Norfolk Southern Railway Company

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Appendix H1 – Sulphur Run Characterization Work Plan

East Palestine Train Derailment

Columbiana County, Ohio

Rev: 2

Rev Date: July 11, 2023

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East Palestine Train Derailment
Columbiana County, Ohio

July 11, 2023

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Version Control

Revision No.	Date Issued	Page No.	Description
0	June 9, 2023		Initial Plan
1	July 6, 2023	All	Plan revised to address US EPA and OH EPA draft comments received June 16, 2023
2	July 11, 2023	All	Plan revised to address US EPA comments received July 7, 2023

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1 Introduction

This Sediment Characterization Work Plan (Plan) was developed on behalf of Norfolk Southern Railway Company (NSRC) by Arcadis U.S., Inc. (Arcadis) in response to the derailment in East Palestine, Ohio, and pursuant to the United States Environmental Protection Agency (USEPA) February 21, 2023 Unilateral Administrative Order for Removal Actions (UAO), which became effective on February 27, 2023. This Plan supports the response, characterization, and any needed remediation activities related to the derailment specific to Sulphur Run starting just north of the railroad tracks (also identified as the North Ditch) to the confluence with Leslie Run (Figure 1). The Plan is an appendix to the Quality Assurance Project Plan (QAPP) to identify and delineate the extent of potential environmental impacts in Sulphur Run, consistent with Paragraphs 36 and 38 of the UAO. This Plan replaces the previous Sediment Sampling Work Plan submitted in March 2023 as Appendix H to the Removal Work Plan (Arcadis 2023).

The purpose of this Plan is to provide details on sampling activities within Sulphur Run proposed to delineate the extent of sediment contamination in Sulphur Run and determine whether Sulphur Run is serving as an ongoing point-source for contaminants of potential concern (COPCs) to Leslie Run and downstream water bodies. The investigation questions to be addressed by the actions outlined herein are identified in the QAPP Worksheet #11: Project Data/Quality Objectives. Sediment investigation activities in Sulphur Run were initially performed in February and March 2023. A qualitative stream sediment assessment was conducted by EnviroScience in Sulphur Run on May 17, 2023. These investigation and assessment activities are summarized in Section 2 and the results guide the investigation efforts proposed herein. Sections 3 and 4 outline the investigation scope, locations, and procedures and Section 5 identifies the analytical testing for the COPCs. Section 6 provides a target schedule for implementation of the proposed sampling activities, and Section 7 lists references used throughout the Plan.

The results from the sampling efforts will be incorporated into the Conceptual Site Model (CSM) – QAPP Worksheet #10 and may lead to additional investigation activities and/or evaluation of future potential removal approaches.

Additional sampling may be directed by the Agencies/Unified Command and the Agencies may take split or co-located samples. Notifications and logistics will accommodate these requests as needed.

2 Completed Sulphur Run Sediment Investigations

Sediment characterization activities were performed in Sulphur Run in February, March, and May 2023, and included the following:

- Sediment sampling on February 15, 2023. One sample was collected co-located with water monitoring station W-2. This station is located 500 feet upstream of confluence with Leslie Run.
- Probing and visual observations to document conditions on February 21-23, 2023, immediately prior to the Ohio Environmental Protection Agency (OEPA)-directed stream washing operations were initiated. Probing was performed along a series of transects spaced approximately every 50 feet from just downstream of the railroad culvert and the unnamed ditch to the confluence with Leslie Run (63 transects). The portion that runs under the town was not accessed. Soft sediment depths ranged from 0.0 to 3.0 feet with materials identified as sand/silt and gravel with cobble and hard bottom at the majority of transects. Water depths ranged from 0.0 to 2.6 feet. One sediment sample was also collected on February 22, 2023 at W-2.
- Sediment sampling on March 16, 2023 at W-2.
- An initial qualitative stream sediment assessment survey of Sulphur Run on May 17, 2023 to visually characterize areas of potentially impacted sediments.

The February and March 2023 Sulphur Run sediment sampling analytical results for W-2 are provided in Table 2-1. This table also includes results from sediment sampling location W-9 which is located in Leslie Run approximately 2,500 feet upstream of the confluence with Sulphur Run near the Brooksdale Avenue crossing – data from this location represent background conditions. All February and March 2023 characterization efforts and corresponding results are summarized in a summary report provided under separate cover. The report documenting the qualitative stream sediment assessment in May 2023 was provided under separate cover; note that this effort also included work in Leslie Run and those results are included in this same report.

3 Sediment Investigation Scope

This section outlines the investigation activities for Sulphur Run proposed to answer the investigative questions identified in the QAPP. Additional investigation efforts and/or potential removal actions will be identified and proposed as necessary pending receipt and evaluation of the data generated through the activities outlined in this section.

3.1 Sediment Sampling

Sediment sampling is proposed for Sulphur Run to assess COPC concentrations primarily in surface sediment as well as obtain information in the biologically active zone (assumed to be the top 6 inches but could be deeper or shallower). The target sampling locations were identified based on the results of the May 2023 qualitative stream sediment assessment. This assessment was performed just downstream of the railroad culvert to the confluence with Leslie Run. During these efforts, the stream was qualitatively categorized with scores of 0 through 3 based on the sheens observed by the field team considering speed of release from the disturbed sediment, horizontal expanse of sheen, and presence of odor. The sheen criteria included the following: Score 0 = no sheen; Score 1 = light sheen; Score 2 = medium sheen; and Score 3 = heavy sheen. Figure 2 provides the results of the sheen assessment. There were no areas within Sulphur Run scored as 0.

Based on this qualitative sheen assessment, sediment sampling will be performed at select locations to provide data from the range of sheen scores, but will primarily target stream extents with scores of 3 and 2 as these areas would be anticipated to potentially contain COPCs. The sampling location will initially target the approximate mid-point (length and stream width) of the selected extent. Probing will then be performed around this location (towards the banks and up to 50 feet upstream and downstream or as limited by the particular targeted sheen category) to identify locations with recoverable sediment that exhibit the greatest sheens when disturbed (i.e., bias sample collection towards sediment that visually appears to be impacted). Sampling locations will also be selected to provide coverage for the length of Sulphur Run and to not sample in similarly scored areas immediately adjacent to each other. A total of 11 locations have been selected for sampling. The rationale for selecting these locations is provided in the bullets below. The proposed locations are overlaid on Figure 2 with the results of the sheen scoring and identified extents.

- Five extents were scored as 3 (heavy sheen) and each of these areas will be sampled.
- Three extents were scored as a combination of 2 and 3 (medium to heavy sheen), and two of these areas will be sampled. The third area was not selected due to its close proximity to another area with this same score.
- Eight extents were scored as 2 (medium sheen), and two of these areas will be sampled. The other six areas were not selected due to proximity to segments scored as 3 or combination of 2 and 3 that will be targeted for sampling under the first two bullets.
- One area scored with a 1 (light sheen) will be sampled. This location coincides with the water monitoring location at W-2. Data from past sampling events in February and March 2023 are also available for this location (see Section 2) to assess changes over time.
- To provide coverage of the complete length of Sulphur Run, one location will be sampled upstream of the railroad culvert and downstream of the North Ditch removal extent. This area was not included in the qualitative assessment.

Sampling will target the surface interval (up to 6 inches) of recoverable material (e.g., silt, sand, and gravel). If less than 6 inches are present, a single grab of the material will be sampled as long as an adequate volume can be obtained for analytical testing. If adequate material is not available with a single grab, multiple grab samples may be collected and composited to form a single sample with an adequate volume; however, this sample will not be submitted for analysis of volatile organic compounds (VOCs). Since the biologically active zone could be deeper or shallower than the assumed 6 inches, samples will also be collected from deeper sediment (target 6 to 12 inches below the sediment surface) as possible in areas identified to contain sheens (i.e., Scores of 3, 2, or a combination thereof – up to 9 deeper samples).

All sediment sampling will be performed in accordance with the Standard Operating Procedure (SOP) #1 provided in Attachment A.

Table 3-1 Sediment Sample Locations

Sample ID	Sheen Score	Sample Interval
SR-1	Not assessed	Surface
SR-2	2	Surface and deeper sediment
SR-3	2	Surface and deeper sediment
SR-4	3	Surface and deeper sediment
SR-5	3	Surface and deeper sediment
SR-6	3	Surface and deeper sediment
SR-7	2 & 3	Surface and deeper sediment
SR-8	3	Surface and deeper sediment
W-2	1	Surface
SR-9	3	Surface and deeper sediment
SR-10	2 & 3	Surface and deeper sediment

3.2 Pore Water Sampling

Pore water sampling is proposed to provide sediment pore water COPC concentrations near the groundwater and surface water interface. Pore water sampling will be performed co-located with 4 of the sediment sample locations identified in Section 3.1 with scores of 3 and 2 (medium to heavy sheen) per the March 2023 qualitative assessment. Pore water samples will also be obtained co-located with the water monitoring location at W-2 which had a score of 1 (light sheen) as well as upstream of the railroad culvert and downstream of the North Ditch removal extent assuming water is present (i.e., if no water is present the location will not be sampled). A total of up to 6 locations are proposed for pore water sampling as shown on Figure 2.

Sampling will be performed in accordance with SOP #2 provided in Attachment A.

3.3 Covered Culvert Creek Inspection and Assessment

There are three sections of Sulphur Run that traverse under parts of the town including both business and residential structures. These covered sections include the approximately 800-ft crossing under E. Taggart St., 200-ft section parallel to Rebecca St., and 200-ft crossing under Market St. The upstream culvert location for each of these sections is identified on Figure 1. These sections have not yet been characterized due to access limitations and health and safety/confined space considerations. The current condition of the underground culvert system structures, the distribution of sediments within the culverts, and any obstructions within the culvert sections will be inspected using a remotely operated camera system. In addition, air quality in the culvert system will be tested to evaluate conditions for future potential personnel access if needed pending results from this initial effort. The efforts proposed herein will be performed remotely without having personnel physically enter the confined space structures.

Inspections will be performed using a Proteus portable sewer inspection system with a mini-cam float raft equipped with a pan and tilt camera head and auxiliary light heads that can illuminate areas of more than 80-inches (Proteus Systems | Minicam (minicaminc.com). Access areas will be identified upstream and downstream of each of the three culvert sections and these work areas will be cordoned off from local foot or street traffic. Flow rates will need to be near base flow levels during these efforts to support the float raft and movement. The float raft will be deployed immediately upstream of the culvert and will slowly travel downstream using a tethered reinforced deployment/retrieval cable. The tethered cable will be managed by the field crew to control the speed and movement of the float raft. The camera will transmit real-time video coverage to a monitor located in a field vehicle positioned adjacent to the culvert. The field team will continuously observe the coverage from the interior of the culvert structures to identify the construction and condition throughout each entire section. Personnel watching the real-time video will also coordinate with personnel operating the tethered cable to make adjustments in position of the raft as needed. Video coverage will also be recorded to the Proteus control unit for future viewing and reference. Approaches for disturbing sediment in the culvert will be field tested on-site and include attaching a small object (e.g., a small cable weight) to the float or the leading tethered cable. A large remote controlled tire crawler camera unit will also be available for use (in lieu of a floating raft) if needed based on field conditions (e.g., water depth is too shallow to float the raft through the sewer).

Air monitoring equipment will be used to obtain air quality information within the culvert areas. The air monitoring equipment will be secured to the floating raft or crawler and will record continuous measurements while passing through the culvert. A Toxi-Rae PID monitor (or similar) will be able to data log and see real time VOC readings. A 4-gas meter will also be utilized to test for oxygen, carbon monoxide, hydrogen sulfide and combustibles. A second run through the culvert segments may be needed to obtain air monitoring data if the air monitoring equipment cannot be securely attached to the floating raft or crawler while video is being collected.

4 Sample Processing

Sediment samples for laboratory analysis will be collected per the procedures described in Attachment A. All samples will be preserved in accordance with analytical method requirements, sealed in coolers, and shipped to the selected laboratory under chain-of-custody protocol and analyzed within required holding times in accordance with the QAPP.

Samples will be labeled using the nomenclature listed below.

Sediment samples:

- Media sampled (SED)
- Location of sample (i.e., W2 for sample co-located at surface water sample SR1 through 10 for new sediment sample locations as shown on Figure 2)
- Sample depth in inches
- Sample Date in YYYYMMDD
- Example: **SED-W2(0-6)-20230615**
- Field duplicate samples
    - SFD (for Sediment Field Duplicate)
    - Sequential number
    - Sample Date in YYYYMMDD
    - Example: **SFD-1-20230615**

Pore water samples:

- Media sampled (PW)
- Location of sample (i.e., W2 for sample co-located at surface water sample and SR1, 2, 6, 8, and 10 for pore water samples co-located sediment samples as shown on Figure 2)
- Sample Date in YYYYMMDD
- Example: **PW-SR1-20230615**
- Field duplicate samples
    - PFD (for Pore Water Field Duplicate)
    - Sequential number
    - Sample Date in YYYYMMDD
    - Example: **PFD-1-20230615**

5 Laboratory Analysis and QA/QC

Sediment and pore water samples will be couriered or shipped to the laboratory under standard chain-of-custody procedures and analyzed for chemical analysis of the parameters listed in Table 5-1. If composite sediment samples are collected, these samples will be submitted for non-VOC analysis only. All sediment samples will also be submitted for total organic carbon analysis and grain size analysis.

Table 5-1 Analyte List

Analyte	CAS#	Analytical Method
1,2,4-Trimethylbenzene	95-63-6	VOCs (USEPA Method 8260)
1-Methylnaphthalene	90-12-0	SVOCs (USEPA Method 8270)
2,4-Dinitrophenol	51-28-5	SVOCs (USEPA Method 8270)
2,6-Dinitrotoluene	606-20-2	SVOCs (USEPA Method 8270)
2-Methylnaphthalene	91-57-6	SVOCs (USEPA Method 8270)
Acenaphthene	83-32-9	SVOCs (USEPA Method 8270)
Acenaphthylene	208-96-8	SVOCs (USEPA Method 8270)
Acetone	67-64-1	VOCs (USEPA Method 8260)
Anthracene	120-12-7	SVOCs (USEPA Method 8270)
Benzene	71-43-2	VOCs (USEPA Method 8260)
Benzo[a]anthracene	56-55-3	SVOCs (USEPA Method 8270)
Benzo[a]pyrene	50-32-8	SVOCs (USEPA Method 8270)
Benzo[b]fluoranthene	205-99-2	SVOCs (USEPA Method 8270)
Benzo[g,h,i]perylene	191-24-2	SVOCs (USEPA Method 8270)
Benzo[k]fluoranthene	207-08-9	SVOCs (USEPA Method 8270)
Benzoic Acid	65-85-0	SVOCs (USEPA Method 8270)
Benzyl Alcohol	100-51-6	SVOCs (USEPA Method 8270)
Carbon Disulfide	75-15-0	VOCs (USEPA Method 8260)
Chrysene	218-01-9	SVOCs (USEPA Method 8270)
Diethylene Glycol	111-46-6	Glycols (USEPA Method 8015)
2-Butyloxyethanol (Ethylene Glycol Monobutyl Ether)	111-76-2	SVOCs (USEPA Method 8270)
2-Ethylhexyl acrylate	103-11-7	VOCs (USEPA Method 8260)
2-Hexanone	591-78-6	VOCs (USEPA Method 8260)
2-Nitrophenol	88-75-5	SVOCs (USEPA Method 8270)
3 & 4-Methylphenol (M, P-Cresols)	65794-96-9	SVOCs (USEPA Method 8270)
4,6-Dinitro-2-Methylphenol	534-52-1	SVOCs (USEPA Method 8270)
4-Nitrophenol	100-02-7	SVOCs (USEPA Method 8270)
Ethylbenzene	100-41-4	VOCs (USEPA Method 8260)

Analyte	CAS#	Analytical Method
Ethylene Glycol	107-21-1	Glycols (USEPA Method 8015)
Fluoranthene	206-44-0	SVOCs (USEPA Method 8270)
Fluorene	86-73-7	SVOCs (USEPA Method 8270)
Indeno[1,2,3-cd]pyrene	193-39-5	SVOCs (USEPA Method 8270)
Isophorone	78-59-1	SVOCs (USEPA Method 8270)
m-Xylene & p-Xylene	179601-23-1	VOCs (USEPA Method 8260)
Methyl Acrylate	96-33-3	VOCs (USEPA Method 8260)
Methyl Ethyl Ketone (2-Butanone)	78-93-3	VOCs (USEPA Method 8260)
Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	108-10-1	VOCs (USEPA Method 8260)
Naphthalene	91-20-3	SVOCs (USEPA Method 8270)
n-Butyl acrylate	141-32-2	VOCs (USEPA Method 8260)
Nitrobenzene	98-95-3	VOCs (USEPA Method 8260)
o-Xylene (1,2-Dimethylbenzene)	95-47-6	VOCs (USEPA Method 8260)
Phenanthrene	85-01-8	SVOCs (USEPA Method 8270)
Phenol	108-95-2	SVOCs (USEPA Method 8270)
Pyrene	129-00-0	SVOCs (USEPA Method 8270)
Styrene	100-42-5	VOCs (USEPA Method 8260)
Toluene	108-88-3	VOCs (USEPA Method 8260)
Vinyl chloride	75-01-4	VOCs (USEPA Method 8260)

Equipment blanks (consisting of rinsate from sampling equipment), field duplicates, and matrix spike/matrix spike duplicates (MS/MSDs) will be collected and analyzed as outlined in the QAPP.

Deliverables will be requested from the laboratory for work conducted under this Plan, and data validation consistent with USEPA guidelines will be completed on each sample data group per the QAPP requirements.

All analytical results will be uploaded into NRSC's EQuIS database in accordance with the QAPP.

6 Schedule

Each of the investigation activities described in Section 3 are proposed as a one-time event. Sampling efforts are targeted for mid-July 2023 pending QAPP and Plan approval by Unified Command. The duration of field activities is anticipated as one week. The need and timing for any additional sampling events will be determined based on results from the initial event as outlined in QAPP Worksheet #11: Project Data/Quality Objectives. The pore water sampling setup (i.e., screen, tubing, etc. as outlined in SOP #2) will remain in place pending review of the COPC results from the initial sampling in the event that future sampling is determined to be necessary. If additional sampling is not necessary, the equipment will be removed from the creeks.

Investigation efforts in downstream creeks (e.g., Leslie Run) are outlined under separate cover[1], and these activities are also targeted for initiation July 2023 pending approval.

[1] This Sulphur Run Sediment Characterization Plan replaces the Sediment Sampling Work Plan included in Appendix H to the March 2023 Removal Work Plan. Future plans developed to address creeks downstream of Sulphur Run will supplement this Plan and also replace Appendix H.

7 Reporting

A brief summary report will be prepared following completion of the field efforts and receipt/validation of the analytical results with a discussion regarding next steps. This report will include data summary tables, figures illustrating results, and a discussion as to how the findings may impact the CSM.

8 References

Arcadis. 2023. Removal Work Plan, East Palestine Train Derailment Site, East Palestine, Ohio, Norfolk Southern Railway Company. March 6.

EnviroScience. 2023. Qualitative Stream Sediment Assessment Sampling Summary Report, East Palestine, Ohio. March 29.

Tables

Table 2-1: Sulphur Run Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID: Sample Depth(ft): Date Collected: Lab Sample ID:	Units	W 2 0 0.2 02/15/23 240 180445 5	W 2 0 0.2 02/22/23 240 180811 15	W 2 0 0.2 03/16/23 240 182042 7	W 9 0 0.4 02/15/23 240 180445 4	W 9 0 0.4 02/22/23 240 180811 19	W 9 0 0.4 03/16/23 240 182042 8
Volatile Organics							
1,1,1-Trichloroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,1,2,2-Tetrachloroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,1,2-trichloro-1,2,2-trifluoroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,1,2-Trichloroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,1-Dichloroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,1-Dichloroethene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,2,4-Trichlorobenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,2-Dibromo-3-chloropropane	mg/kg	<0.55	<0.79 *-	<0.0097	<0.62	<0.47	<0.010
1,2-Dibromoethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,2-Dichlorobenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,2-Dichloroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,2-Dichloropropane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,3-Dichlorobenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
1,4-Dichlorobenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
2-Butanone	mg/kg	<1.1	<1.6	<0.019	<1.2	<0.94	<0.020
2-Ethylhexyl acrylate	mg/kg	**7.5**	<3.9	<0.048	<3.1	<2.3	<0.051
2-Hexanone	mg/kg	<1.1	<1.6	<0.019	<1.2	<0.94	<0.020
4-Methyl-2-pentanone	mg/kg	<1.1	<1.6	<0.019	<1.2	<0.94	<0.020
Acetone	mg/kg	<1.1	<1.6	<0.024	<1.2	<0.94	<0.026
Benzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Bromodichloromethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Bromoform	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Bromomethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Butyl Acrylate	mg/kg	<2.7	<3.9	<0.048	<3.1	<2.3	<0.051
Carbon Disulfide	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Carbon Tetrachloride	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Chlorobenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Chloroethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Chloroform	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Chloromethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
cis-1,2-Dichloroethene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
cis-1,3-Dichloropropene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Cyclohexane	mg/kg	<0.55	<0.79	<0.0097	<0.62	<0.47	<0.010
Dibromochloromethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Dichlorodifluoromethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Ethanol	mg/kg	<0.83	NA	NA	<0.97	NA	NA
Ethylbenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Isopropylbenzene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Methyl acetate	mg/kg	<1.4	**0.60 J**	<0.024	**0.40 J**	<1.2	<0.026
Methyl Acrylate	mg/kg	<0.55	<0.79	<0.0097	<0.62	<0.47	<0.010
Methyl tert-butyl ether	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Methylcyclohexane	mg/kg	<0.55	<0.79	<0.0097	<0.62	<0.47	<0.010
Methylene Chloride	mg/kg	<0.55	<0.79	<0.024	<0.62	<0.47	<0.026
Styrene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Tetrachloroethene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Toluene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
trans-1,2-Dichloroethene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
trans-1,3-Dichloropropene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Trichloroethene	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Trichlorofluoromethane	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Vinyl Chloride	mg/kg	<0.27	<0.39	<0.0048	<0.31	<0.23	<0.0051
Xylenes (total)	mg/kg	<0.55	<0.79	<0.0097	<0.62	<0.47	<0.010
Semivolatile Organics							
1,1'-Biphenyl	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
2,2'-Oxybis(1-Chloropropane)	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
2,4,5-Trichlorophenol	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
2,4,6-Trichlorophenol	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
2,4-Dichlorophenol	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
2,4-Dimethylphenol	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
2,4-Dinitrophenol	mg/kg	<0.36	<12	<0.37	<0.42	<0.37	<0.42
2,4-Dinitrotoluene	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25
2,6-Dinitrotoluene	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25

Table 2-1: Sulphur Run Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

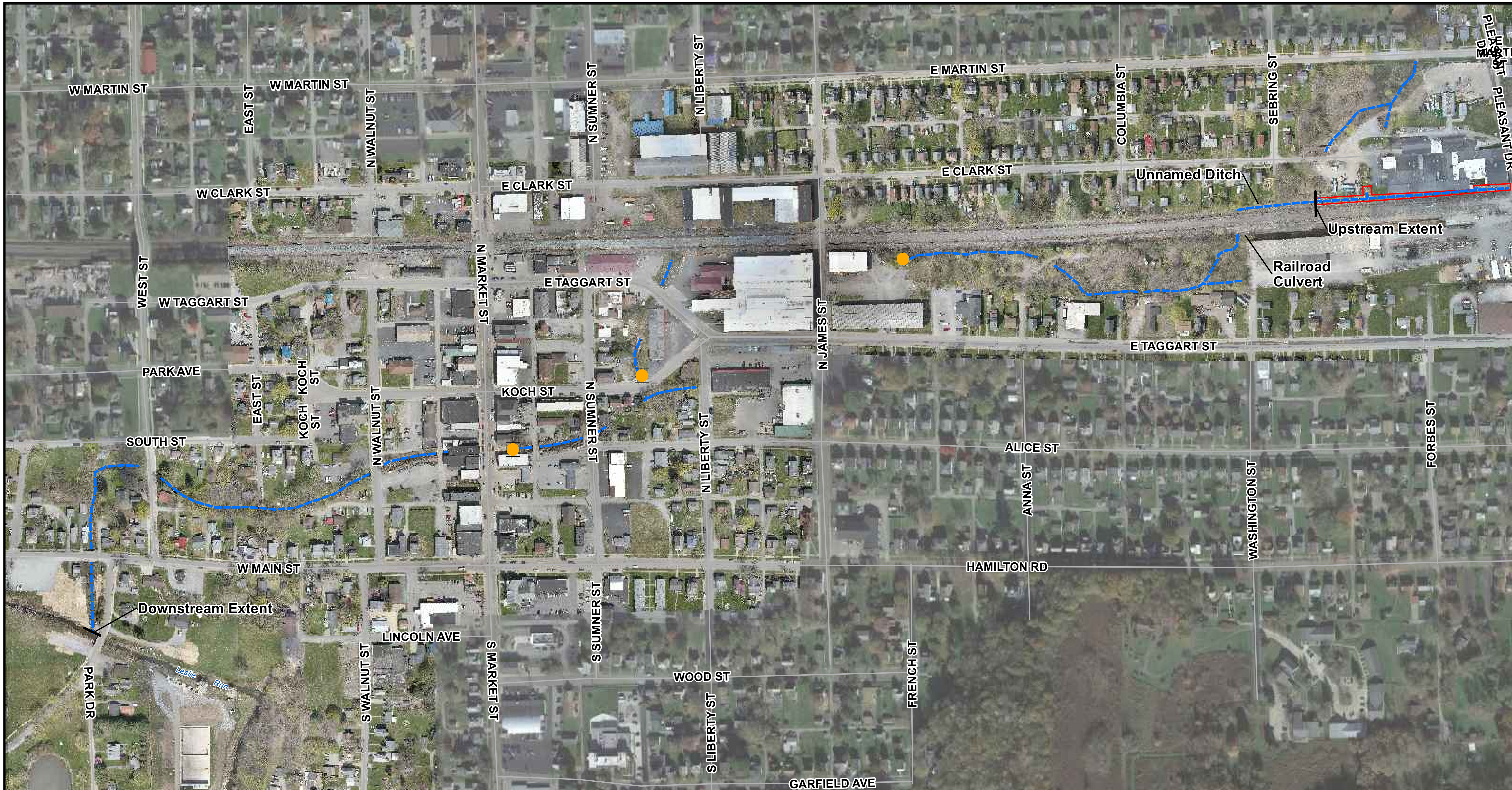
Location ID:		W 2	W 2	W 2	W 9	W 9	W 9
Sample Depth(ft):		0 0.2	0 0.2	0 0.2	0 0.4	0 0.4	0 0.4
Date Collected:		02/15/23	02/22/23	03/16/23	02/15/23	02/22/23	03/16/23
Lab Sample ID:	Units	240 180445 5	240 180811 15	240 182042 7	240 180445 4	240 180811 19	240 182042 8
2-Butoxyethanol	mg/kg	NA	**47**	**0.15**	NA	<0.078	<0.088
2-Butoxyethyl acetate	mg/kg	NA	<2.5	NA	NA	<0.078	NA
2-Chloronaphthalene	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
2-Chlorophenol	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
2-Methylnaphthalene	mg/kg	**0.034**	**1.3**	**0.036**	**0.022**	**0.017**	**0.027**
2-Methylphenol	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25
2-Nitroaniline	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25
2-Nitrophenol	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
3,3'-Dichlorobenzidine	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
3-Methylphenol, 4-Methylphenol	mg/kg	<0.44	<14	<0.45	<0.51	<0.44	<0.50
3-Nitroaniline	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25
4,6-Dinitro-2-methylphenol	mg/kg	<0.36	<12	<0.37	<0.42	<0.37	<0.42
4-Bromophenyl-phenylether	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
4-Chloro-3-Methylphenol	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
4-Chloroaniline	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
4-Chlorophenyl-phenylether	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
4-Nitroaniline	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25
4-Nitrophenol	mg/kg	<0.36	<12	<0.37	<0.42	<0.37	<0.42
Acenaphthene	mg/kg	**0.013 J**	**0.41 J**	**0.0074 J**	<0.019	<0.017	<0.019
Acenaphthylene	mg/kg	<0.016	<0.53	**0.0047 J**	<0.019	<0.017	<0.019
Acetophenone	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
Anthracene	mg/kg	**0.020**	**0.34 J**	**0.022**	**0.0094 J**	**0.0051 J**	**0.0046 J**
Atrazine	mg/kg	<0.22	<7.1	<0.23	<0.26	<0.22	<0.25
Benzaldehyde	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
Benzo(a)anthracene	mg/kg	**0.14**	**1.4**	**0.14**	**0.073**	**0.030**	**0.025**
Benzo(a)pyrene	mg/kg	**0.14 *3**	**1.3**	**0.16**	**0.075**	**0.038**	**0.037**
Benzo(b)fluoranthene	mg/kg	**0.27 *3**	**1.9**	**0.27**	**0.13**	**0.077**	**0.056**
Benzo(g,h,i)perylene	mg/kg	**0.058 *3**	**0.88**	**0.075**	**0.036**	**0.017**	**0.020**
Benzo(k)fluoranthene	mg/kg	**0.085 *3**	**0.79**	**0.093**	**0.047**	**0.030**	**0.024**
bis(2-Chloroethoxy)methane	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
bis(2-Chloroethyl)ether	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
bis(2-Ethylhexyl)phthalate	mg/kg	<0.077	<2.5	**0.067 J**	<0.090	<0.078	<0.088
Butylbenzylphthalate	mg/kg	<0.077	<2.5	<0.079	<0.090	<0.078	<0.088
Caprolactam	mg/kg	<0.36	<12	<0.37	<0.42	<0.37	<0.42
Carbazole	mg/kg	**0.022 J**	<1.8	**0.023 J**	<0.064	<0.055	<0.063
Chrysene	mg/kg	**0.19**	**1.9**	**0.17**	**0.091**	**0.046**	**0.031**
Dibenzo(a,h)anthracene	mg/kg	**0.015 J*3**	<0.53	**0.023**	**0.0098 J**	<0.017	<0.019
Dibenzofuran	mg/kg	**0.023 J**	**0.54 J**	**0.018 J**	<0.064	<0.055	<0.063
Diethylphthalate	mg/kg	<0.077	<2.5	<0.079	<0.090	<0.078	<0.088
Dimethylphthalate	mg/kg	<0.077	<2.5	<0.079	<0.090	<0.078	<0.088
Di-n-Butylphthalate	mg/kg	<0.077	<2.5	<0.079	<0.090	<0.078	<0.088
Di-n-Octylphthalate	mg/kg	<0.077 *3	<2.5	<0.079	<0.090	<0.078	<0.088
Fluoranthene	mg/kg	**0.38**	**3.9**	**0.34**	**0.14**	**0.11**	**0.054**
Fluorene	mg/kg	**0.013 J**	**0.30 J**	**0.0092 J**	<0.019	<0.017	<0.019
Hexachlorobenzene	mg/kg	<0.016	<0.53	<0.017	<0.019	<0.017	<0.019
Hexachlorobutadiene	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
Hexachlorocyclopentadiene	mg/kg	<0.36	<12	<0.37	<0.42	<0.37	<0.42
Hexachloroethane	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
Indeno(1,2,3-cd)pyrene	mg/kg	**0.052 *3**	**0.73**	**0.071**	**0.033**	**0.014 J**	**0.020**
Isophorone	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
Naphthalene	mg/kg	**0.014 J**	**0.88**	**0.022**	**0.012 J**	**0.0088 J**	**0.014 J**
Nitrobenzene	mg/kg	<0.11	<3.5	<0.11	<0.13	<0.11	<0.13
N-Nitroso-di-n-propylamine	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
N-Nitrosodiphenylamine	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
Pentachlorophenol	mg/kg	<0.16	<5.3	<0.17	<0.19	<0.17	<0.19
Phenanthrene	mg/kg	**0.20**	**2.6**	**0.14**	**0.068**	**0.049**	**0.046**
Phenol	mg/kg	<0.055	<1.8	<0.056	<0.064	<0.055	<0.063
Pyrene	mg/kg	**0.39**	**3.6**	**0.31**	**0.14**	**0.092**	**0.054**
Miscellaneous							
Carbon	mg/kg	**7700**	NA	NA	**6400**	NA	NA
Corrosivity	pH Units	8.2 HF	NA	NA	7.9 HF	NA	NA
Oil & Grease	mg/kg	**910**	NA	NA	**160 J**	NA	NA
pH	pH Units	8.2 HF	NA	NA	7.9 HF	NA	NA

Table 2-1: Sulphur Run Sediment Analytical Results for February and March 2023 Sampling Events
Norfolk Southern Railway Company
East Palestine Ohio Train Derailment

Location ID:		W 2	W 2	W 2	W 9	W 9	W 9
Sample Depth(ft):		0 0.2	0 0.2	0 0.2	0 0.4	0 0.4	0 0.4
Date Collected:		02/15/23	02/22/23	03/16/23	02/15/23	02/22/23	03/16/23
Lab Sample ID:	Units	240 180445 5	240 180811 15	240 182042 7	240 180445 4	240 180811 19	240 182042 8
Total Organic Carbon	mg/kg	**7700**	NA	NA	**6400**	NA	NA

Notes:
HF = Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
J = Estimated value
NA = Not applicable/analyzed
*3 = STD response or retention time outside acceptable limits

Figures



Legend

- Sulphur Run
- North Ditch Removal Extent West of North Pleasant Drive
- Start of Covered Culvert

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

0 300 600
Feet

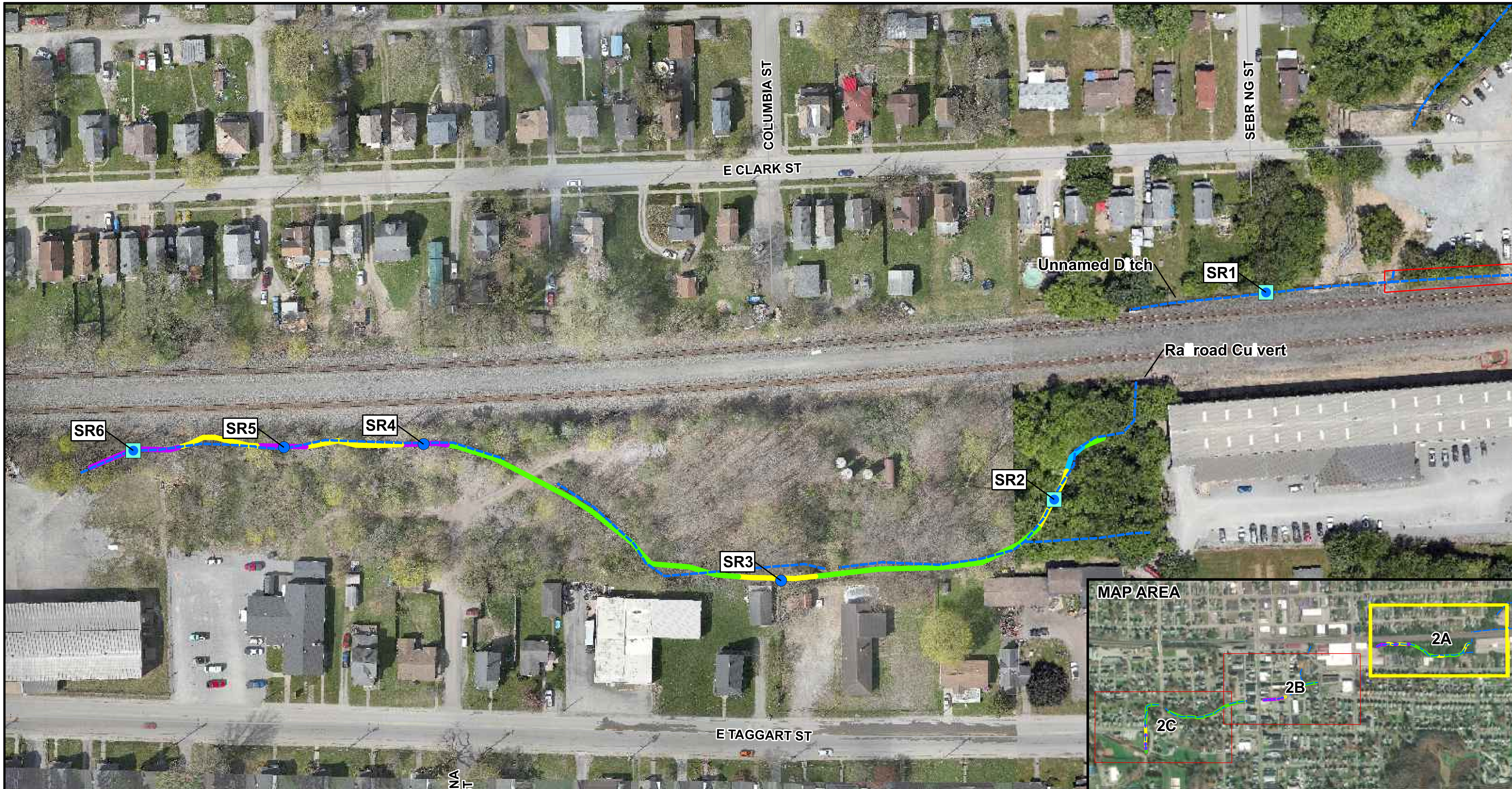
Map Date: 6/22/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN INVESTIGATION EXTENT

ARCADIS

FIGURE
1



Legend

- Sulphur Run
- Sediment Sample Location
- Pore Water Sample Location
- North Ditch Removal Extent West of North Pleasant Drive

Qualitative Sheen Observations

- 1
- 1 & 2
- 2
- 2 & 3
- 3

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

0 100 200
Feet

Map Date: 6/23/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN SEDIMENT INVESTIGATION LOCATIONS

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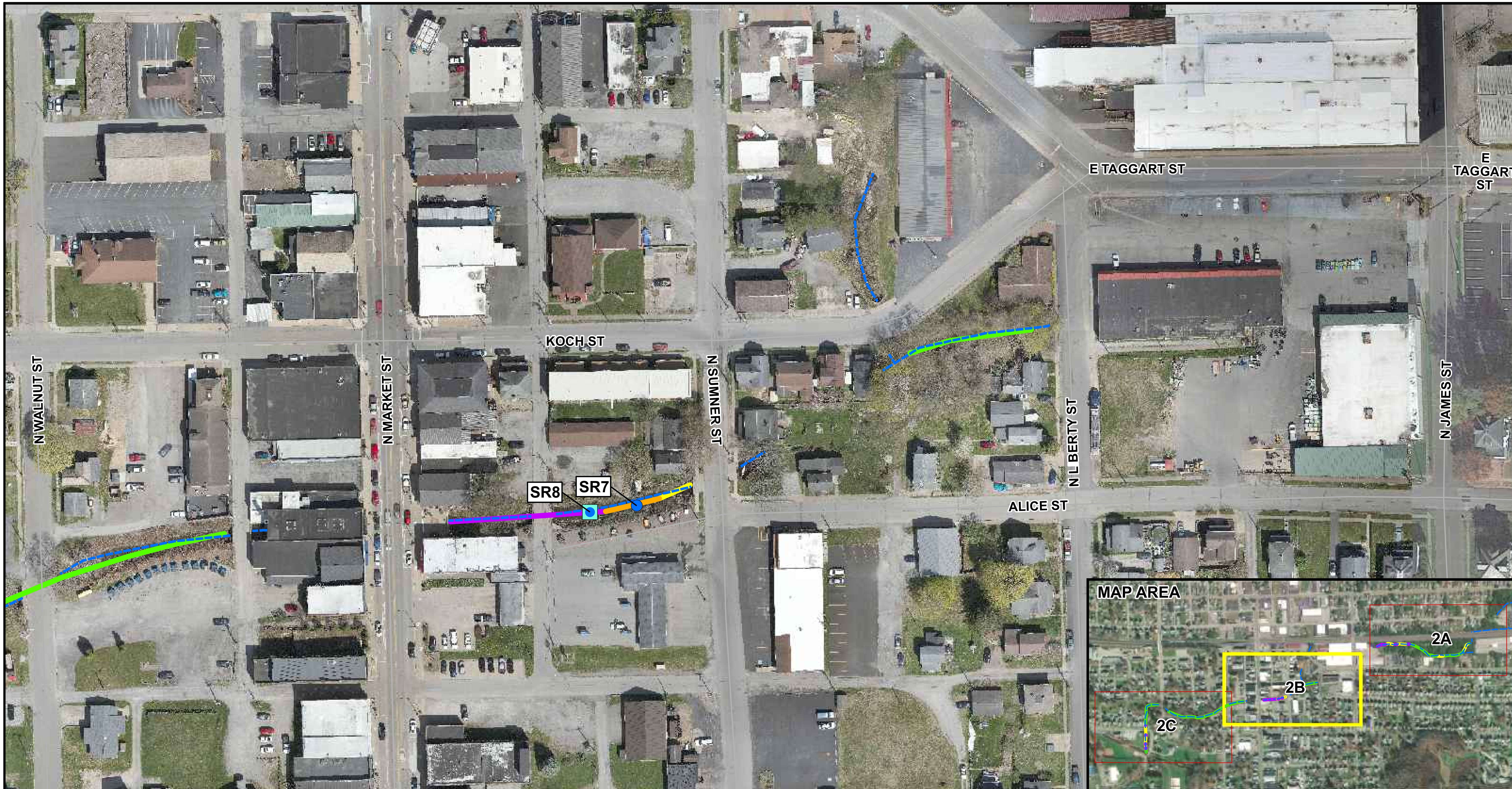
FIGURE
2A

Document Path: T:_ENV\NorfolkSouthern\EastPalestine_Feb5_2023\MXD\SedimentSampling\NS_East Palestine_F2A_2C Sulphur Run Sediment Sampling_DD.mxd



Legend
- Sulphur Run
- Sediment Sample Location
- Pore Water Sample Location

Qualitative Sheen Observations
- 1
- 1 & 2
- 2
- 2 & 3
- 3

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

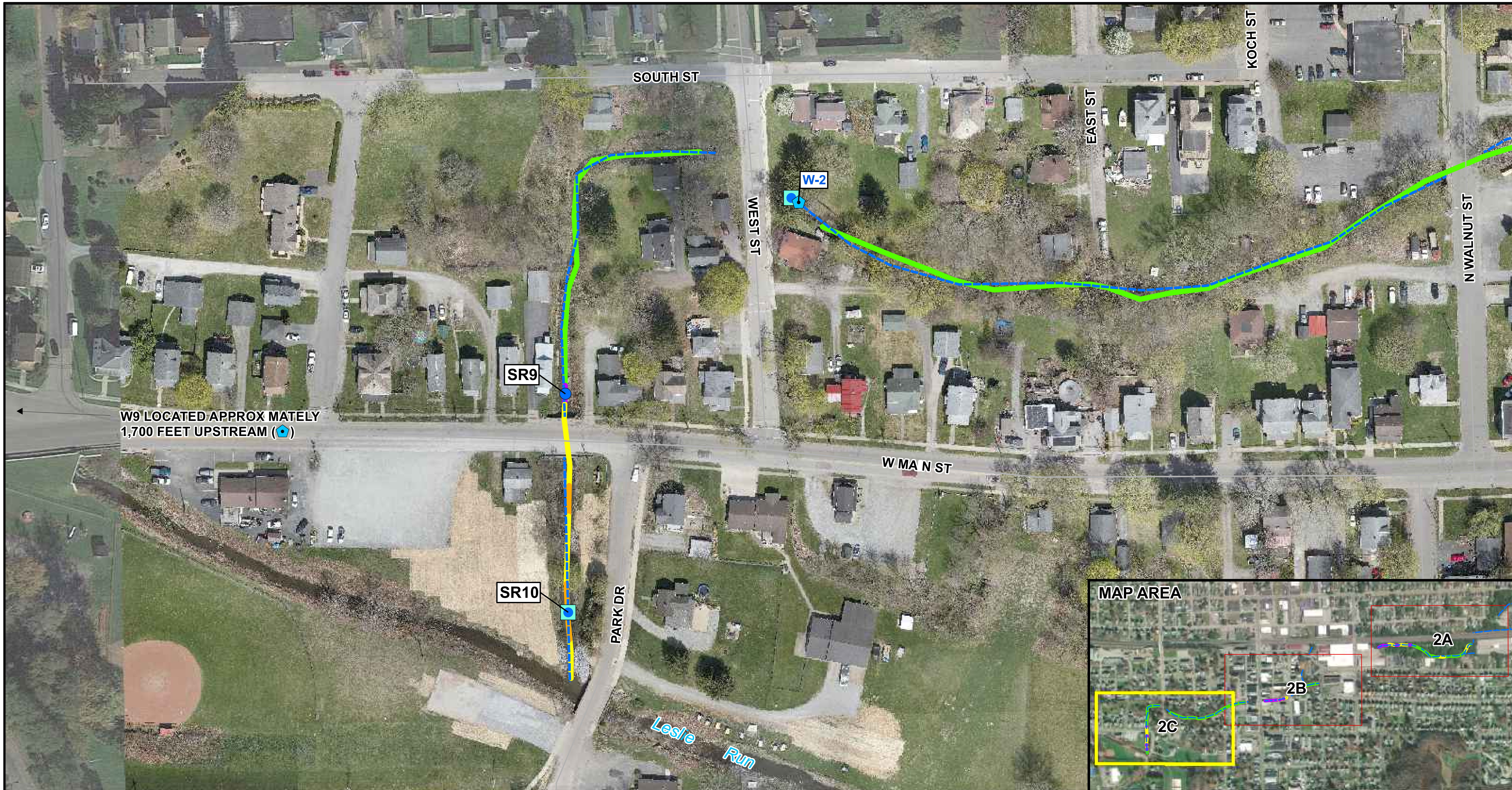
0 100 200
Feet
Map Date: 6/23/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN SEDIMENT INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2B



Legend
- Sulphur Run
- Sediment Sample Location
- Pore Water Sample Location
- Water Column Sample

Qualitative Sheen Observations
- 1
- 1 & 2
- 2
- 2 & 3
- 3

Note:
Qualitative stream sediment assessment work conducted by EnviroScience the week of May 15, 2023. The GIS layers with the sheen extent and corresponding scores were provided by EnviroScience on May 31, 2023.

Drone image onsite dated: 06/01/2023
Drone image offsite dated: 04/15/2023

0 100 200
Feet
Map Date: 6/23/2023

NORFOLK SOUTHERN
EAST PALESTINE, OHIO

SULPHUR RUN SEDIMENT INVESTIGATION LOCATIONS

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FIGURE
2C

Attachment A

Field Standard Operating Procedures

Standard Operating Procedure #1: Sediment Characterization via Probing and Sampling

Rev: 1

Rev Date: July 2023

1 Introduction

This Standard Operating Procedure (SOP) describes the general methods and procedures to characterize the stream via probing and sediment collection. This SOP may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Certified Project Manager (CPM) as well as a Technical Expert and reviewed with Incident Command and agreed upon prior to implementing. In addition, any changes will be documented through field notes and photographed as appropriate.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document.

It is the responsibility of the Arcadis CPM to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Related Documents

- Sediment Characterization Work Plan
- Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)

4 Description of the Procedure

4.1 Pre-Collection

Arcadis field personnel will be versed in the relevant SOPs and will possess the skills and experience necessary to successfully complete the desired field work. Staff assigned the responsibility of collecting cores, samples, and probing information will be provided with the following information:

- Work documents;
- Site maps;
- Collecting and processing procedures; and
- Special instructions (if any).

4.2 Equipment List

The following equipment list contains materials that may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (as required by the HASP)
- Real-Time Kinematic (RTK) survey equipment
- Appropriate sample containers, labels, and forms
- Chest waders/personal floatation device
- Decontamination supplies
- Surveyor's rod
- Calibrated probe rod (⅝-inch outside-diameter metal pipe with maximum graduations of tenths of feet)
- Shovel
- Trowel
- Post-hole digger
- Steel sampling barrel (fitted with a clear PVC liner), slide hammer, and/or use of a jackhammer attachment
- Six-foot rule
- Plastic sealable bags
- Trash bags
- Indelible ink markers
- Digital camera
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice
- Field notebook

4.3 Field Notes

Field notes will be recorded during probing and/or sediment sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel if present;

- General weather conditions;
- Date, time, and sampling locations;
- Total water depth, probing depth, and material descriptions; and
- Any general observations.

Field crews will primarily record field information in a field notebook.

4.4 Stream Bed Probing Procedures

Probing efforts will be performed either as a stand-alone effort or in combination with sediment collection efforts. The following procedures describe the probing efforts.

1. Don personal protective equipment (as required by the HASP).
2. Locate the target location using RTK surveying techniques and identify the proposed probing location in the field notebook.
3. Measure the total depth of the water column using a surveyor's rod to the nearest 0.1 foot and record. Record the water surface elevation using RTK surveying techniques (i.e., elevation above sea level of the water's surface at the target location).
4. Lower the calibrated probing rod through the water column slowly to the stream bed surface.
5. Advance the rod vertically through the stream bottom materials to refusal using reasonable human force (e.g., arm strength and body weight). The depth of refusal will be interpreted as the interface between soft material (e.g., cap material or sediment) and rock or stiff bottom. Record depth, type, and presence of debris or obstructions.
6. Estimate the material thickness and type of material present. The thickness will be determined based on the water depth and the depth of refusal (i.e., depth of refusal minus water depth). The type of material present will be determined by feel of the probe rod as it advances (e.g., soft material, sand, clay, gravel, rock).

4.5 Sediment Collection Procedures

Sediment sampling efforts will be performed in combination with probing as described in Section 4.4. If probing indicates little to no sediment present, expand the probing efforts to an area around the sampling target location in accordance with the plan in an effort to identify a location with recoverable sediment. The following procedures describe the sediment sampling efforts.

1. Don personal protective equipment (as required by the HASP).
2. Locate the target sample location using RTK surveying techniques and identify the proposed sample location in the field notebook.
3. Identify the proposed sample location in the field notebook, including other appropriate information collected during sampling activities.
4. Conduct steps outlined in Section 4.4. Determine the appropriate sampling equipment based on the results of the probing efforts (i.e., sediment thickness present and creek bed conditions including conditions at probe rod refusal such as rocks or clay) and sediment type present (i.e., finer-grained versus coarser materials).

Sampling options include a decontaminated stainless-steel trowel, post-hole digger, coring using steel sampling barrel with slide hammer/jackhammer. Attempt collection using the selected option and adjustment selected method as needed based on sample recovery. Document the selected sampling techniques and rationale for its selection.

5. Lower the sampling equipment until it just reaches the stream bottom. Collect the sample from the stream bottom to the depth targeted in the plan or to refusal pending sub-surface conditions as determined through probing.
6. Record thickness of recovered material to determine the sample depth.
7. Slowly recover the sampling equipment from the stream bed and secure material as needed before it breaks the water surface.
8. Observe the sediment surface during sampling for evidence of impacts; record observations on the field form.
9. Photograph the sample location and general area (upstream, downstream, and each bank) to document conditions. Record observations of major landmarks or features of the channel morphology, adjacent bank conditions, and vegetative zones.
10. Document the appearance and recovery of the sample to confirm acceptability of the sample; target finer-grained material (such as sand) for sampling. Samples containing primarily gravel, stone, or rocks are not acceptable for analytical testing and will be rejected, placed back in the stream, and a new sample will be collected.
11. Photograph the sample. Describe sediment sample according to color, texture and grain size and document other observations such as type of organic material present, odor, sheen, staining, etc. and document.
12. Process samples for submittal to the laboratory. As appropriate, sediment samples will be collected in laboratory supplied and pre-preserved containers for the specified testing method. Collect ample volume of sediment for the proposed analysis. If adequate volume is not available from a single grab sample, multiple grab samples may be collected, composited and thoroughly homogenized to form a single sample for non-VOC analysis. If the event of compositing, document the area samples and number of grab samples collected. Fill containers intended for volatile analysis with sediment sample as soon as possible and prior to homogenization (except for composite samples) in accordance with the QAPP. Homogenize the sample and fill bottleware intended for non-VOC analysis in accordance with the QAPP.
13. Label sample containers in accordance with the procedures presented in the work plan.
14. Once the sample is collected in the appropriate container(s), place on ice in a cooler.
15. Thoroughly decontaminate reusable sampling equipment between each sample using Alconox® or similar product and triple rinse utilizing distilled water. Repeat the above procedures until all samples are collected.
16. Fill out the chain of custody form and handle, pack, and ship the samples in accordance with the procedures described in the QAPP.

5 Waste Management

Investigative-derived waste generated during the sampling activities and disposable equipment will be transported for offsite disposal in accordance with the site-specific Waste Management Plan.

6 Data Recording and Management

All sample and location measurements and observations will be maintained in a field notebook or log. Upon project completion, field notebooks will be forwarded to the Project Manager for storage in the project files.

7 Quality Assurance

Samplers will forward copies of field notes and chains of custody to the CPM for quality assurance checks during project implementation at a frequency determined by the CPM.

Field duplicates and other quality assurance samples (e.g., rinse blanks, trip blanks) will be collected at the frequency presented in the QAPP. Sample quality will be achieved by complying with the procedures outlined in this SOP and by following site-specific plans. Cross-contamination will be prevented by following the protocols described in the QAPP or SOP for Field Equipment Decontamination. Field activities will be supervised by appropriate experienced field supervisors. Additional quality assurance information is presented in the project-specific QAPP.

- END OF PROCEDURE

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Standard Operating Procedure #2: Pore Water Sampling

Rev: 1

Rev Date: July 2023

1 Introduction

This Standard Operating Procedure (SOP) describes the procedures for collecting pore water samples. The procedure described herein was field tested in Leslie Run with Arcadis, United States Environmental Protection Agency (USEPA), and Ohio Environmental Protection Agency (OEPA) staff on May 22, 2023. Substantive modification to this SOP will be approved in advance by the Certified Project Manager (CPM) as well as a Technical Expert and reviewed with Incident Command and agreed upon prior to implementing. In addition, any changes will be documented through field notes and photographed as appropriate.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document.

It is the responsibility of the Arcadis CPM to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Related Documents

- Sediment Characterization Work Plan
- Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)

4 Description of the Procedure

4.1 Pre-Collection

Arcadis field personnel will be versed in the relevant SOPs and will possess the skills and experience necessary to successfully complete the desired field work. Staff assigned the responsibility of collecting samples will be provided with the following information:

- Work documents;
- Site maps;
- Collecting and processing procedures; and
- Special instructions (if any).

4.2 Equipment List

The following equipment list contains materials that may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary. Additional equipment may be required, pending field conditions.

- Personal protective equipment (as required by the HASP)
- Real-Time Kinematic (RTK) survey equipment
- Appropriate sample containers, labels, and forms
- Chest waders and/or muck boots and personal floatation device
- Three-inch stainless steel screens (approximately 7/16-inch outside diameter)
- Stainless steel sampling barrel, slide hammer, and PVC expendable liner
- Bentonite chips and granular
- Peristaltic pump with appropriate power source.
- Polyethylene tubing of an appropriate size for the pump being used.
- Two multi-parameter water-quality meters capable of reading temperature, pH, specific conductivity, oxidation-reduction potential, turbidity, and dissolved oxygen. One meter to be used to monitor surface water parameters and one meter to be used to monitor pore water parameters.
- Silica sand
- Surveyor’s rod (or other applicable water depth measuring device)
- Trash bags
- Indelible ink markers
- Digital camera
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice
- Field notebook

4.3 Field Notes

Field notes will be recorded during sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel if present;

- General weather conditions;
- Date, time, and sampling locations;
- Total water depth, probing depth, and material descriptions;
- Screen installation depths; and
- Any general observations.

Field crews will primarily record field information in a field notebook.

4.4 Procedures

The following steps provide the procedure for pore water sampling. If the stream bed cannot be penetrated to the desired depth due to large cobbles, boulders, or bedrock, the sample location will be relocated to an adjacent location and a note made in the field notebook about the refusal and location.

1. Don personal protective equipment (as required by the HASP).
2. Locate the target sample location using RTK surveying techniques. Identify the proposed sample location in the field notebook.
3. Assess the sediment bed composition and soft sediment depth using a probe rod and document conditions in the field notebook.
4. Load the expendable liner into the stainless steel sampling barrel. Attach the slide hammer and place the sample barrel at the sediment surface. Use the slide hammer to advance the sampling barrel 6 inches into the sediment.
5. Prepare a length of tubing adequate to reach the shoreline and attach one end to a stainless steel screen. Mark the tubing 3 inches above the screen to identify how far to insert the sampler into the sediment.
6. Remove the sample barrel from the sediment bed and immediately place the screen into the hole up to the marker line on the tubing. The screen will be placed into the hole by hand unless water depths (approximately greater than 2 feet of water). If the surface water is greater than two feet deep, a small diameter PVC pipe may be used to guide the screen and tubing into the pilot hole. The screen will now be positioned 3-6 inches below the sediment surface.
7. Fill the interannual space around the screen prior with appropriately sized silica sand prior to collapsing the hole.
8. Place 2-3 handfuls of bentonite chips followed by 2-3 handfuls of granular bentonite in an approximate 6-inch radius around the protruding tubing and inserted sampler and smooth the bentonite over to ensure that surface water does not intrude into the sampler. If necessary, in deeper water an oversized section of Lexan© (larger diameter than the pilot hole) may be used to install the sand annulus and bentonite seal at the sediment surface.
9. Attach the open end of the tubing to a low flow peristaltic pump (50 to 500 milliliters per minute). Slowly draw the water up into the tubing. The initial volume of pore water may be turbid. Purge the location for approximately 5 minutes.

10. Deploy water quality meters to measure parameters in surface water and pore water. It is anticipated that pore water parameters (specifically temperature, dissolved oxygen, and conductivity) will be different than surface water parameters. Surface water parameters will be measured by placing a sonde in the creek water approximately 2-3 feet upstream of the sample location. Pore water parameters will be measured by pumping water through a flow through cell. Review the parameter values to assess if a difference is observed. If observed, the location has been successfully established and developed for future sampling. If not observed, it is possible that the pore water has not been isolated from the surface water and another attempt to establish a location will be made by the field team. Up to 3 attempts will be made at the location to install a sampling set up that exhibits differences in water quality. It is possible that under certain conditions, the parameters measured in pore water and surface water will be similar or indistinguishable from each other in spite of a proper installation. If after the 3 attempts water quality parameters do not show a difference, the pore water be collected at the third location, and the effort will be document in the field notes.
11. Once the location has been determined to be successfully established, cut and cap the tubing in the river approximately 12 inches from the river bottom and allow the location to sit for a minimum of 24 hours before sampling.
12. Once the appropriate time has passed, representative samples can be collected. Attach new tubing to the tubing in the creek. Attach the open end of the tubing to a low flow peristaltic pump (50 to 200 milliliters per minute). Slowly draw the water up into the tubing. Discard the small slug of water sitting in the line above the sediment surface and then immediately sample the water below by filling the bottleware intended for analysis. Do not purge the location.
    a. Avoid overfilling sample containers to prevent preservatives, if present, in sample container from being lost.
    b. When sampling for VOCs, make sure no headspace or air bubbles remain in the sample vial after the collected sample is capped.
13. Document the appearance and recovery of the sample to confirm acceptability of the sample.
14. Label sample containers in accordance with the procedures presented in the work plan.
15. Once the sample is collected in the appropriate container(s), place on ice in a cooler.
16. Record appropriate information in the field notebook.
17. Repeat the above procedures until all pore water samples are collected.
18. Fill out the chain of custody form and handle, pack, and ship the samples in accordance with the procedures described in the QAPP.

5 Waste Management

Investigative-derived waste generated during the sampling activities and disposable equipment will be transported for offsite disposal in accordance with the site-specific Waste Management Plan.

6 Data Recording and Management

All sample and location measurements and observations will be maintained in a field notebook or log. Upon project completion, field notebooks will be forwarded to the Project Manager for storage in the project files.

7 Quality Assurance

Samplers will forward copies of field notes and chains of custody to the CPM for quality assurance checks during project implementation at a frequency determined by the CPM.

Field duplicates and other quality assurance samples (e.g., rinse blanks, trip blanks) will be collected at the frequency presented in the QAPP. Sample quality will be achieved by complying with the procedures outlined in this SOP and by following site-specific plans. Cross-contamination will be prevented by following the protocols described in the QAPP. Field activities will be supervised by appropriate experienced field supervisors. Additional quality assurance information is presented in the project-specific QAPP.

- END OF PROCEDURE -

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