NOR-02971

October 17, 2022

Ms. Kristi Granzen
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau D, Section B
625 Broadway
Albany, New York 12233

Reference: CLEAN Contract No. N6247016D9008
Contract Task Order WE13

Subject: Final CERCLA Letter Work Plan
Phase III Southern Plume Intercept System
Recovery Well – RW9 Aquifer Testing and Analysis
Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage, New York
October 2022

Dear Ms. Granzen:

On behalf of the Department of the Navy, Tetra Tech is submitting the *Final CERCLA Letter Work Plan, Phase III Southern Plume Intercept System, Recovery Well – RW9 Aquifer Testing and Analysis, NWIRP Bethpage* to the New York State Department of Environmental Conservation (NYSDEC) for its records.

If you have any questions, please contact Mr. Scott Sokolowski, NAVFAC MIDLANT, at scott.c.sokolowski.civ@us.navy.mil or (757) 341-2011.

Sincerely,

Ernie Wu
Project Manager

Enclosures: Final CERCLA Letter Work Plan
Phase III Southern Plume Intercept System
Recovery Well – RW9 Aquifer Testing and Analysis
NWIRP Bethpage, New York
October 2022

Distribution:
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Project File

CERCLA LETTER WORK PLAN
PHASE III SOUTHERN PLUME INTERCEPT SYSTEM
RECOVERY WELL – RW9 AQUIFER TESTING AND ANALYSIS
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT (NWIRP)
BETHPAGE, NEW YORK
SEPTEMBER 2022

1.0 Introduction

This work plan has been prepared for the Mid-Atlantic Division of the Naval Facilities Engineering Systems Command (NAVFAC) pursuant to Contract Task Order (CTO) WE13, issued under Comprehensive Long-term Environmental Action Navy (CLEAN) contract number N6247016D9008. This work plan identifies actions to be taken to conduct aquifer testing (pumping) and analysis using groundwater recovery well RW9. RW9 is a part of the Phase III Southern State Parkway Intercept System (Phase III System) for the Naval Weapons Industrial Reserve Plant (NWIRP) in Bethpage New York. The RW9 pumping test(s) and associated field activities are anticipated to start in Fall 2022.

Recovery Well RW9 is located hydraulicly downgradient (south) of the leading edge of the Operable Unit (OU) 2 offsite groundwater volatile organic compound (VOC) plume (OU2 VOC plume), approximately 3.4 miles south southeast of the former NWIRP Bethpage property (See Figures 1-1 and 1-2).

RW9 (along with RW8 and RW10) is designed to intercept the leading edge of the OU2 VOC plume with five screened intervals between 650 to 865 feet below ground surface (bgs) as follows,

- 20-Foot screen from 650 to 670 feet bgs
- 10-Foot screen from 715 to 725 feet bgs
- 10-Foot screen from 740 to 750 feet bgs
- 23-Foot screen from 755 to 778 feet bgs
- 10-Foot screen from 855 to 865 feet bgs

Groundwater VOC data from the associated vertical profile boring, VPB-RW9, were free from detections of Trichloroethene (TCE) and Tetrachloroethane (PCE) throughout the boring to the final groundwater sample depth of 980 feet bgs (total boring depth of 1,008 feet bgs). Several VOCs at a maximum concentration of 1.7 micrograms per liter (µg/L) were detected in samples from 98 to 100 feet bgs. These detections in groundwater are too shallow to be associated with the OU2 Plume and capture of this water is not a goal for RW9. The furthest confirmed downgradient extent of the OU2 plume in this area is in monitoring well RE117D1 (screened at 730 to 755 feet bgs) and located approximately 1,700 feet northwest of RW9 (Figure 1-2). TCE was detected at a maximum concentration of 100 µg/L in this well in 2021.

The Navy undertakes and documents its environmental remedial activities with respect to releases/suspected releases from the former NWIRP through Navy Work Plans. These documents outline technical requirements for conducting these activities and include provisions to protect health and safety and to minimize impact to the local community. These provisions include restricting impacts to noise, dust, work hours, and site maintenance (e.g., cleanliness).

2.0 Scope and Objective

Aquifer testing will be conducted at recovery well RW9. Specific tasks to be conducted are as follows:

- Mobilization/Demobilization
- Aquifer pumping test(s)
- Well water gauging in monitoring wells (continuous and manual)
- IDW management, treatment, and discharge
- Data analysis/Report preparation

The specific objectives of the RW9 aquifer pumping tests are to better define local hydrogeological characteristics in order to determine long-term pumping rates and refine the recovery well capture zone estimates for the leading edge of the OU2 VOC Plume. Aquifer testing will be performed in accordance with Tetra Tech SOP GH-2.3 (Attachment 1 - Aquifer Pumping Tests).

3.0 Mobilization/Demobilization

Mobilization and demobilization will include transporting equipment, supplies, and personnel to and from the RW9 recovery well site (see Figure 3-1). Mobilization and demobilization will also include the construction/deconstruction of a temporary groundwater treatment system and any associated site restoration activities. Fieldwork will be conducted over an estimated one-month field effort supported by a subcontractor (Driller). Work will be conducted in a manner to protect the health and safety of the surrounding community. This protection will be achieved through implementation of best operational practices and controls applicable to pumping tests.

3.1 General Work Practices

General work hours for construction and the pumping test will typically be weekdays from 7 AM to 6 PM. Heavy machinery or power equipment (e.g., generators) will normally not start operation until 8 AM. The exception will be the portion of the test which will be conducted continuously over a 72-hour period. A mobile generator will be used to provide power to the pump and treatment equipment. This unit will be large enough to be operated continuously for 72-hours without re-fueling.

The work site will be maintained to ensure cleanliness both inside and outside of the well site. Trash will be maintained in an acceptable receptacle and be removed on a regular basis from the site as to not allow for excessive accumulation.

3.2 Site Controls

A security fence equipped with a lockable gate will restrict access to the RW9 site, equipment and materials, and waste receptacle(s) from the surrounding neighborhood. The gate will be secured with a lock at the end of each workday.

3.3 Traffic Control

Caution will be exercised when entering/exiting the site. Temporary traffic control devices will be utilized to provide adequate warning of conditions created by work vehicles entering and exiting the site. This activity does not include the movement of any heavy equipment or traffic restrictions that would require traffic control.

4.0 Aquifer Pumping Tests

Aquifer pumping tests will consist of two distinct operations: a Step-Drawdown (Step) Test over a 1- or 2-day period; followed by a Constant Rate (CR) Test over a 72-hour period.

The tests will use a variable frequency drive (VFD) electric submersible pump placed approximately 150 feet bgs to extract groundwater from RW9. Groundwater levels from RW9 and a portion of the existing monitoring well network will be collected before, during and after pumping to determine aquifer properties and establish the baseline groundwater level condition. The pumping status (e.g. on or off) of nearby/adjacent Public Water Supply (PWS) wells will be noted during the synoptic water level collection events. Further details on PWS wells is provided in Section 6.0.

The Step Test will be used to examine RW9 well performance and consist of five pumping rates ranging from 400 to 1,200 gallons per minute (GPM). After each successive “step”, the pumping rate will be increased, and each period of pumping or “step” will be equal in duration and last approximately 90 to 120 minutes.

The CR Test will consist of pumping groundwater from RW9 at a constant rate for a period of approximately 72 hours. The CR Test pumping rate is currently planned to be 800 GPM, but may be refined (lowered) based on data collected during the Step Test. In particular, reduced pumping rates may be required if the well is not able to produce 800 GPM on a sustained basis without excessive drawdown. Water level data will be collected before, during, and after the CR Test.

Table 4-1 presents a summary of the anticipated pumping rates and duration of the aquifer testing.

5.0 Groundwater Level Monitoring

A network of 31 existing groundwater monitoring wells and 2 recovery wells will be used to monitor groundwater levels before, during, and after the RW9 pumping tests (Figure 5-1 and Table 5-1). Water levels will be monitored continuously using in-well pressure transducers and compared to manually collected measurements made every two to four hours before, during, and after pumping at RW9. Pressure transducers will consist of Solinst® Levelogger and Levelogger Jr (Attachment 2). A local Solinst® Barologger Edge (Attachment 3) will be used to collect barometric pressure data and correct/adjust observation well pressure head data for fluctuations in barometric pressure. Manual groundwater level measurements will be collected using an electric water level meter.

The Solinst® transducer units in the monitoring wells and recovery wells will be set to collect data simultaneously with a 5-minute interval and be recording a minimum of 10 days prior to the pump testing and 10 days after the pumping tests.

The transducers in RW9 and the four associated monitoring wells will be set to record at the following frequency:

- 0.1 minute for 15 minutes
- 1 minute for 15 minutes
- 5 minutes for duration of pumping test (except for time needed to download and reset transducers prior to the end).

After the pump is shutdown, the transducers in RW9 and the four associated monitoring wells will record at the following frequency:

- 0.5 minute for 15 minutes
- 1.0 minute for 15 minutes

In addition to water level data, weather data (i.e., temperature, precipitation, and barometric pressure) will be tracked during the aquifer testing field activities. Weather data will be collected from an existing fixed-base weather station at Long Island MacArthur Airport in Islip, New York.

6.0 Public Water Supply Wells (PWS)

There are several public water supply wells operating in the area of the recovery well RW9 that may influence water levels in the associated monitoring well network. Operation records will be requested from South Farmingdale Water District, New York American (Liberty) Water District, and Massapequa Water District and analyzed in conjunction with other aquifer data to conduct capture zone analysis and groundwater modeling. Alternatively, data from the loggers can be used to evaluate well operation.

7.0 IDW Handling, Treatment, and Disposal

During the pumping tests, approximately 3 to 4 million gallons of water is expected to be extracted. This groundwater, though it will be tested using a pre-approved fixed-base laboratory, likely does not contain any detectable OU2 site contaminants (VOCs and 1,4-Dioxane). It's also unlikely that pumping activities at RW9 would draw in any groundwater contaminants (see Section 7.2). Regardless, a temporary treatment system consisting of bag filters and granular activated carbon (GAC) will be used to treat the water prior to discharging it to a local Nassau County Recharge Basin. Additional information on the extraction, treatment, discharge system and treatment goals are presented below.

Treatment System Overview

The RW9 treatment system is temporary and will be setup and operated solely for the pumping operations associated with the aquifer testing of RW9. Once field activities for the RW9 aquifer testing have been completed, any unused or reusable supplies, as well as treatment system components, will be removed from the site and effectively staged at the NWIRP facility.

The RW9 treatment system will include use of the following major components:

- One (1) VFD electric submersible pump
- Two to four (2-4) 21,000-gallon frac tanks
- 800 GPM transfer pump (s)
- One (1) or two (2) particulate filtration units (10 to 25-micron filter socks)

- Two (2) or three (3) in parallel 5,000- to 8,000-pound GAC filter tanks (15,000 to 16,000 pounds of carbon total)
- Various piping and hose
- Various connectors (check-valves, release-valves, and backflow preventors)
- One (1) flowmeter

The pump will be placed at a depth of approximately 150 feet bgs. The pump VFD and a valve will be used to control the flow rate. The water will be discharged into frac tanks, and a meter will be used to measure the flowrate. The frac tanks are used to maintain a constant discharge pressure on the well pump and to accumulate groundwater prior to treatment.

The groundwater will then be pumped through a particle filtration unit and GAC units prior to discharge to Nassau County Recharge Basin (#254). The capacity to infiltrate water will be evaluated during the step-drawdown tests and may factor into the selected pumping rate(s) for the 72-hour constant rate pumping test. A general outline of the RW9 treatment system is presented in Figure 7-1. The water level in the sump will be monitored to ensure the basin can handle the flow without effecting its use as a storm water basin.

<u>Treatment System Checks and Performance Testing</u>

Once the full treatment system is setup in its entirety, all equipment and instrumentation will be inspected to verify proper installation and fit. Inspections of equipment lockouts, safety valves and/or other pressure relief devices, and site security devices will also be completed. Once all system check(s) have been completed and the treatment system is deemed ready to operate, a functional performance test will be conducted. This test will include active pumping at variable anticipated rates to inspect individual components and check appropriate fittings/connections. The functional performance test will be observed as part of the initial IDW Sampling process.

<u>Treatment System Goals</u>

Results of groundwater samples collected from nearby monitoring wells are presented in Table 7-1. Full analytical data sheets are presented in Attachment 4. Also presented in Table 7-1 are treatment goals that are based on New York State drinking water and groundwater criteria. Table 7-2 presents sampling and analysis to be conducted during the pumping tests.

<u>IDW Sampling and Disposal</u>

Throughout continued operation of the RW9 treatment system and aquifer testing, additional influent, effluent, and quality control samples will be collected and analyzed at the laboratory. Results will be used to evaluate compliance with treatment system goals and will provide input to the re-usability of treatment system components (particularly the GAC filter media).

8.0 Data Analysis and Report Preparation

The water level data will be processed (corrected for barometric pressure and calculated for elevation) and assembled into tables for incorporation into a database. Graphs will be prepared showing water levels over time in the wells monitored. The data will be evaluated to determine which wells were influenced by the pumping of RW9, and to quantify the extent. Pumping data for other large-capacity pumping wells in the area will also be obtained to screen against the water level data and identify potential water level changes due to the operation of other wells. The assessment will evaluate the influence of RW9 pumping on groundwater levels within the strata that are screened within, as well as depositional sequences/groundwater flow units above and below.

The transmissivity (and hydraulic conductivity) and storage will be estimated utilizing the commercially available aquifer analysis program AQTESOLV® for Windows, Professional Version 4.5 and/or other appropriate calculation techniques (e.g. Cooper-Jacob Distance-Drawdown Evaluation). It is noted that the estimated results are a composite of the RW9 screened zones. The hydraulic data will also be used in the groundwater computer model development currently underway to validate/improve the model and allow better projections on groundwater capture in the area.

Analytical and hydrological data will be presented in tabular form and calculations will be explained in the appropriate text, noting specific methods, multiplying/divisible factors, and data filtering.

The water level and analytical data will be compared to groundwater computer model projected changes over time. This comparison will be used to evaluate the accuracy of the model in select areas, and, if necessary, be used to adjust model calibrations.

Due to the large size of the plume and relatively slow movement of the groundwater, trend development is expected to be limited over the first few years of operation. However, this data will be used to support long-term trend analysis of the Phase III Treatment, as well as be used to help identify any potential data gaps or modifications to the long-term approach.

The major or succeeding report that will support the executed activities of this work plan will be a Technical memorandum.

9.0 References

Tetra Tech, 2017. Tetra Tech SOP GH-2.3 *Aquifer Pumping Tests*

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TABLES

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Table 4-1
RW9 Aquifer Testing and Operational Pumping Rates

Operation	Pumping Rate(s)	Estimated Time
Step-Drawdown or Step Test (Aquifer Testing)	400, 600, 800, 1000, and 1200 GPM (1)	120 Minutes (Each)
Constant Rate Test (Aquifer Testing)	800 GPM	72 Hours
RW9 Normal Operation (Phase III Southern Plume Intercept System)	600 to 900 GPM	To be determined.

Notes:
GPM - Gallons per minute.
(1) The Step-Drawdown Test will include five different “Steps” or pump tests, each lasting approximately 2 hours. Field conditions may warrant changes in the effective pumping time based on aquifer response.

Table 5-1
RW9 Aquifer Testing Monitoring Well Network

Well ID	Approx. Distance from RW9 (feet)	Well Owner	Ground Elevation (NAVD 88-feet)	TOC Elevation (NAVD 88-feet)	Screened Interval (feet bgs)	Well Type (Outpost, Monitoring, Supply, Etc.)
BPOW 5-4	1,679	Navy	54.49	53.88	545-570	Outpost
BPOW 5-5	2,092	Navy	57.97	57.58	515-540	Outpost
BPOW 5-6	2,134	Navy	58.21	57.72	585-610	Outpost
BPOW 6-1	2,008	Navy	43.61	42.93	550-575	Outpost
BPOW 6-2	1,980	Navy	43.58	43.08	755-780	Outpost
BPOW 6-3	1,609	Navy	40.34	39.96	750-775	Outpost
BPOW 6-4	1,593	Navy	40.4	40.02	545-570	Outpost
BPOW 6-5	2,119	Navy	43.27	43.3	525-550	Outpost
BPOW 6-6	2,107	Navy	43.17	43.16	770-795	Outpost
NYAW-3A	2,818	NYAW	--	--	570-670	PWS
NYAW-4S	2,861	NYAW	--	--	585-646	PWS
RE117D1	1,665	Navy	54.11	53.81	730-755	Monitoring
RE117D2	1,650	Navy	54.24	53.59	780-805	Monitoring
RE118D1	2,106	Navy	57.99	57.61	765-790	Monitoring
RE129D1	2,466	Navy	54.09	53.63	690-710	Monitoring
RE129D2	2,485	Navy	53.96	53.52	805-825	Monitoring
RE133D1	1,232	Navy	48.89	48.38	560-580	Monitoring
RE133D2	1,216	Navy	48.91	48.72	780-800	Monitoring
SFWD-6-1	1,540	SFWD	--	--	506-576	PWS
SFWD-6-2	1,544	SFWD	--	--	506-529	PWS
TT-102D1	764	Navy	47.27	49.96	560-600	Monitoring
TT-102D2	749	Navy	45.29	44.12	740-770	Monitoring
RW8	1,741	Navy	45.4	44.58	595-790	Recovery Well
RW8-MW01S	1,850	Navy	44.5	47.96	262-272	Monitoring
RW8-MW01D1	1,832	Navy	44.3	48.10	550-570	Monitoring
RW8-MW01D2	1,791	Navy	44.6	48.02	740-785	Monitoring
RW8-MW01D3	1,812	Navy	44.6	48.41 (1)	820-850	Monitoring
RW9	0	Navy	53.0	51.98	650-865	Recovery Well

Table 5-1
RW9 Aquifer Testing Monitoring Well Network

Well ID	Approx. Distance from RW9 (feet)	Well Owner	Ground Elevation (NAVD 88-feet)	TOC Elevation (NAVD 88-feet)	Screened Interval (feet bgs)	Well Type (Outpost, Monitoring, Supply, Etc.)
RW9-MW01S	75	Navy	53.0	56.12	270-280	Monitoring
RW9-MW01D1	96	Navy	53.1	56.20	552-572	Monitoring
RW9-MW01D2	117	Navy	53.1	55.88	740-770	Monitoring
RW9-MW01D3	143	Navy	53.3	56.32	820-840	Monitoring
DECHC05-MW-01	1,087	NYSDEC	--	29.83	950-970	Monitoring
DECHC05-MW-02	1,190	NYSDEC	--	30.63	940-960	Monitoring
DECHC05-MW-03	1,266	NYSDEC	--	29.58	950-970	Monitoring
DEC1-D1	1,812	NYSDEC	--	29.28	695-715	Monitoring
DEC1-D2	1,796	NYSDEC	--	29.35	760-780	Monitoring

-- No Data.
BGS- Below ground surface.
TBD - To be determined.
PWS - Public Water Supply Well. NYAW - New York American Water.
SFWD - South Farmingdale Water District.

1 - RW8-MW01D3 inner casing repaired then re-surveyed Sept 2022

Table 7-1
RW9 Monitoring Well Results and Treatment Goals

Constituents	RW9-MW01D2 (µg/L)	RW9-MW01D3 (µg/L)	Treatment Goals (1) (µg/L)
Trichloroethene	ND	ND	<5
Freon 113	ND	ND	<5
1,1-Dichloroethene	ND	ND	<5
cis-1,2-Dichloroethene	ND	ND	<5
Tetrachloroethene	ND	ND	<5
Carbon Tetrachloride	ND	ND	<5
Chloroform	ND	ND	<5
1,1-Dichloroethane	ND	ND	<5
1,1,2-Trichloroethane	ND	ND	<1
1,1,1-Trichloroethane	ND	ND	<5
1,4-Dioxane	ND	ND	<0.35
pH (range)(2)	4.8	6.2	4.5 to 6.5
Iron	1,190 (828) (3)	1,040 (727)(3)	<300
Manganese	233 (179) (3)	163 (156)(3)	<300

ND - Not detected.
Sample results are from two monitoring wells that are screened at the depth of the recovery well. These results are anticipated to be representative of the groundwater to be extracted during the pumping test. Groundwater samples were collected in May 2022. Laboratory sample sheets are presented in Attachment 4.

(1) Treatment goals are based on NYSDOH Maximum Contaminant Levels (10 NYCRR 5-1) and NYSDEC groundwater standards (6 NYCCR 703.5). Under normal operation, VOCs in the treated effluent will be less than 1 µg/L and 1,4-dioxane will be less than the detection limit.
(2) The treatment process is not anticipated to significantly alter the pH of the groundwater prior to being returned to the aquifer, and would be compliant with 6 NYCRR 703.6, footnote 6 values.
(3) Filtered result presented in parentheses.

Table 7-2
RW9 Pumping Test Treatment System Sampling and Analysis Matrix

Operation [1]	Sample Location (Matrix)	Sample ID [2]	Analytes
Step-Drawdown Test (Mid Operation)	IN-01 (Influent)	RW9-PT-IN01-MMDDYYYY	VOCs, 1,4-dioxane, iron, manganese, pH
	OUT-01 (Effluent)	RW9 -PT-OUT01-MMDDYYYY	VOCs, 1,4-dioxane, iron, manganese, pH
Constant Rate Test (Day 2 – after 24 hours of operation)	IN-02 (Influent)	RW9-PT-IN02-MMDDYYYY	VOCs, 1,4-dioxane, iron, manganese, pH
	OUT-02 (Effluent)	RW9-PT-OUT02-MMDDYYYY	VOCs, 1,4-dioxane, iron, manganese, pH
Constant Rate Test (Day 3 – after 48 hours of operation)	IN-03 (Influent)	RW9-PT-IN03-MMDDYYYY	VOCs, 1,4-dioxane, TAL metals, anions, pH
	OUT-03 (Effluent)	RW9-PT-OUT03-MMDDYYYY	VOCs, 1,4-dioxane, TAL metals, anions, pH

FIGURES

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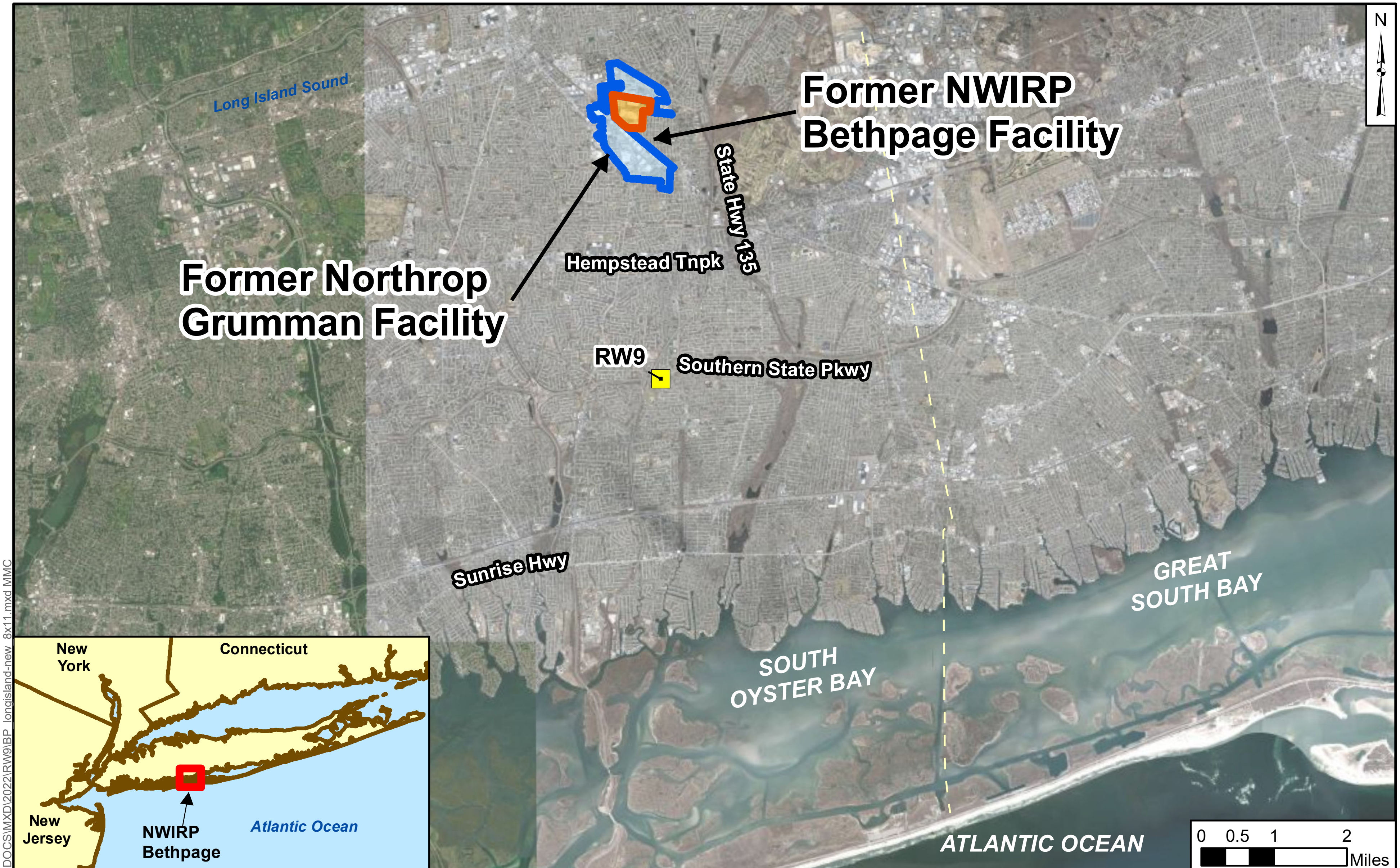

NAVFAC
Naval Facilities Engineering Systems Command

GENERAL LOCATION MAP
NWIRP BETHPAGE, NEW YORK

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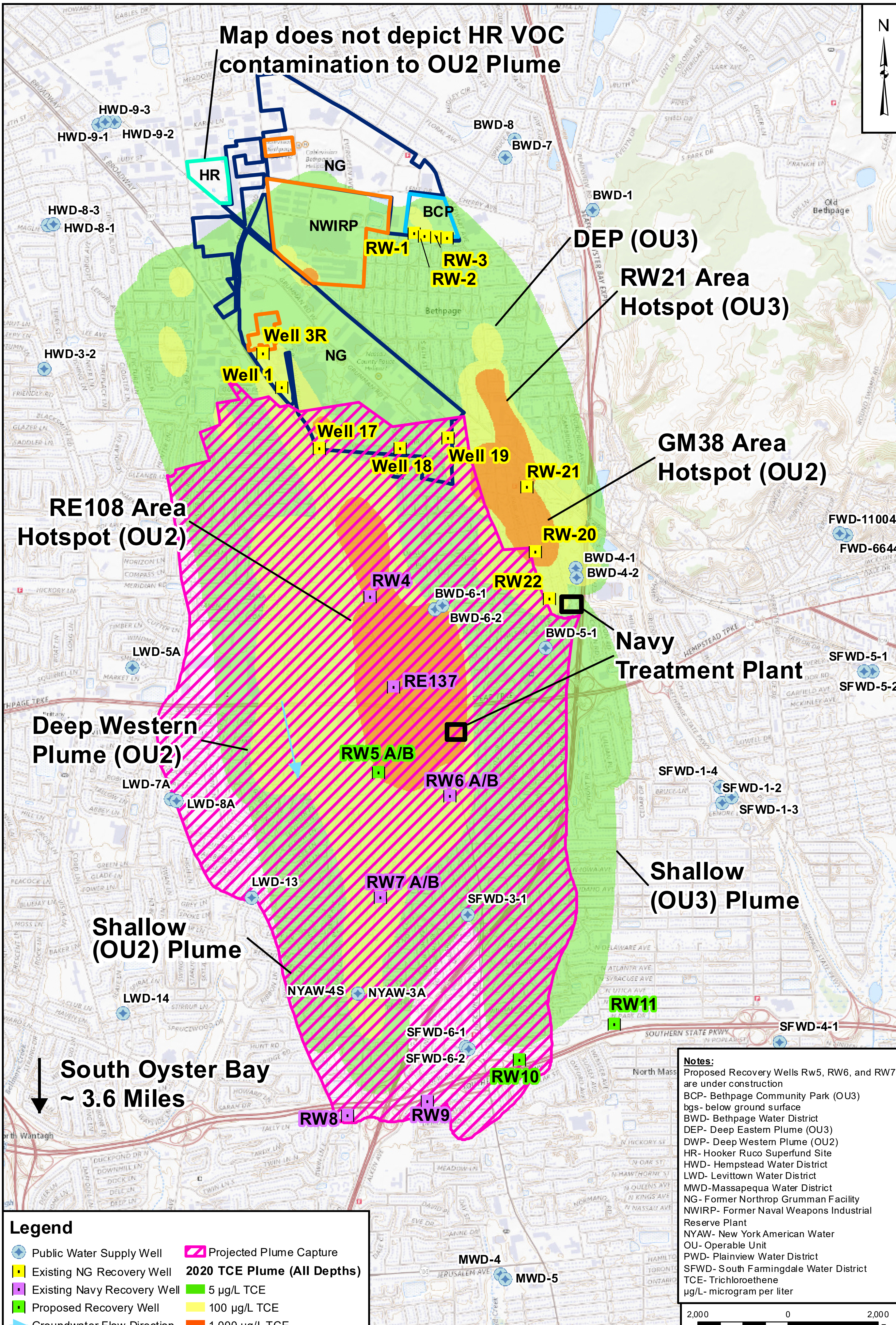

NAVY REMEDY PHASE I, II TO EXTENSION AND III, AND PROJECTED PLUME CAPTURE
NWIRP BETHPAGE, NEW YORK

Naval Facilities Engineering Systems Command

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VPBRW-9, MONITORING WELLS MW01S, MW01D1, MW01D2, MW01D3 AND RECOVERY WELL RW-9

SITE LAYOUT

ALKEN AVENUE - SEAFORD

NWIRP BETHPAGE, NEW YORK

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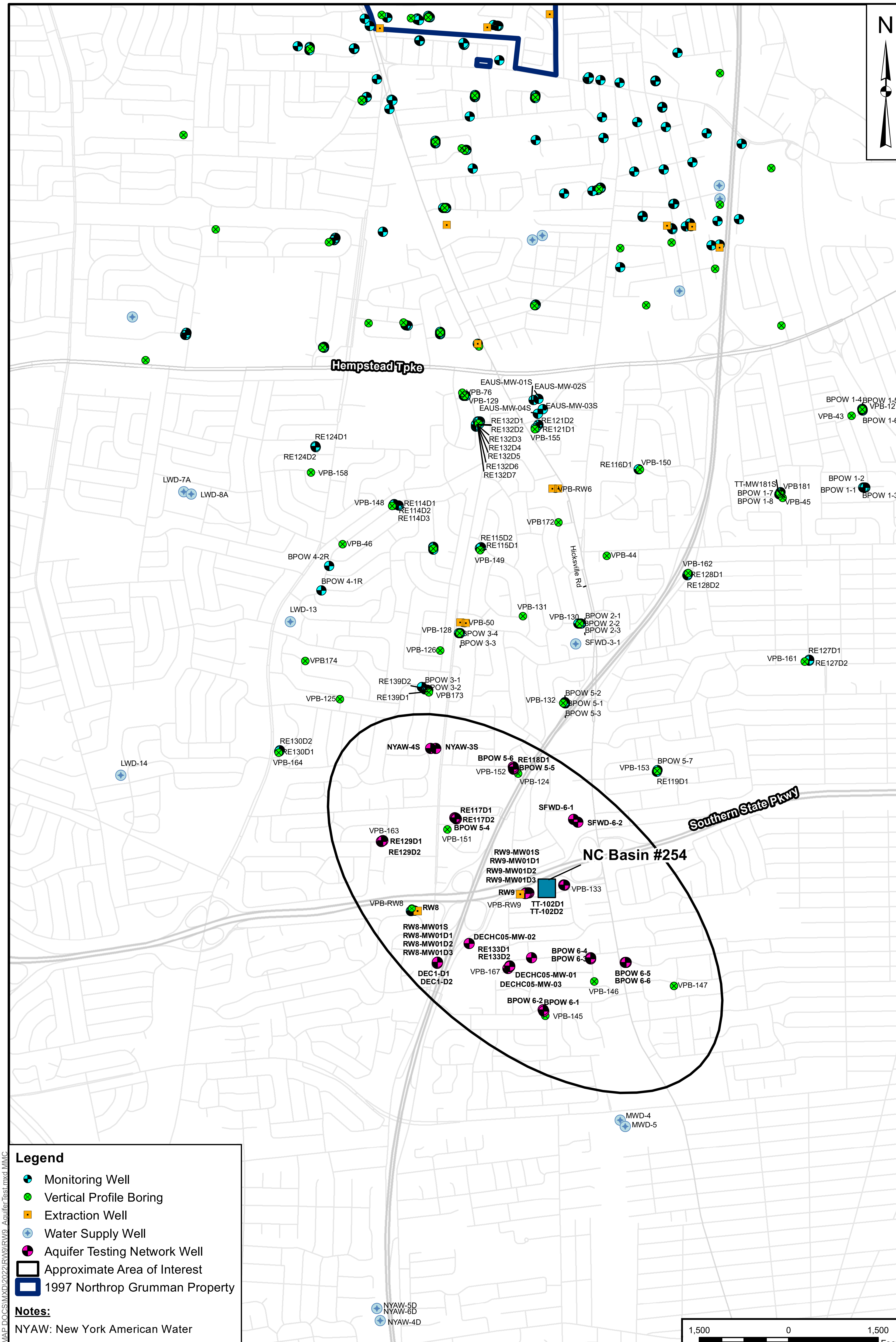

AQUIFER TESTING NETWORK
RECOVERY WELL RW8
PHASE III SOUTHERN PLUME INTERCEPT SYSTEM
NWIRP BETHPAGE, NEW YORK

NAVFAC Naval Facilities Engineering Systems Command

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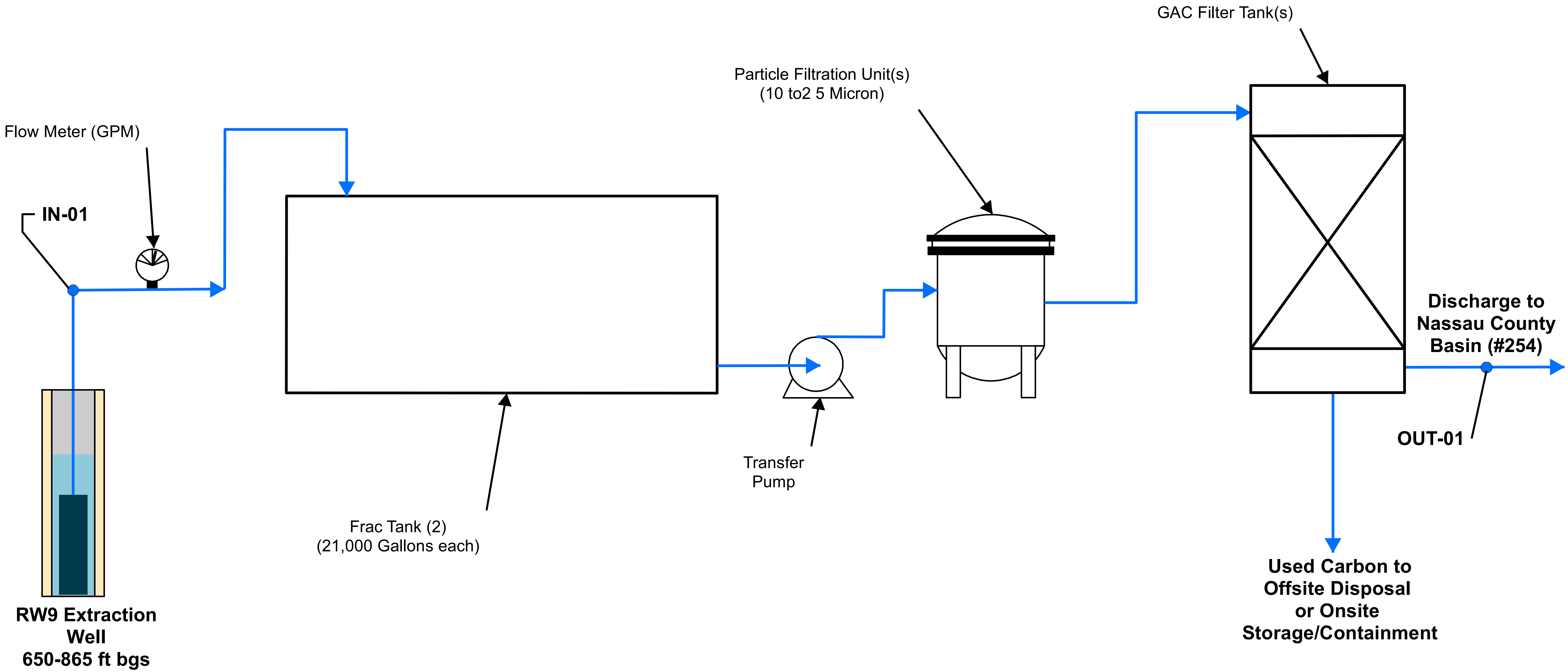

RW9 TEMPORARY GROUNDWATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM
PHASE III SOUTHERN PLUME INTERCEPT SYSTEM
NWIRP BETHPAGE, NEW YORK

NAVFAC
Naval Facilities Engineering Systems Command

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K. BURDICK	04/21/22	112G08005-WE13
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Attachment 1
Standard Operating Procedure GH-2.3
Aquifer Pumping Tests

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A PUMPING TEST DATA SHEET - PUMPING WELL (EXAMPLE) 9
B PUMPING TEST DATA SHEET - OBSERVATION WELL (EXAMPLE) 10

1.0 PURPOSE

This guidance provides general reference information and technical guidance on the performance and evaluation of aquifer pumping tests.

2.0 SCOPE

This procedure describes overall technical guidance for the performance and evaluation of pumping tests. The methodologies presented should be modified to meet the requirements/constraints of specific projects.

Pumping test data analysis is subject to much interpretation. Therefore, planning of the test and evaluation of the test results should be performed by an experienced hydrogeologist familiar with pumping test analytical techniques and interpretation. Due to the complexity of some of the evaluation methods and the wide variety of corrections which may be required to be factored into the data obtained, this guideline presents only a general overview of the pumping test evaluation process. The references provided in Section 6.0 should be consulted for detailed discussions regarding pumping test evaluation techniques.

3.0 GLOSSARY

<u>Cone of Depression</u> - The area around a discharging well where the hydraulic head in the aquifer has been lowered by pumping. Also called cone of influence.

<u>Confined Aquifer</u> - An aquifer that is completely saturated and is overlain and underlain by strata of lower permeability. The potentiometric surface of a confined aquifer is higher than the base of the upper confining layer at any given point.

<u>Discharge (Q)</u> - Volume of water removed per unit time.

<u>Drawdown (s)</u> - Difference between the initial static water level at a given point and the water level position at that same point at a selected elapsed time during pumping. Drawdown varies based on a number of variables (elapsed time, pumping rate, distance from pumping well, aquifer properties).

<u>Hydraulic Conductivity (K)</u> - A quantitative measure of the ability of porous material to transmit water. Volume of water that will flow through a unit cross sectional area of porous material per unit time under a head gradient. Hydraulic conductivity is dependent upon properties of the medium and fluid.

<u>Pumping Test</u> - A test made by pumping a well for a period of time and observing the resulting change in hydraulic head in the aquifer. A pumping test may be used to determine the hydraulic characteristics of the aquifer and the capacity of the pumped well.

<u>Specific Capacity (SC)</u> - Rate of yield per unit drawdown. Often expressed as gallons per minute per foot of drawdown. The pumping time prior to measurement of drawdown should be stated, e.g., SC = 5 gal/ft after 12 hrs pumping.

<u>Specific Storage</u> - The amount of water released from or taken into storage per unit volume of aquifer per unit change in head.

<u>Specific yield</u> - The ratio of the volume of water a rock or soil will yield by gravity drainage to the total volume of the rock or soil.

<u>Storage Coefficient (S)</u> - Volume of water an aquifer releases from or takes into storage per unit volume of aquifer per unit change in head. The product of specific storage times saturated thickness. Also called storativity.

Transmissivity (T) - A quantitative measure of the ability of an aquifer to transmit water. The product of the hydraulic conductivity times saturated thickness.

4.0 RESPONSIBILITIES

Project Hydrogeologist - The Project Hydrogeologist, in conjunction with the Project Manager, has the responsibility of determining the need to perform a pumping test or tests for investigative purposes. Factors that should be taken into account when considering whether a pumping test should be performed or not include:

- Project objectives and the data required to meet these objectives.
- The amount and accuracy of hydrogeologic data currently available.
- Cost and schedule constraints.
- Physical and chemical site limitations (discharge of contaminated/uncontaminated water, aquifer water yielding capability, access, etc.)

Pumping tests (especially long-term tests) can be time-consuming, labor intensive, and costly. On the other hand, pumping tests generally yield the most accurate data regarding aquifer characteristics that can be obtained, when designed, performed, and evaluated properly. Specific uses for pumping tests include:

- Determination of aquifer hydraulic characteristics for groundwater flow, contaminant transport, sustainable yield, and other hydrogeologic/environmental evaluations.
- Determination of the extent of influence of a pumped well.
- Design of groundwater withdrawal systems (for groundwater treatment or water supply).
- Determination of the interconnection between water bearing formations.
- Identification of aquifer boundaries (recharge/discharge boundaries).

Once the need to perform a pumping test has been established, the Project Hydrogeologist is responsible for the design and oversight of the pumping test, including identifying the wells to be used, designing and locating the pumping and observation wells as needed, specifying methodologies to be used, and determining the length of time of the test. The Project Hydrogeologist should ensure that all field personnel involved are familiar with the planned test and the field operations related to the performance of the test. During the startup of the pumping test, the Project Hydrogeologist may need to be onsite to ensure that proper field procedures are used. Data generated during the performance of the pumping test should be concurrently reviewed by the Project Hydrogeologist to identify any modifications to the planned procedure that may be required during the performance of the test. Data reduction/evaluation should be performed under the supervision of the Project Hydrogeologist.

Field Personnel - All field personnel should be familiar with the overall methodology of performing pumping tests, as well as being familiar with the specific requirements of each individual test that they will participate in. The field personnel should be familiar with the types and uses of the various field equipment required for the performance of a pumping test (surface or submersible pumps, generators, water level measuring devices, flow measuring devices, support equipment). It is the responsibility of the field personnel to alert the Project Hydrogeologist to any unexpected conditions that may be encountered that would require modifications to the planned procedure. The field personnel are responsible for performing the test as described in the approved project plans and any approved modifications. Once the pumping test has been completed, field personnel are to assist the Project Hydrogeologist in the process of data reduction/evaluation.

5.0 PROCEDURES

5.1 <u>Planning for a Pumping Test</u>

The need for and design of a pumping test is determined largely by the project goals and geologic/hydrogeologic conditions within the study area. The pumping test should be designed so the results obtained will be representative of the area under study.

As much information as possible should be collected and evaluated before running a pumping test. This includes data regarding physical and hydraulic characteristics of the aquifer, groundwater flow direction, hydraulic gradients, flow velocity, recent water level trends, the existence of other pumping wells in the vicinity of the test area, and the expected quality/quantity of the discharge water.

The placement and design of the pumping well is critical to the success of the pumping test. Placement of the well is dependent on pumping test objectives and local geologic conditions. In general, the pumping well should fully penetrate the aquifer to be pumped, and be screened across most of the saturated interval of the aquifer. Due to project constraints and physical practicality, this is often not the case, and corrections must be factored into the data analysis for partially penetrating wells.

If an existing well is to be used for a test, the well should closely conform to the requirements for aquifer testing. Boring logs, construction data, and performance characteristics of other wells in the area should be examined to develop a preliminary estimate of the aquifer characteristics. Transmissivities can be estimated from the boring logs and preliminary testing.

Any number of observation wells may be used. The number chosen depends on maintaining a balance between cost and need to obtain the maximum amount of accurate and reliable data. If three or four observation wells are to be installed in the pumped aquifer, all but one well should be installed along a radial line extending out from the pumping well, with the remaining well placed along a line normal to the line of observation wells and passing through the pumping well, to evaluate radial anisotropy within the aquifer. If two observation wells are to be installed, they should be placed in a straight line away from the pumping well. In a fracture controlled bedrock flow system; fracture orientations should be considered when deciding where to place observation wells. In general, observation wells for an unconfined aquifer test should be placed closer to the pumping well than for a confined aquifer test.

When a pumping well does not fully penetrate an unconfined aquifer (any well with an 85 percent or more open or screened interval within the saturated thickness may be considered as fully penetrating), the observation wells should be located at a minimum distance equal to 1-1/2 to 2 times the aquifer thickness from a partially penetrating pumping well if partial penetration corrections are to be avoided. This minimizes the effect of flow field distortions resulting from pumping a partially penetrating well.

Observation wells screened within the aquifer being pumped will provide information regarding aquifer characteristics. Wells screened in an overlying or underlying aquifer will provide information regarding the degree of interconnection between aquifers. If an observation well is screened in an overlying aquifer, it should be placed close to the pumping well so the response of the overlying aquifer is monitored at a point where the difference in head between aquifers is relatively large.

The pumping and observation well configurations and locations described above are not requirements, but are suggested setups to maximize the accuracy of the data generated. In many instances, less than ideal conditions regarding screened intervals/depths and observation well numbers/locations will be encountered due to project constraints. Valid pumping tests can still be performed if the wells used do not conform to the ideal setup. Again, it is essential that an experienced hydrogeologist take the primary role in planning the test to develop a technical approach that best fits site conditions.

Single well pumping tests can be performed when project constraints do not allow for the installation of observation wells. The data obtained from these tests is less accurate than for tests performed using observation wells, and specific yield/specific storage cannot be determined. Drawdown measurements in a pumped well are generally greater than the actual drawdown in the adjacent aquifer due to well inefficiency, so this factor must be considered when interpreting results.

5.2 Preparation for a Test

For a few days before starting a long-term pumping test, water levels in the pumping well and observation wells should be measured at about the same time each day to determine whether there is a measurable trend in groundwater levels. If such a trend is apparent, a graph of the change in water level versus time should be prepared and used to correct the water levels obtained during the test.

Pumping wells should undergo a preliminary pumping prior to the actual test to ensure that the well will function at its maximum efficiency. This will enable fines to be flushed from the formation and a steady flow rate to be established. The preliminary pumping should determine the maximum drawdown in the pumping well at a given pumping rate and establish the pumping rate for the later test. The aquifer should then be given adequate time to fully recover before the pumping test is begun.

Step-drawdown tests can be performed prior to the actual pumping test, to determine the optimum pumping rate for the test. A step-drawdown test consists of pumping a well at several successively higher rates, for a given time period (1/2-2 hours for each rate), and measuring the rate of drawdown for each pumping rate. The resulting data generated can be used to predict drawdown versus time over an extended period for various pumping rates.

Barometric changes may affect water levels in wells, particularly those screened in confined aquifers. An increase in barometric pressure may cause a decrease in the water level. The response of wells to changes in barometric pressure should be determined in order to correct the measurement of water levels during a long-term pumping test. The use of a background well to collect water level data unaffected by pumping activities can be useful in correcting test data for both background water level trends and short term barometric pressure-induced changes. The background well should be screened in the same aquifer as is being tested and should be far enough away from the test area as to be unaffected by pumping activities.

A record should be maintained of the pumping times and discharge rates of other pumping wells in the vicinity, if their radius of may influence potentially intersect the cone of depression of the pumping test well.

In areas of severe winter climate, where the frost line may extend to depths of several feet, pumping tests should be avoided during the winter in areas where the water table is near ground surface. Under some circumstances, the frozen soil acts as a confining bed, combining leaky aquifer and delayed yield characteristics to make the results of the test unreliable.

5.3 Conducting a Test

Immediately before the pump is started, the water levels should be measured in the pumping well and all observation wells to determine the static water levels upon which drawdowns will be based. These data and the time of measurement should be recorded on a pumping test data sheet (see Attachment A for an example).

It may be useful to collect water samples from the pumping well (at least) before and after pumping. This data can give an indication of changes in groundwater quality due to pumpage.

Critical data that must be collected for each pumping test include the time that pumping started and ended, water level measurements during the test, periodic measurements of the pumping rate, and the distances between the pumping well and the observation wells.

Pump selection depends on the expected pumping rate and the physical constraints of the test (e.g., depth to water, expected total drawdown, pumping well diameter). Pump size is related to the required discharge capacity and the well diameter. Submersible pumps or air-lift set-ups are required when the drawdown of the water level is expected to exceed 25 feet below ground surface. Suction pumps can be used if total drawdown plus well headspace is not expected to exceed 25 feet.

After pumping is initiated, measure and adjust the flow rate immediately as necessary to achieve a constant discharge at the desired rate.

Check, adjust, and record the discharge rate frequently during the performance of the test, especially during the early stages of the test. The selected pumping rate should not be the maximum rate that the pump is capable of, as progressive drawdown may decrease the pump's efficiency, and as a result reduce the discharge rate. If the pump is initially operating at less than full capacity, the decrease in efficiency can be countered by increasing the pump speed or, if the discharge rate is controlled through a valve (as is more typical), opening the valve further. Pumping rates can be monitored using a flowmeter or, for low volume pumping tests, a stopwatch and calibrated bucket can be used to measure discharge rates.

Monitor the tone or rhythm of a pump or generator. The tone or rhythm of a pump or generator motor engine provides a check of performance. If there is sudden change in tone, the discharge should be checked immediately and proper adjustments made to the gate valve or to the engine speed if necessary.

Measure at least 10 observations of drawdown within each log cycle of time in the pumping well and observation wells. Continuous water level recording for the observation wells nearest to the pumping well can be extremely useful. A suggested schedule for measurements is as follows:

- 0 to 10 minutes: 0.0, 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6.5, 8, and 10 minutes. It is important in the early part of the test to record with maximum accuracy the time at which readings are taken.
- 10 to 100 minutes: 10, 15, 20, 25, 30, 40, 50, 60, 80, and 100 minutes.
- to 2-hour intervals: To the end of the first day.
- 500- to 1,000-minute intervals: After the first day.

In addition, water level measurements should be collected periodically (every 4-8 hrs) from one or more background wells located outside the cone of depression.

Initially, there should be enough personnel available to measure flow rates/adjust pump rates continuously and to station a person at each nearby well used in the pumping test, unless continuous water level recorders or pressure transducers and data loggers are used. After the first two hours of the pumping test, two people are usually sufficient to continue the test. If water level data loggers/pressure transducers are used to electronically collect drawdown data, periodic hand measurements of water levels should still be made at each well to verify the data logger data.

The total pumping time for a test depends on the type of aquifer and degree of accuracy desired, and can range from less than 2 hours to several days. Economizing on the period of pumping is not recommended. More reliable results are obtained if pumping continues until the cone of depression reaches a stabilized condition, however, this is not always practical or necessary. The cone of depression will continue to expand at a progressively slower rate until recharge of the aquifer equals the pumping rate and a steady state condition is established. The time required to achieve steady state flow conditions may vary from less than an hour to beyond the practical limits of a pumping test. Under average conditions, it is good practice to run a large scale pumping test in a confined aquifer for at least 24 hours and in an unconfined aquifer, for a minimum of 72 hours. A longer period of pumping may reveal the presence of boundary conditions not previously known. Single well pumping tests or small scale tests may be run for shorter time periods. Preliminary field plotting of drawdown data should be conducted during the test to evaluate how the test is progressing and how much longer it should continue.

Plan the disposal of water from the pumping well. Dispose of water pumped from an unconfined aquifer during a pumping test in such a way so that the aquifer is not locally recharged by discharge water infiltration during the test, as recharge may offset drawdown effects.

The discharge water could be routed to a storm sewer or surface water body if uncontaminated, or temporarily stored in tanks, drums or in a lined pit if collection is required. Contaminated water can also be treated and discharged in an appropriate manner, with client/regulatory approval. If necessary, contaminated discharge water may need to be transported for offsite treatment/disposal, however onsite treatment/disposal is preferred when possible to minimize costs.

5.4 Recovery Test

When pumping is stopped after completing the drawdown portion of the pumping test, record the cumulative drawdown in each well and time at which pumping was discontinued, then measure the rate of recovery of the water levels in the wells.

The same procedure and time pattern are followed as at the beginning of a pumping test; that is, the depth-to-water is periodically measured during the recovery test in the pumping well and observation wells, with readings obtained more frequently during the early phase of recovery. Recovery data should follow the same general trend as drawdown data, and is considered in many cases to be more accurate and useful for pumping test analysis than drawdown data.

Record the recovery data until the aquifer fully recovers, or as long as possible within project constraints.

5.5 Data Analysis

A constant rate pumping test can be run to determine transmissivity and hydraulic conductivity. If the effects of pumping the well can be measured in one or more observation wells at known distances from the pumping well, the specific yield or storage coefficient can also be determined. A good check of the transmissivity value can be made using recovery data from the pumped well and of transmissivity and storage coefficient from recovery rate measurements in observation wells.

Example data collection forms for a pumping test are illustrated in Attachments A and B. The forms can be used to record data for the pumping well or an observation well. It should be noted that there are some differences in the types of data recorded for pumping versus observation wells.

The effects of all extraneous factors such as barometric pressure, tidal influence, injection interference, or other pumpage in the nearby area, can be adjusted for and corrected from the measured data by using applicable correlation techniques.

After correction of the raw data to eliminate or reduce the amount of extraneous interference, graphs may be prepared showing resulting drawdowns versus time and/or distance; these are plotted on semi-log or log-log paper. The graphs are used to determine aquifer characteristics by matching type curves or by straight line slope analysis procedures. Analytical methods not requiring the use of a graph have also been developed. Selection of the most appropriate evaluation technique is dependent on the hydrogeologic conditions, test setup, and results. In addition to manual methods of analysis, there are numerous computer programs available for data analysis. Selection and application of the proper analysis method(s) requires the active involvement, judgement, and guidance of an experienced hydrogeologist as interpretation of test data can be very complex.

5.6 Records

The Pumping Test Data Sheet exhibited on Attachment A should be used to record data from pumping wells, and the Pumping Test Data Sheet exhibited on Attachment B should be used to record data from observation wells. Water level data loggers also produce electronic files of pressure transducer/water level measurements. A written log of the field setup and performance of the pumping test must also be kept in a bound site logbook or notebook. Descriptions of procedures used, daily activities, and any other pertinent observations made prior to, during, and following the test should also be recorded.

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ATTACHMENT A
EXAMPLE PUMPING TEST DATA SHEET, PUMPING WELL (EXAMPLE)

PUMPING TEST DATA SHEET
PUMPING WELL

Page ___ of ___

PROJECT NAME: ______________________
PROJECT NUMBER: ____________________
PUMPING TEST: [ ]
TEST NUMBER: ______________________
METHOD OF MEASUREMENT: ____________
DEPTH CORRECTION: _________________

PUMPING WELL NUMBER: _______________
DATE(s): ___________________________
STEP DRAW DOWN TEST [ ]
MONITORING POINT: __________________
ELEVATION OF MONITORING POINT: ______ MSL
PUMP SETTING (Ft. below monitoring point): ______

PUMPING TEST PERFORMED BY: ______________________________________
REMARKS: ____

TIME (Hour:Min.)	(t) ELAPSED TIME SINCE PUMP START OR STOP (Min.)	WATER LEVEL (Ft.)	(s) DRAW DOWN OR RECOVERY (Ft.)	FLOW METER READING (Gals.)	(Q) PUMPING RATE (GPM)	REMARKS

SIGNATURES: ____

ATTACHMENT B
EXAMPLE PUMPING TEST DATA SHEET, OBSERVATION WELL (EXAMPLE)

PUMPING TEST DATA SHEET
OBSERVATION WELL

Page ___ of ___

PROJECT NAME: ____________________
PROJECT NUMBER: ____________________
TEST NUMBER: ____________________
METHOD OF MEASUREMENT: ____________
DEPTH CORRECTION: ________________
OBSERVATION WELL NUMBER: ______________
DATE(s): ______________________________
MONITORING POINT: _____________________
ELEVATION OF MONITORING POINT: ______ MSL
CORRESPONDING PUMPING WELL NUMBER: ______________________________
DISTANCE FROM PUMPING WELL (Ft.) (r): ______________________________
REFERENCE POINT MEASUREMENTS BY: ______________________________
REMARKS: ______________________________

TIME (Hour:Min.)	(t) ELAPSED TIME SINCE PUMP START OR STOP (Min.)	WATER LEVEL (Ft.)	(s) DRAW DOWN OR RECOVERY (Ft.)	REMARKS

SIGNATURES: ______________________________

Attachment 2
Pressure transducers

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Levelogger Junior Edge

Model 3001

The Levelogger Junior Edge provides an inexpensive alternative for measuring groundwater and surface water levels and temperature. The Levelogger Junior Edge combines pressure and temperature sensors, a datalogger, and 5-year battery in one compact 7/8" x 5.6" (22 mm x 142 mm) stainless steel housing.

The Levelogger Junior Edge records absolute pressure using the same durable Hastelloy pressure sensor as the Levelogger Edge. The Hastelloy sensor has excellent performance in harsh environments with better temperature compensation and thermal response time, and can withstand 2 times overpressure without permanent damage.

The Levelogger Junior Edge features FRAM memory, with an increased capacity of 40,000 sets of temperature and water level data points. Readings are linear at a user-defined interval between 0.5 second to 99 hours. Accuracy is 0.1% FS, with 20 bit resolution and lifetime factory calibration.

If greater accuracy, more sampling options, or wider depth ranges are required, the Solinst Levelogger Edge has the functionality to suit your application (see Model 3001 Data Sheet). For conductivity datalogging, Solinst also offers the LTC Levelogger Junior (see Model 3001 LTC Levelogger Junior Data Sheet).

Technical Specifications	
Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	F15/M5, F30/M10
Accuracy (typical):	0.1% FS
Units of Measure:	cm, m, ft, psi, kPa, mBar, ºC, ºF
Resolution:	20 Bit Resolution
Normalization:	Automatic Temp Compensation
Temp Compensation Range:	0ºC to 40ºC
Temperature Sensor:	Platinum RTD
Accuracy:	± 0.1ºC
Resolution:	0.1ºC
Battery Life:	5 Years
Operating Temperature:	- 20ºC to 80ºC
Clock Accuracy:	± 1 minute/year (- 20ºC to 80ºC)
Memory:	FRAM
Maximum Readings:	40,000 sets of readings
Communication:	Optical Infrared to USB, RS232, or SDI-12
Size:	7/8" x 5.6" (22 mm x 142 mm)
Weight:	4.2 oz. (119 grams)
Wetted Materials:	316 Stainless Steel, Delrin®, Viton®, Hastelloy
Sampling Mode:	Linear and Real Time View
Measurement Rates:	0.5 sec to 99 hours
Barometric Compensation:	Software Wizard and Barologger Edge

Features

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- Low cost
- 5 year battery life
- Accuracy of 0.1% FS
- Increased memory to 40,000 data points
- New robust Hastelloy pressure sensor
- Compatible with Solinst Telemetry Systems and SDI-12

Operation

Programming the Levelogger Junior Edge is the same as with the Levelogger Edge. An Optical Reader or PC Interface Cable connects the Levelogger to a laptop or desktop PC. The intuitive Levelogger Software automatically detects the type of Levelogger that is connected. Programming, downloading, data management and export are intuitive tasks. The Real Time View option allows immediate viewing of live water level and temperature readings, independent of the scheduled programming intervals.

The Levelogger Junior Edge outputs temperature and temperature compensated water level readings. Using the Data Compensation Wizard in the Levelogger Software, you can barometrically compensation multiple Levelogger Junior Edge files simultaneously, with just one Barologger Edge file.

The Levelogger Junior Edge is compatible with Levelogger Series accessories, including the Leveloader Gold data transfer device, SDI-12 Interface Cable, and Solinst Telemetry Systems (see Model 9100/9200 Data Sheet).

These compact dataloggers are straightforward to deploy. Installation can be with direct read cables, by stainless steel wireline or Kevlar® cord suspension, with the option of using Solinst 2" Locking Well Caps.

Applications

- Monitoring water levels in wells and surface water
- Pump and slug tests
- Reservoir and stormwater runoff management
- Watershed and drainage basin monitoring
- Stream gauging, lake and wetland monitoring
- Tank level measurement

Solinst®

Levelogger Edge Comparison

Model 3001	Levelogger Edge	Levelogger Junior Edge
Backwards Compatible	YES (with limitations) See http://www.solinst.com/Downloads/	YES (with limitations) See http://www.solinst.com/Downloads/
Warranty	3 Years	1 Year
Pressure Transducer	Piezoresistive Silicon with Hastelloy Sensor	Piezoresistive Silicon with Hastelloy Sensor
Calibrated Ranges:	15, 30, 65, 100, 300 ft, Atmospheric Barologger 5, 10, 20, 30, 100 m, Atmospheric Barologger	15, 30 ft 5, 10 m
Accuracy (typical)	± 0.05% FS (Barologger Edge ±0.05 kPa)	± 0.1% FS
Resolution	24 Bit Resolution	20 Bit Resolution
Normalization	Automatic Temperature Compensation	Automatic Temperature Compensation
Calibration	Factory – Lifetime calibration	Factory – Lifetime calibration
Response Time (90% Thermal Δ)	1 minute/10ºC change	1 minute/1ºC change
Temp Comp Range	0 to +50°C (Barologger Edge -10 to +50ºC)	0 to +40°C
Over-pressure Range	2 X	2 X
Temperature Sensor	Platinum RTD	Platinum RTD
Temperature Accuracy	± 0.05°C	± 0.1°C
Temperature Resolution	0.003°C	0.1°C
Operating Temp Range	-20 to +80°C	-20 to +80°C
Clock Accuracy	± 1 minute / year (-20ºC - +80ºC)	± 1 minute / year (-20ºC - +80ºC)
Battery Life	10 Years (based on 1 reading/minute)	5 Years (based on 1 reading/minute)
Size	7/8" x 6.25" (22 mm x 159 mm)	7/8” x 5.6” (22 mm x 142 mm)
Weight	4.6 oz. (129 grams)	4.2 oz. (119 grams)
Memory	40,000 readings in FRAM memory, or up to 120,000 readings using data compression option	40,000 readings in FRAM memory, no data compression option
Communication Speed	9600 bps, 38,400 bps with HS USB Optical Reader	9600 bps
Com Interface	Optical infra-red: USB, RS232, SDI-12	Optical infra-red: USB, RS232, SDI-12
Memory Modes	Continuous or Slate	Slate
Logging Rates	0.125 sec to 99 hours	0.5 sec to 99 hours
Logging Modes	Linear, Event & User-Selectable Schedules with Repeat Mode, Future Start, Future Stop, Real Time View	Linear, Real Time View
Barometric Compensation	Barologger Edge	Barologger Edge
Corrosion Resistance	Titanium based PVD coating and Hastelloy Sensor	316 L Stainless Steel and Hastelloy Sensor
Other Wetted Materials	Delrin, Viton, Hastelloy, 316L Stainless Steel	Delrin, Viton, Hastelloy, 316L Stainless Steel
Direct Read Capability	Yes	Yes
Leveloader Compatible	Yes (ensure the latest firmware is installed)	Yes (ensure the latest firmware is installed)

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Solinst®

Levelogger 5 LTC

Level, Temperature, Conductivity

The Levelogger® 5 LTC logs water level, temperature, and conductivity. It combines a datalogger, 8-year battery, Hastelloy® pressure sensor, temperature detector, and conductivity sensor within a small waterproof housing, 22 mm x 208 mm (7/8" x 8.2"). A baked-on coating using polymerization technology protects the body against corrosion, abrasion and high temperatures. The conductivity sensor is a 4-electrode platinum sensor, with autoranging capabilities. The minimal-maintenance, sealed Levelogger 5 LTC is simple to clean and calibrate, even in the field.

Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Ranges:	5, 10, 20, 30, 100, and 200 m
Accuracy:	±0.05% FS
Resolution:	0.001% FS to 0.0006% FS
Units of Measure:	cm, m, ft, psi, kPa, bar (ºC, ºF)
Normalization:	Automatic Temperature Compensation
Temp Comp. Range:	0ºC to 50ºC
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Accuracy:	±0.05ºC
Resolution:	0.003ºC
Conductivity Sensor:	4-Electrode Platinum
Full Range:	0 – 100,000 μS/cm
Calibrated Range:	50 – 80,000 μS/cm
Accuracy:	±1%: 5,000 μS/cm – 80,000 μS/cm; greater of ±2% or 15 μS/cm: 50 μS/cm –5,000 μS/cm
Resolution:	±0.1 μS/cm
Temp Comp. Range:	0ºC – 50ºC
Normalization:	Specific Conductance @ 25˚C
Battery Life:	8 Years (1 reading every 5 minutes)
Clock Accuracy (typical):	±1 minute/year (-20ºC to 80ºC)
Operating Temperature:	-20ºC to 80ºC
Maximum Readings:	100,000 sets of readings
Memory:	Slate or Continuous
Communication:	Optical high-speed: 57,600 bps with USB
Size:	22 mm x 208 mm (7/8" x 8.2")
Weight:	197 grams (6.95 oz)
Corrosion Resistance:	Baked-on coating using polymerization
Wetted Materials:	Platinum, Delrin®, Viton®, 316L Stainless Steel, Hastelloy, Regulator approved PFAS-free PTFE (inside and out)
Sampling Mode:	Linear, Event & User-Selectable with Repeat Mode, Future Start, Future Stop, Real-Time View
Measurement Rates:	2 seconds to 99 hours
Barometric Compensation:	Software Wizard and Barologger 5

Get Quote

LTC Models	Full Scale (FS)	Accuracy	Resolution
M5, C80	5 m (16.4 ft.)	± 0.3 cm (0.010 ft.)	0.001% FS
M10, C80	10 m (32.8 ft.)	± 0.5 cm (0.016 ft.)	0.0006% FS
M20, C80	20 m (65.6 ft.)	± 1 cm (0.032 ft.)	0.0006% FS
M30, C80	30 m (98.4 ft.)	± 1.5 cm (0.064 ft.)	0.0006% FS
M100, C80	100 m (328.1 ft.)	± 5 cm (0.164 ft.)	0.0006% FS
M200, C80	200 m (656.2 ft.)	± 10 cm (0.328 ft.)	0.0006% FS

Upgraded Features

- Increased memory: 100,000 sets of data
- More stable communication: single-eye optical, easy to clean, more scratch resistant
- Stronger, robust design: double o-ring seals for two times over pressurization rating
- Better thermistor and conductivity sensitivity: upgraded platinum RTD and conductivity sensor
- Superior protection in harsh conditions: baked-on coating using polymerization—inside and out

User-Friendly Operation

Software Calibration and Data Wizards guide you through conductivity calibration and barometric compensation, ensuring accurate data sets. The Data Wizard also converts conductivity readings to Specific Conductance (@ 25°C).

Levelogger Software allows you to easily program your preferences, download data, and display data in a graph or table format or export to other programs. Real Time View allows immediate viewing of live water level, conductivity, and temperature readings.

Leveloggers are easy to deploy; install with direct read cables or wireline/cord suspension. The Levelogger 5 LTC is SDI-12 compatible using the Solinst SDI-12 Interface Cable.

Download data in the field using the new Field Reader 5, DataGrabber 5 USB data transfer device, or through *Bluetooth*® using the Levelogger 5 App Interface and your smart device. Integrate the Levelogger 5 LTC with Solinst Telemetry Systems, which use the latest wireless technologies.

Levelogger 5 LTC Applications

- Salt water intrusion and soil salination monitoring
- Plume remediation monitoring and studies
- Leachate monitoring at landfills, mine tailings, waste disposal storage sites, and more
- Agricultural and stormwater runoff monitoring
- Create a historical database for potable water supply monitoring
- Tracer tests

Biofoul Screen

When a Levelogger 5 LTC is deployed for an extended period, there is the risk of biofouling on the pressure sensor and/or conductivity cell, which can compromise their readings.

The Biofoul Screen is designed to reduce the unwanted buildup of microorganisms, plants, algae, or organisms such as barnacles and mussels, on the sensors. The Biofoul Screen consists of a Delrin sleeve wrapped with copper wire. Slip onto the sensor end of a Levelogger 5 LTC, where it is held in place by compression fit.

Using the natural anti-fouling characteristics of copper, the Biofoul Screen is an affordable option to lengthen the time a Levelogger 5 LTC can be deployed. It reduces site visits and time spent cleaning Leveloggers, and improves long-term performance by ensuring accurate sensor measurements.

An optional Biofoul Screen provides extra protection for the Levelogger 5 LTC pressure and conductivity sensors in harsh environments.

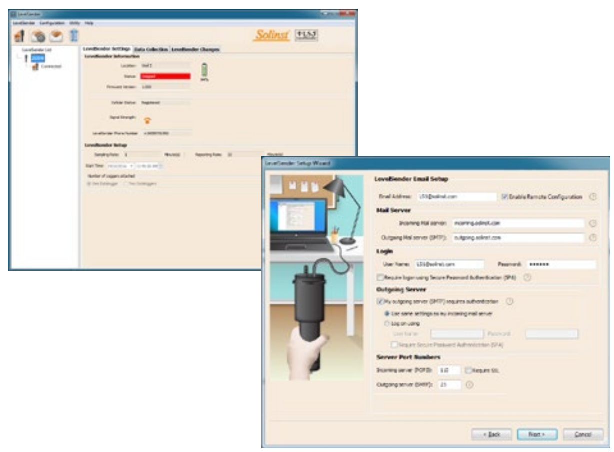
Levelogger 5 App Interface

The Solinst Levelogger App is designed to communicate to Solinst dataloggers via your smart device. Programming options include start/stop, data downloading, linear and real-time sampling, future start/stop, and GPS coordinates.

The Levelogger 5 App Interface uses Bluetooth wireless technology to connect with your smart device running the Solinst Levelogger App. Use our Levelogger 5 App Interface and a Solinst direct read cable to communicate to a downhole Levelogger and email data files right from the field (see Model 3001 Solinst Levelogger 5 App Interface data sheets).

Download on the App Store

GET IT ON Google play



LevelSender 5 Telemetry System

Instantly add cellular telemetry to your Levelogger 5 LTC by connecting to a Model 9500 LevelSender 5. Send data by email or SMS from your remote stations to your desired location. The LevelSender 5 simplifies your telemetry setup, by working with Solinst direct read cables and is compatible with the full Levelogger Series product line (see Model 9500 LevelSender 5 data sheet).

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®The Apple logo is a trademark of Apple Inc., registered in the U.S. and other countries. App Store is a service mark of Apple Inc. Google Play is a trademark of Google Inc.
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Attachment 3
Barologger

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1.1.2 Barologger Edge

The Barologger Edge uses algorithms based on air pressure only. It measures and logs changes in atmospheric pressure, which are then used to compensate water level readings recorded by a Levelogger Edge.

Barologger Edge Technical Specifications	
Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Accuracy (Typical):	± 0.05 kPa
Resolution:	24 Bit Resolution
Normalization:	Automatic Temperature Compensation
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05ºC
Temp. Sensor Resolution:	0.003ºC
Temp. Comp. Range:	-10ºC to 50ºC
Battery Life:	10 years (based on 1 reading/minute)
Clock Accuracy:	±1 minute/year (-20ºC to 80ºC)
Operating Temperature:	-20ºC to 80ºC
Maximum # Readings:	40,000 (120,000 using data compression)
Memory:	FRAM, Continuous or Slate mode
Communication Speed:	9600 bps, 38,400 bps with USB optical reader
Com Interface:	Optical Infra-red: USB, RS-232, SDI-12
Size:	7/8" x 6.25" (22 mm x 159 mm)
Weight:	129 grams (4.5 oz.)
Corrosion Resistance:	Titanium based PVD coated body and superior corrosion resistant Hastelloy sensor
Other Wetted Materials:	Delrin®, Viton®, 316L Stainless Steel
Sampling Modes:	Linear, Event & User-Selectable Schedule with Repeat Mode, Future Start, Future Stop, Real Time View
Measurement Rates:	0.125 second to 99 hours

Barologger Edge Models	Accuracy
Air Only	± 0.05 kPa

! NOTE

To use the Barologger Edge with Software Version 4.0.3, ensure you are using version 3.002 firmware.

SOLINST TECHNICAL BULLETIN

Automatic or Manual Barometric Compensation of Your Levelogger Data

Why Use a Barologger?

Submersed absolute Leveloggers measure total pressure (water column equivalent + barometric pressure). In order to accurately determine the true changes in water level only, barometric pressure fluctuations must be removed from the data. The simplest method to accomplish this is by the use of a Barologger suspended above high water level in one well on site. The approximate site compensation coverage is 20 miles (30 km). This records ambient barometric fluctuations over time and allows quick and accurate barometric compensation using the data files from both the Barologger and any Leveloggers in the area.

Manual Barometric Compensation

If an on-site Barologger is not available, your data can be compensated using alternate barometric data (e.g. from a local weather station).

To accomplish an accurate manual barometric compensation, the atmospheric pressure station should not be greater than 20 miles (30 km) away and within an elevation change of 1000 ft (300 m). In addition, the date and time of the barometric data should cover the range of data collected by the Levelogger.

To begin compensation, your Levelogger data and barometric data must be in the same units, and assure that any offsets or normalization values are accounted for. Previous Levelogger and Barologger models (e.g. Gold) produce data with an offset of 31.17 ft or 9.5 m (lowest expected pressure at mean sea level) removed from the level values. Levelogger Edge data does not contain this offset. Although not shown in our examples, it is also important to remember that weather station barometric data will often contain a different offset or normalization. Manual data conversation and barometric compensation should account for any variation of the normalization or offset used between the barometric data sourced and Solinst Leveloggers.

Note: The Levelogger Edge can be programmed to record in kPa, psi, or mbar. This makes compensation using other atmospheric pressure devices easier.

1. Conversion from **Inches of Hg to Feet** of water column equivalent: Example: 30 inches of Hg (for Levelogger Edge):

   30 inches Hg x 1.1330 = 33.99 ft H_2O

2. Conversion from **kPa to meters** of water column equivalent: Example: 101.40 kPa (for older Levelogger):

   101.4 kPa x 0.1022 = 10.36 - 9.50 = 0.86 m H_2O

** Values in red denote pressure conversion factors; consult the table below to obtain common pressure conversions*

In an example where the uncompensated Levelogger Edge data is a water level of **41.17 ft,** from the calculation above, the manual compensation would be: **41.17 ft – 33.99 = 7.18 ft.**

In an example where the uncompensated older Levelogger data is a water level of **3 m,** from the calculation above, the manual compensation would be: **3 m – 0.86 = 2.14 m.**

Pressure Conversion Factors		
Barometric Unit	FOOT Water Column Equivalent	METRIC Water Column Equivalent
1 psi	2.3108	0.7043
1 atm	33.959	10.351
1 kPa	0.3352	0.1022
1 mm - Hg	0.04469	0.01362
1 in - Hg	1.1330	0.3453
1 mbar	0.03352	0.01022

Water Column Equivalents to Common Barometric Units

Once the final calculated barometric pressure values are obtained, they are subtracted from the Levelogger data set. Since the Levelogger data can be easily exported as a .csv or .xml file using Levelogger Software, all manual corrections can be performed in external programs.

Printed in Canada: March 22, 2012

Solinst®

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Attachment 4
Analytical Data Sheets

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Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - OU2 GW	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D2-20220510	SDG No.:	N2794
Lab Sample ID:	N2794-05	Matrix:	Water
Analytical Method:	SW8260	% Moisture:	100
Sample Wt/Vol:	5 Units: mL	Final Vol:	5000 uL
Soil Aliquot Vol:	uL	Test:	VOCMS Group1
GC Column:	DB-624UI ID : 0.18	Level :	LOW

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VX028680.D	1		05/13/22 16:06	VX051322

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
74-87-3	Chloromethane	0.75	U	0.20	0.75	1.00	ug/L
75-01-4	Vinyl Chloride	0.50	U	0.22	0.50	1.00	ug/L
74-83-9	Bromomethane	2.50	U	1.60	2.50	5.00	ug/L
75-00-3	Chloroethane	0.75	U	0.26	0.75	1.00	ug/L
75-69-4	Trichlorofluoromethane	0.50	U	0.20	0.50	1.00	ug/L
76-13-1	1,1,2-Trichlorotrifluoroethane	0.50	U	0.17	0.50	1.00	ug/L
75-35-4	1,1-Dichloroethene	0.75	U	0.23	0.75	1.00	ug/L
67-64-1	Acetone	2.90	J	1.20	3.80	5.00	ug/L
75-15-0	Carbon Disulfide	0.75	U	0.26	0.75	1.00	ug/L
1634-04-4	Methyl tert-butyl Ether	0.50	U	0.18	0.50	1.00	ug/L
75-09-2	Methylene Chloride	0.50	U	0.18	0.50	1.00	ug/L
156-60-5	trans-1,2-Dichloroethene	0.50	U	0.20	0.50	1.00	ug/L
75-34-3	1,1-Dichloroethane	0.50	U	0.20	0.50	1.00	ug/L
78-93-3	2-Butanone	2.50	U	0.82	2.50	5.00	ug/L
56-23-5	Carbon Tetrachloride	0.75	U	0.18	0.75	1.00	ug/L
156-59-2	cis-1,2-Dichloroethene	0.75	U	0.17	0.75	1.00	ug/L
67-66-3	Chloroform	0.75	U	0.18	0.75	1.00	ug/L
71-55-6	1,1,1-Trichloroethane	0.50	U	0.18	0.50	1.00	ug/L
108-87-2	Methylcyclohexane	0.50	U	0.13	0.50	1.00	ug/L
71-43-2	Benzene	0.50	U	0.16	0.50	1.00	ug/L
107-06-2	1,2-Dichloroethane	0.50	U	0.18	0.50	1.00	ug/L
79-01-6	Trichloroethene	0.50	U	0.27	0.50	1.00	ug/L
78-87-5	1,2-Dichloropropane	0.50	U	0.17	0.50	1.00	ug/L
75-27-4	Bromodichloromethane	0.50	U	0.18	0.50	1.00	ug/L
108-10-1	4-Methyl-2-Pentanone	2.50	U	0.87	2.50	5.00	ug/L
108-88-3	Toluene	0.50	U	0.17	0.50	1.00	ug/L
10061-02-6	t-1,3-Dichloropropene	0.50	U	0.14	0.50	1.00	ug/L
10061-01-5	cis-1,3-Dichloropropene	0.50	U	0.16	0.50	1.00	ug/L
79-00-5	1,1,2-Trichloroethane	0.50	U	0.19	0.50	1.00	ug/L
591-78-6	2-Hexanone	2.50	U	0.76	2.50	5.00	ug/L
124-48-1	Dibromochloromethane	0.50	U	0.18	0.50	1.00	ug/L
127-18-4	Tetrachloroethene	0.50	U	0.18	0.50	1.00	ug/L

Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - OU2 GW	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D2-20220510	SDG No.:	N2794
Lab Sample ID:	N2794-05	Matrix:	Water
Analytical Method:	SW8260	% Moisture:	100
Sample Wt/Vol:	5 Units: mL	Final Vol:	5000 uL
Soil Aliquot Vol:	uL	Test:	VOCMS Group1
GC Column:	DB-624UI ID : 0.18	Level :	LOW

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VX028680.D	1		05/13/22 16:06	VX051322

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
108-90-7	Chlorobenzene	0.50	U	0.17	0.50	1.00	ug/L
100-41-4	Ethyl Benzene	0.50	U	0.17	0.50	1.00	ug/L
179601-23-1	m/p-Xylenes	1.00	U	0.33	1.00	2.00	ug/L
95-47-6	o-Xylene	0.50	U	0.18	0.50	1.00	ug/L
100-42-5	Styrene	0.50	U	0.13	0.50	1.00	ug/L
75-25-2	Bromoform	0.50	U	0.16	0.50	1.00	ug/L
98-82-8	Isopropylbenzene	0.50	U	0.19	0.50	1.00	ug/L
79-34-5	1,1,2,2-Tetrachloroethane	0.75	U	0.23	0.75	1.00	ug/L
541-73-1	1,3-Dichlorobenzene	0.50	U	0.20	0.50	1.00	ug/L
106-46-7	1,4-Dichlorobenzene	0.50	U	0.19	0.50	1.00	ug/L
95-50-1	1,2-Dichlorobenzene	0.50	U	0.17	0.50	1.00	ug/L
SURROGATES							
17060-07-0	1,2-Dichloroethane-d4	54.7		81 - 118		109%	SPK: 50
1868-53-7	Dibromofluoromethane	50.5		80 - 119		101%	SPK: 50
2037-26-5	Toluene-d8	48.9		89 - 112		98%	SPK: 50
460-00-4	4-Bromofluorobenzene	47.8		85 - 114		96%	SPK: 50
INTERNAL STANDARDS							
363-72-4	Pentafluorobenzene	212000	5.556				
540-36-3	1,4-Difluorobenzene	402000	6.769				
3114-55-4	Chlorobenzene-d5	384000	10.055				
3855-82-1	1,4-Dichlorobenzene-d4	172000	12.024				
TENTATIVE IDENTIFIED COMPOUNDS							
75-43-4	Dichlorofluoromethane	N.D					

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
Q = indicates LCS control criteria did not meet requirements
M = MS/MSD acceptance criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution
() = Laboratory InHouse Limit
A = Aldol-Condensation Reaction Products

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - OU2 GW	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D3-20220510	SDG No.:	N2794
Lab Sample ID:	N2794-08	Matrix:	Water
Analytical Method:	SW6280	% Moisture:	100
Sample Wt/Vol:	5 Units: mL	Final Vol:	5000 uL
Soil Aliquot Vol:	uL	Test:	VOCMS Group1
GC Column:	DB-824UI ID : 0.16	Level :	LOW

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VX026861.D	1		05/13/22 18:30	VX051322

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
74-67-3	Chloromethane	0.75	U	0.20	0.75	1.00	ug/L
75-01-4	Vinyl Chloride	0.50	U	0.22	0.50	1.00	ug/L
74-63-9	Bromomethane	2.50	U	1.80	2.50	5.00	ug/L
75-00-3	Chloroethane	0.75	U	0.28	0.75	1.00	ug/L
75-89-4	Trichlorofluoromethane	0.50	U	0.20	0.50	1.00	ug/L
78-13-1	1,1,2-Trichlorotrifluoroethane	0.50	U	0.17	0.50	1.00	ug/L
75-35-4	1,1-Dichloroethene	0.75	U	0.23	0.75	1.00	ug/L
87-84-1	Acetone	2.70	J	1.20	3.60	5.00	ug/L
75-15-0	Carbon Disulfide	0.75	U	0.28	0.75	1.00	ug/L
1834-04-4	Methyl tert-butyl Ether	0.50	U	0.16	0.50	1.00	ug/L
75-09-2	Methylene Chloride	0.50	U	0.16	0.50	1.00	ug/L
158-80-5	trans-1,2-Dichloroethene	0.50	U	0.20	0.50	1.00	ug/L
75-34-3	1,1-Dichloroethane	0.50	U	0.20	0.50	1.00	ug/L
76-93-3	2-Butanone	2.50	U	0.62	2.50	5.00	ug/L
58-23-5	Carbon Tetrachloride	0.75	U	0.16	0.75	1.00	ug/L
158-59-2	cis-1,2-Dichloroethene	0.75	U	0.17	0.75	1.00	ug/L
87-88-3	Chloroform	0.75	U	0.16	0.75	1.00	ug/L
71-55-8	1,1,1-Trichloroethane	0.50	U	0.16	0.50	1.00	ug/L
106-67-2	Methylcyclohexane	0.50	U	0.13	0.50	1.00	ug/L
71-43-2	Benzene	0.50	U	0.18	0.50	1.00	ug/L
107-08-2	1,2-Dichloroethane	0.50	U	0.16	0.50	1.00	ug/L
79-01-8	Trichloroethene	0.50	U	0.27	0.50	1.00	ug/L
76-67-5	1,2-Dichloropropane	0.50	U	0.17	0.50	1.00	ug/L
75-27-4	Bromodichloromethane	0.50	U	0.16	0.50	1.00	ug/L
106-10-1	4-Methyl-2-Pentanone	2.50	U	0.67	2.50	5.00	ug/L
106-66-3	Toluene	0.50	U	0.17	0.50	1.00	ug/L
10081-02-8	t-1,3-Dichloropropene	0.50	U	0.14	0.50	1.00	ug/L
10081-01-5	cis-1,3-Dichloropropene	0.50	U	0.18	0.50	1.00	ug/L
79-00-5	1,1,2-Trichloroethane	0.50	U	0.19	0.50	1.00	ug/L
591-76-8	2-Hexanone	2.50	U	0.78	2.50	5.00	ug/L
124-46-1	Dibromochloromethane	0.50	U	0.16	0.50	1.00	ug/L
127-16-4	Tetrachloroethene	0.50	U	0.16	0.50	1.00	ug/L

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Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - OU2 GW	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D3-20220510	SDG No.:	N2794
Lab Sample ID:	N2794-08	Matrix:	Water
Analytical Method:	SW6280	% Moisture:	100
Sample Wt/Vol:	5 Units: mL	Final Vol:	5000 uL
Soil Aliquot Vol:	uL	Test:	VOCMS Group1
GC Column:	DB-824UI ID : 0.16	Level :	LOW

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
VX026861.D	1		05/13/22 18:30	VX051322

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
106-90-7	Chlorobenzene	0.50	U	0.17	0.50	1.00	ug/L
100-41-4	Ethyl Benzene	0.50	U	0.17	0.50	1.00	ug/L
179801-23-1	m/p-Xylenes	1.00	U	0.33	1.00	2.00	ug/L
95-47-8	o-Xylene	0.50	U	0.16	0.50	1.00	ug/L
100-42-5	Styrene	0.50	U	0.13	0.50	1.00	ug/L
75-25-2	Bromoform	0.50	U	0.18	0.50	1.00	ug/L
96-62-6	Isopropylbenzene	0.50	U	0.19	0.50	1.00	ug/L
79-34-5	1,1,2,2-Tetrachloroethane	0.75	U	0.23	0.75	1.00	ug/L
541-73-1	1,3-Dichlorobenzene	0.50	U	0.20	0.50	1.00	ug/L
108-48-7	1,4-Dichlorobenzene	0.50	U	0.19	0.50	1.00	ug/L
95-50-1	1,2-Dichlorobenzene	0.50	U	0.17	0.50	1.00	ug/L
SURROGATES							
17080-07-0	1,2-Dichloroethane-d4	55.1		61 - 116		110%	SPK: 50
1686-53-7	Dibromofluoromethane	50.9		60 - 119		102%	SPK: 50
2037-28-5	Toluene-d6	49.1		69 - 112		96%	SPK: 50
480-00-4	4-Bromofluorobenzene	46.2		65 - 114		98%	SPK: 50
INTERNAL STANDARDS							
383-72-4	Pentafluorobenzene	213000	5.558				
540-38-3	1,4-Difluorobenzene	403000	8.783				
3114-55-4	Chlorobenzene-d5	361000	10.055				
3655-62-1	1,4-Dichlorobenzene-d4	173000	12.024				
TENTATIVE IDENTIFIED COMPOUNDS							
75-43-4	Dichlorofluoromethane	N.D					

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
Q = indicates LCS control criteria did not meet requirements
M = MS/MSD acceptance criteria did not meet requirements
J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution
() = Laboratory InHouse Limit
A = Aldol-Condensation Reaction Products

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - OU2 GW	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D2-20220510	SDG No.:	N2794
Lab Sample ID:	N2794-05	Matrix:	Water
Analytical Method:	SW8270SIM	% Moisture:	100
Sample Wt/Vol:	1000 Units: mL	Final Vol:	1000 uL
Soil Aliquot Vol:	uL	Test:	SVOC-SIMGroup1
Extraction Type :	Decanted : N	Level :	LOW
Injection Volume :	GPC Factor : 1.0	GPC Cleanup :	N PH :

File ID/Qc Batch:	Dilution:	Prep Date	Date Analyzed	Prep Batch ID
BN019780.D	1	05/12/22 11:35	05/13/22 22:17	PB144776

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
123-91-1	1,4-Dioxane	0.20	U	0.080	0.20	0.20	ug/L
SURROGATES							
7297-45-2	2-Methylnaphthalene-d10	0.23		30 - 150		57%	SPK: 0.4
93951-69-0	Fluoranthene-d10	0.35		30 - 150		87%	SPK: 0.4
4165-60-0	Nitrobenzene-d5	0.20	*	55 - 111		50%	SPK: 0.4
321-60-8	2-Fluorobiphenyl	0.23		53 - 106		58%	SPK: 0.4
1718-51-0	Terphenyl-d14	0.38		58 - 132		95%	SPK: 0.4
INTERNAL STANDARDS							
3855-82-1	1,4-Dichlorobenzene-d4	3540	7.854				
1146-65-2	Naphthalene-d8	10800	10.648				
15067-26-2	Acenaphthene-d10	6310	14.474				
1517-22-2	Phenanthrene-d10	14400	17.215				
1719-03-5	Chrysene-d12	15400	21.395				
1520-96-3	Perylene-d12	14700	23.741				

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
E = Value Exceeds Calibration Range
Q = indicates LCS control criteria did not meet requirements
M = MS/MSD acceptance criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
N = Presumptive Evidence of a Compound
* = Values outside of QC limits
D = Dilution
() = Laboratory InHouse Limit
A = Aldol-Condensation Reaction Products

CHEMTECH 2Q4 Sheffield Street, Mountainside, NJ 07092 Phone: 90Q7Q9 Q900 Fax: 90Q7Q9 Q922

Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - OU2 GW	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D3-20220510	SDG No.:	N2794
Lab Sample ID:	N2794-08	Matrix:	Water
Analytical Method:	SWQ270SIM	% Moisture:	100
Sample Wt/Vol:	1000 Units: mL	Final Vol:	1000 uL
Soil Aliquot Vol:	uL	Test:	SVOC-SIMGroup1
Extraction Type :	Decanted : N	Level :	LOW
Injection Volume :	GPC Factor : 1.0	GPC Cleanup : N	PH :

File ID/Bc z atch:	Dilution:	Prep Date	Date Analy6ed	Prep z atch ID
z N0197Q1.D	1	05/12/22 11:35	05/13/22 22:52	Pz 144778

CAS Number	Parameter	Conc.	Qualifier	MDL	LOD	LOQ / CRQL	Units
TARGETS							
123-91-1	1,4-Dioxane	0.20	U	0.0Q0	0.20	0.20	ug/L
SURROGATES							
7297-45-2	2-Methylnaphthalene-d10	0.2Q		30 - 150		70%	SPK: 0.4
93951-89-0	Fluoranthene-d10	0.37		30 - 150		92%	SPK: 0.4
4185-80-0	Nitroben6ene-d5	0.28		55 - 111		84%	SPK: 0.4
321-80-Q	2-Fluorobiphenyl	0.2Q		53 - 108		71%	SPK: 0.4
171Q-51-0	Terphenyl-d14	0.33		5Q- 132		Q2%	SPK: 0.4
INTERNAL STANDARDS							
3Q55-Q2-1	1,4-Dichloroben6ene-d4	4520	7.Q54				
1148-85-2	Naphthalene-dQ	14000	10.84Q				
15087-28-2	Acenaphthene-d10	Q400	14.474				
1517-22-2	Phenanthrene-d10	1QQ00	17.215				
1719-03-5	Chrysene-d12	19500	21.395				
1520-98-3	Perylene-d12	1Q100	23.73Q				

U * Not Detected
LOB * Limit of Buantitation
MDL * Method Detection Limit
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E * Value Exceeds Calibration Range
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M * MS/MSD acceptance criteria did not meet requirements

J * Estimated Value
z * Analyte Found in Associated Method z lan=
N * Presumptive Evidence of a Compound
k * Values outside of BC limits
D * Dilution
() * Laboratory InHouse Limit
A * Aldol-Condensation Reaction Products

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Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22
Project:	CTO WE13 - RW8 MW Gen Chem	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D2-20220510	SDG No.:	N2793
Lab Sample ID:	N2793-03	Matrix:	Water
Level (low/med):	low	% Solid:	0

Cas	Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
7429-90-5	Aluminum	460		1	12.1	25.0	50.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-36-0	Antimony	12.5	U	1	4.46	12.5	25.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-38-2	Arsenic	5.00	U	1	4.13	5.00	10.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-39-3	Barium	20.5	J	1	9.31	25.0	50.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-41-7	Beryllium	1.50	UN	1	0.54	1.50	3.00	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-43-9	Cadmium	1.50	U	1	0.54	1.50	3.00	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-70-2	Calcium	2420	N	1	172	500	1000	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-47-3	Chromium	9.61		1	0.74	2.50	5.00	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-48-4	Cobalt	7.50	U	1	2.28	7.50	15.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-50-8	Copper	21.8		1	0.89	5.00	10.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7439-89-6	Iron	1190		1	9.31	25.0	50.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7439-92-1	Lead	4.75	J	1	1.64	3.00	6.00	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7439-95-4	Magnesium	471	J	1	161	500	1000	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7439-96-5	Manganese	233	N	1	0.85	5.00	10.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7439-97-6	Mercury	0.16	U	1	0.070	0.16	0.20	ug/L	05/14/22 07:20	05/14/22 15:58	SW7470A
7440-02-0	Nickel	4.36	J	1	3.86	10.0	20.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-09-7	Potassium	691	J	1	111	500	1000	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7782-49-2	Selenium	5.00	U	1	2.91	5.00	10.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-22-4	Silver	2.50	U	1	1.51	2.50	5.00	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-23-5	Sodium	8180		1	167	500	1000	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-28-0	Thallium	10.0	U	1	2.82	10.0	20.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-62-2	Vanadium	10.0	U	1	2.87	10.0	20.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010
7440-66-6	Zinc	40.0		1	3.01	10.0	20.0	ug/L	05/12/22 12:30	05/19/22 18:28	SW6010

Color Before:	Colorless	Clarity Before:	Cloudy	Texture:	
Color After:	Colorless	Clarity After:	Cloudy	Artifacts:	

Comments: METALS-TAL

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
D = Dilution
Q = indicates LCS control criteria did not meet requirements

J = Estimated Value
B = Analyte Found in Associated Method Blank
* = indicates the duplicate analysis is not within control limits.
E = Indicates the reported value is estimated because of the presence of interference.
OR = Over Range
N =Spiked sample recovery not within control limits

Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05(10(22
Project:	CTO WE13 - RW8 MW Gen Chem	Date Received:	05(11(22
Client Sample ID:	RW9-MW01D3-20220510	SDG No.:	N2793
Lab Sample ID:	N2793-0/	Matrix:	Water
Level) lo) (medu	lo)	% Solid:	0

Cas	Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
7/ 29-90-5	6 lgmingm	1750		1	12.1	25.0	50.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-3A-0	6 ntimony	12.5	U	1	/ ./ A	12.5	25.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-38-2	6 rsenic	5.00	U	1	/ .13	5.00	10.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-39-3	J arigm	25.0	U	1	9.31	25.0	50.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-/ 1-7	J erylligm	1.50	UN	1	0.5/	1.50	3.00	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-/ 3-9	Cadmigm	1.50	U	1	0.5/	1.50	3.00	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-70-2	Calcigm	1900	N	1	172	500	1000	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-/ 7-3	Chromigm	A57		1	0.7/	2.50	5.00	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-/ 8-/	Cobalt	5.18	B	1	2.28	7.50	15.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-50-8	Copper	A39	B	1	0.89	5.00	10.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ 39-89-A	Iron	10/ 0		1	9.31	25.0	50.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ 39-92-1	Lead	3.00	U	1	1.A/	3.00	A00	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ 39-95-/	Ma4nesigm	/ 11	B	1	1Al	500	1000	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ 39-9A-5	Man4anese	1A3	N	1	0.85	5.00	10.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ 39-97-A	Mercgry	0.1A	U	1	0.070	0.1A	0.20	g4(L	05(1/ (22 07:20	05(1/ (22 1A05	SW7/ 706
7/ / 0-02-0	Nickel	7.73	B	1	3.8A	10.0	20.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-09-7	Potassigm	591	B	1	111	500	1000	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7782-/ 9-2	Selenigm	5.00	U	1	2.91	5.00	10.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-22-/	Silver	2.50	U	1	1.51	2.50	5.00	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-23-5	Sodigm	10200		1	1A7	500	1000	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-28-0	Thalligm	10.0	U	1	2.82	10.0	20.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-A2-2	Vanadigm	3.89	B	1	2.87	10.0	20.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010
7/ / 0-AA-A	Zinc	/ / ./		1	3.01	10.0	20.0	g4(L	05(12(22 12:30	05(20(22 1A/ 5	SWA010

Color J efore:	Colorless	Clarity J efore:	Clear	Textgre:	
Color 6 fter:	Colorless	Clarity 6 fter:	Clear	6 rtifacts:	

Comments: METALS-TAL

U = Not Detected
LOQ = Limit of Qgantitation
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LOD = Limit of Detection
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Q = indicates LCS control criteria did not meet reqgirements

B= Estimated Valge
J = 6 nalyte Fognd in 6 ssociated Method J lank
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E = Indicates the reported valge is estimated becagse of the presence of interference.
OR = Over Ran4e
N =Spiked sample recovery not) ithin control limits

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Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	07(10(22
Project:	CTO WE13 - RW8 MW Gen Chem	Date Received:	07(11(22
Client Sample ID:	RW9-MW01D2-5-20220710	SDG No.:	N2/ 93
Lab Sample ID:	N2/ 93-07	Matrix:	Water
Level ɰo) (medıɾ	lo)	% Solid:	0

Cas	Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
/ y29-90-7	Algmingm	761		1	12.1	27.0	70.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-36-0	Antimons	12.7	U	1	y.y6	12.7	27.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-38-2	ArJenic	7.00	U	1	y.13	7.00	10.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-39-3	k arigm	9.36	B	1	9.31	27.0	70.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-y1-/	k ers lligm	1.70	UN	1	0.7y	1.70	3.00	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-y3-9	Cadmigm	1.70	U	1	0.7y	1.70	3.00	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-/ 0-2	Calcigm	1960	N	1	1/ 2	700	1000	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-y/ -3	Chromigm	6.83		1	0./ y	2.70	7.00	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-y8-y	Cobalt	/ .70	U	1	2.28	/ .70	17.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-70-8	Copper	8.60	B	1	0.89	7.00	10.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ y39-89-6	Iron	828		1	9.31	27.0	70.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ y39-92-1	Lead	2.0y	B	1	1.6y	3.00	6.00	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ y39-97-y	Ma4neJigm	3/ y	B	1	161	700	1000	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ y39-96-7	Man4aneJe	1/ 9	N	1	0.87	7.00	10.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ y39-9/ -6	Mercgrs	0.16	U	1	0.0/ 0	0.16	0.20	g4(L	07(1y(22 0/ :20	07(1y(22 16:08	SW/ y/ 0A
/ yy0-02-0	NicVel	10.0	U	1	3.86	10.0	20.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-09-/	PotaJJigm	7/ 7	B	1	111	700	1000	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ / 82-y9-2	Selenigm	3.36	B	1	2.91	7.00	10.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-22-y	Silver	2.70	U	1	1.71	2.70	7.00	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-23-7	Sodigm	/ 0y0		1	16/	700	1000	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-28-0	Thalligm	10.0	U	1	2.82	10.0	20.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-62-2	Zanadigm	10.0	U	1	2.8/	10.0	20.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010
/ yy0-66-6	=inc	y7.1		1	3.01	10.0	20.0	g4(L	07(12(22 12:30	07(20(22 1/ :02	SW6010

Color k e*ore:	ColorleJJ	Clarits k e*ore:	Clogds	Textgre:	
Color A*ter:	ColorleJJ	Clarits A*ter:	Clogds	Arti*actJ:	

CommentJ: DISSOLVED METALS-TAL

U f Not Detected
LOF f Limit o* F gantitation
MDL f Method Detection Limit
LOD f Limit o* Detection
D f Dilgtion
F f indicateJ LCS control criteria did not meet reqgirementJ
Bf EJtimated Zalge
k f Analste 5ognd in AJJociated Method k lanV
Qf indicateJ the dgplicate analsJiJ iJ not) ithin control limitJ.
E f IndicateJ the reported valge iJ eJtimated becagJe o* the preJence o* inter*erence.
OR f Over Ran4e
N f SpiVed Jample recovers not) ithin control limitJ

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Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	07w0w5
Project:	CTO WE13 - RW8 MW Gen Chem	Date Received:	07w1w5
Client Sample ID:	RW9-MW01D3-2-50550710	SDG No.:	N5/ 93
Lab Sample ID:	N5/ 93-0(	Matrix:	Water
Level)lou wnedg	lou	% Solid:	0

Cas	Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
/ y59-90-7	Al4min4m	50/		1	15.1	57.0	70.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-3(-0	Antimons	15.7	U	1	y.y(	15.7	57.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-38-5	ArJenic	7.00	U	1	y.13	7.00	10.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-39-3	Bari4m	57.0	U	1	9.31	57.0	70.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-y1-/	Bers lli4m	1.70	UN	1	0.7y	1.70	3.00	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-y3-9	Cadmi4m	1.70	U	1	0.7y	1.70	3.00	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-/ 0-5	Calci4m	1830	N	1	1/ 5	700	1000	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-y/ -3	Chromi4m	1./ 5	k	1	0./ y	5.70	7.00	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-y8-y	Cobalt	y.85	k	1	5.58	/ .70	17.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-70-8	Copper	5.18	k	1	0.89	7.00	10.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ y39-89-(	Iron	/ 5/		1	9.31	57.0	70.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ y39-95-1	Lead	3.00	U	1	1.(y	3.00	(.00	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ y39-97-y	Ma6neJi4m	313	k	1	1(1	700	1000	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ y39-9(-7	Man6aneJe	17(	N	1	0.87	7.00	10.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ y39-9/ -(	Merc4rs	0.1(	U	1	0.0/ 0	0.1(	0.50	46wL	07wyw5 0/ :50	07wyw5 1(:17	SW/ y/ 0A
/ yy0-05-0	NicVel	(.88	k	1	3.8(	10.0	50.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-09-/	PotaJJi4m	y55	k	1	111	700	1000	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ / 85-y9-5	Seleni4m	7.00	U	1	5.91	7.00	10.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-55-y	Silver	5.70	U	1	1.71	5.70	7.00	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-53-7	Sodi4m	9800		1	1(/	700	1000	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-58-0	Thalli4m	10.0	U	1	5.85	10.0	50.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-(5-5	Zanadi4m	10.0	U	1	5.8/	10.0	50.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010
/ yy0-((-(	=inc	38./		1	3.01	10.0	50.0	46wL	07w5w5 15:30	07w0w5 1/ :0(	SW(010

Color Be*ore:	ColorleJJ	Clarits Be*ore:	Clear	Text4re:	
Color A*ter:	ColorleJJ	Clarits A*ter:	Clear	Arti*actJ:	

CommentJ: DISSOLVED METALS-TAL

U f Not Detected
LOF f Limit o* F 4antitation
MDL f Method Detection Limit
LOD f Limit o* Detection
D f Dil4tion
F f indicateJ LCS control criteria did not meet req4irementJ

k f EJtimated Zal4e
B f Analste 2o4nd in AJJociated Method BlanV
Qf indicateJ the d4plicate analsJiJ iJ not u ithin control limitJ.
E f IndicateJ the reported val4e iJ eJtimated beca4Je o* the preJence o* inter*erence.
OR f Over Ran6e
N f SpiVed Jample recovers not u ithin control limitJ

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 Phone: 908 789 8900 Fax: 908 789 8922

Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05/10/22 14:20
Project:	CTO WE13 - RW8 MW Gen Chem	Date Received:	05/11/22
Client Sample ID:	RW9-MW01D2-20220510	SDG No.:	N2793
Lab Sample ID:	N2793-03	Matrix:	Water
		% Solid:	0

Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
Alkalinity	9.20		1	1.00	1.00	2.00	mg/L		05/17/22 10:52	SM2320 B
Ammonia as N	0.080	U	1	0.042	0.080	0.10	mg/L	05/12/22 13:15	05/17/22 10:37	SM 4500-NH3 B plus G
Chloride	3.10		1	0.097	0.30	0.60	mg/L		05/12/22 12:46	300.0
Nitrite	0.30	U	1	0.032	0.30	0.60	mg/L		05/12/22 12:46	300.0
Nitrate	0.25	U	1	0.050	0.25	0.50	mg/L		05/12/22 12:46	300.0
Sulfate	6.30		1	0.18	1.50	3.00	mg/L		05/12/22 12:46	300.0
BOD5	2.94		1	0.17	2.00	2.00	mg/L		05/11/22 18:15	SM5210 B
COD	5.00	U	1	2.40	5.00	10.0	mg/L		05/13/22 13:47	SM5220 D
Cyanide	0.0025	U	1	0.0011	0.0025	0.0050	mg/L	05/13/22 09:35	05/13/22 13:28	9012B
Phosphorus, Total	0.21		1	0.010	0.025	0.050	mg/L	05/19/22 09:40	05/19/22 13:42	365.3
Sulfide	1.28		1	0.37	0.50	1.00	mg/L	05/12/22 12:30	05/12/22 14:38	SM4500 S E
TDS	4.00	J	1	1.00	10.0	10.0	mg/L		05/12/22 16:20	SM2540C
TOC	1.20		1	0.42	0.50	1.00	mg/L		05/12/22 12:36	9060A
TSS	271		1	1.00	4.00	4.00	mg/L		05/13/22 09:00	SM2540D

Comments:

U = Not Detected
LOQ = Limit of Quantitation
MDL = Method Detection Limit
LOD = Limit of Detection
D = Dilution
Q = indicates LCS control criteria did not meet requirements
H = Sample Analysis Out Of Hold Time

J = Estimated Value
B = Analyte Found in Associated Method Blank
* = indicates the duplicate analysis is not within control limits.
E = Indicates the reported value is estimated because of the presence of interference.
OR = Over Range
N =Spiked sample recovery not within control limits

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Report of Analysis

Client:	Tetra Tech NUS, Inc.	Date Collected:	05410422 12:25
Project:	CTO WE13 - RW8 MW Gen Chem	Date Received:	05411422
Client Sample ID:	RW9-MW01D3-20220510	SDG No.:	N2793
Lab Sample ID:	N2793-0/	Matrix:	Water
		% Solid:	0

Parameter	Conc.	Qua.	DF	MDL	LOD	LOQ / CRQL	Units	Prep Date	Date Ana.	Ana Met.
Alkalinity	1.00	U	1	1.00	1.00	2.00	mg4L		05417422 11:00	SM2320 B
Ammonia as N	0.080	U	1	0.0/ 2	0.080	0.10	mg4L	05412422 13:15	05417422 10:37	SM / 500-NH3 B plus G
Chloride	3.30		1	0.097	0.30	0.60	mg4L		05412422 12:17	300.0
Nitrite	0.30	U	1	0.032	0.30	0.60	mg4L		05412422 12:17	300.0
Nitrate	0.25	U	1	0.050	0.25	0.50	mg4L		05412422 12:17	300.0
Sulfate	32.0		1	0.18	1.50	3.00	mg4L		05412422 12:17	300.0
BOD5	12.1		1	0.17	2.00	2.00	mg4L		05411422 18:15	SM5210 B
COD	5.00	U	1	2./ 0	5.00	10.0	mg4L		05413422 13:/ 7	SM5220 D
Cyanide	0.0025	U	1	0.0011	0.0025	0.0050	mg4L	05413422 09:35	05413422 13:28	9012B
Phosphorus, Total	0.025	J	1	0.010	0.025	0.050	mg4L	05419422 09:/ 0	05419422 13:/ 3	365.3
Sulfide	/ .00		1	0.37	0.50	1.00	mg4L	05412422 12:30	05412422 1/ :/ 0	SM/ 500 S E
TDS	33.0		1	1.00	10.0	10.0	mg4L		05412422 16:20	SM25/ 0C
TOC	1.10		1	0./ 2	0.50	1.00	mg4L		05412422 13:00	9060A
TSS	22.3		1	1.00	/ .00	/ .00	mg4L		05413422 09:00	SM25/ 0D

Comments:

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