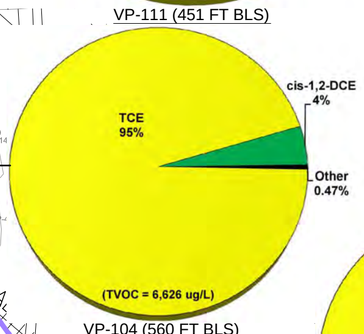
GM-13D (200-210 FT BLS)



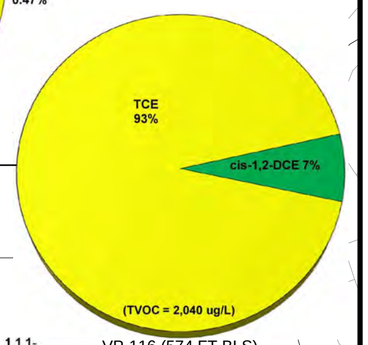
GM-33D2 (500-520 FT BLS)



VP-111 (451 FT BLS)



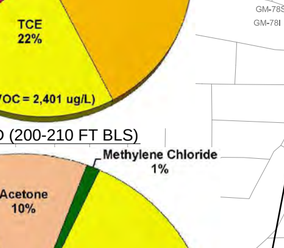
VP-104 (560 FT BLS)



VP-116 (574 FT BLS)

GM-75D2 (505-525 FT BLS)

GM-34D (309-319 FT BLS)



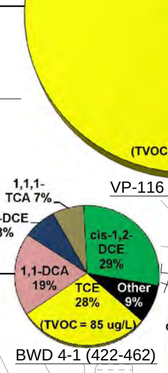
GM-35D2 (510-530 FT BLS)

BWD 6-2 (700-735)

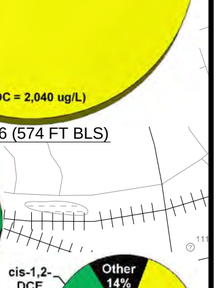
BWD 6-1 (327-384)

GM-36D (204-214 FT BLS)

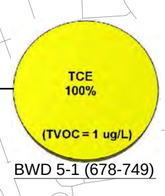
GM-38D2 (475-495 FT BLS)



BWD 4-1 (422-462)



BWD 4-2 (555-605)



BWD 5-1 (678-749)

EXPLANATION:

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE PROPERTY
- PROPERTY BOUNDARY OF THE FORMER U.S. NAVY PROPERTY
- PROPERTY BOUNDARY OF THE FORMER OCC PROPERTY
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY
- DENOTES FORMER U.S. NAVY OWNED PROPERTY
- RECHARGE BASIN
- APPROXIMATE LIMIT OF REGIONAL AREA OF VOC-IMPACTED GROUNDWATER (BASED ON TVOC CONCENTRATION OF 5 Õg/L

Õg/L MICROGRAMS PER LITER
TVOC TOTAL VOLATILE ORGANIC COMPOUNDS
FT BLS FEET BELOW LAND SURFACE
BWD BETHPAGE WATER DISTRICT

- OBSERVATION / MONITORING WELL
- INDUSTRIAL WELL
- PUBLIC SUPPLY WELL
- IRRIGATION WELL
- INJECTION WELL
- NORTHROP GRUMMAN OR NAVY PRODUCTION WELL
- OU2 VERTICAL PROFILE BORING
- OU3 VERTICAL PROFILE BORING
- ABANDONED WELL

DESIGNATION OF HYDROGEOLOGIC ZONE FOR MONITORING WELL SCREENED INTERVALS (ARCADIS 2003)

SHALLOW DEEP
INTERMEDIATE DEEP2

NOTES:

1. CONCENTRATION SHOWN REPRESENTS THE HIGHEST TVOC CONCENTRATION FOR THE VERTICAL PROFILE BORING OR FOR THE PERIOD OF RECORD FOR THE WELL.
2. "OTHER" CONSISTS OF COMPILATION OF COMPOUNDS DETECTED, BUT AT LOWER CONCENTRATIONS THAN THOSE INDICATED ON THE CHART AND USUALLY IS COMPRISED OF; 1,1-DICHLOROETHANE, 1,1-DICHLOROETHENE, 1,1,1-TETRACHLORETHANE, 1,2-DICHLOROETHANE, CHLOROFORM, AND TETRACHLOROETHENE.
   THE FOLLOWING WELLS EXHIBITED DETECTIONS OF ONE OR MORE OF THE ABOVE VOCs, PLUS ADDITIONAL VOCs, AS DESCRIBED BELOW:
   - GM-34D : FREON 12 AND FREON 22
   - GM-35D2 : CARBON TETRACHLORIDE
   - GM-75D2 : CIS-1,2-DICHLOROETHENE
   - HN-24I : CARBON TETRACHLORIDE, TOLUENE
   - MW-61D2 : BENZENE
   - VP-104 : 1,1,2-TRICHLOROETHANE
   - VP-109 : 1,2-DICHLOROETHENE, 4-METHLY-2-PENTANONE, TRANS-1,2-DICHLOROETHENE, VINYL CHLORIDE

0 800' 1600'
SCALE IN FEET

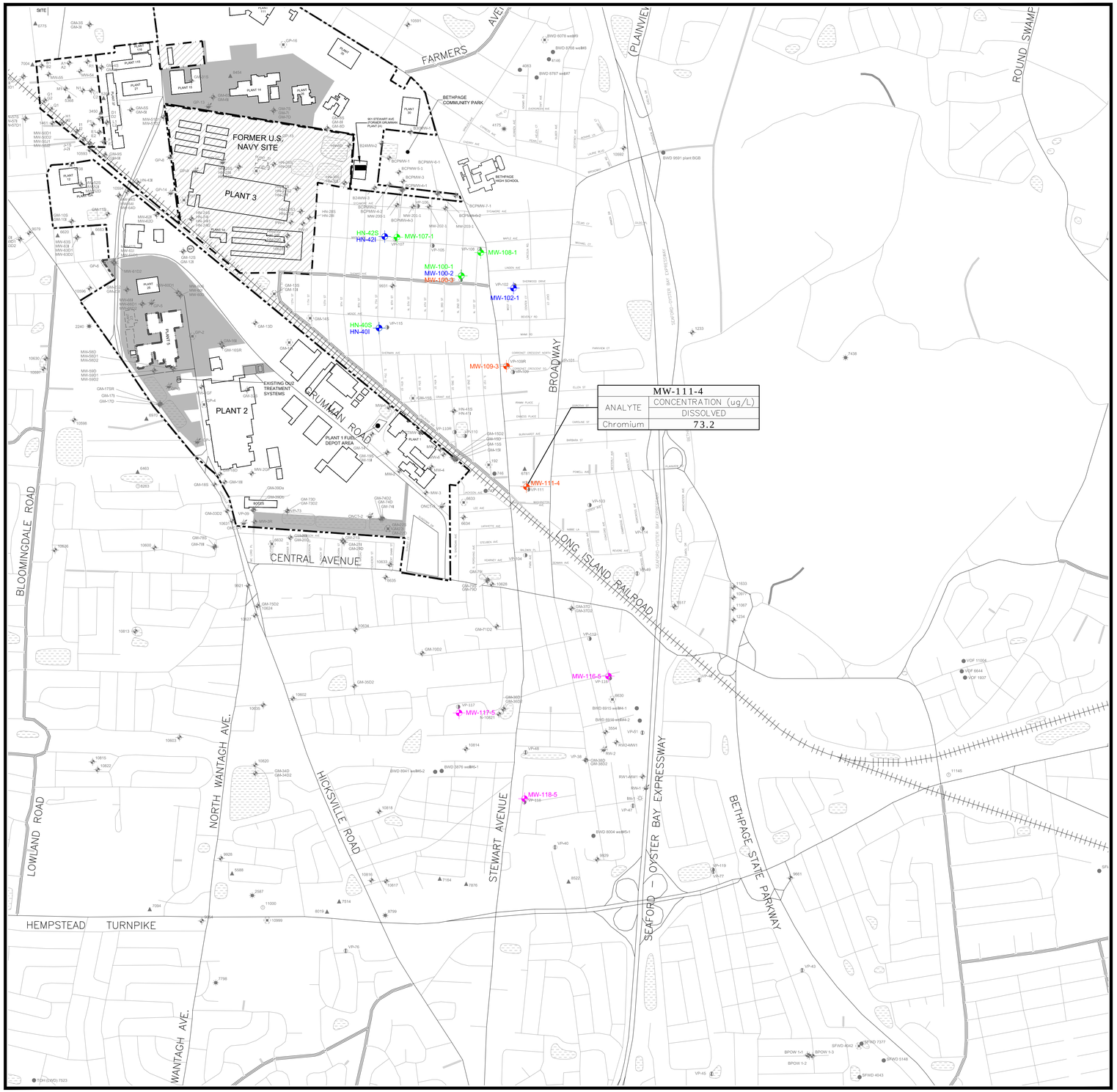
ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

PERCENTAGE OF VOCs IN SELECT VERTICAL PROFILE BORINGS AND WELLS

ARCADIS

FIGURE 6



MW-111-4	
ANALYTE	CONCENTRATION (ug/L)
	DISSOLVED
Chromium	73.2

N

EXPLANATION:

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE SITE
- PROPERTY BOUNDARY OF FORMER U.S. NAVY SITE
- PROPERTY BOUNDARY OF THE FORM OCC PROPERTY
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY (AS OF 2003)
- DENOTES FORMER U.S. NAVY OWNED PROPERTY
- RECHARGE BASIN
- OBSERVATION, MONITORING WELL
- INDUSTRIAL WELL
- PUBLIC SUPPLY WELL
- IRRIGATION WELL
- INJECTION WELL
- NORTHROP GRUMMAN OR NAVY PRODUCTION WELL
- OU2 VERTICAL PROFILE BORING
- OU3 VERTICAL PROFILE BORING
- ABANDONED WELL

BWD BETHPAGE WATER DISTRICT
VPB VERTICAL PROFILE BORING
RI REMEDIAL INVESTIGATION
OU2 OPERABLE UNIT 2
OU3 OPERABLE UNIT 3
µg/L MICROGRAMS PER LITER

DESIGNATION OF HYDROGEOLOGIC ZONE FOR MONITORING WELL SCREENED INTERVALS (ARCADIS 2003)

- SHALLOW
- INTERMEDIATE
- DEEP
- DEEP2

0 800' 1600'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

CHROMIUM (Cr) EXCEEDANCE IN GROUNDWATER

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FIGURE 7

CITY:Melville-NY DIV/GROUP:SER1 DB:A.Sanchez LD: PIC: PM:C.S.Giovanni TM:D.Stern LYR:ON=*;OFF=*REF*
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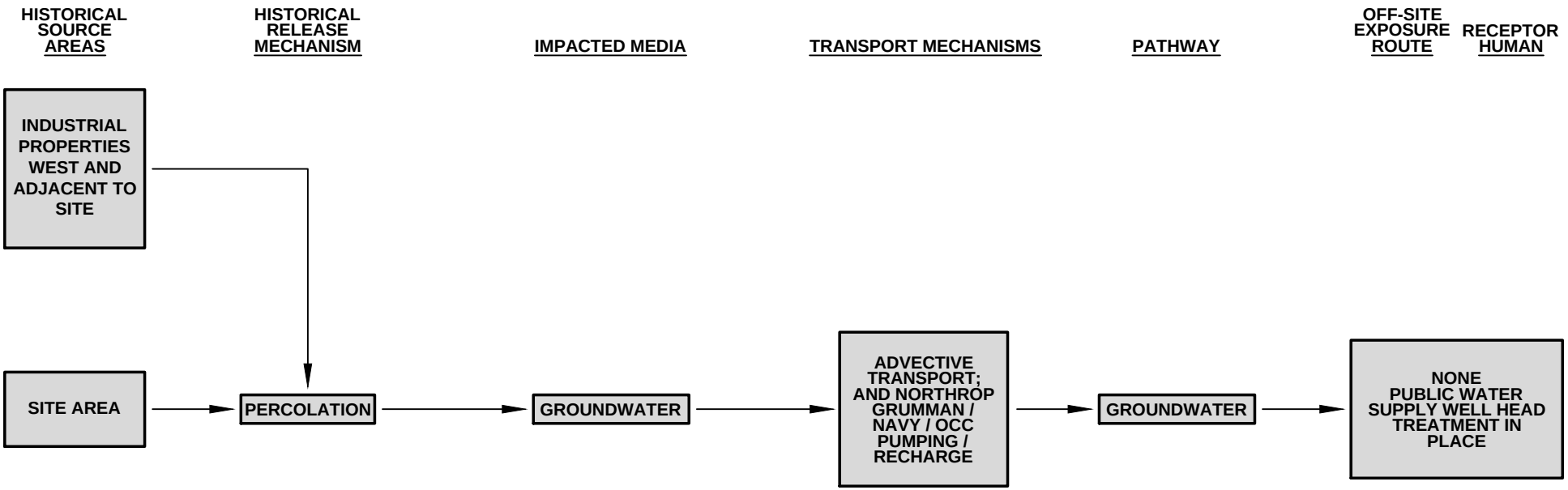

* OFF-SITE MIGRATION OF VOCs NOW CONTROLLED BY INTERIM REMEDIAL MEASURE SINCE JULY 2009

NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

GROUNDWATER PORTION OF CONCEPTUAL SITE MODEL

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FIGURE
8