ARCADIS Design & Consultancy for natural and built assets

Ms. Jamie Verrigni
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C, 625 Broadway, 11th Floor
Albany, New York 12233-7014

Arcadis of New York, Inc.
855 Route 146
Suite 210
Clifton Park
New York 12065
Tel 518 250 7300
Fax 518 250 7301
www.arcadis.com

Subject:

Pre-Design Investigation Work Plan

Orange and Rockland Utilities, Inc.
Port Jervis Former MGP Site
City of Port Jervis, Orange County, New York
Site No. 3-36-049

ENVIRONMENT

Date:
October 24, 2016

Contact:
Mark Flusche

Phone:
518.250.7322

Email:
Mark.flusche@arcadis.com

Our ref:

B0043021.0012

Dear Ms. Verrigni:

This letter presents the work plan for the installation and sampling of groundwater from Continuous Multichannel Tubing (CMT) monitoring wells, the scope of a treatability study, and the preparation of a summary letter report documenting those activities at the Orange and Rockland Utilities, Inc. (O&R) former manufactured gas plant (MGP) site in Port Jervis, New York. The activities will include an evaluation of volatile organic compound (VOC) concentrations, semi-volatile organic compound (SVOC) concentrations and biogeochemical analyses from groundwater samples followed by a bench-scale treatability study to evaluate options for enhancing polycyclic aromatic hydrocarbon (PAH) biodegradation at the site. The purpose of this work is to identify the optimal method of biodegradation for the site prior to implementing a field-scale pilot study or full-scale remedy.

The fieldwork will be conducted in general accordance with the applicable standard operating procedures (SOPs) for field activities, soil investigation, and groundwater/non-aqueous phase liquid (NAPL) assessment included in the NYSDEC-approved *Remedial Design Work Plan* (ARCADIS, January 2010).

CMT Well Installation

CMT wells will be installed at three locations between Pike Street and First Street, as indicated on Figure 1. The purpose of installing these wells is to characterize the subsurface conditions and to provide vertical delineation of groundwater concentrations, near the downgradient edge of the plume, where

measures to control migration of the plume would likely be implemented, if necessary. CMT wells are constructed so that ports and dedicated tubing channels may be added at up to seven different depths in one multichannel plastic casing.

Prior to drilling at each proposed boring location, subsurface utility clearance will be performed by calling Dig Safely NY and clearing utilities to approximately 5 feet below ground surface (bgs) using a vacuum truck/trailer or by manual methods. The CMT wells will be installed using sonic drilling methods with continuous soil sampling in five to ten foot intervals to a depth of approximately 55 feet below ground surface (bgs). Recovered soils will be visually characterized for soil type, color and moisture content, and screened for VOCs using a photoionization detector (PID). The presence of staining, NAPL and odors (as applicable) will be noted. A subset of soil collected during these activities will be retained to support the bench-scale treatability study (described below). Each CMT well will include sample ports at depths of approximately 22, 32, 42, and 52 feet bgs. A sand filter pack will be placed around the sample port and will extend approximately two feet above and below each sample port. A six foot thick bentonite seal will be placed between the sand filter packs of each sampling port. All down-hole tooling will be steam cleaned between borings. Each of the CMT well ports will be developed, to the extent practicable, using a peristaltic pump to remove sediments and improve hydraulic communication between the well and the surrounding formation. The effectiveness of the development procedure will be monitored using measurements of field parameters, such as turbidity, pH, oxidation reduction potential (ORP), temperature, and specific conductivity. In general, monitoring well development will be discontinued after 10 well volumes have been removed and stabilization of field parameter measurements has occurred, or when the turbidity of the discharge water reaches 50 nephelometric turbidity units (NTUs) or less. Following well installation, the well coordinates and the elevation of the ground surface and top of inner casing of each newly installed well will be surveyed.

Community Air Monitoring

Community air monitoring will be performed on a daily basis during the drilling activities to provide real-time measurements of total VOCs and particulate matter less than 10 microns in diameter (PM_{10}) at the upwind and downwind perimeter of the work area. The community air monitoring procedures and action levels for total VOCs and PM_{10} are specified in the New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan included as Appendix 1A of NYSDEC Program Policy DER-10. Community air monitoring stations (one upwind and one downwind location) will be established at the start of each work day based on the predominant wind direction and general location of work activities at that site. Each monitoring station will include a PID and dust meter with either data logging capabilities or readings being manually recorded every 15 minutes.

CMT Groundwater Sampling

Following installation and development of the new CMT wells, O&R will conduct one round of sampling from each of the 12 CMT ports. CMT wells will be sampled no sooner than one week from completion of well development activities to allow the ports to equilibrate with the aquifer. All CMT groundwater samples will be collected using low-flow techniques or a well volume approach if low-flow sampling is not possible due to low recharge rates. Prior to sample collection, groundwater quality parameters (i.e. temperature, specific conductivity, pH, ORP, and turbidity) will be monitored and recorded as groundwater is purged. Groundwater

samples will be collected in laboratory provided pre-cleaned and preserved containers. Samples will be sent following chain of custody procedures to a New York ELAP-certified laboratory for analysis.

Groundwater samples from the CMT ports will be analyzed for Target Compound List (TCL) VOCs and TCL SVOCs with a standard turnaround time. The newly collected data will be evaluated, along with the results of the groundwater sampling event that was completed in September 2016, as described below.

Investigation Derived Waste

Investigation derived waste (i.e., soil, water, PPE, disposable well construction and sampling materials) will be containerized in NYSDOT-approved 55-gallon steel drums to be temporarily staged onsite prior to disposal by an approved waste disposal vendor under existing waste characterization profiles and in accordance with applicable local, state, and federal regulations.

Biogeochemical Evaluation

A groundwater sampling event was completed in September 2016 to identify if the PAH-impacted aquifer is anoxic, deeply anaerobic, or sulfate reducing, as each of these conditions could warrant a different remedial approach. The biogeochemical evaluation sampling included analysis of groundwater samples for VOCs and SVOCs from 22 existing wells and for biogeochemical parameters (total and dissolved iron and manganese, alkalinity, sulfide, sulfate, nitrate and methane) from 12 of these wells, as follows:

- Target Compound List (TCL) VOCs and TCL SVOCs: MW1D, MW2, MW6, MW7R, MW10D, MW10I, MW10S, MW11, MW15S, MW17I, MW17S, MW18I, MW20S, MW21, MW22, MW23I, MW23S, MW24, MW25, MW26, MW27, and MW29; and
- Biogeochemical analyses: MW2, MW6, MW7R, MW11, MW21, MW22, MW23S, MW24, MW25, MW26, MW27, and MW29.

The biogeochemical data and previous analytical data have been evaluated to help select a remedial approach or combination of remedial approaches best suited to aquifer conditions. The biogeochemical data confirm the aquifer is anoxic at a minimum and is deeply anaerobic with indications of sulfate reduction at many of the wells. Contaminant concentrations were most elevated near the source zone at MW1D (near historic tar separator), and at MW7R and MW26 (immediately north and south of Pike Street). In addition, elevated contaminant concentrations are also present in downgradient portions of the plume at MW22, MW24, and MW25. The areas with highest VOC and SVOC concentrations display classic biogeochemical indications of being deeply anaerobic such as high dissolved iron and manganese concentrations and the presence of elevated concentrations of methane.

Interpretation of the MW6 groundwater biogeochemistry results shows that the sulfate concentration upgradient of the plume is approximately 40 milligrams/liter (mg/L). Both Arcadis' past experience and the literature document that Sulfate Reducing Bacteria (SRB) are capable of biodegrading benzene, toluene, ethylbenzene and xylenes (BTEX) as well as PAHs. However, SRB require much higher sulfate concentrations in groundwater to be metabolically active to a degree that will result in achieving groundwater clean-up levels. The low background sulfate concentration of 40 mg/L will support a small population of SRB whose metabolic activity is curtailed by low sulfate availability. However, it is important

to note the presence of this small SRB population, because the existence of a small population will promote a more rapid expansion in population size and metabolic activity if sulfate amendment is selected as a remedy component.

Therefore, based on the biogeochemical results, the contaminant plume is predominately anaerobic with soil bound iron and manganese acting as alternative electron acceptors with indications of initial sulfate reduction trends as supported by the limited sulfate naturally available in groundwater upgradient of the plume. A more complete analysis and interpretation of the biogeochemical data will be provided in a report following installation and sampling of groundwater from the CMT wells.

Treatability Study

Based on the biogeochemical results and the contaminant distribution, a laboratory bench-scale treatability study will be conducted to include consideration of both aerobic biodegradation (air/pure oxygen sparging) and sulfate driven anaerobic bio-oxidation as potentially contributing to the final remedy at the site.

Soil collected during CMT drilling activities and groundwater collected at the same time will be used to support the bench-scale test. The treatability study including evaluation of both aerobic and anaerobic (sulfate driven biooxidation) requires 54 liters of groundwater (1.5x contingency against glass bottles potentially broken in transit to the Arcadis Treatability Lab) and 5 kilograms of soil. To the extent practicable, soil will be collected, shipped and stored in acetate or PVC liners until the treatability study begins to protect the anaerobic bacterial community whose presence is demonstrated in the biogeochemical results.

Arcadis will conduct the bench-scale treatability study to evaluate biodegradation of PAHs in groundwater under both aerobic and sulfate reducing conditions as outlined in Table 1 below.

Table 1. Port Jervis PAH Biodegradation Treatability Study Experimental Matrix

Description	Baseline	Week 4	Week 8	Week 12	Week 16	Week 20
Abiotic Control	Triplicate	X	X	X	X	X
Aerobic	NA	X	X	X	X	X
Sulfate Reducing	NA	X	X	X	X	X

NA-Not Applicable

Each glass microcosm vessel will be approximately 2 liters in volume. Abiotic control microcosms will be treated with sodium azide and mercuric chloride to discourage biodegradation. Aerobic microcosms will contain a bubble of pure oxygen approximately 10 milliliters (mL) in volume. Sulfate reducing microcosms will be spiked with 300-500 milligrams per liter (mg/L) sulfate as magnesium sulfate. All microcosms will be inoculated with 200 grams of homogenized site soil to serve as a bacterial inoculum. During each analytical event, aqueous samples will be collected from all microcosms noted in Table 1 above for the following analytes:

- pH (Arcadis Treatability Lab)
- Dissolved Oxygen (Arcadis Treatability Lab)
- Oxidation/Reduction Potential (Arcadis Treatability Lab)

- Alkalinity (TestAmerica)
- Dissolved Organic Carbon (TestAmerica)
- Sulfate (TestAmerica)
- SVOCs by Method 8270 (TestAmerica)
- VOCs by Method 8260 (TestAmerica)

The four-week interval used for timing of sample collection events in Table 1 is projected based on professional judgement. Sample collection event timing may be shortened or extended following the review of data from preceding treatability study analytical events. Treatability study data will be tabulated and reviewed as it is made available to foster discussions about the remedy selection process. The treatability study may be terminated early if definitive results are obtained with less than the five rounds of analytical testing presented in Table 1.

After bench-scale testing is complete, O&R and Arcadis will tailor the full-scale PAH biodegradation enhancing remedy to be cost effective and technically responsive to actual aquifer biogeochemistry. Considering aquifer biogeochemistry during remedy selection has been associated with more efficient, functional remedies during past biodegradation projects. Prior to full-scale implementation, field-scale pilot testing may be required. This remedy selection process will be discussed and summarized for NYSDEC in the report outlined below.

Summary Letter Reports

Letter reports will be prepared and submitted to NYSDEC following the completion of the CMT groundwater sampling and the treatability study. The first report will contain:

- A summary of the CMT well installation, development and sampling activities;
- Boring logs and an updated site figure showing the location of the CMT wells;
- Analytical data tables and;
- Modifications to the treatability study scope (if required) based on the biogeochemical and CMT well analytical results.

The second letter report will contain:

- A discussion of the methods and results of the treatability study, including the PAH biodegradation enhancing remedy recommended;
- Tables summarizing the treatability study results;
- Interpretations of the results; and
- Recommendations for additional future pre-design work, such as field-scale testing, and the remedy.

Schedule

The drilling and well development activities described herein are anticipated to last approximately 7 business days. Following an equilibration period of at least one week after well development, groundwater samples will be collected from the CMT wells in what is anticipated to be a two day mobilization. A letter report summarizing the well installation and groundwater analytical results will be submitted within 60 days of receipt of the groundwater analytical results. The treatability study will commence once the soil and groundwater samples are collected concurrent with the drilling activities. The treatability study is anticipated to require approximately 20 weeks to complete. Following the conclusion of the study, a summary letter report will be submitted within approximately 60 days of completion of the treatability study. Please contact Maribeth McCormick at 845.294.1757 with any questions or comments regarding the information provided.

Sincerely,

Arcadis of New York, Inc.

Mark A. Flusche

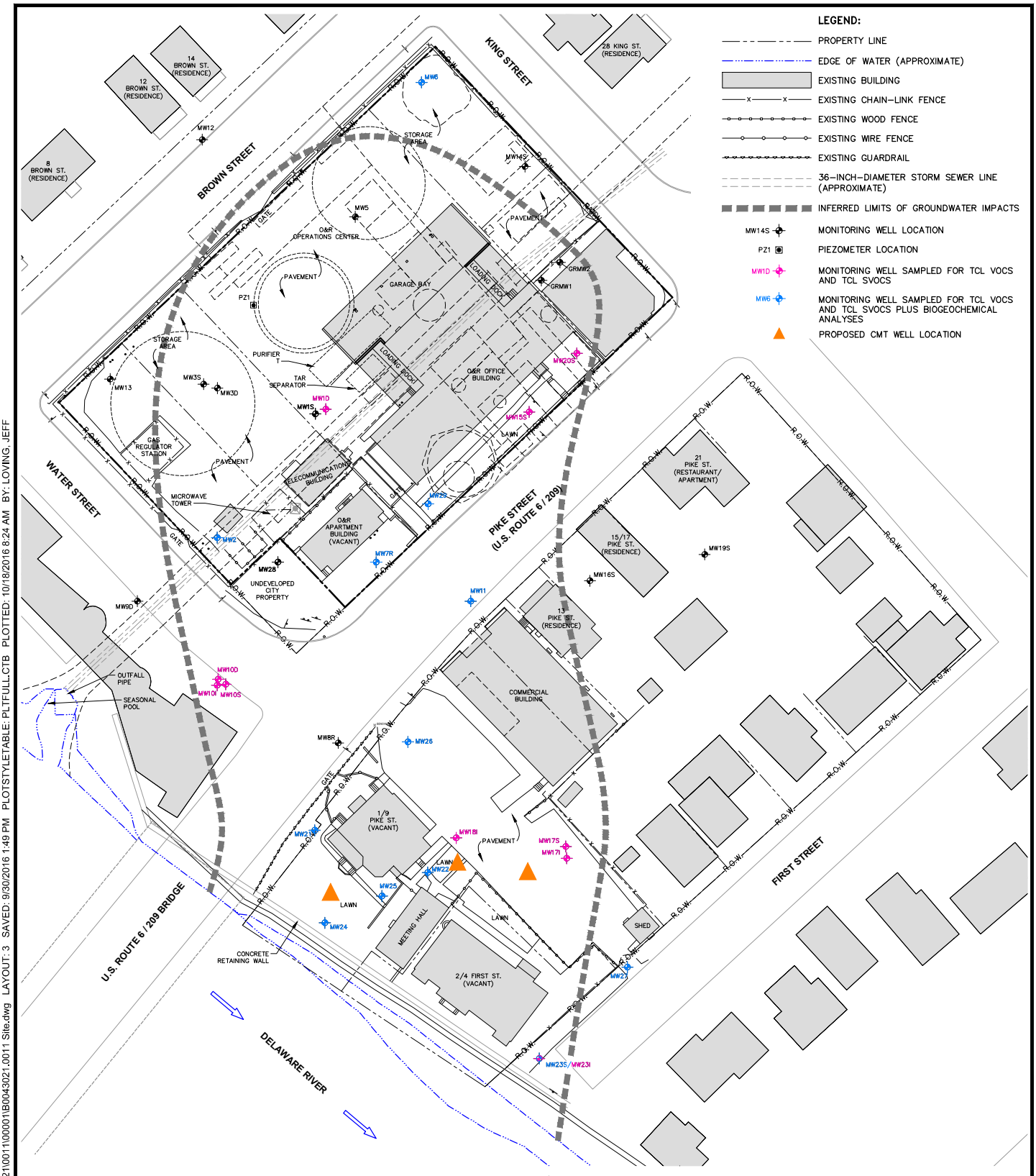
Senior Hydrogeologist

Copies:
Maribeth McCormick, O&R
Adam Etringer, Arcadis
David Cornell, PG, Arcadis
David Liles, Arcadis

Enclosures:

Figures

1 Monitoring Well Locations



NOTES:

1. BASE MAP MODIFIED FROM DRAWINGS PORT_JERVIS_08.DWG AND FIG2-1_GW3-08.DWG PROVIDED BY AECOM AND BASED ON ELECTRONIC COPY OF SURVEY DRAWING NO. 100204, TITLED "SURVEY OF PROPERTY", DATED 03-25-10, PROVIDED BY BORBAS SURVEYING AND MAPPING, LLC.
2. HORIZONTAL DATUM IS THE NORTH AMERICAN DATUM OF 1983 (NAD 83); NEW YORK STATE PLANE EAST COORDINATE SYSTEM, IN U.S. SURVEY FEET. VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
3. ALL LOCATIONS AND SITE FEATURES ARE APPROXIMATE

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK
PRE-DESIGN INVESTIGATION WORK PLAN

MONITORING WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1