

**2016 OU2 GROUNDWATER INVESTIGATION
RE130D1, RE130D2 (VPB164)
INSTALLATION REPORT**

**NAVAL WEAPONS INDUSTRIAL RESERVE PLANT (NWIRP)
SITE 1 OU2
BETHPAGE, NY**

Prepared for:



**Department of the Navy
Naval Facilities Engineering Command, Atlantic
9324 Virginia Avenue
Building Z-144
Norfolk, Virginia 23511**

June 2017

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INSTALLATION REPORT**

**NWIRP BETHPAGE
SITE 1 OU2
BETHPAGE, NY**

Prepared for:



**Department of the Navy
Naval Facilities Engineering Command, Atlantic
9324 Virginia Avenue
Building Z-144
Norfolk, Virginia 23511**

Prepared by:



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**Contract Number: N62470-11-D-8013
CTO WE15**

June 2017

A handwritten signature in black ink that reads "Brian Caldwell".

**Brian Caldwell
Contract Task Order Manager**

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List of Acronyms and Abbreviations

AOC	Area of Concern
bgs	below ground surface
CSM	Conceptual Site Model
COR	Continuously Operating Reference
EPA	Environmental Protection Agency, United States
ESS	Environmental Sequence Stratigraphy
ft	feet
GOCO	Government-Owned Contractor-Operated
GPS	Global Positioning System
IDW	Investigation Derived Waste
IR	Installation Restoration
Katahdin	Katahdin Analytical Services
NAD	North American Datum
NAVD	North American Vertical Datum
NAVFAC	Naval Facilities Engineering Command
NG	Northrop Grumman
NTU	nephelometric turbidity units
NWIRP	Naval Weapons Industrial Reserve Plant
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
PVC	Polyvinylchloride
SAP	Sampling and Analysis Plan
SVOC	Semivolatile Organic Compounds
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
UFP	United Federal Programs
US	United States
VOC	Volatile Organic Compounds
VPB	Vertical Profile Boring

1.0 PROJECT BACKGROUND

Resolution Consultants has prepared this Data Summary Report for the Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic under contract task order WE15 Contract N62470-11-D-8013. This report describes the installation of two monitoring wells and one initial groundwater monitoring event (specifically at the Vertical Profile Boring [VPB] 164 location) in 2016 for the Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage Operable Unit (OU) 2 Site 1 offsite plume. NWIRP Bethpage is located in east-central Nassau County, Long Island, New York, approximately 30 miles east of New York City (Figure 1).

1.1 Scope and Objectives

This report provides information on the installation of RE130D1 and RE130D2, monitoring wells associated with VPB164. The purpose of this investigation was to ascertain subsurface conditions and contaminant levels and the western extent of the offsite plume south of Hempstead Turnpike and west of Seaman's Neck Road. The locations of RE130D1 and RE130D2, as well as other VPBs and monitoring well locations, are shown in Figure 2.

The field investigation included completing two monitoring wells, well development, soil/groundwater analysis, groundwater sampling, and surveying. Field tasks were conducted in 2016 in accordance with the *United Federal Programs Sampling and Analysis Plan (UFP SAP)*, Bethpage, New York (Resolution, 2013a). In addition, the work adhered to the following UFP SAP Addendums: *Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling Protocol* (Resolution Consultants, 2013b) and *Installation of Vertical Profile Borings and Monitoring Wells* (Resolution Consultants, 2013c).

Documentation of these activities is included in Appendix A of this report.

1.2 Site History

NWIRP Bethpage is in the Hamlet of Bethpage, Town of Oyster Bay, New York. Since its inception in 1941, the plant's primary mission was the research, prototyping, testing, design, engineering, fabrication, and primary assembly of military aircraft. The facilities at NWIRP included four plants used for assembly and prototype testing, a group of quality control laboratories, two warehouse complexes (north and south), a salvage storage area, water recharge basins, the Industrial Wastewater Treatment Plant, and several smaller support buildings.

The Navy's property originally totaled 109.5 acres and was formerly a Government-Owned Contractor-Operated (GOCO) facility that was operated by Northrop Grumman (NG) until September 1998. Prior to 2002, the NWIRP property was bordered on the north, west, and south by current or former NG facilities, and on the east by a residential neighborhood. By March 2008, approximately 100 acres of NWIRP property were transferred to Nassau County in three separate actions. The remaining 9 acres and access easements were retained by the Navy to continue remedial efforts at Installation Restoration (IR) Site 1 – Former Drum Marshalling Area and Site 4 – Former Underground Storage Tanks (Area of Concern [AOC] 22). A parcel of land connecting the two sites was also retained. Currently, the 9-acre parcel of NWIRP is bordered on the east by the residential neighborhood and on the north, south, and west by Steel Equities; however, a small portion is still owned by Nassau County. Access to the NWIRP is from South Oyster Bay Road.

1.3 Geology and Hydrogeology

Overburden at the site consists of well over 1,000 feet (ft) of unconsolidated deposits overlying crystalline bedrock of the Hartland Formation. Overburden is divided into four geologic units: the upper Pleistocene deposits, the Magothy Formation, the clay member of the Raritan Formation ("Raritan Clay") and the Lloyd Sand member of the Raritan Formation ("Lloyd Sand") (Geraghty and Miller, 1994).

The upper Pleistocene ranges in thickness from approximately 50 to 100 ft and consists of till and outwash deposits of medium to coarse sand and gravel with lenses of fine sand, silt and clay (Smolensky and Feldman, 1988); these deposits form the Upper Glacial Aquifer. Directly underlying this unit is the Magothy Formation with a thickness of 650 to 900 ft and lower extent of 700 to 1,000 ft below ground surface (bgs), as observed at the former NWIRP and extending southeast to areas south of Southern State Parkway. Locally at the RE130 locations, the bottom of the Magothy (top of the Raritan Clay) is encountered at approximately 958 feet bgs. The Magothy is characterized by fine to medium sands and silts interbedded with zones of clays, silty sands and sandy clays. Sand and gravel lenses are found in some areas between depths of 600 and 880 ft bgs; these deposits form the main producing zones of the Magothy Aquifer.

Investigations performed by the Navy since 2012 indicate that the bottom of the Magothy (top of the Raritan Clay) can extend to depths of 700 to greater than 1,000 ft bgs. The top of the Raritan Clay deepens to the south-southeast, as evidenced by clay depths of 1,000 ft bgs (or more) in borings installed offsite. The Raritan Clay Unit is of continental origin and consists of clay, silty clay, clayey silt, and fine silty sand. This member acts as a confining layer over the Lloyd Sand Unit. The Lloyd Sand Unit is also of continental origin, having been deposited in a large fresh water lacustrine

environment. The material consists of fine to coarse-grained sands, gravel, inter-bedded clay, and silty sand. These deposits form the Lloyd Aquifer.

The Upper Glacial Aquifer and the Magothy Aquifer comprise the aquifers of interest at the NWIRP. Regionally, these formations are generally considered to form a common, interconnected aquifer as the coarse nature of each unit near their contact and the lack of any regionally confining clay unit allows for the unrestricted flow of groundwater between the formations.

The Magothy Aquifer is the major source of public water in Nassau County. The most productive water bearing zones are the discontinuous lenses of sand and gravel that occur within the siltier matrix. The major water-bearing zones are coarse sand and gravel lenses located in the lower portion of the Magothy. The Magothy Aquifer is commonly regarded to function overall as an unconfined aquifer at shallow depths and a confined aquifer at deeper depths. The drilling program at the NWIRP has revealed that clay zones beneath the facility are common but laterally discontinuous. No confining clay units of facility-wide extent have been encountered. This is also the case for borings installed offsite.

Groundwater is encountered at a depth of approximately 50 ft bgs at the facility. Historically, because of pumping and recharge at the facility, groundwater depths have been measured to range from 40 to 60 ft bgs. The groundwater flow in the area is to the south-southeast.

Resolution Consultants reviewed the geologic data and regional literature and developed four representative base-wide cross sections to support development of a Conceptual Site Model (CSM). A description of the application of Environmental Sequence Stratigraphy (ESS) and the results are provided in Appendix B.

2.0 FIELD PROGRAM

Two monitoring wells were installed in the vicinity of VPB164 between May 2016 and June 2016. Field investigation activities consisted of drilling, well installation, well development, sampling, soil/groundwater analysis, and surveying. Drilling during this investigation was performed by Delta Well and Pump Company of Ronkonkoma, New York. A description of these tasks is provided below.

2.1 Drilling and Well Construction

Monitoring wells RE130D1 and RE130D2 were installed using mud rotary drilling techniques (Figure 2). Depths of monitoring wells RE130D1 and RE130D2 were 580 ft and 665 ft respectively. Well construction details are summarized in Table 1. Boring logs with lithologic descriptions of the well screen interval are included in Appendix A. *2016 OU2 Groundwater Investigation VPB164* (Resolution Consultants, 2017) documents the installation of VPB164 including detailed lithologic descriptions, continuous gamma plot and multiple Volatile Organic Compounds (VOC) sample results over the entire boring length. The gamma and trichloroethene (TCE) tetrachloroethene (PCE) plot for VPB164 along with the well screen intervals at RE130D1 and RE130D2 is included in Appendix A.

Prior to installing each monitoring well, screen intervals were determined based on intervals with the highest VOC concentrations as measured in the VPB164 hydropunch samples and coincident intervals with the highest apparent permeability based on the VPB164 gamma logs and geologist logs. During the monitoring well installation, split spoon samples were collected every 5 ft in the screen interval. One soil sample per monitoring well was analyzed for Total Organic Carbon (TOC) via United States (US) Environmental Protection Agency (EPA) series SW-846 method 9060A by Katahdin Analytical Services (Katahdin). Data validation of TOC data was performed by Resolution Consultants. Data validation packages and analytical data tables are included in Appendix A.

Wells were constructed of 4-inch diameter, Schedule 80, National Sanitation Foundation-approved polyvinylchloride (PVC) riser pipe and .010-slot well screen. Wells were completed at the surface with a 12-inch diameter steel curb box. Well risers were set below grade and fit with lockable J plugs. Detailed monitoring well construction diagrams are included in Appendix A.

2.2 Well Development

Following installation, all monitoring wells were developed to evacuate silts and other fine-grained materials and to establish the filter pack to promote a hydraulic connection between the well and

the surrounding aquifer. Well development was not initiated until at least 24 hours after well installation.

Monitoring well screens were developed using a combination of air lifting, manual surging, and pumping with a submersible pump. Turbidity was monitored during development to determine stabilization. In compliance with New York State Department of Environmental Conservation (NYSDEC) policy, wells were developed until turbidity was less than 50 nephelometric turbidity units (NTUs) if possible. Table 2 summarizes total pumped volume from air and pump development and final turbidity. Well development logs are included in Appendix A.

2.3 Sampling

Following development, wells were allowed to stabilize for at least 2 weeks prior to groundwater sampling in accordance with low flow sampling procedures. Wells were purged using a bladder pump with a drop tube intake placed at the approximate midpoint of the screened interval. The following water quality parameters were continuously measured: water temperature, pH, conductivity, oxidation-reduction potential, dissolved oxygen and turbidity. Groundwater analytical samples were collected when water quality parameters stabilized. Samples were analyzed for VOCs via method 8260C and 1,4-dioxane via Method 8270D SIM by Katahdin. All development and purge water was managed as investigation derived waste (IDW). Groundwater sample logs and data validation packages are included in Appendix A.

Monitoring wells RE130D1 and RE130D2 were sampled by Resolution Consultants on October 18, 2016. Analytical results and stabilized field parameters for these monitoring wells are summarized in Table 3 and 4, respectively. Data validation is documented in Appendix A. These monitoring wells will be included in quarterly sampling as part of the Navy's ongoing Environmental Restoration Program.

2.4 Decontamination and Investigation Derived Waste

Resolution Consultants utilized dedicated and disposable sampling equipment when possible to avoid the potential for cross-contamination of samples. The sampling equipment included dedicated plastic scoops, disposable polyethylene tubing, disposable gloves, and laboratory supplied sample bottles. Hand held equipment and split spoons were decontaminated using Luminol and water wash, a potable water rinse, followed by a distilled water rinse. Water was collected in 5-gallon pails or 55-gallon drums. Non dedicated sampling equipment was decontaminated as outlined in the UFP SAP Addendum - *Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling Protocol* (Resolution Consultants, 2013b).

As part of the IDW management practices and in accordance with the SAP, the investigation waste (consisting of soil cuttings, drilling muds, IDW fluids, and personal protective equipment [PPE]) generated during the groundwater monitoring well installation and sampling was containerized and staged at NWIRP Bethpage.

IDW solids were containerized in roll offs. Representative samples from each roll off were submitted to Katahdin for analysis of:

- Target Compound List (TCL) VOCs
- TCL Semi-volatile Organic Compounds (SVOCs)
- Toxicity Characteristic Leaching Procedure (TCLP) Metals
- Polychlorinated Biphenyls (PCBs)
- Total petroleum hydrocarbons
- Corrosivity
- Ignitability
- Reactive Cyanide
- Reactive Sulfide
- Paint Filter

IDW fluid generated during well development and purging was containerized in frac tanks and stored at NWIRP Bethpage for characterization and ultimate disposal to the Publicly Owned Treatment Works (POTW), in accordance with the facilities existing discharge permit. A representative water sample was collected from each frac tank and submitted to Katahdin for analysis of VOCs via Method SW 624, pH via Method SW 9040B, PCBs via Method 8082 and Total Metals via Method SW 846. All analytical criteria were met for disposal of water.

2.5 Surveying

A survey of the monitoring well locations was conducted at the end of fieldwork by C. T. Male, Inc., of Latham, NY, under the direct supervision of Resolution Consultants. The locations were tied into the existing base map developed for this investigation. The survey elevation is referenced to the North American Vertical Datum (NAVD) 1988 and has a vertical accuracy of 0.01 foot. Vertical control is based on observations of the Continuously Operating Reference (COR) Stations Queens and Central Islip. The horizontal location is referenced to the North American Datum (NAD) 1983 (2011) NY. Long Island Zone 3104 and has an accuracy of 0.1 foot. Local horizontal and vertical

control is based on Global Positioning System (GPS) observations using the NYSNet Real Time Network.

A table of survey data (latitude/longitude, northing/easting, elevations of ground, rim and PVC) and a survey map is included in Appendix A.

3.0 REFERENCES

Geraghty and Miller, Inc., 1994. *Remedial Investigation Report, Grumman Aerospace Corporation, Bethpage, New York*. Revised September 1994.

Resolution Consultants, 2013a. *United Federal Programs Sampling and Analysis Plan, Site OU-2 Offsite Trichloroethene (TCE) Groundwater Plume Investigation, Bethpage, New York*. April 2013.

Resolution Consultants, 2013b. UFP SAP Addendum, *Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling Protocol*. November 2013.

Resolution Consultants, 2013c. UFP SAP Addendum, *Installation of Vertical Profile Borings and Monitoring Wells*. December 2013.

Resolution Consultants, 2017. *2016 OU2 Groundwater Investigation VPB164, Bethpage, NY*. May 2017.

Smolensky, D., and Feldman, S., 1988. *Geohydrology of the Bethpage-Hicksville-Levittown Area, Long Island, New York, U.S. Geological Survey Water-Resourced Investigations Report 88-4135*, 25 pp.

Tables

TABLE 1
MONITORING WELL CONSTRUCTION SUMMARY
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

MONITORING WELL	WELL COMPLETION DATE	GROUND ELEVATION (MSL)	PVC ELEVATION (INNER CASING) (MSL)	WELL DEPTH (ft bgs)	SURFACE CASING DEPTH (ft bgs)	SCREEN INTERVAL (ft bgs)	SUMP DEPTH INTERVAL (ft bgs)	BORING DEPTH (ft bgs)
RE130D1	5/27/2016	57.87	57.59	580	53	555-575	575-580	592
RE130D2	6/16/2016	57.97	57.72	665	53.5	640-660	660-665	677

MSL - mean sea level
ft bgs - feet below ground surface

TABLE 2
MONITORING WELL DEVELOPMENT SUMMARY
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

MONITORING WELL	AIR DEVELOPMENT		PUMP DEVELOPMENT			APPROX. TOTAL DEVELOPMENT VOLUME (GAL)	FINAL TURBIDITY (NTUs)
	DATE	APPROX. VOLUME (GAL)	DATE	FINAL PUMP DEPTH (FT BGS)	APPROX. VOLUME (GAL)		
RE130D1	6/22/2016	9,000	6/23/2016	555-575	4,500	13,500	1.33
RE130D2	6/21/2016	11,000	6/24/2016	640-660	3,800	14,800	1.03

GAL - gallon

FT BGS - feet below ground surface

NTUs - Nephelometric Turbidity Units

TABLE 3
ANALYTICAL DATA SUMMARY
 2016 OU2 GROUNDWATER INVESTIGATION
 NWIRP BETHPAGE, NY

Location	NYSDEC Groundwater Guidance or Standard Value (Note 1)	RE130D1	RE130D2	RE130D2
Sample Date		10/18/2016	10/18/2016	10/18/2016
Sample ID		RE130D1-GW-101816	RE130D2-GW-101816	DUP1-GW-101816
Sample type code		Groundwater	Groundwater	FD
VOC 8260C (ug/L)				
1,1,1-TRICHLOROETHANE	5	<0.50 U	<0.50 U	<0.50 U
1,1,2,2-TETRACHLOROETHANE	5	<0.50 U	<0.50 U	<0.50 U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	5	<0.50 U	<0.50 U	<0.50 U
1,1,2-TRICHLOROETHANE	1	<0.50 U	<0.50 U	<0.50 U
1,1-DICHLOROETHANE	5	<0.50 U	<0.50 U	<0.50 U
1,1-DICHLOROETHENE	5	<0.50 U	<0.50 U	<0.50 U
1,2,4-TRICHLOROBENZENE	5	<0.50 U	<0.50 U	<0.50 U
1,2-DIBROMO-3-CHLOROPROPANE	0.04	<0.75 U	<0.75 U	<0.75 U
1,2-DIBROMOETHANE	NL	<0.50 U	<0.50 U	<0.50 U
1,2-DICHLOROBENZENE	3	<0.50 U	<0.50 U	<0.50 U
1,2-DICHLOROETHANE	5	<0.50 U	<0.50 U	<0.50 U
1,2-DICHLOROETHENE, TOTAL	5	<1.0 U	<1.0 U	<1.0 U
1,2-DICHLOROPROPANE	1	<0.50 U	<0.50 U	<0.50 U
1,3-DICHLOROBENZENE	3	<0.50 U	<0.50 U	<0.50 U
1,4-DICHLOROBENZENE	3	<0.50 U	<0.50 U	<0.50 U
1,4-DIOXANE (Method 8270D_SIM)	NL	<0.18 U	<0.17 U	<0.18 U
2-BUTANONE	50	<2.5 UJ	<2.5 UJ	<2.5 UJ
2-HEXANONE	50	<2.5 U	<2.5 U	<2.5 U
4-METHYL-2-PENTANONE	NL	<2.5 U	<2.5 U	<2.5 U
ACETONE	50	<2.5 UJ	<2.5 UJ	<2.5 UJ
BENZENE	1	<0.50 U	<0.50 U	<0.50 U
BROMODICHLOROMETHANE	50	<0.50 U	<0.50 U	<0.50 U
BROMOFORM	50	<0.50 U	<0.50 U	<0.50 U
BROMOMETHANE	5	<1.0 U	<1.0 U	<1.0 U
CARBON DISULFIDE	60	<0.50 UJ	<0.50 UJ	<0.50 UJ
CARBON TETRACHLORIDE	5	<0.50 U	<0.50 U	<0.50 U
CHLOROBENZENE	5	<0.50 U	<0.50 U	<0.50 U
CHLOROETHANE	5	<1.0 UJ	<1.0 UJ	<1.0 UJ
CHLOROFORM	7	<0.50 U	<0.50 U	<0.50 U
CHLOROMETHANE	5	<1.0 UJ	<1.0 UJ	<1.0 UJ
CIS-1,2-DICHLOROETHENE	5	<0.50 U	<0.50 U	<0.50 U
CIS-1,3-DICHLOROPROPENE	0.4	<0.50 U	<0.50 U	<0.50 U
CYCLOHEXANE	NL	<0.50 U	<0.50 U	<0.50 U
DIBROMOCHLOROMETHANE	5	<0.50 U	<0.50 U	<0.50 U
DICHLORODIFLUOROMETHANE	5	<1.0 UJ	<1.0 UJ	<1.0 UJ
ETHYLBENZENE	5	<0.50 U	<0.50 U	<0.50 U
ISOPROPYLBENZENE	5	<0.50 U	<0.50 U	<0.50 U
M- AND P-XYLENE	NL	<1.0 U	<1.0 U	<1.0 U
METHYL ACETATE	NL	<0.75 U	<0.75 U	<0.75 U
METHYL CYCLOHEXANE	NL	<0.50 U	<0.50 U	<0.50 U
METHYL TERT-BUTYL ETHER	10	<0.50 U	<0.50 U	<0.50 U
METHYLENE CHLORIDE	5	<2.5 U	<2.5 U	<2.5 U
O-XYLENE	NL	<0.50 U	<0.50 U	<0.50 U
STYRENE	5	<0.50 U	<0.50 U	<0.50 U
TETRACHLOROETHENE	5	<0.50 U	<0.50 U	<0.50 U
TOLUENE	5	<0.50 U	<0.50 U	<0.50 U
TRANS-1,2-DICHLOROETHENE	5	<0.50 U	<0.50 U	<0.50 U
TRANS-1,3-DICHLOROPROPENE	0.4	<0.50 U	<0.50 U	<0.50 U
TRICHLOROETHENE	5	<0.50 U	<0.50 U	<0.50 U
TRICHLOROFUOROMETHANE	5	<1.0 U	<1.0 U	<1.0 U
VINYL CHLORIDE	2	<1.0 U	<1.0 U	<1.0 U
XYLENES, TOTAL	5	<1.5 U	<1.5 U	<1.5 U

TABLE 3
ANALYTICAL DATA SUMMARY
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

Notes:

1 New York State Department of Environmental Conservation Division of Water Technical and Operation Guidance series
(6 NYCRR 700-706, Part 703.5 summarized in TOGS 1.1.1)

Ambient water quality standards and groundwater effluent limitations, class GA; NL = Not Listed

Bold = Detected; ***Bold and Italics*** = Not detected exceeds NYS Groundwater Standards or guidance value

Yellow highlighted values exceed Groundwater Standards or guidance value

Sample type codes: N - normal environmental sample, FD - field duplicate

U = Nondetected result. The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte.

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

M = the matrix spike or matrix spike duplicate did not meet recovery or precision requirements.

TABLE 4
STABILIZED FIELD PARAMETERS
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

Well	Date	Temperature (°C)	pH	Specific Conductance (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to water (ft bgs)	Flow rate (ml/min)
RE130D1	10/18/2016	16.73	5.28	0.121	1.53	82.7	10.94	26.84	200
RE130D2	10/18/2016	17.22	2.45	0.072	1.01	-11.9	33.1	26.15	500

°C - degrees Celsius

µS/cm - Microsiemens per Centimeter

mg/L - milligrams per liter

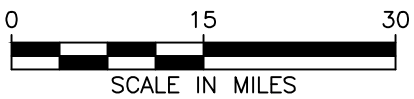
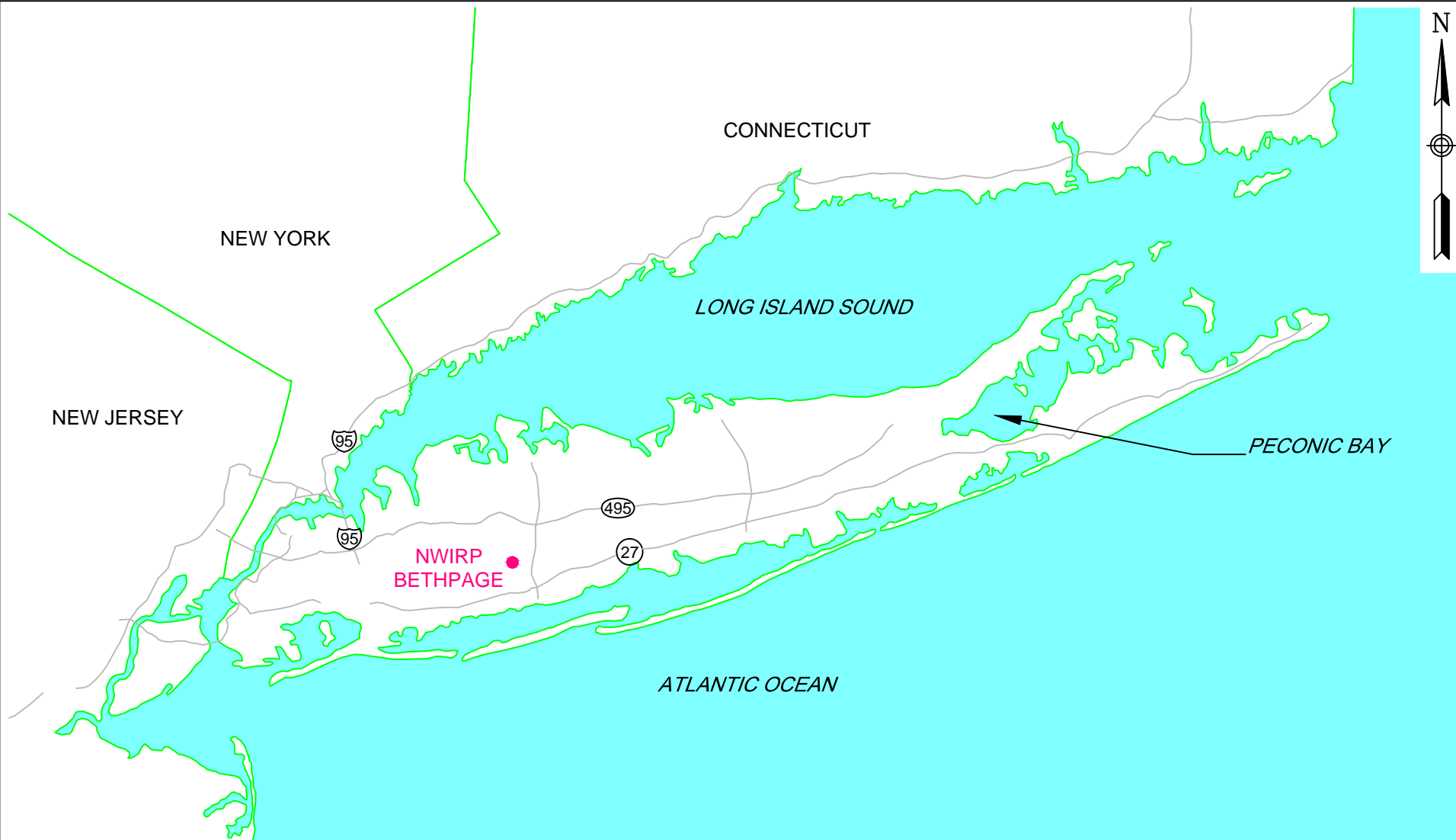
mV - Millivolts

NTU - Nephelometric Turbidity Unit

ft bgs - feet below ground surface

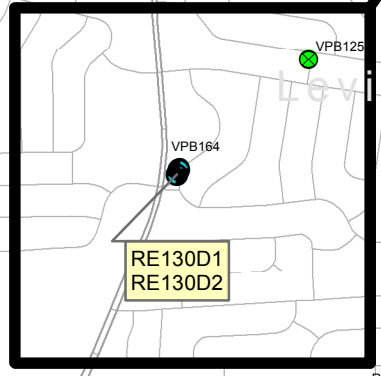
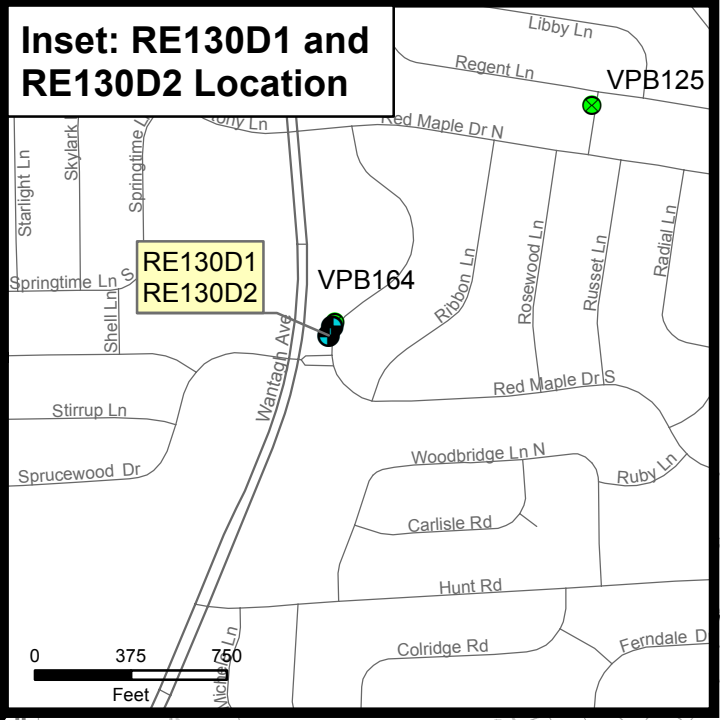
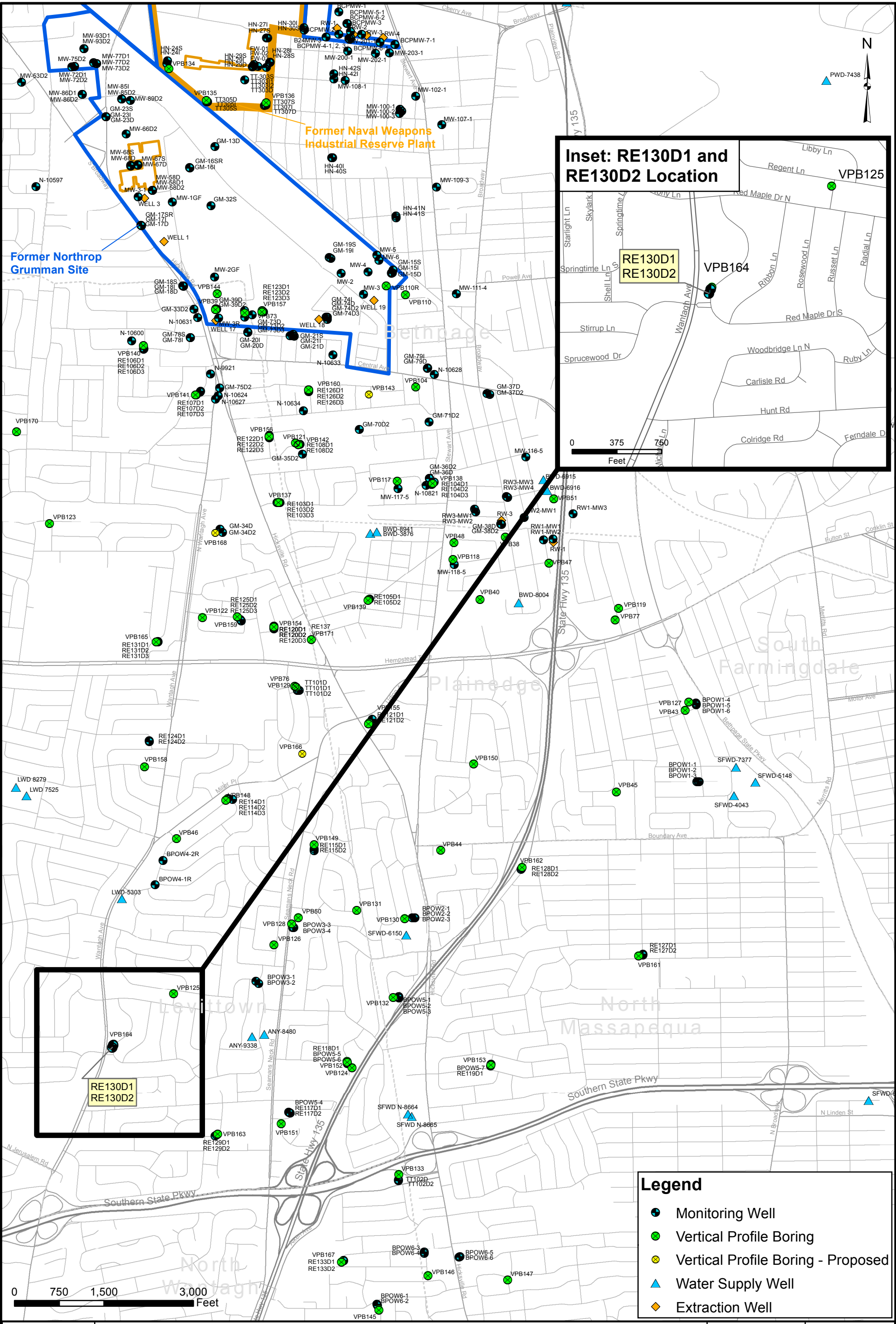
ml/min - milliliters per minute

Figures



GENERAL LOCATION MAP
NWIRP BETHPAGE
BETHPAGE, NEW YORK

CONTRACT NUMBER N62470-11-D-8013		CTO NUMBER WE15	
APPROVED BY ---		DATE ---	
APPROVED BY ---		DATE ---	
FIGURE NO. 1			REV 0



Legend	
	Monitoring Well
	Vertical Profile Boring
	Vertical Profile Boring - Proposed
	Water Supply Well
	Extraction Well



RE130D1 AND RE130D2 LOCATION MAP
 NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
 BETHPAGE, NEW YORK

CONTRACT NUMBER N62470-11-D8013	CTO NUMBER WE15
APPROVED BY PS	DATE 3/22/2017
APPROVED BY	DATE
FIGURE NO. 2	REV 0

Appendices

Appendix A

RE130D1, RE130D2

Section 1

Boring Logs

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		Logged By: V. Varricchio
Location: Wantagh Ave & West Red Maple Dr, Town of Hampstead, NY		Drilling Company: Delta Well & Pump
Project #: 60266526	Ground Elevation (msl): 57.87	Well Screen Interval (ft): 555-575
Start Date: 5/19/2015*	Drilling Method: Auger (0-50' bgs) Mud Rotary (>50' bgs)	Water Level (ft):
Finish Date: 5/27/2016	Northing: 197584.59 Easting: 1122360.37	Total Depth (ft): 592.0

* Casing installed with Auger rig 5/16/16 - 5/17/16.

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
0					0-558 ft; See VPB164 for Descriptions		
50							10" Diameter Steel Casing
100							
150							
200							Bentonite Grout
250							
300							
350							
400							
450							4" Diameter Schedule 80 PVC Riser
500							

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		Logged By: V. Varricchio
Location: Wantagh Ave & West Red Maple Dr, Town of Hampstead, NY		Drilling Company: Delta Well & Pump
Project #: 60266526	Ground Elevation (msl): 57.87	Well Screen Interval (ft): 555-575
Start Date: 5/19/2015	Drilling Method: Auger (0-50' bgs) Mud Rotary (>50' bgs)	Water Level (ft):
Finish Date: 5/27/2016	Northing: 197584.59 Easting: 1122360.37	Total Depth (ft): 592.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
500					0-558 ft; See VPB164 for Descriptions (<i>continued</i>)		
502							
504							
506							
508							
510							
512							
514							
516							
518							
520							
522							
524							
526							
528							
530							
532							
534							
536							
538							
540							
542							
544							
546							
548							
550							
552							
554							
556							
558	0		SW		Gray (10YR 5/1) well graded fine to medium subrounded SAND, trace lignite		
560							
562	0		SP		Gray (10YR 6/1) poorly graded fine SAND		
564							
566	0		SP		Gray (10YR 6/1) poorly graded fine SAND		4" Diameter Schedule 80 PVC, 10 Slot Well Screen (555-575 ft bgs)
568							
570	0		SP		Gray (10YR 6/1) poorly graded fine SAND		
572							
574	0		SP		Gray (10YR 5/1) poorly graded fine SAND		
576							
578							Sump
580							
582							
584							
586							
588							#1 Sand to Bottom
590							
592					End of boring at 592.0 ft. bgs.		

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		Logged By: V. Varricchio
Location: Wantagh Ave & West Red Maple Dr, Town of Hampstead, NY		Drilling Company: Delta Well & Pump
Project #: 60266526	Ground Elevation (msl): 57.97	Well Screen Interval (ft): 640-660
Start Date: 6/2/2016 *	Drilling Method: Auger (0-50' bgs) Mud Rotary (>50' bgs)	Water Level (ft):
Finish Date: 6/16/2016	Northing: 197604.41 Easting: 1122370.25	Total Depth (ft): 677.0

* Casing installed with Auger rig 5/12/16 - 5/13/16.

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
0					0-643 ft; See VPB164 for Descriptions		
50							10" Diameter Steel Casing
100							
150							
200							
250							Bentonite Grout
300							
350							
400							
450							
500							4" Diameter Schedule 80 PVC Riser
550							

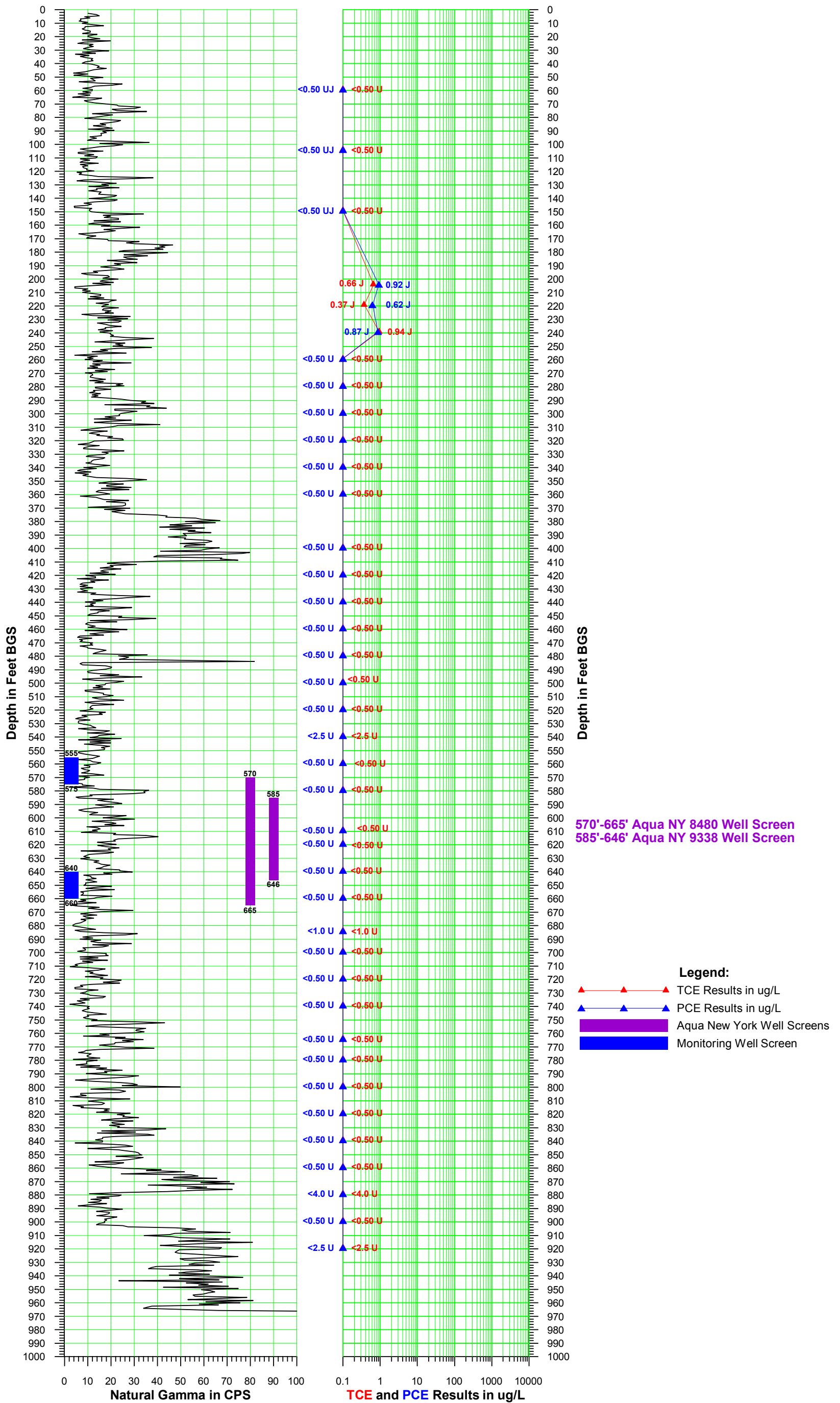
Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		Logged By: V. Varricchio
Location: Wantagh Ave & West Red Maple Dr, Town of Hampstead, NY		Drilling Company: Delta Well & Pump
Project #: 60266526	Ground Elevation (msl): 57.97	Well Screen Interval (ft): 640-660
Start Date: 6/2/2016	Drilling Method: Auger (0-50' bgs) Mud Rotary (>50' bgs)	Water Level (ft):
Finish Date: 6/16/2016	Northing: 197604.41 Easting: 1122370.25	Total Depth (ft): 677.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
590					0-643 ft; See VPB164 for Descriptions (<i>continued</i>)		
592							
594							
596							
598							
600							
602							
604							
606							
608							
610							
612							
614							
616							
618							
620							
622							
624							
626							
628							
630							
632							
634							
636							
638							
640							
642	0		SP		Gray (10YR 6/1) poorly graded medium SAND, trace lignite		
644							
646							
648	0		SW		Gray (10YR 6/1) well graded medium to coarse subrounded SAND		
650							
652							
654	0		SW		Yellow (10YR 7/6) well graded fine to coarse subrounded SAND		4" Diameter Schedule 80 PVC, 10 Slot Well Screen (640-660 ft bgs)
656							
658	0		SP		Light gray (10 YR 7/2) poorly graded fine SAND, trace silt		
660							
662							Sump
664							
666							
668							
670							
672							#1 Sand to Bottom
674							
676							
End of boring at 677.0 ft. bgs.							

Section 2

VPB164 Gamma and TCE/PCE Plot

**Vertical Profile Boring VPB-164
Downward Run - May 2, 2016
Validated Analytical Data**



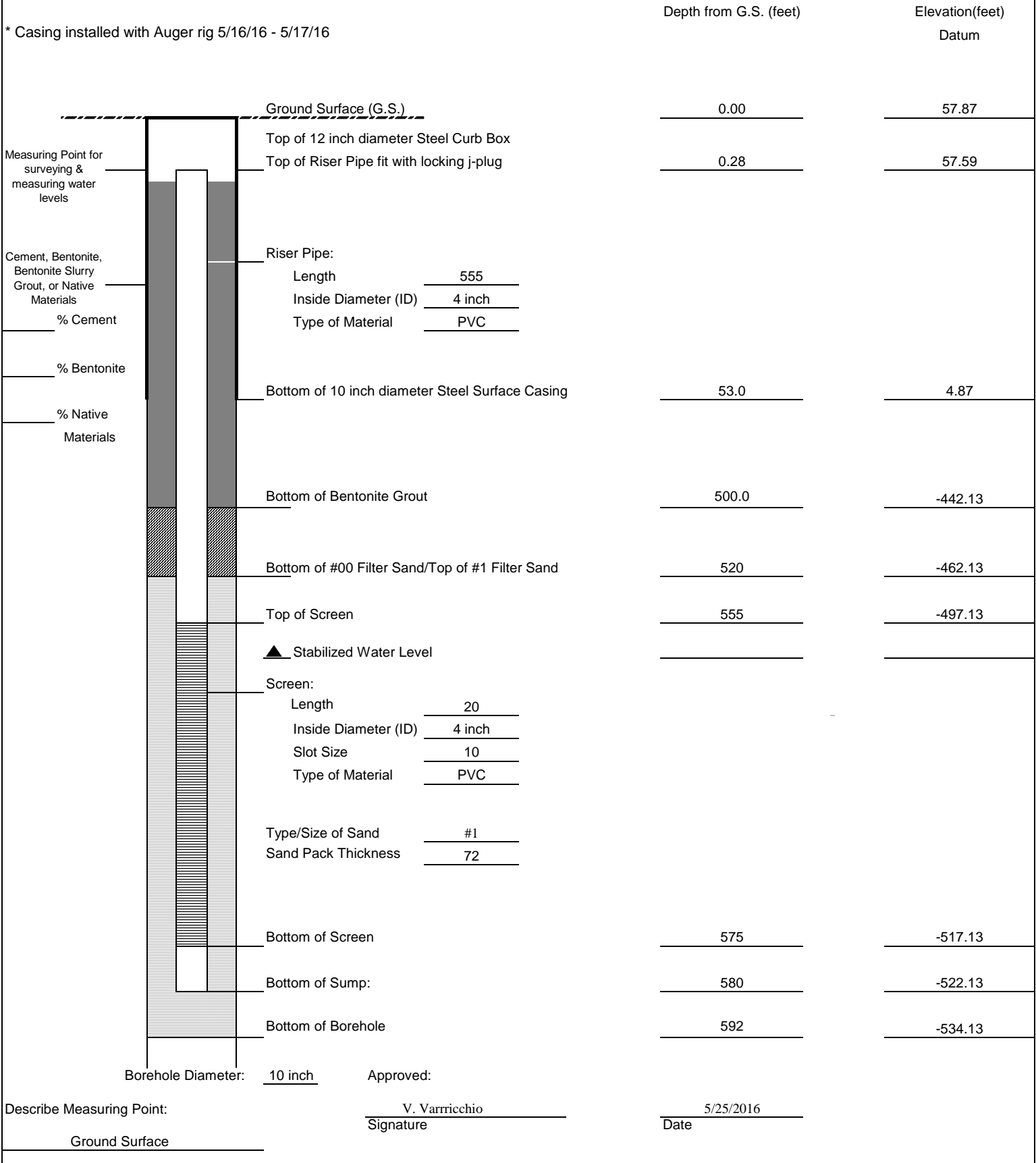
Section 3

Monitoring Well Construction Logs



Client: NAVFAC	Project Number: 60266526	WELL ID: RE130D1
Site Location: NWIRP BETHPAGE, NY		
Well Location: Wantagh Ave & West Red Maple Dr, Town of Hampstead, NY		Date Installed: 5/19/2016 - 5/27/2016*
Method: MUD ROTARY		Inspector: V. Varricchio
Coords: Northing: 197584.59 Easting: 1122360.37		Contractor: DELTA WELL & PUMP

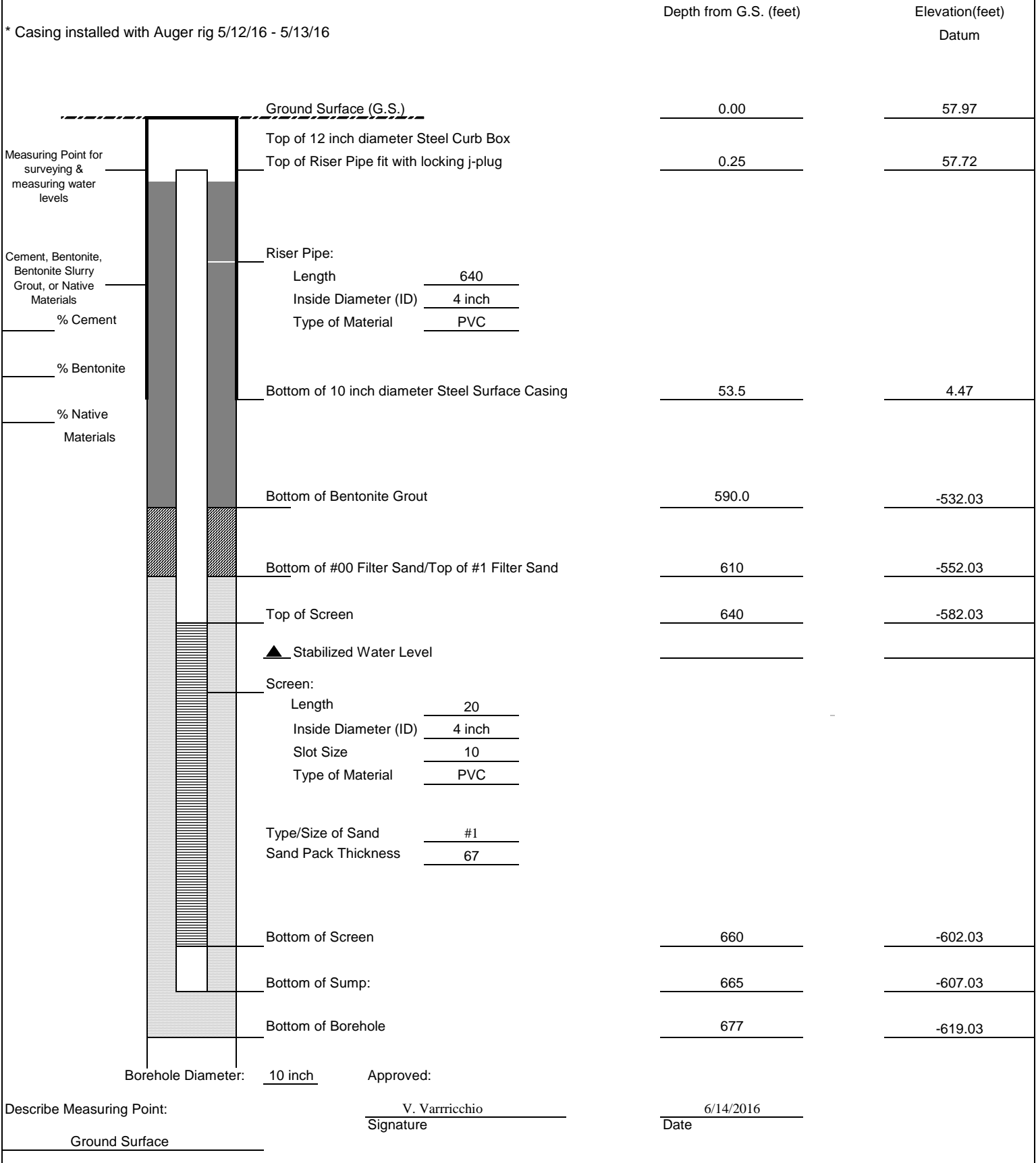
MONITORING WELL CONSTRUCTION DETAIL





Client: NAVFAC	Project Number: 60266526	WELL ID: RE130D2
Site Location: NWIRP BETHPAGE, NY		
Well Location: Wantagh Ave & West Red Maple Dr, Town of Hampstead, NY		Date Installed: 6/2/2016 - 6/16/2016*
Method: MUD ROTARY		Inspector: V. Varricchio
Coords: Northing: 197604.41 Easting: 1122370.25		Contractor: DELTA WELL & PUMP

MONITORING WELL CONSTRUCTION DETAIL



Section 4

Groundwater Sample Log Sheets



RESOLUTION CONSULTANTS

Well ID: RE13001

Low Flow Ground Water Sample Collection Record

Client: NWIRP Bethpage Date: 10.18.16 Time: Start 1:30 am/pm
 Project No: 60266526 Finish 1:15 am/pm
 Site Location: Red Maple N
 Weather Conds: Sunny 80° Collector(s): Paul Kurek

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length 580 ft c. Length of Water Column _____ ft (a-b) Casing Diameter/Material 4-inch PVC
 b. Water Table Depth 26.89 ft d. Calculated System Volume (see back) 13.1 gal. 20 screen length (ft)

2. WELL PURGE DATA

a. Purge Method: Geotech bladder pump with drop tube assembly

b. Acceptance Criteria defined (see workplan)

- Temperature ± 3%
 - pH ± 0.1 unit
 - Conductivity ± 3%
 - Turbidity ± 10%
 - ORP ± 10mV
 - Drawdown < 0.3'
 - D.O. ± 10% (values >0.5 mg/L)
- Remove a minimum 1 screen volume

c. Field Testing Equipment used:

Make	Model	Serial Number
YSI	556	15218
LaMotte	2020	82090

Time (24hr)	Volume Removed (gallons)	Temp. (°C)	Conduct. (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Depth to water (ft)	Color/Odor
1405										ON
1420		17.57	0.114	3.75	5.05	100.9		600		
1425		17.35	0.117	2.65	5.10	103.4			26.89	
1430		17.32	0.127	2.45	5.35	94.2				
1435		17.31	0.125	2.24	5.23	97.9				
1440	5 gal	17.24	0.124	2.04	5.22	94.2	18.2			

d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Has required turbidity been reached	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Have parameters stabilized	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If no or N/A - Explain below.

3. SAMPLE COLLECTION:

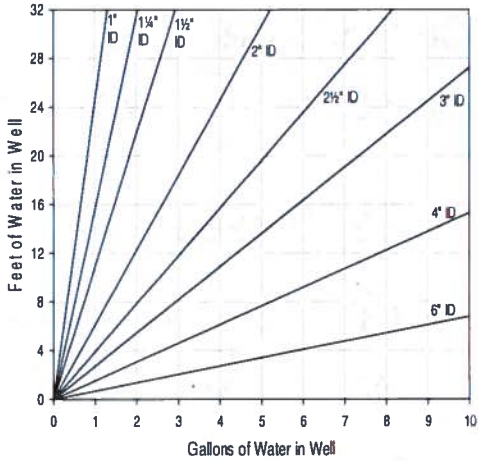
Method: Geotech bladder pump with drop tube assembly

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time
<u>RE13001-GW-101816</u>	40-mL vials	3	HCl	VOCs	1530
	1-L amber	2	none	1,4-Dioxane	

Comments: hit bottom with tubing

Signature: Paul Kurek Date: 10/18/16

Purge Volume Calculation



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
0.25	0.0025	0.0097
0.375	0.0057	0.0217
0.5	0.0102	0.0386
0.75	0.0229	0.0869
1	0.0408	0.1544
1.25	0.0637	0.2413
1.5	0.0918	0.3475
2	0.1632	0.6178
2.5	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

One screen volume (4-inch well)

- 15 ft = 37.1 L / 9.8 G
- 20 ft = 49.4 L / 13.1 G
- 25 ft = 61.8 L / 16.3 G
- 30 ft = 74.3 L / 19.6 G
- 40 ft = 99.2 L / 26.1 G
- 50 ft = 123.6 L / 32.6 G

Well ID: RE130 D1 14:15

(continued from front)										
Time (24 hr)	Volume Removed (gallons)	Temp (°C)	Conduct. (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Depth to water (ft)	Color/Odor
1445		17.05	0.123	1.84	5.14	98.2	11.0	650	26.88	
1455		17.11	0.123	1.77	5.19	98.6	14.36			
1455		17.09	0.122	1.82	5.22	99.4	10.70			
1500		17.09	0.123	1.79	5.22	96.6	19.0			
1505	10 gal	16.98	0.122	1.62	5.23	93.0	12.27	650	26.89	
1510		16.77	0.122	1.70	5.24	84.5	20.6			
1515		16.83	0.122	1.60	5.28	81.9	11.64			
1520	13 gal	16.84	0.122	1.56	5.29	80.8	11.00		26.84	
1525		16.76	0.121	1.53	5.29	81.7	17.79			
1530	15 gal	16.77	0.121	1.53	5.28	82.7	10.94			
1530								200		Sample
										1530-1545 purge



Well ID: RE130D2

Low Flow Ground Water Sample Collection Record

Client: NWIRP Bethpage Date: 10-18-16 Time: Start 1400 am/pm
 Project No: 60266526 Finish 1615 am/pm
 Site Location: Red Maple N
 Weather Conds: Sunny 80° Collector(s): Paul Kurethy

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length 665 ft c. Length of Water Column _____ ft (a-b) Casing Diameter/Material 4-inch PVC
 b. Water Table Depth 26.15 ft d. Calculated System Volume (see back) 13.1 gal. 20 screen length (ft)

2. WELL PURGE DATA

a. Purge Method: Geotech bladder pump with drop tube assembly

b. Acceptance Criteria defined (see workplan)

- Temperature ± 3%
 - pH ± 0.1 unit
 - Conductivity ± 3%
 - Turbidity ± 10%
 - ORP ± 10mV
 - Drawdown < 0.3'
 - D.O. ± 10% (values >0.5 mg/L)
- Remove a minimum 1 screen volume

c. Field Testing Equipment used:

Make	Model	Serial Number
YSI	556	74830
LaMotte	2020	82090

Time (24hr)	Volume Removed (gallons)	Temp. (°C)	Conduct. (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Flow Rate (mL/min)	Depth to water (ft)	Color/Odor
1405		17.86	0.074		1.64	59.6				Start pump, ^{easy} No od
1425		17.68	0.075	3.17	1.68	38.8		500		
1430		17.81	0.083	2.23	2.13	10.5			26.10	
1435		17.60	0.080	1.89	2.09	10.9	56	500		
	56									
1440		17.41	0.073	1.32	1.96	20.1	48	500	26.15	

d. Acceptance criteria pass/fail

	Yes	No	N/A	(continued on back)
Has required volume been removed	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Has required turbidity been reached	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Have parameters stabilized	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

If no or N/A - Explain below.

3. SAMPLE COLLECTION:

Method: Geotech bladder pump with drop tube assembly

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time
<u>RE130D2-GW-101816</u>	<u>40-mL vials</u>	<u>3</u>	<u>HCl</u>	<u>VOCs</u>	<u>1535</u>
<u>RE130D2-GW-101816</u>	<u>1-L amber</u>	<u>2</u>	<u>none</u>	<u>1,4-Dioxane</u>	
<u>DUPI-GW-101816</u>					<u>1545</u>

Comments _____

Signature Sally Veldijk Date 10/18/16

Section 5

Analytical Data Validation

[The Data Validation report included here contains only result tables for RE130D1 and RE130D2; for the complete September 2016 Quarterly Sampling Data Validation, see September *2016 Groundwater Sampling Data Summary Report, Bethpage, NY*, Resolution Consultants, 2016.]

September 2016
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

Sample Delivery Group				SJ8622		
Lab ID				SJ8622-5		
Sample ID				RE130D1-GW-101816		
Sample Date				10/18/2016		
Sample Type				Groundwater		
Method	Analyte	CAS No	Units	Result	Qual	RC
8260C	1,1,1-TRICHLOROETHANE	71-55-6	UG_L	0.5	U	
8260C	1,1,2,2-TETRACHLOROETHANE	79-34-5	UG_L	0.5	U	
8260C	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	UG_L	0.5	U	
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.5	U	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.5	U	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	0.5	U	
8260C	1,2,4-TRICHLOROBENZENE	120-82-1	UG_L	0.5	U	
8260C	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	UG_L	0.75	U	
8260C	1,2-DIBROMOETHANE	106-93-4	UG_L	0.5	U	
8260C	1,2-DICHLOROBENZENE	95-50-1	UG_L	0.5	U	
8260C	1,2-DICHLOROETHANE	107-06-2	UG_L	0.5	U	
8260C	1,2-DICHLOROETHENE, TOTAL	540-59-0	UG_L	1	U	
8260C	1,2-DICHLOROPROPANE	78-87-5	UG_L	0.5	U	
8260C	1,3-DICHLOROBENZENE	541-73-1	UG_L	0.5	U	
8260C	1,4-DICHLOROBENZENE	106-46-7	UG_L	0.5	U	
8260C	2-BUTANONE	78-93-3	UG_L	2.5	UJ	c
8260C	2-HEXANONE	591-78-6	UG_L	2.5	U	
8260C	4-METHYL-2-PENTANONE	108-10-1	UG_L	2.5	U	
8260C	ACETONE	67-64-1	UG_L	2.5	UJ	c
8260C	BENZENE	71-43-2	UG_L	0.5	U	
8260C	BROMODICHLOROMETHANE	75-27-4	UG_L	0.5	U	
8260C	BROMOFORM	75-25-2	UG_L	0.5	U	
8260C	BROMOMETHANE	74-83-9	UG_L	1	U	
8260C	CARBON DISULFIDE	75-15-0	UG_L	0.5	UJ	c
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	0.5	U	
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	UJ	c
8260C	CHLOROFORM	67-66-3	UG_L	0.5	U	
8260C	CHLOROMETHANE	74-87-3	UG_L	1	UJ	c
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	0.5	U	
8260C	CIS-1,3-DICHLOROPROPENE	10061-01-5	UG_L	0.5	U	
8260C	CYCLOHEXANE	110-82-7	UG_L	0.5	U	
8260C	DIBROMOCHLOROMETHANE	124-48-1	UG_L	0.5	U	
8260C	DICHLORODIFLUOROMETHANE	75-71-8	UG_L	1	UJ	c
8260C	ETHYLBENZENE	100-41-4	UG_L	0.5	U	
8260C	ISOPROPYLBENZENE	98-82-8	UG_L	0.5	U	
8260C	M- AND P-XYLENE	108-38-3/106-42	UG_L	1	U	
8260C	METHYL ACETATE	79-20-9	UG_L	0.75	U	
8260C	METHYL CYCLOHEXANE	108-87-2	UG_L	0.5	U	
8260C	METHYL TERT-BUTYL ETHER	1634-04-4	UG_L	0.5	U	
8260C	METHYLENE CHLORIDE	75-09-2	UG_L	2.5	U	
8260C	O-XYLENE	95-47-6	UG_L	0.5	U	
8260C	STYRENE	100-42-5	UG_L	0.5	U	
8260C	TETRACHLOROETHENE	127-18-4	UG_L	0.5	U	
8260C	TOLUENE	108-88-3	UG_L	0.5	U	
8260C	TRANS-1,2-DICHLOROETHENE	156-60-5	UG_L	0.5	U	
8260C	TRANS-1,3-DICHLOROPROPENE	10061-02-6	UG_L	0.5	U	
8260C	TRICHLOROETHENE	79-01-6	UG_L	0.5	U	
8260C	TRICHLOROFLUOROMETHANE	75-69-4	UG_L	1	U	
8260C	VINYL CHLORIDE	75-01-4	UG_L	1	U	
8260C	XYLENES, TOTAL	1330-20-7	UG_L	1.5	U	
8270D_SIM	1,4-DIOXANE	123-91-1	UG_L	0.18	U	

Notes:

- UG_L = Micrograms per liter
- NA = Not applicable
- Qual = Final qualifiers (See Attachment B)
- RC = Reason codes (See Attachment C)

September 2016
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

Sample Delivery Group				SJ8622		
Lab ID				SJ8622-6		
Sample ID				RE130D2-GW-101816		
Sample Date				10/18/2016		
Sample Type				Groundwater		
Method	Analyte	CAS No	Units	Result	Qual	RC
8260C	1,1,1-TRICHLOROETHANE	71-55-6	UG_L	0.5	U	
8260C	1,1,2,2-TETRACHLOROETHANE	79-34-5	UG_L	0.5	U	
8260C	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	UG_L	0.5	U	
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.5	U	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.5	U	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	0.5	U	
8260C	1,2,4-TRICHLOROBENZENE	120-82-1	UG_L	0.5	U	
8260C	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	UG_L	0.75	U	
8260C	1,2-DIBROMOETHANE	106-93-4	UG_L	0.5	U	
8260C	1,2-DICHLOROBENZENE	95-50-1	UG_L	0.5	U	
8260C	1,2-DICHLOROETHANE	107-06-2	UG_L	0.5	U	
8260C	1,2-DICHLOROETHENE, TOTAL	540-59-0	UG_L	1	U	
8260C	1,2-DICHLOROPROPANE	78-87-5	UG_L	0.5	U	
8260C	1,3-DICHLOROBENZENE	541-73-1	UG_L	0.5	U	
8260C	1,4-DICHLOROBENZENE	106-46-7	UG_L	0.5	U	
8260C	2-BUTANONE	78-93-3	UG_L	2.5	UJ	c
8260C	2-HEXANONE	591-78-6	UG_L	2.5	U	
8260C	4-METHYL-2-PENTANONE	108-10-1	UG_L	2.5	U	
8260C	ACETONE	67-64-1	UG_L	2.5	UJ	c
8260C	BENZENE	71-43-2	UG_L	0.5	U	
8260C	BROMODICHLOROMETHANE	75-27-4	UG_L	0.5	U	
8260C	BROMOFORM	75-25-2	UG_L	0.5	U	
8260C	BROMOMETHANE	74-83-9	UG_L	1	U	
8260C	CARBON DISULFIDE	75-15-0	UG_L	0.5	UJ	c
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	0.5	U	
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	UJ	c
8260C	CHLOROFORM	67-66-3	UG_L	0.5	U	
8260C	CHLOROMETHANE	74-87-3	UG_L	1	UJ	c
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	0.5	U	
8260C	CIS-1,3-DICHLOROPROPENE	10061-01-5	UG_L	0.5	U	
8260C	CYCLOHEXANE	110-82-7	UG_L	0.5	U	
8260C	DIBROMOCHLOROMETHANE	124-48-1	UG_L	0.5	U	
8260C	DICHLORODIFLUOROMETHANE	75-71-8	UG_L	1	UJ	c
8260C	ETHYLBENZENE	100-41-4	UG_L	0.5	U	
8260C	ISOPROPYLBENZENE	98-82-8	UG_L	0.5	U	
8260C	M- AND P-XYLENE	108-38-3/106-42	UG_L	1	U	
8260C	METHYL ACETATE	79-20-9	UG_L	0.75	U	
8260C	METHYL CYCLOHEXANE	108-87-2	UG_L	0.5	U	
8260C	METHYL TERT-BUTYL ETHER	1634-04-4	UG_L	0.5	U	
8260C	METHYLENE CHLORIDE	75-09-2	UG_L	2.5	U	
8260C	O-XYLENE	95-47-6	UG_L	0.5	U	
8260C	STYRENE	100-42-5	UG_L	0.5	U	
8260C	TETRACHLOROETHENE	127-18-4	UG_L	0.5	U	
8260C	TOLUENE	108-88-3	UG_L	0.5	U	
8260C	TRANS-1,2-DICHLOROETHENE	156-60-5	UG_L	0.5	U	
8260C	TRANS-1,3-DICHLOROPROPENE	10061-02-6	UG_L	0.5	U	
8260C	TRICHLOROETHENE	79-01-6	UG_L	0.5	U	
8260C	TRICHLOROFLUOROMETHANE	75-69-4	UG_L	1	U	
8260C	VINYL CHLORIDE	75-01-4	UG_L	1	U	
8260C	XYLENES, TOTAL	1330-20-7	UG_L	1.5	U	
8270D_SIM	1,4-DIOXANE	123-91-1	UG_L	0.17	U	

Notes:

- UG_L = Micrograms per liter
- NA = Not applicable
- Qual = Final qualifiers (See Attachment B)
- RC = Reason codes (See Attachment C)

September 2016
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

Sample Delivery Group				SJ8622		
Lab ID				SJ8622-7		
Sample ID				DUP1-GW-101816		
Sample Date				10/18/2016		
Sample Type				Duplicate of RE130D2-GW-101816		
Method	Analyte	CAS No	Units	Result	Qual	RC
8260C	1,1,1-TRICHLOROETHANE	71-55-6	UG_L	0.5	U	
8260C	1,1,2,2-TETRACHLOROETHANE	79-34-5	UG_L	0.5	U	
8260C	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	UG_L	0.5	U	
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.5	U	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.5	U	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	0.5	U	
8260C	1,2,4-TRICHLOROBENZENE	120-82-1	UG_L	0.5	U	
8260C	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	UG_L	0.75	U	
8260C	1,2-DIBROMOETHANE	106-93-4	UG_L	0.5	U	
8260C	1,2-DICHLOROBENZENE	95-50-1	UG_L	0.5	U	
8260C	1,2-DICHLOROETHANE	107-06-2	UG_L	0.5	U	
8260C	1,2-DICHLOROETHENE, TOTAL	540-59-0	UG_L	1	U	
8260C	1,2-DICHLOROPROPANE	78-87-5	UG_L	0.5	U	
8260C	1,3-DICHLOROBENZENE	541-73-1	UG_L	0.5	U	
8260C	1,4-DICHLOROBENZENE	106-46-7	UG_L	0.5	U	
8260C	2-BUTANONE	78-93-3	UG_L	2.5	UJ	c
8260C	2-HEXANONE	591-78-6	UG_L	2.5	U	
8260C	4-METHYL-2-PENTANONE	108-10-1	UG_L	2.5	U	
8260C	ACETONE	67-64-1	UG_L	2.5	UJ	c
8260C	BENZENE	71-43-2	UG_L	0.5	U	
8260C	BROMODICHLOROMETHANE	75-27-4	UG_L	0.5	U	
8260C	BROMOFORM	75-25-2	UG_L	0.5	U	
8260C	BROMOMETHANE	74-83-9	UG_L	1	U	
8260C	CARBON DISULFIDE	75-15-0	UG_L	0.5	UJ	c
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	0.5	U	
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	UJ	c
8260C	CHLOROFORM	67-66-3	UG_L	0.5	U	
8260C	CHLOROMETHANE	74-87-3	UG_L	1	UJ	c
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	0.5	U	
8260C	CIS-1,3-DICHLOROPROPENE	10061-01-5	UG_L	0.5	U	
8260C	CYCLOHEXANE	110-82-7	UG_L	0.5	U	
8260C	DIBROMOCHLOROMETHANE	124-48-1	UG_L	0.5	U	
8260C	DICHLORODIFLUOROMETHANE	75-71-8	UG_L	1	UJ	c
8260C	ETHYLBENZENE	100-41-4	UG_L	0.5	U	
8260C	ISOPROPYLBENZENE	98-82-8	UG_L	0.5	U	
8260C	M- AND P-XYLENE	108-38-3/106-42	UG_L	1	U	
8260C	METHYL ACETATE	79-20-9	UG_L	0.75	U	
8260C	METHYL CYCLOHEXANE	108-87-2	UG_L	0.5	U	
8260C	METHYL TERT-BUTYL ETHER	1634-04-4	UG_L	0.5	U	
8260C	METHYLENE CHLORIDE	75-09-2	UG_L	2.5	U	
8260C	O-XYLENE	95-47-6	UG_L	0.5	U	
8260C	STYRENE	100-42-5	UG_L	0.5	U	
8260C	TETRACHLOROETHENE	127-18-4	UG_L	0.5	U	
8260C	TOLUENE	108-88-3	UG_L	0.5	U	
8260C	TRANS-1,2-DICHLOROETHENE	156-60-5	UG_L	0.5	U	
8260C	TRANS-1,3-DICHLOROPROPENE	10061-02-6	UG_L	0.5	U	
8260C	TRICHLOROETHENE	79-01-6	UG_L	0.5	U	
8260C	TRICHLOROFLUOROMETHANE	75-69-4	UG_L	1	U	
8260C	VINYL CHLORIDE	75-01-4	UG_L	1	U	
8260C	XYLENES, TOTAL	1330-20-7	UG_L	1.5	U	
8270D_SIM	1,4-DIOXANE	123-91-1	UG_L	0.18	U	

Notes:

- UG_L = Micrograms per liter
- NA = Not applicable
- Qual = Final qualifiers (See Attachment B)
- RC = Reason codes (See Attachment C)

Attachment A
Final Qualifier Codes and Explanations

Qualifier	Explanation
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual quantitation limit necessary to accurately and precisely measure the analyte in the sample.
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Attachment B
Reason Codes and Explanations

Reason Code	Explanation
be	Equipment blank contamination
bf	Field blank contamination
bl	Laboratory blank contamination
bm	Missing Blank Information
bt	Trip blank contamination
c	Calibration issue
cr	Chromatographic resolution
d	Reporting limit raised due to chromatographic interference
dt	Dissolved result > total over limit
e	Ether interference
ej	Above calibration range; result estimated.
f	Presumed contamination from FB or ER.
fd	Field duplicate RPDs
h	Holding times
hs	Headspace greater than 6mm in all sample vials
i	Internal standard areas
ii	Injection internal standard area or retention time exceedance
it	Instrument Tune
k	Estimated Maximum Possible Concentrations (EMPC)
l	LCS recoveries
lc	Labeled compound recovery
ld	Laboratory duplicate RPDs (matrix duplicate, MSD, LCSD)
lp	Laboratory control sample/laboratory control sample duplicate RPDs
m	Matrix spike recovery
mc	Deviation from the method
md	MS/MSD precision
nb	Negative laboratory blank contamination
p	Chemical preservation issue
p-h	Uncertainty near detection limit (< Reporting Limit), historical reason code applied.
pe	Post Extraction Spike
q	Quantitation issue
r	Dual column RPD
rt	SIM ions not within + 2 seconds
s	Surrogate recovery
sp	Sample preparation issue
su	Evidence of ion suppression
t	Temperature Preservation Issue
x	Low % solids
y	Serial dilution results
z	ICS results



DATA VALIDATION REPORT

Project:	Regional Groundwater Investigation — NWIRP Bethpage		
Laboratory:	Katahdin Analytical		
Sample Delivery Groups:	SJ3645		
Analyses/Method:	Total Organic Carbon (TOC) by U.S. EPA SW-846 Method 9060A and Standard Method 5310B for Total Organic Carbon by High-Temperature Combustion		
Validation Level:	2		
Project Number:	0888812477.SA.DV		
Prepared by:	Dana Miller/Resolution Consultants	Completed on:	6/15/2016
Reviewed by:	Tina Cantwell/Resolution Consultants	File Name:	SJ3645_9060A_5310B

SUMMARY

This report summarizes data review findings for samples listed below, collected by Resolution Consultants from the Regional Groundwater Investigation — NWIRP Bethpage site on 24 May 2016 in accordance with the following Sampling and Analysis Plans:

- *Sampling and Analysis Plan, Bethpage, New York.* (Resolution Consultants April 2013).
- *UFP SAP Addendum, Installation of Vertical Profile Borings and Monitoring Wells, Operable Unit 2, NWIRP Bethpage, New York.* (Resolution Consultants November 2013).
- *UFP SAP Addendum, Inclusion of Additional Target Analytes for Volatile Organics Analyses, NWIRP Bethpage OU2, Bethpage, New York.* (Resolution Consultants August 2014).

Sample ID	Lab ID	Matrix/Sample Type	Analysis
RE130D1-SOIL-052416-558-560	SJ3645-1	Soil	9060A
RE130D1-EB-052416	SJ3645-2	Equipment Blank	5310B

Data validation activities were conducted using the following guidance documents: *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, specifically Method 9060A, Total Organic Carbon* (U.S. EPA, 1996), *Method SM5310B, Total Organic Carbon by High-Temperature Combustion*, *U.S. Environmental Protection Agency (U.S. EPA) Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (NFG, January 2010), and *Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2* (October 2010). In

the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

REVIEW ELEMENTS

The data were evaluated based on the following parameters (where applicable to the method):

- ✓ Data completeness (chain-of-custody)/sample integrity
- ✓ Holding times and sample preservation
- ✓ Gas chromatography/Mass spectrometer performance checks
- NA Initial calibration/continuing calibration verification
- ✓ Laboratory blanks/equipment blanks/field blanks/trip blanks
- NA Surrogate spike recoveries
- NA Matrix spike and/or matrix spike duplicate results
- ✓ Laboratory control sample laboratory control sample duplicate results
- NA Field duplicates
- NA Internal standards
- ✓ Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. Acceptable data parameters for which all criteria were met and no qualification was performed, and non-conformance or other issues that were noted during validation, but did not result in qualification of data are not discussed further.

Qualifications Actions

The data were reviewed independently from the laboratory to assess data quality. All compounds detected at concentrations less than the limit of quantitation but greater than the method detection limit were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation. No results were qualified during this review. Analytical completeness was calculated to be 100% and the data are usable for their intended purpose, according to U.S. Environmental Protection Agency and Department of Defense guidelines. Attachment A, Table A-1 provides final results after data review.

ATTACHMENTS

Attachment A: Table A-1 Final Results after Data Review

Attachment A
Final Results after Data Review

**Table A-1
Final Results after Data Review
Regional Groundwater Investigation NWIRP Bethpage**

Sample Delivery Group				SJ3645		SJ3645	
Lab ID				SJ3645-1		SJ3645-2	
Sample ID				RE130D1-SOIL-052416-558-560		RE130D1-EB-052416	
Sample Date				5/24/2016		5/24/2016	
Sample Type				Soil		Equipment Blank	
Method	Analyte	CAS No	Units	Result	Qual	Result	Qual
2540G	TOTAL SOLIDS	-29	PCT	89		NA	
5310B	TOTAL ORGANIC CARBON	-28	MG_L	NA		0.21	J
9060A	TOTAL ORGANIC CARBON	-28	UG_G	570		NA	

Notes:

- ID = Identification
- PCT = Percent
- MG_L = Milligrams per liter
- UG_G = Micrograms per gram
- Qual = Final interpreted qualifier
- NA = Not analyzed
- J = Estimated value – Value was below the limit of quantitation.



DATA VALIDATION REPORT

Project:	Regional Groundwater Investigation — NWIRP Bethpage		
Laboratory:	Katahdin Analytical		
Sample Delivery Groups:	SJ4358		
Analyses/Method:	Total Organic Carbon (TOC) by U.S. EPA SW-846 Method 9060A and Standard Method 5310B for Total Organic Carbon by High-Temperature Combustion		
Validation Level:	2		
Project Number:	0888812477.SA.DV		
Prepared by:	Dana Miller/Resolution Consultants	Completed on:	10/8/2016
Reviewed by:	Tina Cantwell/Resolution Consultants	File Name:	SJ4358_9060A_5310B

SUMMARY

This report summarizes data review findings for samples listed below, collected by Resolution Consultants from the Regional Groundwater Investigation — NWIRP Bethpage site on 13 June 2016 in accordance with the following Sampling and Analysis Plans:

- *Sampling and Analysis Plan, Bethpage, New York.* (Resolution Consultants April 2013).
- *UFP SAP Addendum, Installation of Vertical Profile Borings and Monitoring Wells, Operable Unit 2, NWIRP Bethpage, New York.* (Resolution Consultants November 2013).
- *UFP SAP Addendum, Inclusion of Additional Target Analytes for Volatile Organics Analyses, NWIRP Bethpage OU2, Bethpage, New York.* (Resolution Consultants August 2014).

Sample ID	Lab ID	Matrix/Sample Type	Analysis
RE130D2-SOIL-0613-643-645	SJ4358-1	Soil	9060A
RE130D2-EB-061316	SJ4358-2	Equipment Blank	5310B

Data validation activities were conducted using the following guidance documents: *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, specifically Method 9060A, Total Organic Carbon* (U.S. EPA, 1996), *Method SM5310B, Total Organic Carbon by High-Temperature Combustion*, *U.S. Environmental Protection Agency (U.S. EPA) Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (NFG, January 2010, and Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (October 2010). In

the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

REVIEW ELEMENTS

The data were evaluated based on the following parameters (where applicable to the method):

- ✓ Data completeness (chain-of-custody)/sample integrity
- ✓ Holding times and sample preservation
- ✓ Gas chromatography/Mass spectrometer performance checks
- NA Initial calibration/continuing calibration verification
- ✓ Laboratory blanks/equipment blanks/field blanks/trip blanks
- NA Surrogate spike recoveries
- ✓ Matrix spike and/or matrix spike duplicate results
- ✓ Laboratory control sample laboratory control sample duplicate results
- NA Field duplicates
- NA Internal standards
- ✓ Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. Acceptable data parameters for which all criteria were met and no qualification was performed, and non-conformance or other issues that were noted during validation, but did not result in qualification of data are not discussed further.

Qualifications Actions

The data were reviewed independently from the laboratory to assess data quality. All compounds detected at concentrations less than the limit of quantitation but greater than the method detection limit were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation. No results were qualified during this review. Analytical completeness was calculated to be 100% and the data are usable for their intended purpose, according to U.S. Environmental Protection Agency and Department of Defense guidelines. Attachment A, Table A-1 provides final results after data review.

ATTACHMENTS

Attachment A: Table A-1 Final Results after Data Review

Attachment A
Final Results after Data Review

**Table A-1
Final Results after Data Review
Regional Groundwater Investigation NWIRP Bethpage**

Sample Delivery Group				SJ4358		SJ4358	
Lab ID				SJ4358-1		SJ4358-2	
Sample ID				RE130D2-SOIL-0613-643-645		RE130D2-EB-061316	
Sample Date				6/13/2016		6/13/2016	
Sample Type				Soil		Equipment Blank	
Method	Analyte	CAS No	Units	Result	Qual	Result	Qual
2540G	TOTAL SOLIDS	-29	PCT	84		NA	
5310B	TOTAL ORGANIC CARBON	-28	MG_L	NA		0.35	J
9060A	TOTAL ORGANIC CARBON	-28	UG_G	2700		NA	

Notes:

ID = Identification
PCT = Percent
MG_L = Milligrams per liter
UG_G = Micrograms per gram
Qual = Final interpreted qualifier
NA = Not analyzed
J = Estimated value – Value was below the limit of quantitation.

Section 6

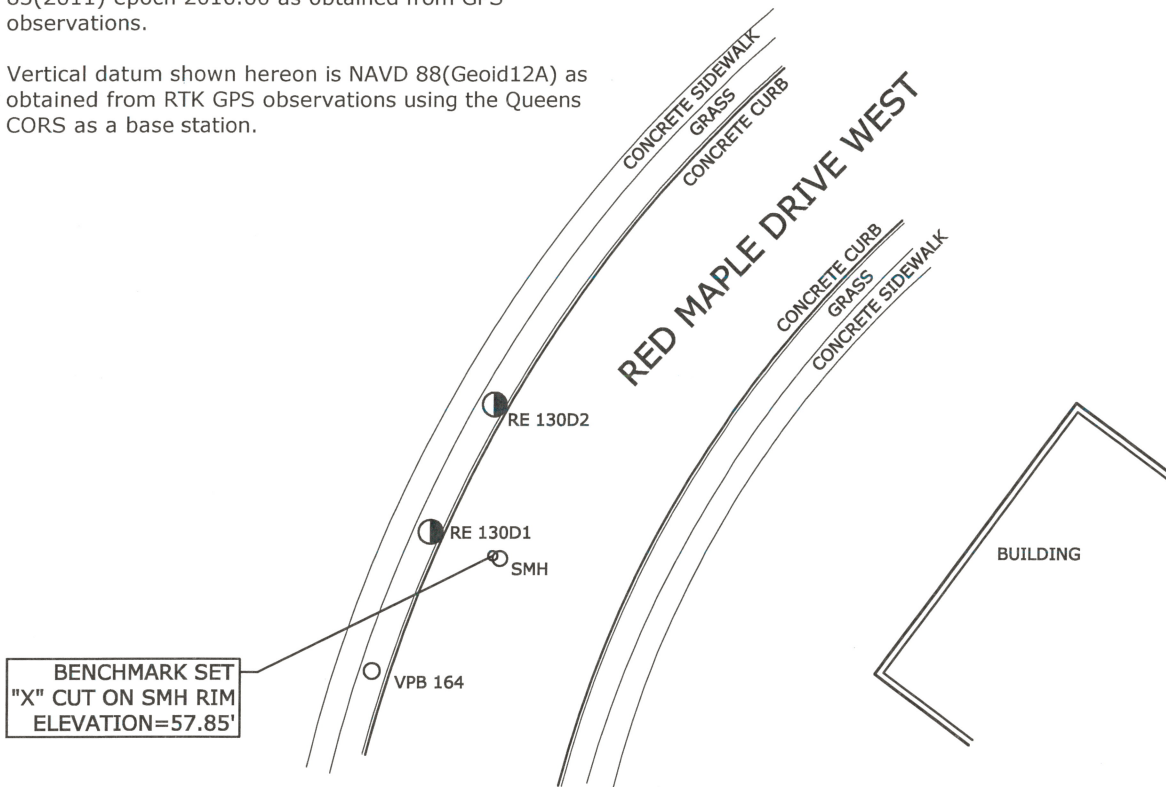
Survey

UNAUTHORIZED ALTERATION OR ADDITION TO THIS DOCUMENT IS A VIOLATION OF SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

Description	Northing	Easting	Latitude	Longitude	Ground	Top of Casing	PVC
VPB 164	197562.93	1122351.40	N40-42-28.31	W73-30-06.78	56.79	NA	NA
RE 130D1	197584.59	1122360.37	N40-42-28.52	W73-30-06.66	57.87	57.99	57.59
RE 130D2	197604.41	1122370.25	N40-42-28.72	W73-30-06.53	57.97	57.21	57.72

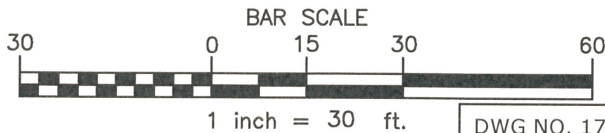
Map Notes

- Information shown hereon was compiled from an actual field survey conducted on March 20, 2017.
- North orientation is Grid North based on the New York State Plane Coordinate System, Long Island Zone, NAD 83(2011) epoch 2010.00 as obtained from GPS observations.
- Vertical datum shown hereon is NAVD 88(Geoid12A) as obtained from RTK GPS observations using the Queens CORS as a base station.



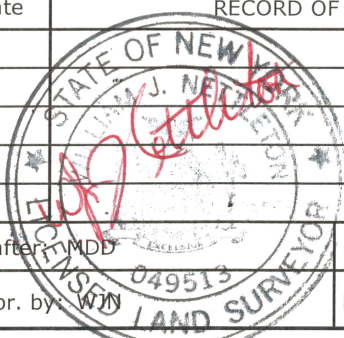
Legend

- RE 130D1 Monitor Well
- SMH Sanitary Manhole
- VPB 140 Vertical Profile Boring



DWG NO. 17-223

Date	RECORD OF WORK	Appr.	VERTICAL PROFILE BORING 164 SURVEY LOCATION 370 RED MAPLE DRIVE WEST
			TOWN OF WANTAGH
			NASSAU COUNTY, NEW YORK
			C.T. MALE ASSOCIATES Engineering, Surveying, Architecture & Landscape Architecture, D.P.C.
			50 CENTURY HILL DRIVE, LATHAM, NY 12110 518.786.7400 * FAX 518.786.7299
Drafter: MDD	Checker: MPN		SCALE: 1"=30'
Appr. by: WJN	Proj. No. 14.4121		
			DATE: MARCH 20, 2017



Appendix B
Geologic Cross Sections derived from
Environmental Sequence Stratigraphy (ESS)

Appendix B. Geologic Cross Sections derived from Environmental Sequence Stratigraphy

Resolution Consultants reviewed the geologic data and regional literature at the Naval Weapons Industrial Reserve Plant at Bethpage, New York and developed four representative base-wide cross sections to support development of a CSM. The cross sections are presented in Figure 1 - Figure 4. The cross sections provide geologic context for groundwater and analytical data and can be used as the framework upon which new and existing datasets (groundwater, analytical chemistry, geophysical data, etc.) can be analyzed to better understand groundwater flow-paths and contaminant transport and storage zones. As such, these sections are an integral component of an effective CSM.

The cross sections were developed using ESS. The ESS approach examines subsurface data in the context of the depositional environments and petroleum industry best practices of sequence stratigraphy and facies models. Shown for each boring included in the stratigraphic analysis are a vertical series of colored blocks which correspond to boring log lithology and a continuous data curve (in red or as a scan of a paper document, which corresponds to the gamma log). These colored blocks represent vertical grain size distribution and are the basis for the correlations between the data points.

The color coded blocks correspond to the graphic grainsize scale as shown in the cross-sections' keys. The width of the block increases with relative grainsize. Block color indicates the textural classification of the sediment (e.g., yellow for sand, green for silt, blue for clay) as written in the field notes of the core logging geologist (see the cross section keys for further definition).

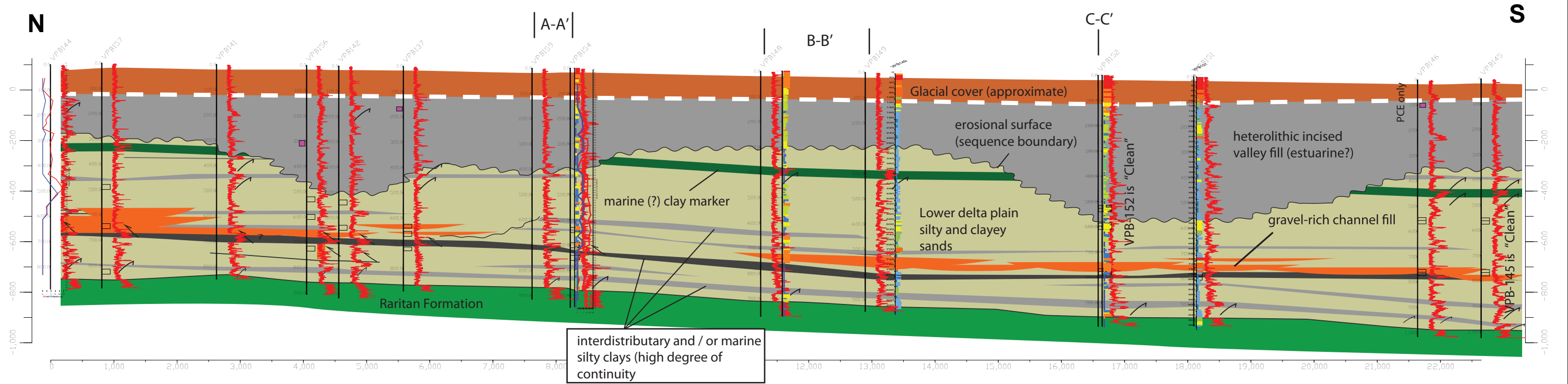
Logs of natural gamma emissions are a common proxy for grainsize. They typically are used as a correlation aide because repetitive spatially extensive trends in grainsize are easily identified visually when curves are examined along a given section. In non-granitic aquifer material, the chemistry of minerals found in clays result in higher concentrations of gamma emitting anions as opposed to the quartz, heavy minerals, and lithic fragments that generally predominate the coarser size fractions. Thus, peaks in the gamma logs can be indicative of clay layers and in general as gamma count per second increases, the grainsize decreases. Gamma logs should always be "calibrated" by comparing side by side with a lithologic log at representative locations. Good agreement between gamma logs and lithology logs were noted in the data points used for the ESS sections at Bethpage.

The previously established general hydrostratigraphy at Bethpage consists of the basal Raritan confining unit, the Magothy aquifer, and the shallow glacial aquifer. The stratigraphy shown in the sections presented in this technical memo is consistent with this general model but additionally shows the Magothy to consist of basal zone gravel-rich channel fills (orange in sections); extensive, planar marine clays (thin units shown in grey and dark green); and silty sands of inter-distributary and delta front origins (shown in tan). Additionally, an erosional incision into the lower delta plain sediments is observed throughout the site (portrayed in sections as a wavy solid black line). Above this, the Magothy sediments are more likely estuarine "incised valley fill" as indicated by the more heterogeneous gamma ray character. In some locations, such as VPB139 on section A-A', there appears to be clear lithologic control on contaminant distribution within the estuarine facies where the higher TCE and PCE concentrations occur in the coarser lithologic zones.

The depositional axis of the incised valley fill likely trends north-south/southeast. The incision is clearly indicated on all sections via the correlation of a prominent clay layer shown in sections in dark green. Where this clay is missing in the gamma logs, it is likely that it was eroded during a lowstand of sea level. Additionally, while relatively planar in their geometry, the major units dip gently south-south east. This is an important geologic characteristic to consider when comparing analytical results because hydrologic zones separated by thin confining layers within the Magothy may be accessed by screens of similar depth.

One of the most important benefits of the ESS approach is to develop and refine the CSM. ESS facilitates an understanding of the geology governing groundwater occurrence and movement, and provides an element for refining the approaches for assessment and remediation. The ESS results from this effort suggest that a modern analog (a modern geological setting that allows an understanding of the ancient environment) for the Magothy depositional environments is the Mackenzie River Delta, shown in Figure 5. Basal gravel zones are represented by the braided river deposits of the Toklat River, Alaska, in Figure 6.

Environmental Sequence Stratigraphy Cross Section



GRAIN SIZE LOG INDEX*

* not all grainsize categories shown in the comprehensive key are present at the site. Site sediments are predominately fine (clays, sandy clays, silts, and fine to medium sand)

Clay	Silty Sand (Medium Sand with 10-20% Fines)
Clay with 10% Sand	Clayey Sand (Medium Sand with 10-20% Fines)
Clay with 20% Sand	Fine Sand with Fine Gravel
Clay with 30% Sand	Fine Sand with Medium Gravel
Clay with 40% Sand	Fine Sand with Coarse Gravel
Clay with Fine Gravel	Medium Sand
Clay with Medium Gravel	Silty Sand (Coarse Sand with 50% Fines)
Clay with Coarse Gravel	Clayey Sand (Coarse Sand with 50% Fines)
Silt	Silty Sand (Coarse Sand with 40% Fines)
Silt with 10% Sand	Clayey Sand (Coarse Sand with 40% Fines)
Silt with 20% Sand	Silty Sand (Coarse Sand with 30% Fines)
Sandy Silt	Clayey Sand (Coarse Sand with 30% Fines)
Silty Sand	Silty Sand (Coarse Sand with 10-20% Fines)
Silty Sand	Clayey Sand (Coarse Sand with 10-20% Fines)
Silty Sand (Fine Sand with 40% Fines)	Medium Sand with Fine Gravel
Clayey Sand (Fine Sand with 40% Fines)	Medium Sand with Medium Gravel
Silty Sand (Fine Sand with 30% Fines)	Medium Sand with Coarse Gravel
Clayey Sand (Fine Sand with 30% Fines)	Coarse Sand
Silty Sand (Fine Sand with 10-20% Fines)	Coarse Sand with Fine Gravel
Clayey Sand (Fine Sand with 10-20% Fines)	Coarse Sand with Medium Gravel
Gravelly Silt (Silt with Fine Gravel)	Coarse Sand with Coarse Gravel
Gravelly Silt (Silt with Medium Gravel)	Clayey/Silty Gravel (Fine gravel with clay/silt)
Gravelly Silt (Silt with Coarse Gravel)	Clayey/Silty Gravel (Medium gravel with clay/silt)
Fine Sand	Clayey/Silty Gravel (Coarse gravel with clay/silt)
Silty Sand (Medium Sand with 50% Fines)	Sandy Gravel (Fine Gravel with Sand)
Clayey Sand (Medium Sand with 50% Fines)	Sandy Gravel (Medium Gravel with Sand)
Silty Sand (Medium Sand with 40% Fines)	Sandy Gravel (Coarse Gravel with Sand)
Clayey Sand (Medium Sand with 40% Fines)	Fine Gravel
Silty Sand (Medium Sand with 30% Fines)	Medium Gravel
Clayey Sand (Medium Sand with 30% Fines)	Coarse Gravel

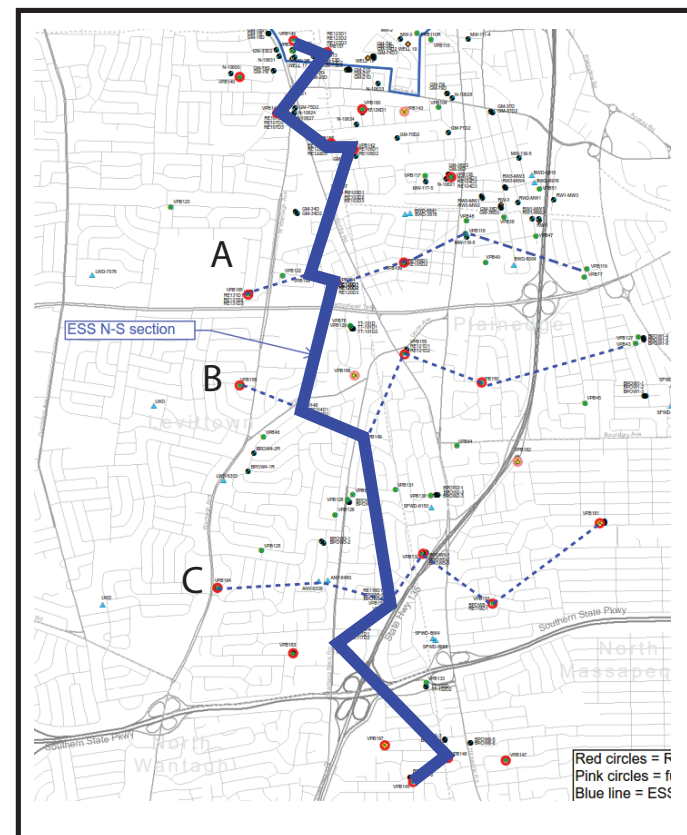


Figure 1. Cross Section N-S

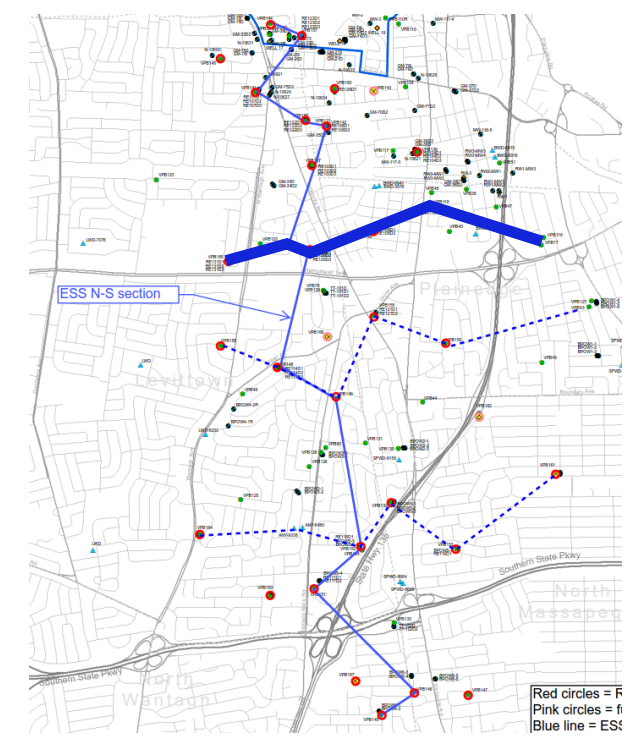
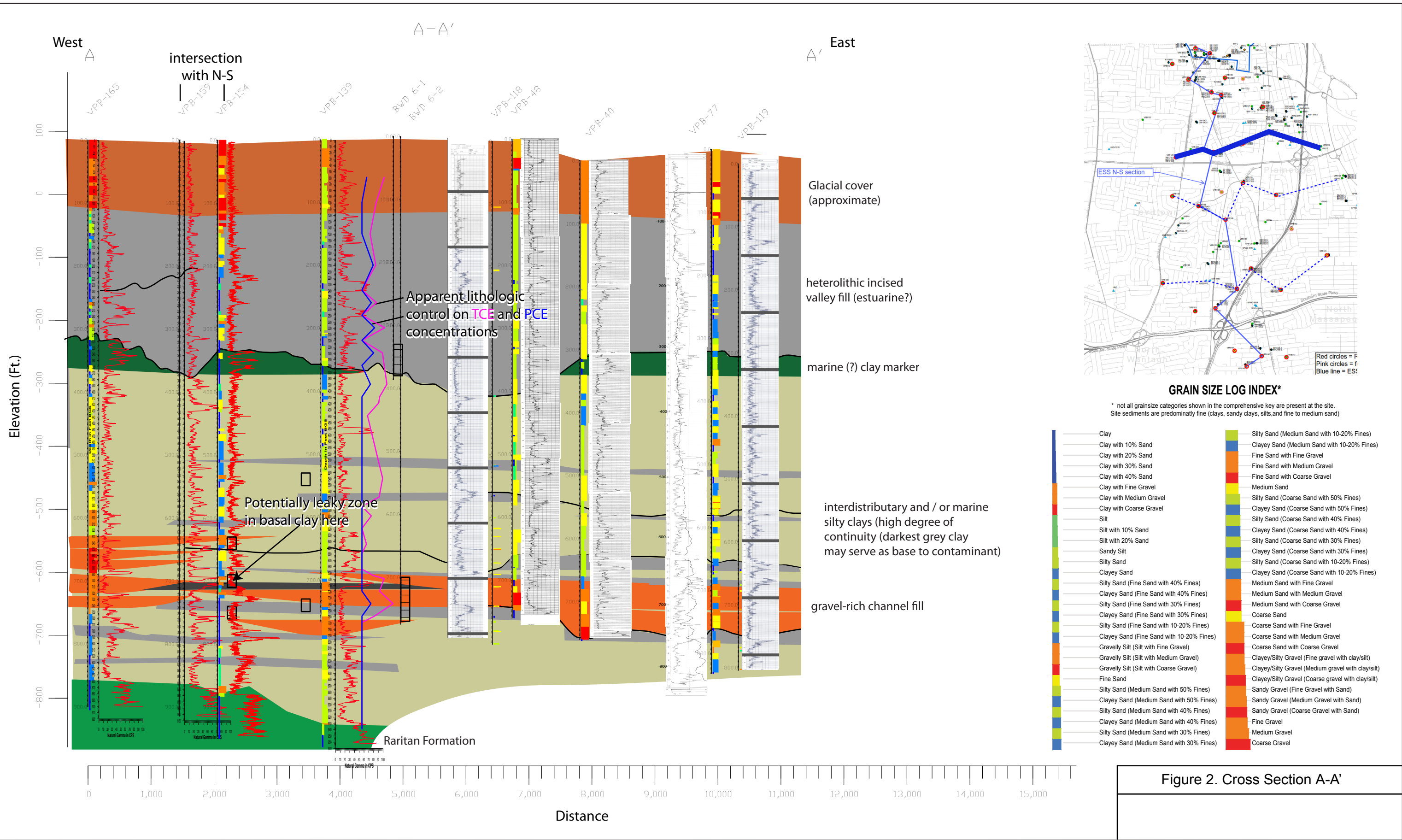
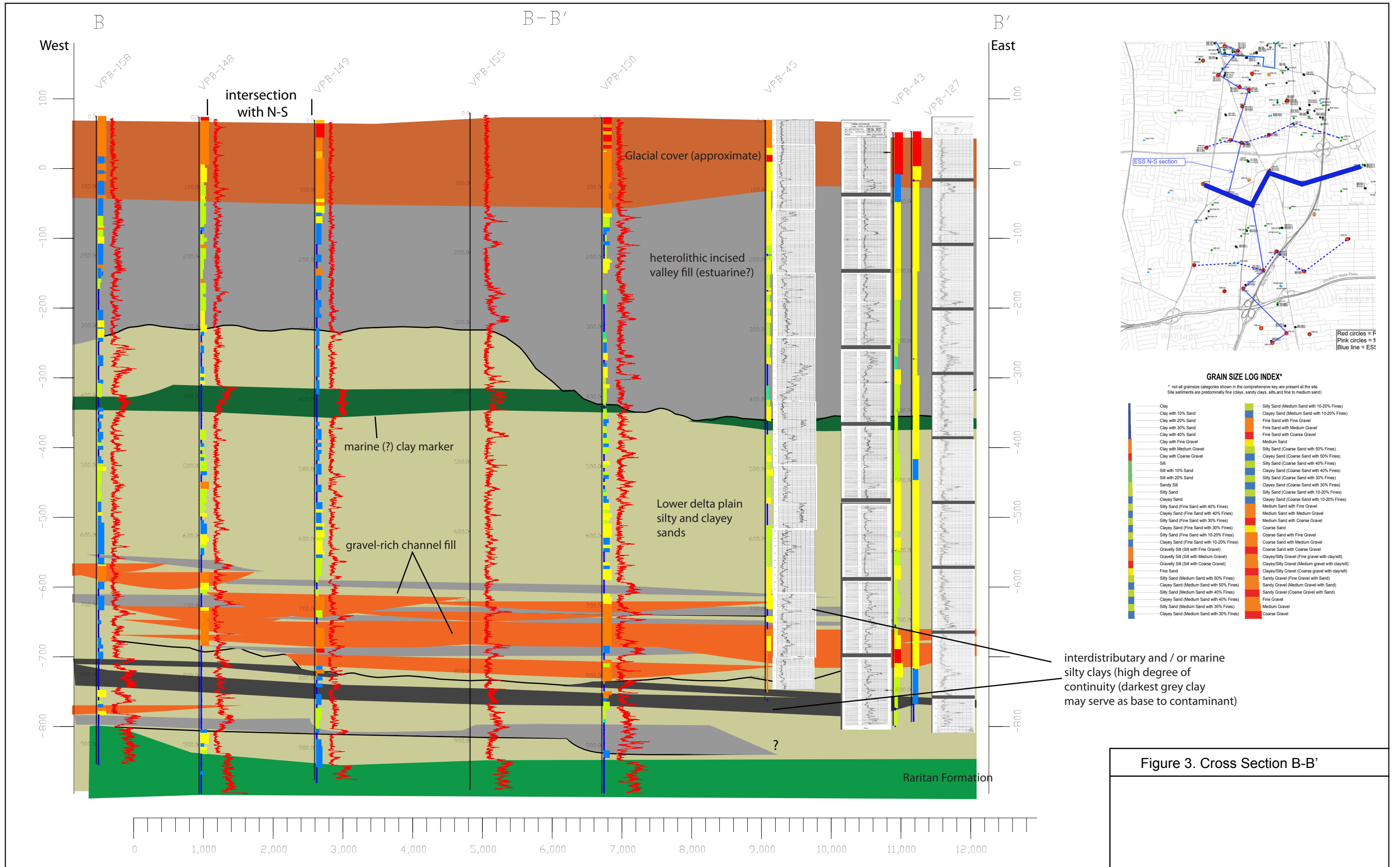
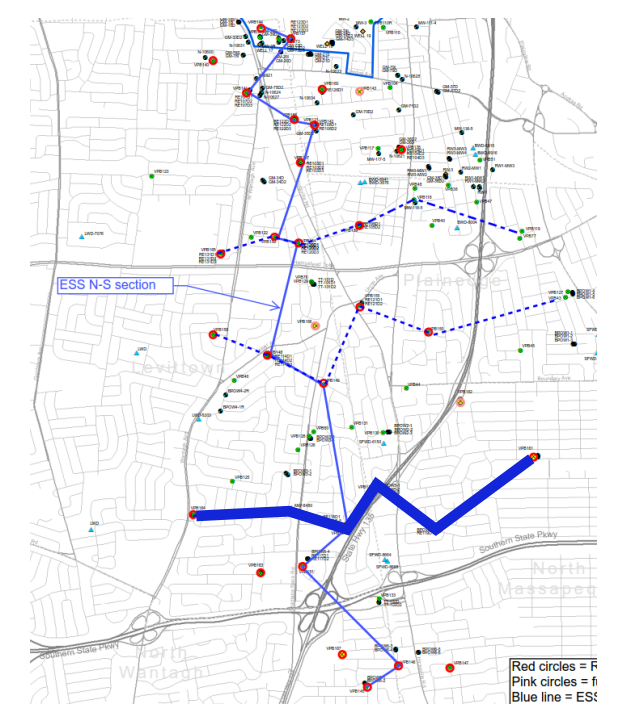
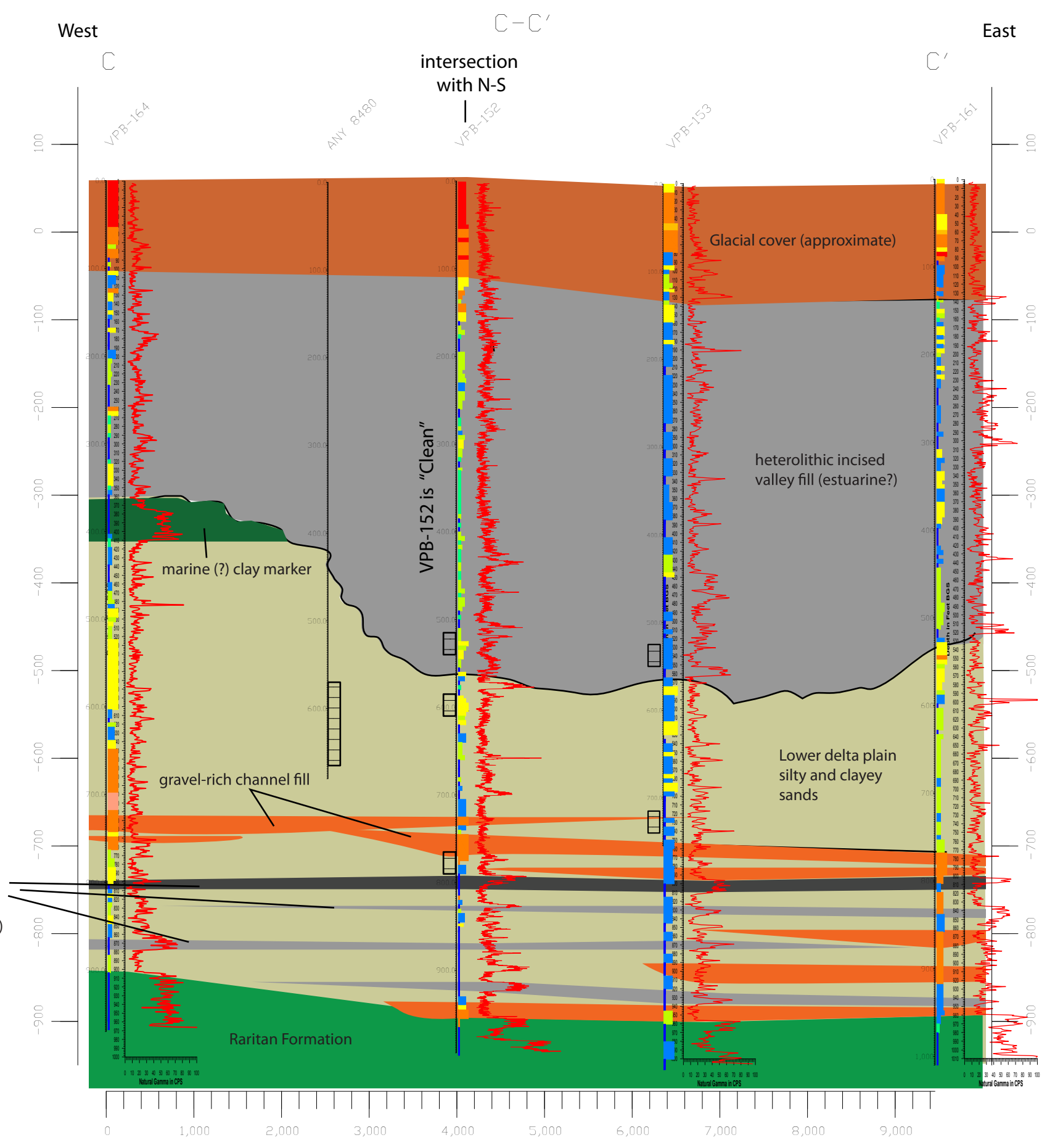


Figure 2. Cross Section A-A'





GRAIN SIZE LOG INDEX*

* not all grainsize categories shown in the comprehensive key are present at the site. Site sediments are predominately fine (clays, sandy clays, silts, and fine to medium sand)

- | | |
|---|--|
| Clay | Silty Sand (Medium Sand with 10-20% Fines) |
| Clay with 10% Sand | Clayey Sand (Medium Sand with 10-20% Fines) |
| Clay with 20% Sand | Fine Sand with Fine Gravel |
| Clay with 30% Sand | Fine Sand with Medium Gravel |
| Clay with 40% Sand | Fine Sand with Coarse Gravel |
| Clay with Fine Gravel | Medium Sand |
| Clay with Medium Gravel | Silty Sand (Coarse Sand with 50% Fines) |
| Clay with Coarse Gravel | Clayey Sand (Coarse Sand with 50% Fines) |
| Silt | Silty Sand (Coarse Sand with 40% Fines) |
| Silt with 10% Sand | Clayey Sand (Coarse Sand with 40% Fines) |
| Silt with 20% Sand | Silty Sand (Coarse Sand with 30% Fines) |
| Sandy Silt | Clayey Sand (Coarse Sand with 30% Fines) |
| Silty Sand | Silty Sand (Coarse Sand with 10-20% Fines) |
| Clayey Sand | Clayey Sand (Coarse Sand with 10-20% Fines) |
| Silty Sand (Fine Sand with 40% Fines) | Medium Sand with Fine Gravel |
| Clayey Sand (Fine Sand with 40% Fines) | Medium Sand with Medium Gravel |
| Silty Sand (Fine Sand with 30% Fines) | Medium Sand with Coarse Gravel |
| Clayey Sand (Fine Sand with 30% Fines) | Coarse Sand |
| Silty Sand (Fine Sand with 10-20% Fines) | Coarse Sand with Fine Gravel |
| Clayey Sand (Fine Sand with 10-20% Fines) | Coarse Sand with Medium Gravel |
| Gravelly Silt (Silt with Fine Gravel) | Coarse Sand with Coarse Gravel |
| Gravelly Silt (Silt with Medium Gravel) | Clayey/Silty Gravel (Fine gravel with clay/silt) |
| Gravelly Silt (Silt with Coarse Gravel) | Clayey/Silty Gravel (Medium gravel with clay/silt) |
| Fine Sand | Clayey/Silty Gravel (Coarse gravel with clay/silt) |
| Silty Sand (Medium Sand with 50% Fines) | Sandy Gravel (Fine Gravel with Sand) |
| Clayey Sand (Medium Sand with 50% Fines) | Sandy Gravel (Medium Gravel with Sand) |
| Silty Sand (Medium Sand with 40% Fines) | Sandy Gravel (Coarse Gravel with Sand) |
| Clayey Sand (Medium Sand with 40% Fines) | Fine Gravel |
| Silty Sand (Medium Sand with 30% Fines) | Medium Gravel |
| Clayey Sand (Medium Sand with 30% Fines) | Coarse Gravel |

interdistributary and / or marine silty clays (high degree of continuity (darkest grey clay may serve as base to contaminant))

Figure 4. Cross Section C-C'



Figure 5. Mackenzie River Delta Depositional Environment

Source: Thermal Emission and Reflection Radiometer image from NASA's TERRA satellite, August 4, 2005, Mackenzie River, Canada. Image from GSFC/METI/ERSDAC/JAROS and the US/Japan ASTER Science Team. <http://earthobservatory.nasa.gov/IOTD/view.php?id=8320>





Figure 6. Braided River Depositional Environment

Source: East Fork Toklat River, Alaska Range, Denali National Park <https://pubs.usgs.gov/of/2004/1216/b/b.html>

