Pelton, Jason M (DEC)

From: Hannon, ED [US] (AS) <Edward.Hannon@ngc.com>
Sent: Wednesday, August 08, 2018 11:35 AM
To: Pelton, Jason M (DEC); mrusso@OYSTERBAY-NY.gov
Cc: Richard Lenz; Weber, Fred [US] (AS); Dave Stern (David.Stern@arcadis-us.com); Bill Lais
Subject: OU3 Park Ball Field LNAPL Work Plan-August 3, 2018
Attachments: 2018 LNAPL_Work Plan_2018 0725 NG -final.pdf

Importance: High

Jason / Matt

As I have previously informed you, during our recent routine measurements of groundwater and perched water levels from wells in and around the Park Ball Field we found LNAPL located in one Piezometer Well, ID number I-4-PZ. The LNAPL tested as being primarily water containing petroleum and other contaminants.

Based on our extensive collection of soil sampling data and our understanding of the underlying soils via our use of 3D EVS (Earth Volumetric Studio) computer modeling it is our understanding that Piezometer I-4-PZ in located within an area of perched water and does not appear to connect to the groundwater table. This understanding is also supported by approximately 9 years of ground water sampling data from the four On-Site Ground Water Containment Systems monitoring wells.

Northrop Grumman instructed Arcadis to prepare a Work Plan for delineating this light non-aqueous phase liquid as fast as possible in preparation of our commencing with implementing the preparations activities in the VOC thermal remedy Work Plan this month. You will note that logically this LNAPL Work Plan also includes additional VOC soil sampling to supplement our EVS delineation of both the LNAPL and VOC model.

Drilling will be conducted using a small direct push Geoprobe rig and use of a dual tube sampling system.

To assist our contractors in reducing the length of time they will be in the closed off area of the Ball Field and shorten the time it will take to delineate this LNAPL we plan on utilizing UVOST (Ultra-Violet Optical Screening) technology on the surrounding soil to gather true (real-time) in-situ delineation of the LNAPL and to direct our drilling in an effort to shorten the length of time required to complete the Work Plan.

The general objectives of this Work Plan are as follows:

1. Delineate the extent of and determine the distribution of LNAPL previously observed at Piezometer I-4-PZ.

2. Further refine the physical properties of the low permeability zone (LPZ) and perched water at and around Piezometer I-4-PZ.

3. Refine the vertical extent of the VOCs in soil, and update the EVS model.

Other considerations:

1. We have included provisions for sampling for PCBs any time LNAPL samples are obtained.

2. Current schedule is to commence pre-field preparation supporting both the LNAPL Work Plan and VOC Thermal remedy plan which will include utility mark-out, staking of borings, and brush hog of ISTR and the drilling areas the week of 8/13. LNAPL related drilling will commence the week of 8/20 and proceed for 3-4 weeks, based on the Work Plan scope.

I will be out of the office Friday – Tuesday August 10 - 14 returning Wednesday August 15. I will not have email capabilities during that short period. However, in order to maintain our schedules and our commitments to the State and Town and to support critical contracts released please submit your questions and any comments to this email distribution list.

I can be reached at all times and while out of the office via mobile phone at 516-353-4618.

Thank You
Edward J. Hannon
Director ESHM
Northrop Grumman
516-575-2333

ARCADIS Design & Consultancy for natural and built assets

Mr. Jason Pelton
Project Manager, Division of Environmental Remediation
Remedial Bureau D, Section B
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-7015

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Two Huntington Quadrangle
Suite 1S10
Melville
New York 11747
Tel 631 249 7600
Fax 631 249 7610
www.arcadis.com

ENVIRONMENT

Subject:
Work Plan for Delineation of Perched LNAPL and to Supplement the Delineation of VOCs in Soil, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Date:
August 3, 2018

Contact:
David Stern

Phone:
631-391-5284

Email:
David.Stern@arcadis.com

Our ref:
NY001496.3702

Dear Mr. Pelton:

Arcadis of New York, Inc. (Arcadis) has prepared this Work Plan on behalf of Northrop Grumman Systems Corporation (Northrop Grumman). This Work Plan has been prepared to delineate light non-aqueous phase liquid (LNAPL) present in perched water, specifically in Piezometer I-4-PZ and to supplement the delineation of volatile organic compounds (VOCs) in soil in the ballfield area of the Bethpage Community Park, Bethpage, New York (Site). This work is being performed in support of the upcoming remedial action to address VOCs in soil at the Site. The remediation of VOCs in soil will be performed to meet the requirements of the Operable Unit 3 Record of Decision (ROD). The scope of work and schedule are provided below. The site location is shown on **Figure 1**. Site features are shown on **Figure 2**.

The general objectives of this Work Plan are as follows:

1. Delineate the extent of and determine the distribution of LNAPL previously observed at Piezometer I-4-PZ.
2. Further refine the physical properties of the low permeability zone (LPZ) at and around Piezometer I-4-PZ.
3. Refine the vertical extent of VOCs in soil.

Arcadis utilized the existing Earth Volumetric Studio (EVS) model for Site soils in placement of the borings proposed in this Work Plan; the rationale for placement is further detailed below.

BACKGROUND

On March 19, 2018, Piezometer I-4-PZ and other piezometers were gauged in advance of planned decommissioning activities prior to implementation of the soil VOC remedy. An in-well LNAPL thickness of 3.95 feet was measured in Piezometer I-4-PZ on March 19, 2018. Fluid-level gauging and visual confirmation of LNAPL (using a bailer) was completed at Piezometer I-4-PZ on March 20, 2018. Additional fluid-level gauging was conducted at accessible piezometers (I-4-PZ, F-8-PZ, H-7-PZ) through June 13, 2018 to monitor for the absence/presence of LNAPL. While LNAPL thicknesses in Piezometer I-4-PZ have ranged from 0.15 to 3.95 feet during the monitoring period, LNAPL has not been detected in Piezometers F-8-PZ or H-7-PZ; Piezometer H-3-PZ was apparently damaged by others and could not be located. **Attachment 1** of this Work Plan provides the fluid-level gauging data collected between March 19 and June 13, 2018.

On May 8, 2018, a single LNAPL sample was collected from Piezometer I-4-PZ and submitted to a laboratory for chemical composition analyses. The LNAPL sample was analyzed for VOCs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), hydrocarbon fingerprinting, and Resource Conservation and Recovery Act (RCRA) characteristics (i.e., corrosivity, ignitability, and reactivity). **Attachment 2** of this Work Plan provides data tables summarizing the chemical composition analytical data. The analytical data indicate that the LNAPL sample from Piezometer I-4-PZ contains chlorinated VOCs (CVOCs) including, but not limited to, trichloroethene, cis-1,2-dichloroethene, and vinyl chloride; toluene, ethylbenzene, and xylenes were also detected in the sample (**Attachment 2a**). The LNAPL sample also contains SVOCs (**Attachment 2b**) and PCBs (**Attachment 2c**). The initial findings of the hydrocarbon fingerprinting (**Attachment 2d**) indicate that the LNAPL sample matches gasoline (carbon range C4-C12), with a notation indicating that an unknown pattern is present in the range of fuel oil (carbon range C12-C36); Arcadis will continue to evaluate existing hydrocarbon fingerprinting data and assess the need for additional data as the investigation progresses. The RCRA characteristics results are provided in **Attachment 2e**.

On May 9, 2018, a single LNAPL sample was collected from Piezometer I-4-PZ and submitted to a laboratory for physical properties analyses. The physical properties analytical report is provided in **Attachment 3** of this Work Plan. The physical properties analytical data indicate that the density of the LNAPL is approximately 0.87 grams per cubic centimeter (at 70 degrees F); the LNAPL has a relatively low viscosity (approximately 30 centipoise at 70 degrees F), and has a water/LNAPL interfacial tension of approximately 14 dynes/centimeter (at 74 degrees F).

PROPOSED SCOPE OF WORK

The LNAPL investigation will consist of drilling six (6) borings (LIF-HPT-1 through LIF-HPT-6) in the area around Piezometer I-4-PZ to delineate LNAPL observed in I-4-PZ. Additionally, two (2) borings (LIF-HPT-7 and LIF-HPT-8) will be drilled near historical soil borings B-34-14 and VP-27/VP-27-14 to evaluate if LNAPL is present in these areas. Collectively, these eight borings will also serve to further refine the physical properties of the LPZ. The EVS model representation of the upper surface of the LPZ (depth to top of LPZ contours) and proposed locations of borings are shown on **Figure 3**. As the depth of the upper surface of the LPZ varies significantly, proposed borings were placed using EVS to balance spatial distribution with consideration of variations in the depth of the upper surface. The LNAPL investigation

activities proposed herein will be performed using an adaptive approach to allow for flexibility in number and location of borings and selection of intervals to be sampled based on evaluation of field data (see Phase I subsection below).

A total of five (5) soil borings (LPZ-1 through LPZ-5) will be drilled at the locations shown on **Figure 3** to further characterize the physical properties of the LPZ and collect supplemental soil quality data, if warranted (see Phase III below).

A total of ten (10) soil borings will be drilled at the locations shown on **Figure 4** to refine the delineation of VOCs in soil in the ballfield portion of the Site (see Phase IV below).

Table 1 provides a summary of the proposed borings (Phases I through III). The LNAPL investigation will be implemented in phases as described below. Additional borings may be drilled, if necessary, based on the data collected from the borings, to meet the general investigation objectives stated above. Permanent wells may also be installed at locations where LNAPL is detected. The wells would be constructed based on the vertical distribution of LNAPL, and in a manner such that the screen interval would not fully penetrate the LPZ. If wells are installed and LNAPL is present, additional gauging and sampling activities will be conducted.

Phase I – Ultra-Violet Optical Screening Tool (UVOST)/Hydraulic Profiling Tool (HPT)

The investigation techniques that will be employed at Borings LIF-HPT-1 through LIF-HPT-8 will include laser-induced fluorescence (LIF), specifically the ultra-violet optical screening tool (UVOST®), and the Geoprobe® Hydraulic Profiling Tool (HPT). In conjunction, the HPT and UVOST® systems will allow for a correlation between the LNAPL distribution and stratigraphy. The specific objectives of the Phase I activities are to:

- Delineate the three-dimensional extent of the LNAPL, as observed in Piezometer I-4-PZ;
- Define the vertical distribution of the LNAPL relative to the geologic framework;
- Map the local hydrostratigraphy; and
- Further understand the local thickness and morphology of the LPZ.

It is anticipated that the LIF/HPT borings will be drilled to a depth of approximately 50 ft bls (i.e., approximate bottom depth [48 ft bls] of Piezometer I-4-PZ screen interval) with the objective of vertically delineating the LNAPL. The terminal depth of the borings will be based on field data. The LIF/HPT investigation will utilize direct push drilling techniques (Geoprobe® rig) suitable for both LNAPL distribution definition and hydrostratigraphic mapping.

The UVOST® system uses a sapphire window in the side of a direct push probe to measure front-face fluorescence of petroleum LNAPL as the probe is advanced into the soil. Polycyclic aromatic hydrocarbon (PAH) fluorescence of LNAPL is directed back to the surface where it will be analyzed. Responses are indicated in real-time on a graph of UVOST® signal versus depth. A document describing the UVOST® methodology (prepared by Dakota Technologies) is provided as **Attachment 4** of this Work Plan.

The Geoprobe® HPT will be employed to map hydrostratigraphy by determining zones of relative higher and lower permeability. The HPT is advanced through the subsurface at a constant rate while water is injected through a screen on the side of the probe. An in-line pressure sensor measures the pressure

response of the soil to water injection. The pressure response identifies the relative ability of the soil to transmit water. Pressure and flow rate are logged versus depth. A document describing the HPT methodology (prepared by Geoprobe Systems®) is provided as **Attachment 5** of this Work Plan.

After each LIF/HPT boring has been drilled to its completion depth and the probe rods have been removed from the subsurface, a separate set of probe rods will be immediately advanced (i.e., the boring will be re-drilled) to the completion depth so that the boring can be grouted from the bottom up to land surface.

Phase II – Soil Borings

After the LIF/HPT borings have been completed, soil borings will be drilled adjacent to the LIF/HPT borings where LNAPL was detected to collect soil samples for laboratory analysis. The soil borings will be approximately 3-4 inches in diameter and will be drilled utilizing direct push drilling techniques (Geoprobe® rig). The borings will be grouted from the bottom up to land surface. The soil cores will be screened in the field using a photoionization detector (PID) and soil samples will be collected from targeted intervals based on the LIF response from the Phase I borings and PID readings from the soil cores. The soil cores will be vertically split (two equivalent portions of the soil core from the same horizon will be used for LIF field testing and submittal to the laboratory) so that LIF responses can be compared to soil sampling analytical results. It is anticipated that the soil samples submitted to the laboratory will be collected from a 2-ft interval based on an evaluation of the LIF data and PID readings and to allow for sufficient soil volume for laboratory analysis. Soil samples submitted for laboratory analysis will be sent to a New York State Department of Health (NYSDOH) accredited laboratory for the analysis of Target Compound List (TCL) VOCs, SVOCs, PCBs, 1,4-dioxane, total petroleum hydrocarbons (TPH) gasoline range organics (GRO [carbon range C6-C10]) and TPH diesel range organics (DRO)/Petroleum Hydrocarbons (carbon range C10-C40).

Sample analyses will follow the NYSDEC Analytical Services Protocol (ASP) and will include quality assurance/quality control (QA/QC) samples consisting of trip blanks, equipment blanks, and field duplicate samples, in accordance with the NYSDEC-approved Quality Assurance Project Plan (QAPP). Analytical results will be reported using NYSDEC ASP Category B data deliverables. Data obtained from the analytical laboratory will be validated in accordance with the QAPP.

Phase III – Lower Permeability Zone Soil Borings

Five (5) soil borings (LPZ-1 through LPZ-5) will be drilled to further characterize the lithology (field description/visual inspection of soil cores) and determine the thickness of the LPZ at these locations. The soil borings will be approximately 3-4 inches in diameter and will be drilled utilizing direct push drilling techniques (Geoprobe® rig) and the Dual-Tube Sampling System. The borings will be grouted from the bottom up to land surface. Soil cores will be collected continuously from 35 ft bls (above the top of the LPZ based on previous data) to the bottom of the LPZ and will be screened in the field using a PID; soil samples may be submitted to the laboratory for the analytical parameters described above (see Phase II – Soil Borings) if field screening indicates impacts are present.

Phase IV - Supplemental VOC Soil Delineation

Refining the delineation of VOCs, as noted above, is another objective of this Work Plan. Supplemental soil sampling will be conducted as summarized in the table below.

Proposed Soil Boring ID	Proposed Sampling Intervals (ft bls)
K-8-18	42-44; 44-46; 46-48
nK-11-18	42-44; 44-46; 46-48
R-9-18	44-46; 52-54; 54-56; 58-60
J-5-18	46-48; 48-50
G-5-18	46-48; 48-50
I-6-18	48-50; 50-52
nG-6-18	46-48; 48-50
I-7-18	46-48; 48-50
nR-8-18	50-52; 52-54
nS-8-18	50-52; 52-54

A total of 10 soil borings will be drilled to different depths in the ballfield. **Figure 4** shows the proposed boring locations. The soil borings will be approximately 3-4 inches in diameter and will be drilled utilizing direct push drilling techniques (Geoprobe® rig) and the Dual-Tube Sampling System. The borings will be grouted from the bottom up to land surface. Soil cores will be collected from the intervals identified in the table above and will be screened in the field using a PID.

Soil samples submitted for laboratory analysis will be sent to a NYSDOH accredited laboratory for the analytical parameters described above (see Phase II – Soil Borings). Data obtained from the analytical laboratory will be validated in accordance with the QAPP.

FIELD PROGRAM LOGISTICS

Arcadis will adhere to the provisions of access agreed to by Northrop Grumman and the Town of Oyster Bay (Town) for field activities performed at the Site and will coordinate with the Town during the planning and performance of the work.

Locations will be staked out in the field prior to commencing intrusive activities. Subsurface utilities will be cleared using a minimum of three lines of evidence (e.g., One Call, soft dig, review of utility maps and previous geophysical survey data, site inspection) in accordance with the existing site-specific health and safety plan (HASP). The boring locations will also be cleared of utilities to a depth of 5 feet ft bls using soft dig techniques (e.g., hand digging using a hand auger).

It is anticipated that the investigation program described above will be performed as a single mobilization and sampling event. The drilling operations will be overseen continuously by an Arcadis field geologist. Sample collection, coordination with the analytical laboratory and sample shipment, and sample logging

will be conducted by Arcadis personnel. Drilling locations may be adjusted in the field based on access restrictions or the presence of utilities. Depending on the results obtained from the field data and/or laboratory analyses, additional borings may be advanced to meet the objectives of this investigation. Community air monitoring will be conducted in accordance with the NYSDEC-approved Community Air Monitoring Plan.

Investigation-derived waste (IDW) management, equipment decontamination, and site control will be performed consistent with previous Site work. Soil cuttings and other IDW (e.g., PPE, decontamination water, etc.) will be segregated by waste type and placed in appropriate waste containers (e.g., Department of Transportation [DOT]-approved 55-gallon steel drums). The drums of wastes generated during the activities will be temporarily stored at a secure location on Northrop Grumman property until disposal. IDW (e.g., drill cuttings) will be analyzed for total and toxicity characteristic leaching procedure (TCLP) VOCs, SVOCs, RCRA metals, pesticides, and RCRA characteristics, plus other analytes as may be required by the disposal facility. The “as-found” PCB concentrations in the soil samples will also be used to support waste characterization. Waste characterization results will be used to develop waste profiles for disposal of IDW.

ESTIMATED SCHEDULE

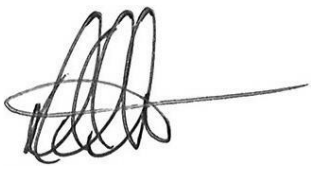
Northrop Grumman is coordinating access with the Town of Oyster Bay and we anticipate commencing the investigation activities during the week of August 13, 2018. Field work is anticipated to require 5 weeks (actual duration contingent on findings) to complete and will be performed Monday to Friday from 8 a.m. to 5 p.m. (work will not be conducted on-Site during Town holidays).

The investigation results will be provided in a summary report at the end of the investigation program and after the data have been evaluated and validated.

Please contact me if you have any questions or need additional information.

Sincerely,

Arcadis of New York, Inc.



David E. Stern
Project Manager

Jason Pelton
NYSDEC
August 3, 2018

Copies:
Ed Hannon, Northrop Grumman
Steve Karpinski, NYSDOH
John Lovejoy, NCDOH
Mike Wolfert, Arcadis
William Lais, EMAGIN

Enclosures:

Table

1 Proposed Soil Borings to Support Delineation of Perched LNAPL

Figures

1 Site Location
2 Site Features
3 Proposed LNAPL Investigation Locations
4 VOC Source Area and Sampling Locations

Attachments

1 Fluid-Level Gauging Measurements in Piezometers
2 I-4-PZ LNAPL Sample Chemical Composition Data Tables
3 I-4-PZ LNAPL Sample Physical Properties Data
4 UVOST Information
5 HPT Information

TABLES

Table 1
Proposed Soil Borings to Support Delineation of Perched LNAPL,
Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds),
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

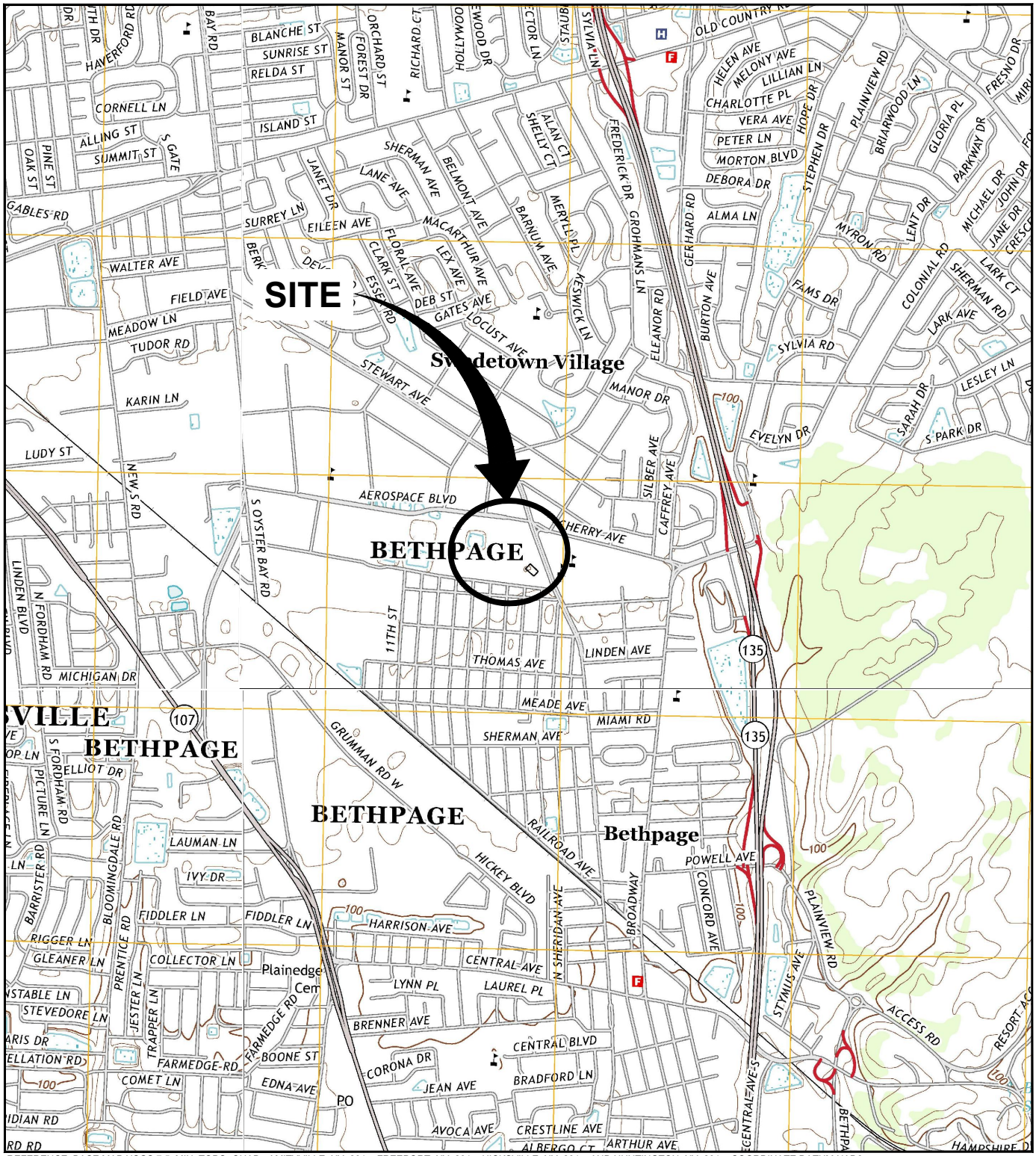
Proposed Boring ID	Proposed Depth [1] (ft bls)	Sampling Interval [2, 3] (ft bls)	Rationale
Phase I and II			
LIF-HPT-1	50	TBD	Assess LNAPL distribution adjacent to I-4-PZ and determine how well the LNAPL will respond to LIF.
LIF-HPT-2	50	TBD	Delineation south of I-4-PZ.
LIF-HPT-3	50	TBD	Delineation southwest of I-4-PZ.
LIF-HPT-4	50	TBD	Delineation northwest of I-4-PZ.
LIF-HPT-5	50	TBD	Delineation north of I-4-PZ.
LIF-HPT-6	50	TBD	Delineation east of I-4-PZ.
LIF-HPT-7	50	TBD	Evaluate if LNAPL is present in the areas of historical soil boring B-34-14.
LIF-HPT-8	50	TBD	Evaluate if LNAPL is present in the areas of historical soil boring VP-27 and VP-27-14.
Phase III			
LPZ-1	TBD	35-TBD	Further refine the physical properties of the low permeability zone; collect soil quality data if warranted.
LPZ-2	TBD	35-TBD	Further refine the physical properties of the low permeability zone; collect soil quality data if warranted.
LPZ-3	TBD	35-TBD	Further refine the physical properties of the low permeability zone; collect soil quality data if warranted.
LPZ-4	TBD	35-TBD	Further refine the physical properties of the low permeability zone; collect soil quality data if warranted.
LPZ-5	TBD	35-TBD	Further refine the physical properties of the low permeability zone; collect soil quality data if warranted.

Notes:

1. Terminal depth of borings will be determined based on field observations and measurements.
2. Phase II soil borings will be drilled adjacent to Phase I LIF borings. Sampling intervals from such borings will be determined based on LIF response and field screening.
3. Sampling interval in Phase III LPZ soil borings will start at 35 ft bls (above the top of the LPZ) and the terminal depth will be determined based on soil core lithologic observations. Soil cores will be field screened using a PID and soil samples will be submitted to a laboratory for analyses if warranted based on field screening.

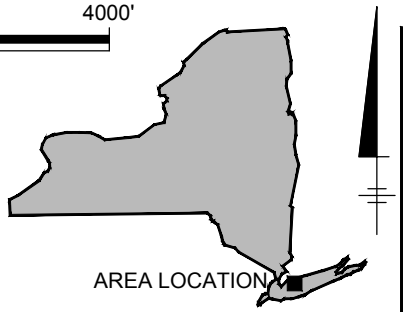
LIF	Laser-Induced Fluorescence
HPT	Hydraulic Profiling Tool
LPZ	Low Permeability Zone
TBD	To Be Determined
LNAPL	Light Non-Aqueous Phase Liquid
PID	Photoionization Detector
ft bls	feet below land surface

FIGURES



REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., AMITYVILLE, NY, 201□, FREEPORT, NY, 201□, HICKSVILLE, NY, 201□, AND HUNTINGTON, NY, 201□, COORDINATE DATUM NAD8□

0 2000' 4000'



NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

SITE LOCATION

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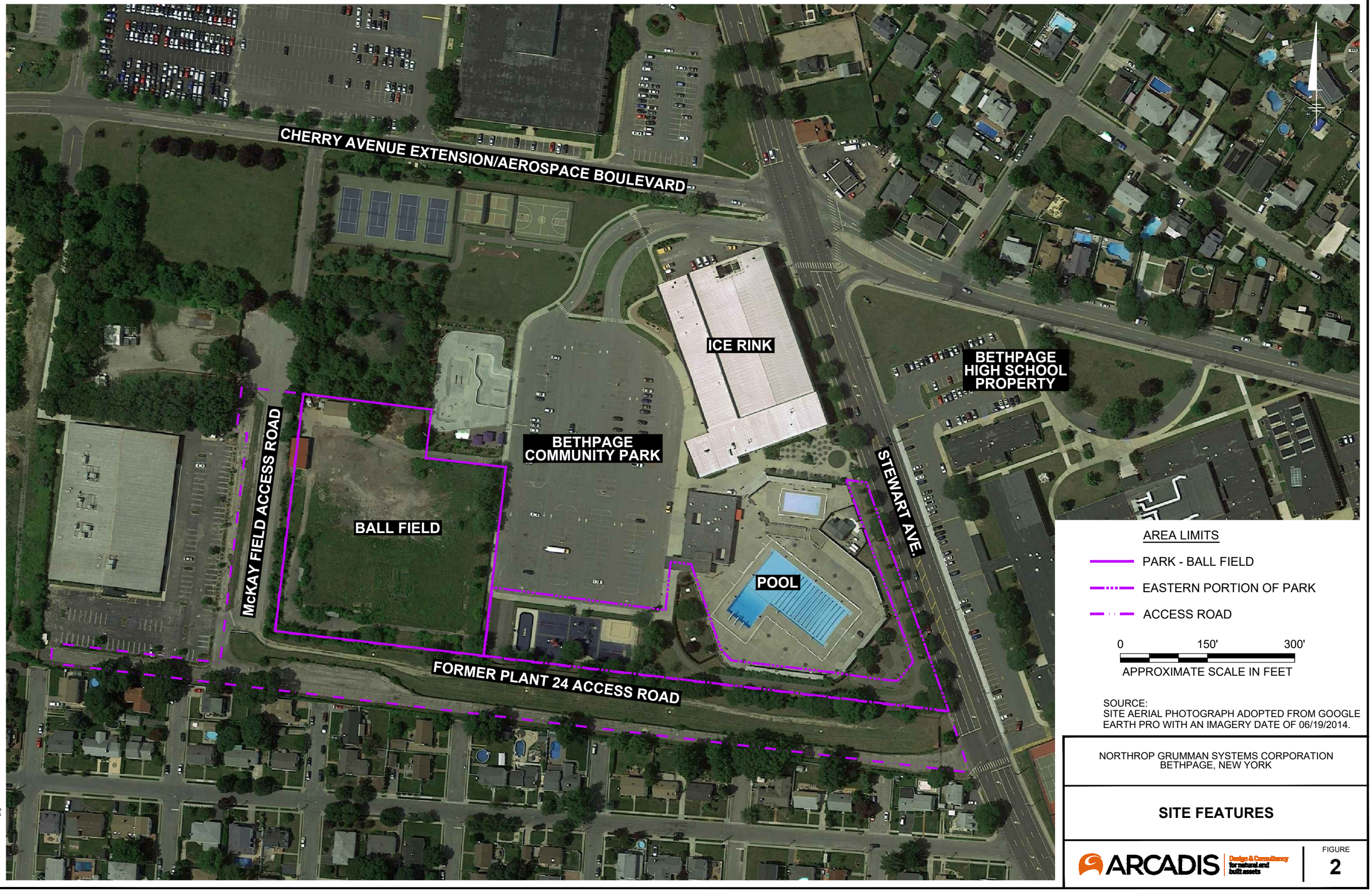
FIGURE 1



AREA LIMITS

- PARK - BALL FIELD
- EASTERN PORTION OF PARK
- ACCESS ROAD

0 150' 300'

APPROXIMATE SCALE IN FEET

SOURCE:
SITE AERIAL PHOTOGRAPH ADOPTED FROM GOOGLE EARTH PRO WITH AN IMAGERY DATE OF 06/19/2014.

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

SITE FEATURES

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FIGURE 2

CITY: Novi DIV: ENV DB: TRY PIC: PM: TM: TR: PROJECT NUMBER: COORDINATE SYSTEM: NAD 1983 StatePlane New York Long Island FIPS 3104 Feet
G:\COMMON\Northrop Grumman\Bethpage\EVS_VOC_PCB\GISNG_Bethpage_LPZ_Contours.mxd PLOTTED: 7/13/2018 4:16:29 PM BY: dolexa

H-6-17
I-6-17
J-6-17
M-6-17
nK-7-14
O-5-14
M-7-14
G-4
L-8-14
H-4
LIF-HPT-4
LIF-HPT-5
VP-9
P-7-14
Q-6.5-17
LPZ-5
LIF-HPT-6
nQ-8-17
nR-8-17
J-4
nS-8-17
I-4
LIF-HPT-1
LIF-HPT-3
O-8-14
Q-8-14
SGP-8
LIF-HPT-2
LPZ-1
M-9-14
LPZ-2
nN-9-14
P-9-14
Q-9-14
K-10-14
B-34-14
LIF-HPT-7
G-3
nM-10-14
nL-10-14R
H-3
LPZ-3
I-3
VP-27-14
VP-27
LIF-HPT-8
VP-27A
nM-11-14
nR-10-14
S-10-17
nQ-10-14R
R-11-17
S-11-17
L-12-14
LPZ-4
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BCPMW-5-1
P-12-14
J-3
R-12-17
K-2
G-2
K-13-17
M-13-17
I-2
nQ-13-14R
J-2
P-13-17
SGP-6
VP-19A

LEGEND

- PROPOSED LIF-HPT BORING LOCATION
- PROPOSED SOIL BORING LOCATION
- PREVIOUS BORING LOCATION
- TOP OF LPZ CONTOUR (FEET BELOW LAND SURFACE)
- HISTORIC RAG PIT

0 20 40
SCALE IN FEET

OPERABLE UNIT 3
NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

PROPOSED LNAPL INVESTIGATION LOCATIONS

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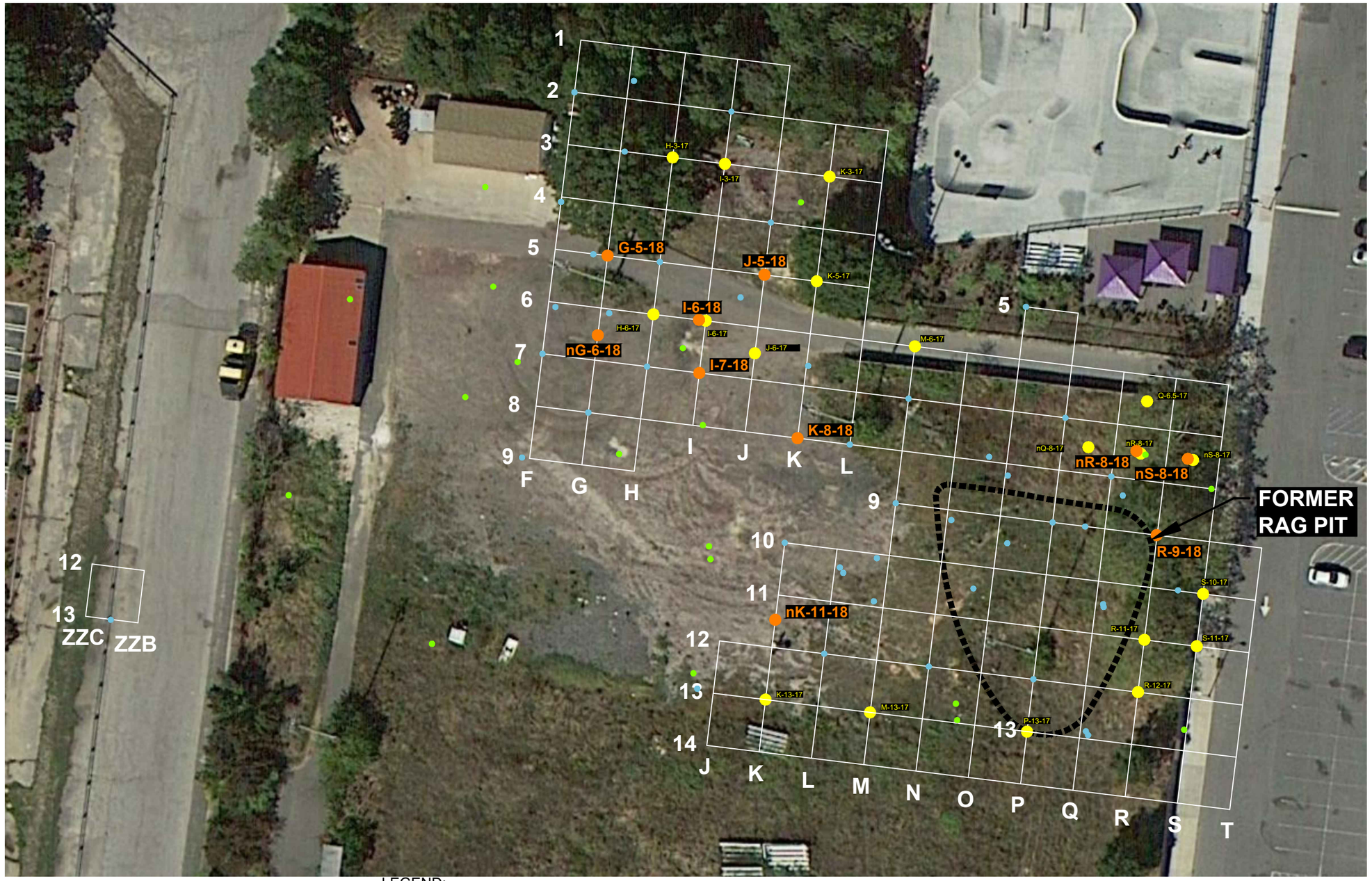
FIGURE
3



0 40' 80'

APPROXIMATE SCALE IN FEET

LEGEND:

- HISTORICAL VOC SAMPLE LOCATIONS (PRE 2014)
- HISTORICAL VOC SAMPLE LOCATIONS (2014 PRE-DESIGN INVESTIGATION)
- HISTORICAL VOC SAMPLE LOCATIONS (2017 SUPPLEMENTAL PRE-DESIGN INVESTIGATION)
- PROPOSED DELINEATION SAMPLE LOCATIONS

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

VOC SOURCE AREA AND SAMPLING LOCATIONS

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FIGURE 4

ATTACHMENT 1

Attachment 1
Fluid-Level Gauging Measurements in Piezometers,
Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds),
Bethpage, New York

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Well ID	Date	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Product Thickness (ft)
I-4-PZ	3/19/2018	45.65	49.60	3.95
	3/20/2018	45.50	48.26	2.76
	4/19/2018	45.95	46.14	0.19
	5/2/2018	46.10	48.90	2.80
	5/8/2018 (pre-sampling)	46.05	49.25	3.20
	5/8/2018 (post-sampling)	47.08	47.65	0.57
	5/9/2018 (pre-sampling)	46.05	47.80	1.75
	5/9/2018 (post-sampling)	47.55	47.70	0.15
	5/10/2018	46.10	47.40	1.30
	5/11/2018	46.21	47.55	1.34
	5/14/2018	46.12	47.04	0.92
	5/15/2018	46.07	47.23	1.16
	5/16/2018	46.30	47.45	1.15
	5/23/2018	46.22	47.55	1.33
	5/30/2018	46.26	47.22	0.96
	6/4/2018	46.20	47.55	1.35
	6/13/2018	46.28	47.44	1.16
H-7-PZ	3/19/2018	ND	43.35	ND
	4/19/2018	ND	43.82	ND
	5/2/2018	ND	44.72	ND
	5/16/2018	ND	45.40	ND
	5/23/2018	ND	44.78	ND
	5/30/2018	ND	43.97	ND
	6/4/2018	ND	43.31	ND
	6/13/2018	ND	44.81	ND
F-8-PZ	3/19/2018	ND	27.78	ND
	4/19/2018	ND	26.57	ND
	5/2/2018	ND	28.62	ND

Notes and Abbreviations:

ft	Feet.
btoc	Below top of casing.
ND	Not detected.

ATTACHMENT 2

Attachment 2a
Concentrations of Volatile Organic Compounds in LNAPL Sample Collected from Piezometer I-4-PZ, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

CONSTITUENT (units in ug/kg)	Sample Location: Sample Date:	I-4-PZ 5/8/2018
Volatile Organic Compounds [(1)]		
1,1,1-Trichloroethane		**57,400**
1,1,2,2-Tetrachloroethane		< 10,000
1,1,2-Trichloroethane		< 10,000
1,1-Dichloroethane		**2,560 J**
1,1-Dichloroethene		**7,090**
1,2-Dichloroethane		< 5,000
1,2-Dichloropropane		< 10,000
2-Butanone		< 50,000
2-Hexanone		< 25,000
4-Methyl-2-pentanone		< 25,000
Acetone		< 50,000
Benzene		< 2,500
Bromodichloromethane		< 10,000
Bromoform		< 25,000
Bromomethane		< 25,000
Carbon disulfide		< 10,000
Carbon tetrachloride		< 10,000
Chlorobenzene		< 10,000
Chlorodifluoromethane (Freon 22)		< 25,000
Chloroethane		< 25,000
Chloroform		< 10,000
Chloromethane		< 25,000
cis-1,2-Dichloroethene		**964,000**
cis-1,3-Dichloropropene		< 10,000
Dibromochloromethane		< 10,000
Dichlorodifluoromethane (Freon 12)		< 25,000
Ethylbenzene		**215,000**
Freon 113		< 25,000
Freon 142B		< 50,000
Methyl Tert Butyl Ether		< 5,000
Methylene chloride		< 25,000
Styrene		< 10,000
Tetrachloroethene		< 10,000
Toluene		**3,340,000**
trans-1,2-Dichloroethene		< 5,000
trans-1,3-Dichloropropene		< 10,000
Trichloroethene		**270,000**
Trichlorofluoromethane (CFC 11)		< 25,000
Vinyl Chloride		**54,000**
Xylene-O		**191,000**
Xylene-M&P		**556,000**
Xylene (total)		**747,000**

Footnotes and abbreviations on next page

Attachment 2a
Concentrations of Volatile Organic Compounds in LNAPL Sample Collected from Piezometer I-4-PZ, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Notes and Abbreviations:

1. Sample analyzed for VOCs using USEPA Method 8260C.

USEPA	United States Environmental Protection Agency
LNAPL	Light non-aqueous phase liquid
VOC	Volatile organic compound
J	Value is estimated
ug/kg	Micrograms per kilogram

Attachment 2b
Concentrations of Semi-Volatile Organic Compounds in LNAPL Sample Collected from Piezometer I-4-PZ, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

CONSTITUENT (units in ug/L)	Sample Location: Sample Date:	I-4-PZ 5/8/2018
Semi-Volatile Organic Compounds [(1)]		
1,2-Dichlorobenzene		< 10,000
1,2-Diphenylhydrazine		< 10,000
1,3-Dichlorobenzene		< 10,000
1,4-Dichlorobenzene		< 10,000
1,4-Dioxane		<10,000
2,4,5-Trichlorophenol		< 50,000
2,4,6-Trichlorophenol		< 50,000
2,4-Dichlorophenol		< 20,000
2,4-Dimethylphenol		< 50,000
2,4-Dinitrophenol		< 50,000
2,4-Dinitrotoluene		< 10,000
2,6-Dinitrotoluene		< 10,000
2-Chloronaphthalene		< 20,000
2-Chlorophenol		< 50,000
2-Methylnaphthalene		**114,000**
2-Methylphenol		< 20,000
2-Nitroaniline		< 50,000
2-Nitrophenol		< 50,000
3,3'-Dichlorobenzidine		< 20,000
3-Nitroaniline		< 50,000
3&4-Methylphenol		< 20,000
4,6-Dinitro-2-methylphenol		< 50,000
4-Bromophenyl phenyl ether		< 20,000
4-Chloro-3-methylphenol		< 50,000
4-Chloroaniline		< 50,000
4-Chlorophenyl phenyl ether		< 20,000
4-Nitroaniline		< 50,000
4-Nitrophenol		< 100,000
Acenaphthene		< 10,000
Acenaphthylene		< 10,000
Acetophenone		< 20,000
Anthracene		< 10,000
Atrazine		< 20,000
Benzaldehyde		< 50,000
Benzidine		< 100,000
Benzo(a)anthracene		< 10,000
Benzo(a)pyrene		< 10,000
Benzo(b)fluoranthene		< 10,000
Benzo(g,h,i)perylene		< 10,000
Benzo(k)fluoranthene		< 10,000
Benzyl Alcohol		< 20,000
Biphenyl		< 10,000

Footnotes and abbreviations on next page

Attachment 2b
Concentrations of Semi-Volatile Organic Compounds in LNAPL Sample Collected from Piezometer I-4-PZ, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

CONSTITUENT (units in ug/L)	Sample Location: Sample Date:	I-4-PZ 5/8/2018
Bis(2-chloro-1-methylethyl) ether		< 20,000
Bis(2-chloroethoxy)methane		< 20,000
Bis(2-chloroethyl)ether		< 20,000
Bis(2-ethylhexyl)phthalate (BEHP)		**41,700**
Butylbenzylphthalate		< 20,000
Caprolactam		< 20,000
Carbazole		< 10,000
Chrysene		**21,600**
Dibenz(a,h)anthracene		< 10,000
Dibenzofuran		< 50,000
Diethylphthalate		< 20,000
Dimethylphthalate		< 20,000
Di-n-butylphthalate		**21,600**
Di-n-octylphthalate		< 20,000
Fluoranthene		**5,630 J**
Fluorene		**15,500**
Hexachlorobenzene		< 10,000
Hexachlorobutadiene		< 10,000
Hexachlorocyclopentadiene		< 100,000
Hexachloroethane		< 20,000
Indeno(1,2,3-cd)pyrene		< 10,000
Isophorone		< 20,000
Naphthalene		**101,000**
Nitrobenzene		< 20,000
N-Nitrosodimethylamine		< 20,000
N-Nitroso-di-n-propylamine		< 20,000
N-Nitrosodiphenylamine		< 50,000
Pentachlorophenol		< 40,000
Phenanthrene		**46,800**
Phenol		< 20,000
Pyrene		**15,300**

Notes and Abbreviations:

1. Sample analyzed for SVOCs using USEPA Method 8270D.

USEPA	United States Environmental Protection Agency
LNAPL	Light non-aqueous phase liquid
SVOC	Semi-volatile organic compound
J	Value is estimated
ug/L	Micrograms per liter

Attachment 2c
Concentrations of Polychlorinated Biphenyls in LNAPL Sample Collected from Piezometer I-4-PZ, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

CONSTITUENT (units in ug/L)	Sample Location: Sample Date:	I-4-PZ 5/8/2018
Polychlorinated Biphenyls [(1)]		
Aroclor-1016		< 500
Aroclor-1221		< 500
Aroclor-1232		< 500
Aroclor-1242		< 500
Aroclor-1248		**49,500**
Aroclor-1254		**67,900**
Aroclor-1260		**12,400**
Aroclor-1268		< 500
Aroclor-1262		< 500

Notes and Abbreviations:

1. Sample analyzed for PCBs using USEPA Method 8082.

USEPA	United States Environmental Protection Agency
LNAPL	Light non-aqueous phase liquid
PCB	Polychlorinated biphenyl
ug/L	Micrograms per liter

Attachment 2d
Hydrocarbon Fingerprinting Results for LNAPL Sample Collected from Piezometer I-4-PZ,
Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds),
Bethpage, New York

	Sample Location: / Sample Date:	I-4-PZ / 5/8/2018
Hydrocarbon Fingerprinting [1]		
Diesel/Fuel Oil No. 2 (C9-C22)		No Match
Fuel Oil No. 4 (C11-C24)		No Match
Fuel Oil No. 6 (C11-C26)		No Match
Gasoline (C4-C12)		**Match**
Kerosene (C9-C18)		No Match
Turpentine (C9-C11)		No Match
Mineral Spirits (C9-C12)		No Match
Other Patterns [2]		No Match

Notes and Abbreviations:

1. Sample analyzed for hydrocarbon fingerprinting using USEPA Method 8015.
2. Unknown pattern present in the range of fuel oil, Carbon range C12-C36.

USEPA United States Environmental Protection Agency
LNAPL Light non-aqueous phase liquid

Attachment 2e
RCRA Characteristics Results for
LNAPL Sample Collected from Piezometer I-4-PZ,
Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds),
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

	Sample Location: / Sample Date:	I-4-PZ / 5/8/2018	
RCRA Characteristics		Result	Unit
Corrosivity as pH		5.40 NC	SU
Cyanide Reactivity		<10	mg/L
Ignitability (Flashpoint)		>200	Deg F
Sulfide Reactivity		<100	mg/L

Notes and Abbreviations:

RCRA	Resource Conservation and Recovery Act
LNAPL	Light non-aqueous phase liquid
mg/L	Milligrams per liter
SU	Standard Unit
Deg F	Degree Farenheit
NC	Non-Corrosive

ATTACHMENT 3

The results set forth herein are provided by SGS North America Inc.

e-Hardcopy 2.0
Automated Report

Technical Report for

Arcadis

Northrop Grumman, OU3 Hydro, Bethpage, NY

NY001496.3701.GWMI3

SGS Job Number: JC65914X

Sampling Date: 05/09/18

Report to:

Arcadis
2 Huntington Quad Suite 1S10
Melville, NY 11747
kristin.degraw@sgs.com

ATTN: Xuan (Sunny) Xu

Total number of pages in report: **11**

Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Program and/or state specific certification programs as applicable.

Nancy Cole
Laboratory Director

Client Service contact: Kristin Degraw 732-329-0200

Certifications: NJ(12129), NY(10983), CA, CT, FL, IL, IN, KS, KY, LA, MA, MD, ME, MN, NC, OH VAP (CL0056), AK (UST-103), AZ (AZ0786), PA, RI, SC, TX, UT, VA, WV, DoD ELAP (ANAB L2248)

Sections:

1
2
3

Table of Contents

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SGS North America Inc.

Sample Summary

Arcadis

Job No: JC65914X

Northrop Grumman, OU3 Hydro, Bethpage, NY
Project No: NY001496.3701.GWMI3

Sample Number	Collected Date	Time	By	Received	Matrix Code	Type	Client Sample ID
JC65914-1	05/09/18	15:00	PP	05/10/18	AQ	Ground Water	I-4-PZ

Subcontract Lab Data

Report of Analysis

5730 Centralcrest St. • Houston, TX 77092
Telephone (713) 316-1800 • Fax (877) 225-9953

May 22, 2018

Kristin Degraw.
Project Contact,
SGS North America Inc.
2235 Route 130,
Dayton, NJ 08810.

Re: PTS File No: 48117
Project Name: Northrop Grumman, OU3 Hydro, Bethpage, NY
Project Number: N/A
Subject: Density, Specific Gravity, Viscosity & Interfacial Tension (IFT)

Dear Kristin Degraw,

Please find enclosed report for Physical Properties analyses conducted upon samples received from your Northrop Grumman, OU3 Hydro, Bethpage, NY project. All analyses were performed by applicable ASTM, EPA, or API methodologies. The samples are currently in storage and will be retained for thirty days past the completion of testing at no charge. Please note that the samples will be disposed of at that time. You may contact me regarding storage, disposal, or return of the samples

PTS Laboratories appreciates the opportunity to be of service. If you have any questions or require additional information, please contact myself or Emeka Anazodo at (713) 316-1800.

Sincerely,
PTS Laboratories, Inc.

C.A.Umeh

Chidi Umeh
Flow Laboratory Supervisor

Encl.

PTS Laboratories

Project Name: Northrop Grumman, OU3 Hydro, Bethpage, NY
Project Number: N/A

PTS File No: 48117
Client: SGS North America, Inc.

TEST PROGRAM - 20180516

FLUID ID	Date	Time	Fluid Type	Density/ Gravity	Specific Gravity	3-Point Viscosity LNAPL	Interfacial Tension Oil/Water at 70ºF	Fluid Cleaning	Comments
			Method:	ASTM D1481	ASTM D1298	ASTM D445, D1481	ASTM D971	Proprietary	
Date Received: 20180516									
I-4-PZ	**5/9/18**	**1500**	**NAPL**	**X**	**X**	**X**	**X**	**X**	1litre Amber Glass Bottle
I-4-PZ	**5/9/18**	**1500**	**G.Water**						1litre Amber Glass Bottle
				1	**1**	**1**	**1**	**1**	**1**

Standard TAT for basic analysis is 10-15 business days.
Fluid Properties Package - LNAPL & Water: Includes dynamic viscosity and fluid density at three temperatures (70, 100, 130°F), surface tension for each fluid, and interfacial tensions (three phase pairs; oil/water, oil/air, and water/air (at ambient laboratory temperature)).
If no groundwater received, use filtered Houston tap water for interfacial tension testing.

PTS File No: 48117
Client: SGS North America, Inc.
Report Date: 05/22/18

VISCOSITY, DENSITY, and SPECIFIC GRAVITY DATA

(METHODOLOGY: ASTM D445, ASTM D1481, API RP40)

Project Name: Northrop Grumman, OU3 Hydro, Bethpage, NY
Project Number: N/A

SAMPLE ID	MATRIX	TEMPERATURE, °F	SPECIFIC GRAVITY	DENSITY, g/cc	VISCOSITY	
					centistokes	centipoise
I-4-PZ _NAPL	LNAPL	70	0.873	0.872	34.810	30.35
		100	0.867	0.861	17.800	15.33
		130	0.862	0.850	10.724	9.114
I-4-PZ _WATER	WATER	70	0.999	0.998	1.001	0.999
		100	1.000	0.993	0.696	0.691
		130	0.994	0.980	0.545	0.534

QUALITY CONTROL DATA

Date: 05/22/18
FLUID TYPE: Cannon® CVS S3
TEMPERATURE, °F: 70
DENSITY, MEASURED: 0.8615
DENSITY, PUBLISHED: 0.8615
RPD: 0.00
VISCOSITY, MEASURED: 4.53
VISCOSITY, PUBLISHED: 4.47
RPD: 1.30
CVS Lot #: 17301

PTS File No: 48117
Client: SGS North America, Inc.
Report Date: 05/22/18

INTERFACIAL / SURFACE TENSION DATA
(METHODOLOGY: DuNuoy Method - ASTM D971)

Project Name: Northrop Grumman, OU3 Hydro, Bethpage, NY
Project Number: N/A

PHASE PAIR		TEMPERATURE,	INTERFACIAL TENSION,
SAMPLE ID / PHASE	SAMPLE ID / PHASE	°F	Dynes/centimeter
I-4-PZ _WATER	Air	73.5	52.9
I-4-PZ _NAPL	Air	74.0	30.1
I-4-PZ _WATER	I-4-PZ _NAPL	74.0	13.8

QUALITY CONTROL DATA

Date: 05/22/18
PHASE PAIR: DIWATER / AIR
TEMPERATURE, °F: 73.1
IFT, MEASURED: 72.7
IFT, PUBLISHED: 72.3
RPD: 0.52

CHAIN OF CUSTODY

48117

Page 1 of 1

SGS

2235 Route 130, Dayton, NJ 08810
TEL. 732-329-0200 FAX: 732-329-3499/3480

FED-EX Tracking #: | Bottle Order Control #:
SGS Quote #: | SGS Job #: JC65914X

Client / Reporting Information

Company Name: SGS North America Inc.
Street Address: 2235 Route 130
City: Dayton State: NJ Zip: 08810
Project Contact: Kristin.Degraw@sgs.com E-mail:
Phone #: 732-329-0200 Fax #:
Sampler(s) Name(s): PP Phone:

Project Information

Project Name: Northrop Grumman, OU3 Hydro, Bethpage, NY
Street:
City: State:
Project #:
Client Purchase Order #:
Project Manager:

Billing Information (if different from Report to)

Company Name:
Street Address:
City: State: Zip:
Attention:

Requested Analysis (see TEST CODE sheet)

Matrix Codes

DW - Drinking Water
GW - Ground Water
WW - Water
SW - Surface Water
SO - Soil
SL- Sludge
SED-Sediment
O! - Oil
LIQ - Other Liquid
AIR - Air
SOL - Other Solid
WP - Wipe
FB-Field Blank
EB-Equipment Blank
RB- Rinse Blank
TB-Trip Blank

SGS Sample #	Field ID / Point of Collection	MEOH/DI Vial #	Collection Date	Collection Time	Sampled by	Matrix	# of bottles	Number of preserved Bottles: HCl	NaOH	HNO3	H2SO4	NONE	DI Water	MEOH	ENCORE	Density (ASTM D1481)	Specific Gravity (ASTM D1298)	Viscosity (ASTM D445)	Interfacial Tension (ASTM D971)	LAB USE ONLY
1	I-4-PZ		5/9/18	3:00:00 PM	PP	AQ	2					2				X	X	X	X	

Turnaround Time (Business days)

Approved By (SGS PM): / Date:

- [ ] Std. 10 Business Days
- [ ] 5 Day RUSH
- [ ] 3 Day EMERGENCY
- [ ] 2 Day EMERGENCY
- [ ] 1 Day EMERGENCY
- [X] other Due 5/24/2018

Emergency & Rush T/A data available VIA Lablink

Data Deliverable Information

- [ ] Commercial "A" (Level 1)
- [ ] Commercial "B" (Level 2)
- [ ] FULLT1 (Level 3+4)
- [ ] NJ Reduced
- [ ] Commercial "C"
- [ ] NYASP Category A
- [ ] NYASP Category B
- [ ] State Forms
- [ ] EDD Format
- [X] Other COMMC+

Commercial "A" = Results Only
Commercial "B" = Results + QC Summary
NJ Reduced = Results + QC Summary + Partial Raw data

Comments / Special Instructions

Please send sample receipt confirmation, level 3 report, and invoice to Kristin.DeGraw@sgs.com.

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler: 1	Date Time: 5-15-18 1100	Received By: 1 FEDEX	Relinquished By: 2	Date Time: 5/16/18 0900	Received By: 2 PTS LABS. INC
Relinquished by Sampler: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal # 541 [X] Intact [ ] Not intact	Preserved where applicable [ ]	On Ice [X] Cooler Temp. 7.1°C

CHAIN OF CUSTODY

48117

SGS
2235 Route 130, Dayton, NJ 08810
TEL. 732-329-0200 FAX: 732-329-3499/3480

FED-EX Tracking #:
Bottle Order Control #:
SGS Quote #:
SGS Job #: JC65914X

Client / Reporting Information

Company Name: SGS North America Inc.
Street Address: 2235 Route 130
City: Dayton State: NJ Zip: 08810
Project Contact: Kristin.Degraw@sgs.com E-mail:
Phone #: 732-329-0200 Fax #:
Sampler(s) Name(s): PP Phone:

Project Information

Project Name: Northrop Grumman, OU3 Hydro, Bethpage, NY
Street:
City: State:
Project #:
Client Purchase Order #:
Project Manager:

Billing Information (if different from Report to)

Company Name:
Street Address:
City: State: Zip:
Attention:

Requested Analysis (see TEST CODE sheet)

SGS Sample #	Field ID / Point of Collection	MEOH/DI Vial #	Collection Date	Collection Time	Sampled by	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	NONE	DI Water	MEOH	ENCORE	Density (ASTM D1481)	Specific Gravity (ASTM D1298)	Viscosity (ASTM D445)	Interfacial Tension (ASTM D971)	LAB USE ONLY
1	I-4-PZ		5/9/18	3:00:00 PM	PP	AQ	2					2				X	X	X	X	

Number of preserved Bottles

Matrix Codes

DW - Drinking Water
GW - Ground Water
WW - Water
SW - Surface Water
SO - Soil
SL- Sludge
SED-Sediment
OI - Oil
LIQ - Other Liquid
AIR - Air
SOL - Other Solid
WP - Wipe
FB-Field Blank
EB-Equipment Blank
RB- Rinse Blank
TB-Trip Blank

Turnaround Time (Business days)

Approved By (SGS PM): / Date:

- [ ] Std. 10 Business Days
- [ ] 5 Day RUSH
- [ ] 3 Day EMERGENCY
- [ ] 2 Day EMERGENCY
- [ ] 1 Day EMERGENCY
- [X] other Due 5/24/2018

Emergency & Rush T/A data available VIA Lablink

Data Deliverable Information

- [ ] Commercial "A" (Level 1)
- [ ] Commercial "B" (Level 2)
- [ ] FULLT1 (Level 3+4)
- [ ] NJ Reduced
- [ ] Commercial "C"
- [ ] NYASP Category A
- [ ] NYASP Category B
- [ ] State Forms
- [ ] EDD Format
- [X] Other COMMC+

Commercial "A" = Results Only
Commercial "B" = Results + QC Summary
NJ Reduced = Results + QC Summary + Partial Raw data

Comments / Special Instructions

Please send sample receipt confirmation, level 3 report, and invoice to Kristin.DeGraw@sgs.com.

* ADDITIONAL VOLUME

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler: 1	Date Time: 5/22/18 0900	Received By: 1	Relinquished By: 2	Date Time: 5/22/18 1000	Received By: 2 Chicli
Relinquished by Sampler: 3	Date Time:	Received By: 3	Relinquished By: 4	Date Time:	Received By: 4
Relinquished by: 5	Date Time:	Received By: 5	Custody Seal #	[ ] Intact [ ] Not intact	Preserved where applicable [ ] On Ice [ ] Cooler Temp.

Misc. Forms

Custody Documents and Other Forms

ATTACHMENT 4

UVOST®

Ultra-Violet Optical Screening Tool

At Dakota Technologies, we understand the challenges involved in combining high tech with demanding field conditions.

Our Ultra-Violet Optical Screening Tool (UVOST®) is the culmination of nearly two decades of field experience as LIF service providers. Its highly sophisticated yet rugged design allows the UVOST to reliably delineate nearly any petroleum NAPL including gasoline, diesel, crude oil, kerosene, and many others. It can be deployed by any type of direct push platform. UVOST is simply the world's finest laser-induced fluorescence (LIF) system and it was built to do one thing – find petroleum NAPL.

UVOST benefits include:

- **Real-time data**— allows for "on-the-fly" guidance of the next bore-hole location, leading to better bounding of source term
- **No IDW**— true in-situ information without investigation derived waste, carryover, or handling and storage of samples
- **Fast**— production rates of 300 to 500 feet per day (typical direct push conditions)
- **Flexible**— percussion (i.e. Geoprobe®) or cone penetration test (CPT)
- **Color-coded logs**— the ultimate in qualitative and semi-quantitative information at-a-glance
- **High data density**— one inch/data point
- **Sensitive**— low detection limits and baselines that only laser-based systems provide
- **Selective**— fluorescence time-domain waveforms offer positive identification and interference rejection
- **Proven**— technology with nearly 20 years experience built in
- **Quality**— LIF service by the scientists who pioneered commercial LIF
- **UVOST-HP**— UVOST is now available with built-in hydraulic profiling capability for comprehensive subsurface characterization using a single tool

Our innovative UVOST mates with direct-push platforms such as Geoprobe and CPT. UVOST is percussion-drivable... a Dakota Technologies exclusive!

The UVOST system uses a sapphire window in the side of the direct push probe to measure front-face fluorescence of the petroleum NAPL as the probe is advanced into the soil with nearly any DPT platform.

PAH fluorescence of fuels/oils is directed back to the surface where it is analyzed. Responses are indicated in real-time on a graph of UVOST signal vs. depth.

Petroleum hydrocarbons contain significant amounts of naturally fluorescent PAHs. Laser-induced fluorescence systems consistently detect them. The UVOST system was specifically designed to respond to these challenging NAPLs and precisely log their presence versus depth.

DAKOTA TECHNOLOGIES

www.dakotatechnologies.com
info@dakotatechnologies.com
701.237.4908

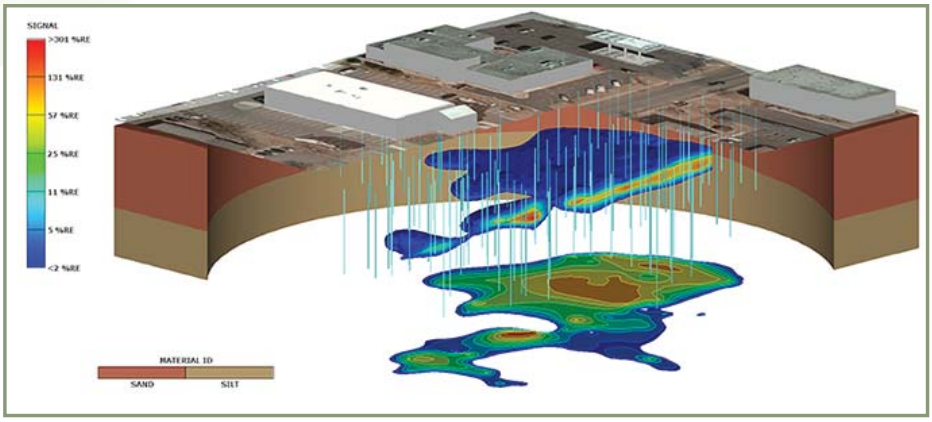
Atlanta, GA
Boston, MA
Minneapolis, MN
Morris, MN
Kansas City, MO
Fargo, ND
Columbus, OH
Charleston, SC
Virginia Beach, VA

UVOST®

Ultra-Violet Optical Screening Tool

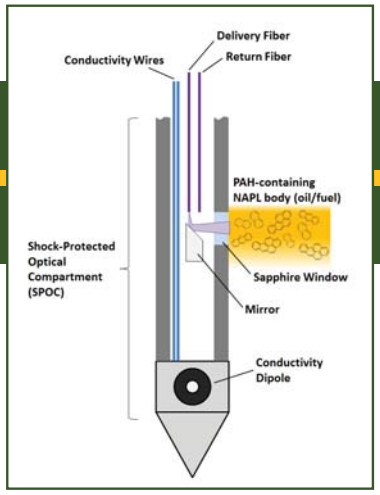
Successful remediation and treatment systems require detailed knowledge of NAPL location and distribution. UVOST provides the site characterization professional with a conceptual site model at unprecedented speed, detail, and efficiency. Traditional soil and ground water sampling techniques simply cannot compete with UVOST's production rates.

Since the first full-scale site characterization project with UVOST LIF technology in 1997, the UVOST system has been successfully applied and validated across a wide range of site conditions and deployment platforms, including Geoprobe and CPT. Nearly every major consulting firm in the U.S. has used UVOST to generate CSMs of petroleum NAPL.



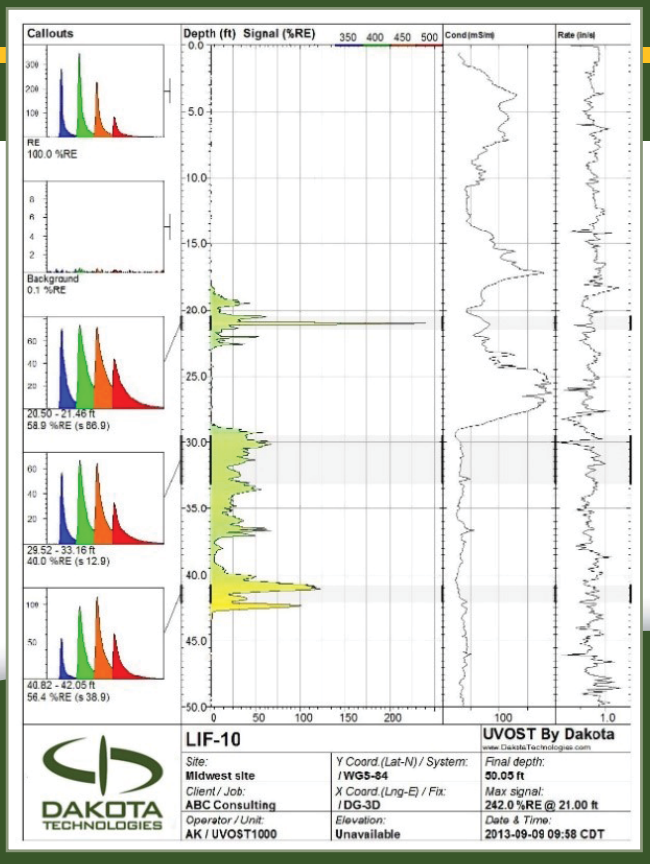
UVOST Data—Conceptual Site Model (CSM)

The end result of a UVOST boring is a high-density, non-subjective electronic data log (bottom left) readily incorporated into accurate conceptual site models. Accurate source term models lead to knowledgeable decisions, accurate treatment and removal designs, and realistic cost estimates—saving time and money.



UVOST Technology Overview

PAHs fluoresce and emit longer wavelength light. This light is captured by the return fiber and sent to the surface for processing with Dakota's proprietary Optical Screening Tool (OST) software.



Example Field UVOST Log

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ATTACHMENT 5

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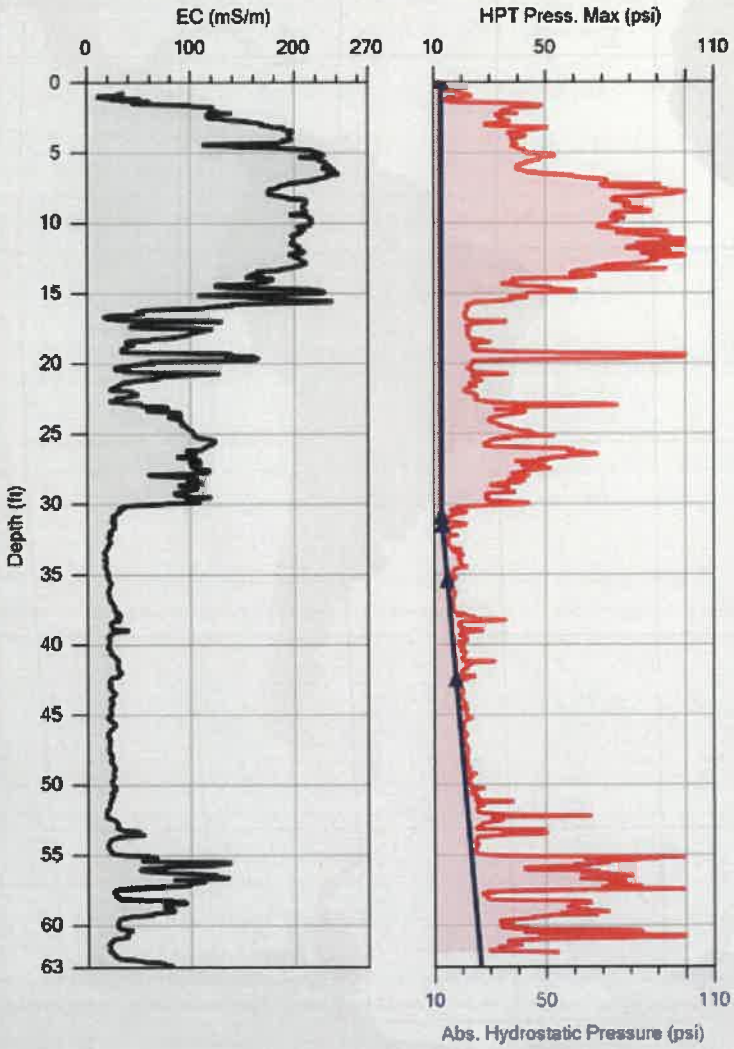
Hydraulic Profiling Tool (HPT)

HPT Introduction:

The Hydraulic Profiling Tool is a logging tool that measures the pressure required to inject a flow of water into the soil as the probe is advanced into the subsurface. This injection pressure log is an excellent indicator of formation permeability (Figure 1). In addition to measurement of injection pressure, the HPT can also be used to measure hydrostatic pressure under the zero flow condition. This allows the development of a hydrostatic pressure graph for the log and prediction of the position of the water table.



- HPT produces a detailed hydrostratigraphic log
- Can be used to estimate hydraulic conductivity in the saturated zone
- Logs both HPT injection pressure and electrical conductivity
- Measures hydrostatic pressure and depth to water table
- HPT logging is easy to learn and operate
- Interpretation of HPT logs is straight forward and intuitive

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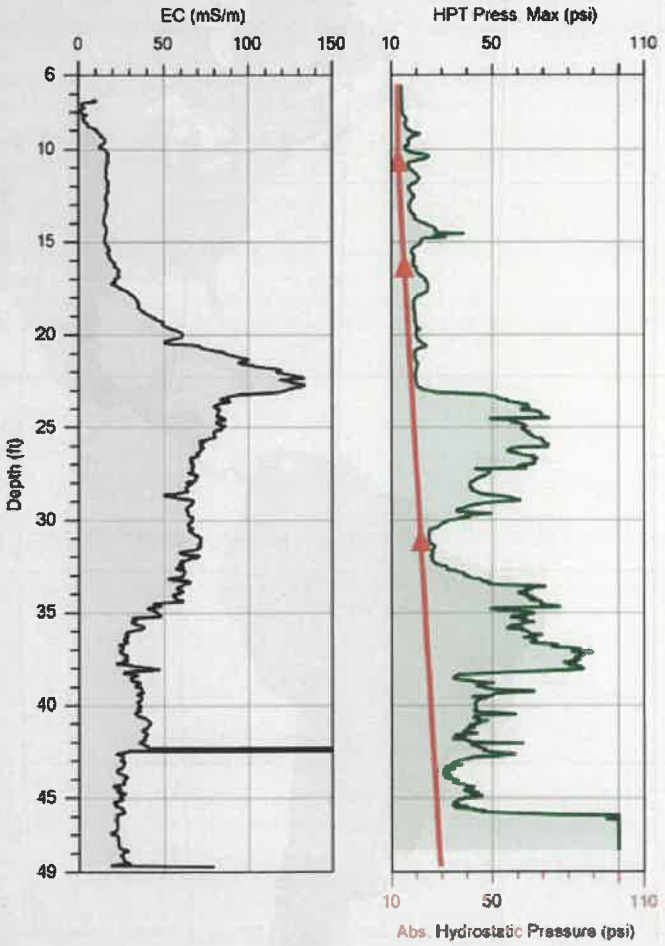
Hydraulic Profiling Tool (HPT)

The HPT is also useful for the detection of brines or other high electrical conductivity fluids in soil. These brines may originate from oilfield production or storage activities. Other high ionic fluids amenable to this technique include road salts and remediation fluids. Detection of these fluids is detected as an anomaly between the EC and HPT log. This occurs when the EC increases, in some cases even above that observed in background logs, while the HPT indicates a zone of high permeability.



An example of the detection of salt or brine contaminated groundwater using the HPT and EC logs. In this case (Left), the EC increases from baseline to maximum value in the 15 to 23 feet interval. At the same time the HPT pressure remains low, indicating that this is a zone of high permeability. The rise in EC in this case is caused by in increase in salt content in the groundwater, yielding specific conductance values in groundwater samples that are several times above background. The shape of the EC curve in this interval is also characteristic of salt contamination.

The equipment to perform HPT logging is simple. In addition to the Field Instrument (FI6000) for data acquisition, HPT requires the use of the K6300 Controller. This instrument provides the pump and pressure and flow measurement required to perform HPT logging.

HPT probes are available in both 1.75 in. (44.5mm) diameter for use with 1.5 inch (38mm) probe rods and 2.25 in. (57mm) diameter probes for use with 2.25 in. probe rods. Tools string diagrams for these probes may be found at: geoprobe.com/hpt-tool-string-diagrams. HPT probes are robust, driveable under all Geoprobe® 54 series and 60 series hammers, and can be factory rebuilt when they wear out (provided remaining thread life is deemed sufficient).