Norfolk Southern Railway Company

Sulphur Run Culvert Sediment Removal Plan

East Palestine Train Derailment

Columbiana County, Ohio

Rev: 2

Rev Date: November 10, 2023

Sulphur Run Culvert Sediment Removal Plan

East Palestine Train Derailment
Columbiana County, Ohio

November 10, 2023

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Version Control

Revision No.	Date Issued	Description
0	November 1, 2023	Initial Plan
1	November 8, 2023	Revised based on Agency comments received November 3, 2023
2	November 10, 2023	Revised based on Agency Approval with Modifications received November 9, 2023

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1 Introduction

Arcadis U.S., Inc. (Arcadis) developed this Sulphur Run Culvert Sediment Removal Plan (Plan) on behalf of Norfolk Southern Railway Company (NSRC) in response to the February 3, 2023 derailment in East Palestine, Ohio. This Plan was prepared in accordance with the United States Environmental Protection Agency (USEPA) Administrative Order (Docket No. CWA-1321-5-24-001) pursuant to Section 311 of the Clean Water Act (CWA), which became effective on October 18, 2023. This Plan supports actions to remove sediment within culverts along Sulphur Run as required in Paragraphs 59, 60 and 61 of the Administrative Order.

There are five culverts in Sulphur Run covered within this Plan. These culverts are identified on Figure 1-1 (C0, C1, C2, C3, and C4), and include:

- Culvert C0: Approximately 150-foot corrugated steel pipe transitioning to a concrete pipe that runs through a wooded area south of the tracks.
- Culvert C1: Minimum 800-foot (actual length is unknown) concrete box culvert transitioning to a corrugated metal arch pipe that runs under E. Taggart Street/James Street to an outlet on the western side of North Liberty Street. The length and constructed condition of Culvert C1 will be verified via drone survey as discussed in Section 3.2.
- Culvert C2: Approximately 200-foot concrete box culvert parallel to Rebecca Street that runs under Rebecca Place (191 East Rebecca Street in East Palestine, Ohio).
- Culvert C3: Approximately 200-foot concrete box culvert under Market Street located beneath the East Palestine Municipal Building (85 North Market Street in East Palestine, Ohio).
- Culvert C4: Approximately 60-foot corrugated metal arch pipe that runs under West Street near the intersection with South Street.

The purpose of this Plan is to summarize currently available information on the condition of the culverts and present the proposed investigation and sediment removal activities. Specifically, Section 2 summarizes the previous completed culvert reconnaissance efforts and associated findings; Section 3 describes the proposed health and safety and culvert integrity assessment activities; Section 4 outlines the sediment removal procedure; Section 5 provides a schedule for implementation of the proposed actions and reporting; and Section 6 lists references cited throughout this Plan.

2 Current Culvert Conditions

Culvert inspections were conducted on August 3, 2023 for three culverts (C1, C2, and C3; Figure 1-1) in Sulphur Run to assess the condition of the structures using a remotely operated camera system and to document air quality. This inspection was performed in accordance with the East Palestine Train Derailment Site Sediment Quality Assurance Project Plan (Sediment QAPP) including the Sulphur Run Characterization Work Plan Appendix H1 and appended plan (Arcadis 2023d and 2023b, respectively). The Sediment QAPP was developed pursuant to the USEPA February 21, 2023 Unilateral Administrative Order for Removal Actions, which became effective on February 27, 2023. An initial reconnaissance was performed in late July 2023 to support the August 2023 video inspection.

The culvert reconnaissance and inspection efforts included the following:

- Initial reconnaissance was conducted through visual observations at the upstream and downstream openings for each culvert.
- Inspections within the culverts were performed by GPRS using a remotely operated rover camera system advanced to the extent possible through the culvert based on bottom conditions. The presence of obstructions (e.g., deposited debris, rock, etc.) within the culvert limited the ability of the camera system to advance through the culvert.
- Continuous air monitoring was conducted during the inspections in C2 and C3 by attaching real-time air monitoring instruments to the rover as it advanced into the culverts. Monitoring was performed for volatile organic compounds (VOCs), carbon monoxide (CO), hydrogen sulfide (H_2S), oxygen (O_2), and atmospheric flammability measured as a percentage of the lower explosive limit (% LEL). Air monitoring was also performed alongside workers positioned outside of the culvert.

The culvert reconnaissance and inspection findings are summarized below. A photolog with images of the upstream/downstream ends and interior of the culverts is provided in Appendix A. A brief report summarizing the GPRS locating activities, photographs, and findings are provided in Appendix A. Video from the inspection will also be provided electronically as separate submittal.

- Culvert C1
  - Inspection: Culvert was only accessed from the downstream end by the rover camera system; upstream end not accessible with the system. The rover only advanced approximately 5 feet into the culvert due to accumulated debris obstructing the unit. Therefore, conditions along the culvert length are unknown.
  - Construction: Downstream end is corrugated metal arch pipe, approximately 5.5 feet high and 15 feet wide. There is no clear line of sight from the downstream to upstream end. The culvert transitions to a taller concrete box culvert with a concrete bottom at some point moving upstream.
  - Previous work: Previously jetted in April 2023 by SPSI. Jetting extended approximately 100 feet to the east and west from the manhole on the southwest corner of James Street and Taggart Street. Absorbent booms were installed and jetting was performed until a sheen was no longer visible. No sediment material was removed.
- Culvert C2
  - Inspection: Rover camera system traversed the full length of the culvert with no obstructions encountered. The culvert contains multiple breaks and fractures mostly at the downstream end, and wooden slats were

observed along the ceiling. The bottom appeared to be relatively clean and free of sediment deposits, with occasional small piles of debris. A thin layer of sediment was observed at the entrance and exit.

  - Construction: Concrete box structure, approximately 150 feet in length and 5 feet tall by 8 feet wide. There is a clear line of sight from the upstream to downstream opening.

- Culvert C3
  - Inspection: Two attempts were made by the rover camera system, starting at the upstream and downstream ends. During each effort, the system advanced approximately 30 feet from each end before the presence of debris obstructed progress. There was evidence of larger cobbles, concrete, other debris and sediment on the bottom, thickness is unknown.
  - Construction: Concrete box structure, approximately 8 feet tall by 8 feet wide. The culvert does not have a clear line of sight from upstream to downstream and is divided by a concrete wall that extends a minimum of 30 feet into the culvert (actual length to be verified).
  - Previous work: Previously jetted in April 2023 by SPSI; approximately 100 feet from the inlet and outlet. Absorbent booms were installed and jetting was performed until a sheen was no longer visible. No sediment material was removed.
- Real-time air monitoring
  - As noted above, continuous air-monitoring was conducted at Culverts C2 and C3. There were no detections of VOCs, CO, H_2S, or % LEL, and all oxygen measurements were within the expected range within Culverts C2 and C3. No measurements exceeded the site-specific action levels for Worker Monitoring established in the Air Sampling and Analysis Plan (SAP, CTEH 2023). Further, no measurements exceeded health-protective occupational exposure guidelines/limits. A summary of the air monitoring and results are provided in Appendix A.

Additional visual inspections were conducted on October 25 and 26, 2023 in order to confirm culvert construction type and presence of an engineered hard bottom at C0 and C4, and to evaluate potential staging areas for all culverts included in this Plan. Based on visual inspections near the inlets and outlets, materials within the culverts appear to include a mixture of typical stream sediments, larger stone, concrete, and other debris. Photographs of the inlets and outlets were taken as presented on Figures 2-1 and 2-2.

3 Proposed Culvert Investigations

Prior to commencing sediment removal work, a detailed health and safety assessment, including air monitoring, and a culvert integrity assessment will be conducted at each culvert location as described below. The purpose of these assessments is to verify existing conditions within the culverts and fill data gaps where previous investigations were unsuccessful in gathering the information.

3.1 Health and Safety Assessment

A detailed health and safety assessment will be conducted at each culvert location to evaluate hazards in the work area and identify controls to be implemented during material removal. It is anticipated that all culverts included in the scope of this Plan will be treated as a confined space. Visual assessment by health and safety personnel will be conducted to determine appropriate means of rescue on a culvert specific basis.

In addition to hazards associated with confined space, several other hazards may exist. Overhead hazards (e.g., low clearances) are present when entering the culvert area. Culverts with low lighting and slippery surfaces present slips, trips, and falls hazards. Access points into the culvert inlets or outlets will require walking down into the streambed. Biological hazards are present, including insects and plants near the culvert inlets and outlets. Personnel will be working in or near cold water in cold temperatures for prolonged periods. These hazards will be evaluated with contractor personnel and mitigated appropriately. All work will be conducted in accordance with the site Health and Safety Plan (HASP, Arcadis 2023c), and associated Job Hazard Analyses.

During the health and safety assessment and prior to entry into the culverts, atmospheric monitoring will be conducted remotely within each culvert utilizing Spot®, the Boston Dynamic robot. Spot® is a quad-legged robot with the ability to traverse complex terrains, and is capable of carrying air-monitoring equipment, specification sheet included in Appendix B. Spot® will be used to conduct real-time air monitoring for total VOCs, butyl acrylate, and vinyl chloride in each culvert and will be used to collect an air sample for analysis of butyl acrylate and vinyl chloride. Air monitoring instrumentation and air sampling methods that will be used and their associated detection limits are listed in Tables 4.7 and 3.5, respectively, of the CTEH Air SAP v3.1 (CTEH 2023). Results of the Job Hazard Analyses and atmospheric monitoring will dictate the type of engineering control to be implemented within the culvert during material removal activities. Controls may include temporary fans for ventilation throughout the culvert, or increased respiratory protection while working in the culvert, such as a self-contained breathing apparatus.

3.1.1 Worker Air Monitoring

During active cleanup activities, handheld real-time air monitoring will be conducted within the culverts for total VOCs and other analytes as indicated by the initial health and safety assessment and the Job Hazard Analysis for confined space entry (e.g., oxygen, % LEL, hydrogen sulfide). The work area surrounding the culverts with be monitored for total VOCs, butyl acrylate, and vinyl chloride. Personnel conducting work within the culvert will also have personal air samples for butyl acrylate and vinyl chloride. In the instance that butyl acrylate is detected during real-time air monitoring in the work area or odors consistent with butyl acrylate are observed, CTEH personnel will inform the EPA Operations Section Chief, which may dispatch EPA START's HAPSITE to collect grab samples for butyl acrylate and vinyl chloride at the nearest downwind community receptor. Air monitoring instrumentation and air sampling methods that will be used in the work area and their associated detection limits

are listed in Tables 4.5 and 3.5, respectively, of the CTEH Air SAP v3.1 (CTEH 2023). Further details on the sampling regime, including the communication workflow for the EPA START's HAPSITE, are included in the Decision Tree for Ongoing Operations During Culvert Work (Appendix C) and the EPA START's HAPSITE plans and protocols.

3.1.2 Community Air Monitoring

During active cleanup activities, handheld real-time air monitoring will be conducted in the community for total VOCs. The presence and character of any odors will be documented during handheld air monitoring. In addition, air sampling will be conducted using both canisters and stationary badges at 4 to 6 locations in the community, with emphasis on locations in proximity to the culvert cleanup activities, for a panel of 75 VOCs, including vinyl chloride and butyl acrylate. Air monitoring instrumentation and air sampling methods that will be used in the community and their associated detection limits are listed in Tables 4.6 and 3.5, respectively, and Section 3.2.1 of the CTEH Air SAP v3.1 (CTEH 2023). Additionally, the EPA START's HAPSITE will be available during active cleanup activities and will follow the methods and actions outlined in the EPA START's HAPSITE plans and protocols. In the instance that butyl acrylate is detected during real-time air monitoring in the work area or odors consistent with butyl acrylate are observed, CTEH personnel will inform the EPA Operations Section Chief, which may dispatch EPA START's HAPSITE to collect grab samples for butyl acrylate and vinyl chloride at the nearest downwind community receptor. Further details on the sampling regime, including the communication workflow for the EPA START's HAPSITE, are included in the Decision Tree for Ongoing Operations During Culvert Work (Appendix C) and the EPA START's HAPSITE plans and protocols.

In addition, odor reports will continue to be investigated by Community Strike Teams during the culvert cleanup activities, who immediately respond to the area of the odor report and conduct outdoor air monitoring using handheld instruments, deploy an air sample for butyl acrylate, and characterize and document odors in the area. In the instance that an odor report is received, CTEH personnel will inform the EPA Operations Section Chief, which may dispatch EPA START's HAPSITE to collect grab samples for butyl acrylate and vinyl chloride in the area of the odor report. Further details on methods and actions are outlined in the EPA START's HAPSITE plans and protocols.

3.2 Culvert Integrity Assessment

Simultaneously with the health and safety assessment, a visual culvert integrity assessment will be conducted at each culvert location to evaluate the structural stability of the culverts and associated supporting structures. Visual assessment will be conducted at the inlets and outlets. A drone, where necessary, will also be utilized to fly through the culverts to conduct the culvert assessment and confirm the Spot® robot, fitted with air monitoring equipment, can get through the culvert unobstructed. It is anticipated, at a minimum, that Culverts C1 and C3 will require a drone investigation. Drone assessment is necessary because previous rover investigations of Culverts C1 and C3 were not effective as the culverts were obstructed by debris. Any additional culvert investigations where rover progress is obstructed by debris will also require drone investigation. The purpose of this assessment is to identify deteriorated culvert conditions (rusted metal pipe, broken concrete, blockages) that could pose a potential hazard to workers or result in further damaging the culvert by conducting cleaning activities.

The culvert integrity assessment will also include an inventory of inlets and other lateral pipes that discharge to the culvert to determine if additional controls (e.g., temporary plugging) during cleaning activities are necessary. If the inlet or lateral pipe entering the culvert is associated with a specific property owner, notifications pre- and post- cleaning will be conducted to minimize the discharge from the feature to the culvert during culvert cleaning to the extent practicable.

Additionally, during this assessment period, staff will verify that Culverts C0, C1, C2, C3, and C4 contain an engineered hard bottom by visual means and a probe will be used to approximate the depth of material. Culverts containing large debris or rocks that may require removal prior to using the hi-vac truck will be identified.

The investigations to date, as described in Section 2, have provided the culvert information included in Table 3-1 below. Where indicated, incomplete data will be collected during the culvert integrity assessment.

Table 3-1 Culvert Investigation Summary

Culvert ID	Length (feet)	Type	Culvert Condition	Approximate Sediment Depth	Atmospheric Conditions Known	Engineered Hard Bottom Present
C0	150	Corrugated metal pipe at inlet; transitions to concrete	Good, appears structurally sound, no signs of rust, joint failure, or damage to side walls	*	No*	Yes
C1	800*	Concrete box culvert transitions to corrugated metal arch pipe	*	*	No*	Yes*
C2	200	Concrete box culvert	*	*	Yes	Yes
C3	200	Concrete box culvert	*	*	Yes	Yes
C4	60	Corrugated metal arch pipe	Good, appears structurally sound, no signs of rust, joint failure, or damage to side walls	*	No*	Yes

Notes: * = information to be determined or verified in the field

4 Proposed Culvert Cleaning Approach

The proposed culvert cleaning approach includes a five-step process summarized below, with details and culvert-specific information further discussed in Sections 4.1 through 4.5.

1. Establishment of site access and controls and site preparation activities
2. Equipment staging
3. Stream bypass
4. Material removal
5. Material dewatering and disposal.

4.1 Site Access, Controls and Preparation

Access agreements will be required prior to commencing investigation or intrusive work for culverts crossing through private property, as well as staging areas located on private property. In particular, Culvert C0, the inlet of Culvert C1, inlet of Culvert C2, and Culvert C4 contain work areas within private property and require appropriate access agreements. In addition, select culverts will utilize public streets as equipment staging areas (further discussed in Section 4.2), and may require a one-lane closure during the work. Where new or updated access agreements are required to implement the scope described herein, NSRC will make multiple attempts through the duration of the field work to contact and obtain agreements from property owners. These efforts will be documented and progress communicated with USEPA. NSRC may require USEPA support in gaining access.

Lane closure will require coordination with and approval from the City of East Palestine. Flaggers and traffic control will be utilized during periods of road closures and communicated ahead of time with the local community.

The outlet of Culvert C1, and Culverts C2, C3 and C4 contain work areas in close proximity to residential areas. In particular, Culvert C3 crosses underneath multiple houses. Increased noise from a hi-vac truck is anticipated. As such, anticipated working days and hours will be communicated with the local residences to ensure they are aware of the noise. Adjusted working hours, as necessary, may be implemented during removal activities to reduce impacts to local residences.

Anticipated site controls include but are not limited to traffic controls, erosion and sediment controls, and air-related quality controls. Traffic controls will be utilized when road closures are required for equipment staging and include flaggers and signage. Erosion and sediment controls will be utilized during and after in-stream work and may include stream bypass facilities during the work and erosion control blankets to facilitate stream bank restoration. Air-related quality controls will be selected based on the results of air monitoring to be conducted as previously discussed in Section 3. Industrial fans will be on location and available if changes in odor are observed during removal activities.

Lastly, to prepare the site, vegetation clearing at the inlet and/or outlet of each culvert will be conducted to allow access to the culvert. Access ramps will be constructed, as necessary, to allow for personnel and equipment to safely access the work area.

4.2 Equipment and Material Staging

It is anticipated that a hi-vac truck, de-watering boxes, pickup trucks, and a dump ramp will be required to facilitate sediment removal from the culverts. A remote-controlled skid steer style machine may be utilized to remove large debris that cannot be removed via hi-vac, and a pressure washer may be utilized following sediment removal to further clean the bottom at select culvert locations. In addition, materials such as sandbags, bypass piping or lay flat hose, and pumps will be utilized for diverting flow around work areas as discussed in Section 4.3. If required, dewatering boxes may be utilized for onsite dewatering and temporary storage of the dewatered sediments prior to offsite disposal. Dewatering roll-off boxes will be staged and preparation of sediments for offsite disposal will occur in Tank Farm 5 or 6 (Figure 1-1). Tank Farms 5 and 6 are constructed with a secondary containment liner system in the event of spills during material dewatering activities. Material dewatering and staging will not occur at the culvert locations.

The anticipated staging locations for proposed equipment are summarized below, but subject to change:

- Culvert C0 – equipment would be staged in the northeast corner of Strohecker property on James Street.
- Culvert C1 – pending further investigation to determine number and locations of bends in the culvert; anticipate needing to stage equipment at both ends due to length of culvert, and/or in the middle at a manhole near the corner of Taggart Street and James Street.
- Culvert C2 – equipment would be staged either on Sumner Street near the outlet, or Koch Street near the inlet; would require closing one lane.
- Culvert C3 – equipment would be staged behind the Municipal Building near the outlet.
- Culvert C4 – equipment would be staged on West Street; would require closing one lane.

4.3 Stream Bypass

Material removal will be conducted in the dry, therefore, prior to initiating removal activities, base flow in Sulphur Run will be bypassed. In consideration of constructability and health and safety considerations, sediment removal activities will be scheduled and performed during periods of dry weather or during light precipitation events, subject to stream flow at the time of the work. Sandbag berms will be installed both upstream and downstream of the culverts to be cleaned. Any water that accumulates upstream of the downstream berm will be collected and removed via hi-vac to prevent sediment-laden water and any sheen from being transported downstream. Energy dissipation controls will be utilized to control erosion at the stream bypass outlet (i.e., pipe or hose outlet) and may include installing a temporary pad of stone or other temporary dissipation structure. Two bypass options are summarized below. Selection for implementation will be based on site and flow conditions:

- Method one will utilize a temporary passive bypass pipe installed inside the existing culvert. The temporary passive bypass pipe will be sized to convey the stream base flow at the time of the cleaning and may be supplemented with pumps or additional pipes. Sandbags will be used to anchor the pipe at the inlet and outlet and along the length of the pipe as necessary.
- Method two will utilize pumping through the culvert or above grade over top of the culvert to divert stream base flow to facilitate sediment removal. A mechanical trash pump and lay flat hose will collect flow upstream of the sandbag berm and divert it past the downstream sandbag berm. Bypass pumping may be supplemented with additional pumps as necessary based on the stream flow at the time of the cleaning.

4.4 Material Removal

Following installation of the stream bypass, workers will enter the culvert and vacuum remove sediment from the base of the culvert until the engineered hard bottom is reached. Culverts C0, C1, C2, C3, and C4 are all anticipated to contain engineered hard bottoms throughout the length of the culvert. This will be verified during the Culvert Integrity Assessment as discussed in Section 3. Significant amounts of bricks, large rocks, and other solid debris throughout the culverts will be removed manually and segregated as appropriate, prior to vacuuming soft sediments. Immediately following material removal, while the stream bypass is still in place, photo documentation of the clean bottom of the culvert will be completed to verify the completion of sediment removal. Final verification observations, including photo logs, will be included with the final completion report referenced in Section 5.

4.5 Material Dewatering and Disposal

Material removed from the culverts will be stored in dewatering roll-off boxes in Tank Farm 5 or 6 (Figure 1-1) to allow for dewatering via gravity. Water, collected from the work area within the culverts and from the dewatering roll-offs, will be off-loaded to the one-million gallon Modular Tanks for treatment in the on-site water treatment system and subsequently disposed of off-site as non-hazardous water. Settled solids from the roll-offs will be disposed of as a separate waste stream. All waste will be managed in accordance with the East Palestine Waste Management Plan (Appendix L) which was approved by USEPA on April 18, 2023 (Arcadis 2023a). Upon generation of the waste, a Waste Determination Memorandum will be provided for approval that describes the proposed sampling and disposal plan.

5 Schedule

Work will be scheduled during dry weather, or during light precipitation events, subject to stream flow assessment to mitigate health and safety concerns. Additionally, dry weather will allow for easier removal due to a lower base flow. Weather-related delays may occur.

It is anticipated Culverts C0, C2, and C4 will take two working days at each culvert to complete sediment removal, and C3 will take three working days. Anticipated duration for cleaning Culvert C1 is pending results of the health and safety assessment as well as the culvert integrity assessments described in Section 3.

It is anticipated that cleaning of Culverts C0, C2, and C4 will be conducted by one crew, simultaneously with cleaning at C3 conducted by a second crew. Cleaning of Culvert C1 will follow the cleaning of Culverts C0, C2, and C4 or Culvert C3 to allow sufficient time for the Culvert C1 assessment.

6 References

Arcadis 2023a. Appendix L – East Palestine Waste Management Plan. April 18.

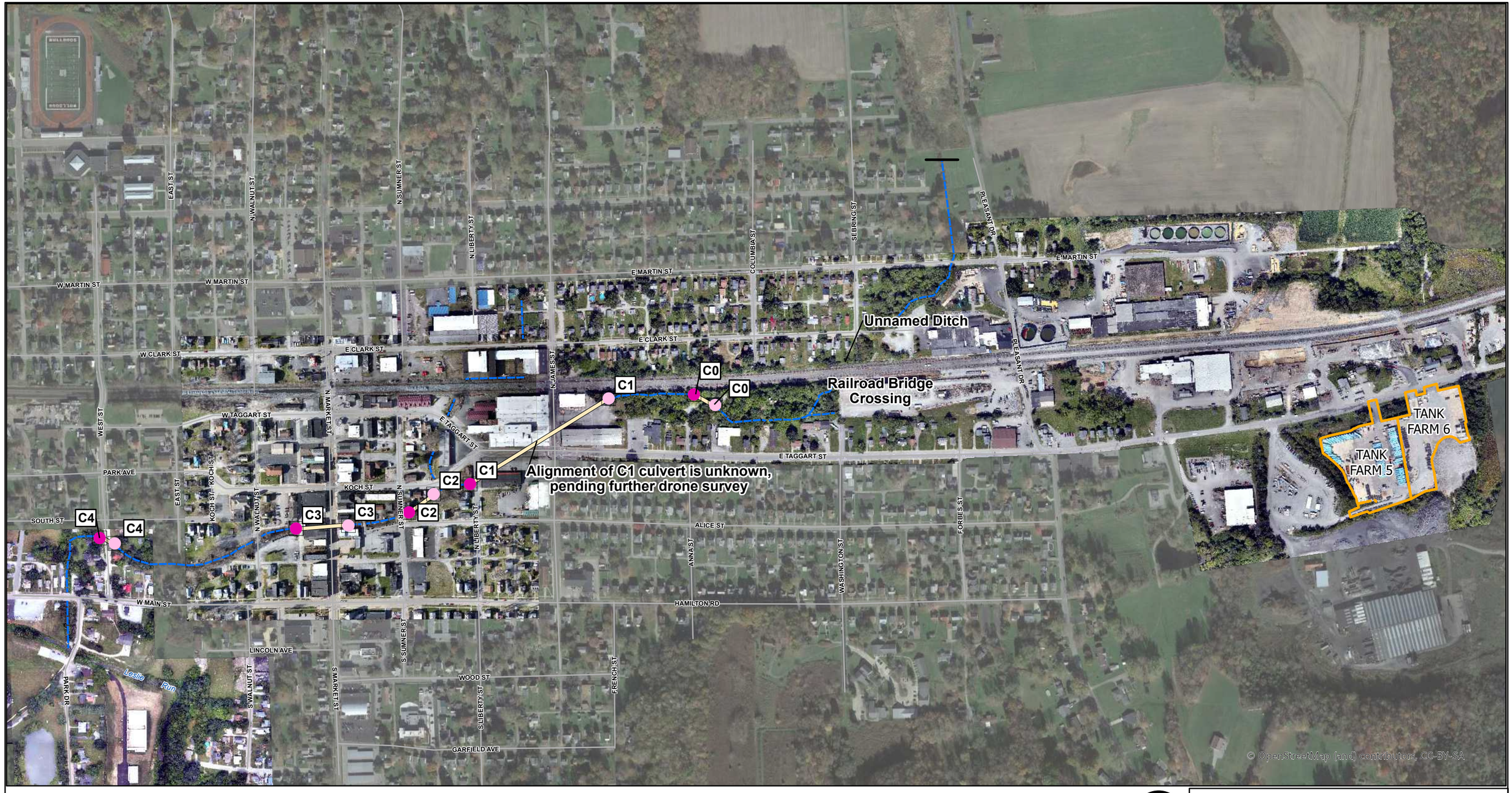
Arcadis. 2023b. Appendix H1 – Sulphur Run Characterization Work Plan. Rev 2. July 11.

Arcadis. 2023c. East Palestine Train Derailment Site Health and Safety Plan. Rev 3.2. July 23.

Arcadis. 2023d. East Palestine Trail Derailment Site Sediment Quality Assurance Project Plan – Appendix H2. Rev 3. August 8.

CTEH. 2023. CTEH Air Sampling and Analysis Plan. Rev 3.1. October 18, 2023.

Figures



Legend

- Start of Covered Culvert
- End of Covered Culvert
- Sulphur Run
- Culvert Alignment

Map Date: 11/4/2023

0 450 900
Feet

NORFOLK SOUTHERN
EAST PALESTINE, OHIO
SULPHUR RUN CULVERT SEDIMEMNT REMOVAL PLAN

SULPHUR RUN CULVERTS

ARCADIS

FIGURE
1-1

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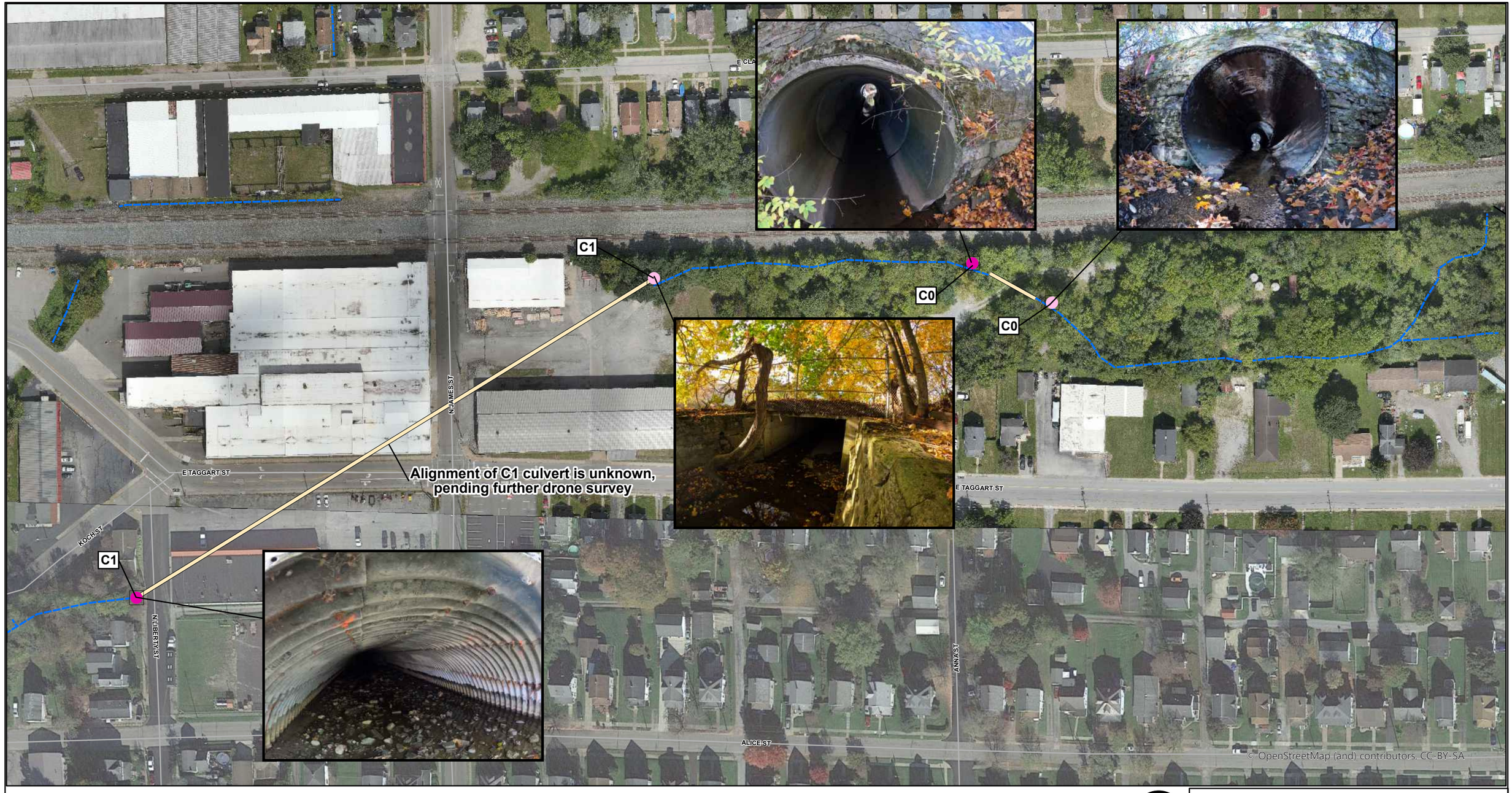

Legend

- Start of Covered Culvert
- End of Covered Culvert
- Sulphur Run
- Culvert Alignment

Map Date: 11/4/2023

0 120 240
Feet

NORFOLK SOUTHERN
EAST PALESTINE, OHIO
SULPHUR RUN CULVERT SEDIMEMNT REMOVAL PLAN

CULVERT C0 AND C1 INLETS AND OUTLETS

ARCADIS

FIGURE
2-1

Document Path: Tl_ENV\Norfolk\Southern\EastPalestine_Feb5_2023\Arc\Pro\SedimentSampling\SedimentSampling.aprx

C1

C2

C2

C3

C3

C4

C4

Legend

- Start of Covered Culvert
- End of Covered Culvert
- Sulphur Run
- Culvert Alignment

Map Date: 11/4/2023

0 140 280

Feet

NORFOLK SOUTHERN
EAST PALESTINE, OHIO
SULPHUR RUN CULVERT SEDIMEMNT REMOVAL PLAN

CULVERT C2, C3 AND C4 INLETS AND OUTLETS

ARCADIS

FIGURE
2-2

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Appendix A

Existing Culvert Conditions Information

Culvert Air Monitoring Data

NORFOLK SOUTHERN RAILWAY COMPANY

AIR MONITORING SUMMARY:

CULVERT ASSESSMENT

East Palestine, Ohio

East Palestine Train Derailment 02032023

August 3, 2023

PROJ-024579

Submitted on October 18, 2023

1.0 INTRODUCTION

On August 3, 2023, rover-assisted air monitoring was conducted in two culverts along Sulphur Run to evaluate potential impacts related to the East Palestine Train Derailment that occurred on February 3, 2023. The culverts were located 1) under Rebecca Place (located at 191 East Rebecca Street in East Palestine, Ohio) and 2) behind the East Palestine Municipal Building (located at 85 North Market Street in East Palestine, Ohio). The culvert assessments were completed by attaching real-time air monitoring instruments to a remote-controlled rover and directing the rover into the culverts to collect air monitoring data. During the culvert entries, air monitoring was also conducted alongside workers positioned outside the culvert.

This report summarizes the results of real-time air monitoring conducted within the culverts and the results of real-time air monitoring conducted alongside the workers positioned outside of the culvert.

2.0 AIR MONITORING METHODS

Real-time air monitoring refers to the use of direct-reading instruments to provide a near-instantaneous readout of a chemical concentration in the air. Real-time air monitoring was conducted in accordance with the Worker Monitoring and Site Assessment plans outlined in the Air Sampling and Analysis Plan (SAP) developed for the East Palestine Train Derailment.

Worker Monitoring was conducted alongside workers positioned outside of the culvert using handheld RAE Systems by Honeywell MultiRAE Pro instruments. All Worker Monitoring readings were taken at a height representative of the breathing zone. Site Assessment within the culverts was conducted by affixing a RAE Systems by Honeywell MultiRAE Pro instrument to the top of a remote-controlled rover, which was used to enter the culverts and datalog the real-time air monitoring readings.

The MultiRAE Pro instruments were equipped with photoionization detectors and electrochemical sensors to monitor for volatile organic compounds (VOCs), carbon monoxide (CO), hydrogen sulfide (H_2S), oxygen (O_2), and atmospheric flammability measured as a percentage of the lower explosive limit (% LEL).

All instrumentation was calibrated prior to use or per manufacturer's recommendations.

3.0 AIR MONITORING RESULTS

The results of real-time air monitoring conducted alongside workers positioned outside the culvert (Worker Monitoring) are summarized in Table 1 below. The results of rover-assisted real-time air monitoring conducted within the culverts (Site Assessment) are summarized in Table 2 below.

Table 1. Summary of Air Monitoring Results | Worker Monitoring

Instrument	Location	Analyte	Number of Readings	Number of Detections	Concentration Range*
MultiRAE Pro	Behind Municipal Building	VOCs	6	0	< 0.1 ppm
		% LEL	1	0	< 1 %
		CO	1	0	< 1 ppm
	Rebecca Place	VOCs	2	0	< 0.1 pm
		CO	1	0	< 1 ppm

*Analytes with no detections are reported as less than (<) the instrument's Limit of Detection (LOD); ppm = parts per million

Table 2. Summary of Air Monitoring Results | Rover-Assisted Site Assessment

Instrument	Location	Analyte	Number of Readings	Number of Detections	Concentration Range*
MultiRAE Pro	Behind Municipal Building	VOCs	345	0	< 0.1 ppm
		% LEL	345	0	< 1 %
		O_2	345	345	20.9 %
		CO	345	0	< 1 ppm
		H_2S	345	0	< 0.1 ppm
	Rebecca Place	VOCs	9	0	< 0.1 ppm
		% LEL	9	0	< 1 %
		O_2	9	9	20.9 %
		CO	9	0	< 1 ppm
		H_2S	9	0	< 0.1 ppm

*Analytes with no detections are reported as less than (<) the instrument's Limit of Detection (LOD); ppm = parts per million

During real-time air monitoring conducted alongside workers positioned outside of the culvert, there were no detections of VOCs, CO, or % LEL. Similarly, during real-time air monitoring conducted within the culverts using remote-controlled rovers, there were no detections of VOCs, CO, H_2S, or % LEL, and all oxygen measurements were within the expected range. No measurements taken during the culvert assessments exceeded the site-specific action levels for Worker Monitoring established in the Air SAP. Further, no measurements exceeded health-protective occupational exposure guidelines/limits established by the American Conference of Governmental Industrial Hygienists (ACGIH), including the time-weighted average Threshold Limit Values (TLV-TWA) of 25 ppm for CO and 1 ppm for H_2S.

Culvert Photo Log

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714

Photograph: 1

Description:
Culvert C1 upstream end, looking downstream at entrance

Location:
Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph: 2

Description:
Culvert C1 interior, looking downstream at entrance

Location:
Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714

Photograph: 3

Description:
Culvert C1 downstream end, looking upstream at exit

Location:
Sulphur Run

Photograph taken by:
D. Cornell

Date: 8/3/2023

Photograph: 4

Description:
Culvert C1 interior, looking upstream at exit – rover camera unit in foreground

Location:
Sulphur Run

Photograph taken by:
D. Cornell

Date: 8/3/2023

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714

Photograph: 5

Description:
Culvert C2 upstream end, looking downstream at entrance

Location:
Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph: 6

Description:
Culvert C2 interior, looking downstream at entrance – rover camera unit in foreground

Location:
Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714

Photograph: 7

Description:
Rover camera unit with air monitoring equipment entering Culvert C2

Location:
Sulphur Run

Photograph taken by:
D. Cornell

Date: 8/3/2023

Photograph: 8

Description:
Culvert C2 downstream end, looking upstream at exit

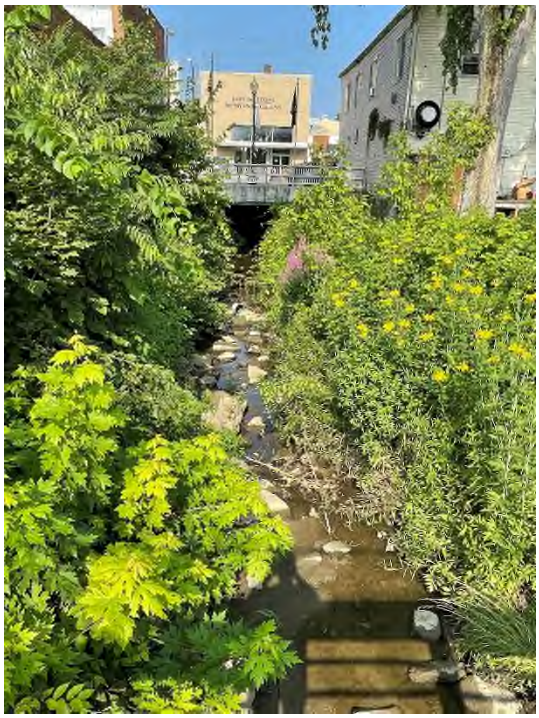
Location:
Sulphur Run

Photograph taken by:
D. Cornell

Date: 8/3/2023

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714



Photograph: 9

Description:
Culvert C3 upstream end, looking downstream at entrance

Location: Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph: 10

Description:
Culvert C3 upstream end and interior, looking downstream at entrance

Location:
Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714

Photograph: 11

Description:
Culvert C3 downstream end, looking upstream at exit

Location:
Sulphur Run

Photograph taken by:
T. O'Rourke

Date: 7/20/2023

Photograph: 12

Description:
Culvert C3 interior, looking upstream from exit – left side/channel

Location:
Sulphur Run

Photograph taken by:
D. Cornell

Date: 8/3/2023

Photograph Log

Norfolk Southern Railway Company
East Palestine Train Derailment, Columbiana County, Ohio
30169714

Photograph: 13

Description: Culvert C3 interior, looking upstream from exit – right side/channel

Location: Sulphur Run

Photograph taken by: D. Cornell

Date: 8/3/2023

GPRS Culvert Inspection Summary

GPRS

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WEB PROJECT
CLICK TO OPEN

Project

Project	2023_08_03_Arcadis_East Palestine_Culverts
	8/3/2023

GPRS

Tel. 440-226-0698
Kyle.Zenobi@gprsinc.com

Table of Contents

Project		
2023_08_03_Arcadis_East Palestine_Culverts		**8/3/2023**

GPRS

Tel. 440-226-0698
Kyle.Zenobi@gprsinc.com

Project Information

Project		
2023_08_03_Arcadis_East Palestine_Culverts		**8/3/2023**

Contractor

Name: GPRS
: Kyle Zenobi
:
:
City:
: 440-226-0698
:
:
: Kyle.Zenobi@gprsinc.com

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Section Profile

Project
2023_08_03_Arcadis_East Palestine_Culverts

No.	PSR	Upstream MH	Downstream MH	Date	Material	Total Length	Length Surveyed
3	Rebecca St Upstream-Rebecca St Downstream	Rebecca St Upstream	Rebecca St Downstream	8/3/2023	RCP	147.70	147.70

96/96 Square = 213.58 Total Length (1 Inspections, 147.70 Length Surveyed)

213.58 Total Length (1 Inspections, 147.70 Length Surveyed)

GPRS

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Section Summary

Project	
2023_08_03_Arcadis_East Palestine_Culverts	**8/3/2023**

Number of sections	4
Total length of sections	213.58 ft
Total length of inspected sections	213.58 ft
Total length of not inspected sections	0.00 ft
Total abandoned inspections	3
Number of section inspection photos	13
Number of section inspection videos	4
Number of section inspection scans	0
Number of section inclination measurements	0

Pipe Segment Reference	**South Channel Upstream-South Channel Municipal Building**	Upstream MH	**South Channel Upstream**
City	**East Palestine**	Downstream MH	**South Channel Municipal Building**
Street	**Rebecca St**	Profile	**Square 96inch**
Total Length	**27.7**	Material	**Reinforced Concrete Pipe**

	Distance	PACP Code	Observation
1	0.0	AEP	End of Pipe
2	0.0	MWL	Water Level, 5% of the vertical dimension
3	27.7	MSA	Miscellaneous Survey Abandoned

Pipe Segment Reference	**North Channel Upstream-North Channel Municipal Building**	Upstream MH	**North Channel Upstream**
City	**East Palestine**	Downstream MH	**North Channel Municipal Building**
Street	**Rebecca St**	Profile	**Square 96inch**
Total Length	**33.3**	Material	**Reinforced Concrete Pipe**

	Distance	PACP Code	Observation
1	0.0	AEP	End of Pipe
2	0.0	MWL	Water Level, 5% of the vertical dimension
3	33.3	MSA	Miscellaneous Survey Abandoned

Pipe Segment Reference	**Rebecca St Upstream-Rebecca St Downstream**	Upstream MH	**Rebecca St Upstream**
City	**East Palestine**	Downstream MH	**Rebecca St Downstream**
Street	**Rebecca St**	Profile	**Square 96inch**
Total Length	**147.7**	Material	**Reinforced Concrete Pipe**

	Distance	PACP Code	Observation
1	0.0	AEP	End of Pipe
2	0.0	MWL	Water Level, 5% of the vertical dimension
3	112.7	FM	Fracture Multiple from 1 o'clock to 5 o'clock, Start
4	135.7	B	Broken from 1 o'clock to 4 o'clock

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Section Summary

Project	
2023_08_03_Arcadis_East Palestine_Culverts	**8/3/2023**

	Distance	PACP Code	Observation
5	147.7	B	Broken at 12 o'clock
6	147.7	FM	Fracture Multiple from 1 o'clock to 5 o'clock, Finish
7	147.7	AEP	End of Pipe

Pipe Segment Reference	**Liberty St Culvert Upstream-Liberty St Culvert Downstream**	Upstream MH	**Liberty St Culvert Upstream**
City	**East Palestine**	Downstream MH	**Liberty St Culvert Downstream**
Street	**Liberty St**	Profile	**Square 96inch**
Total Length	**4.9**	Material	**Reinforced Concrete Pipe**

	Distance	PACP Code	Observation
1	0.0	AEP	End of Pipe
2	0.0	MWL	Water Level, 5% of the vertical dimension
3	4.9	MSA	Miscellaneous Survey Abandoned

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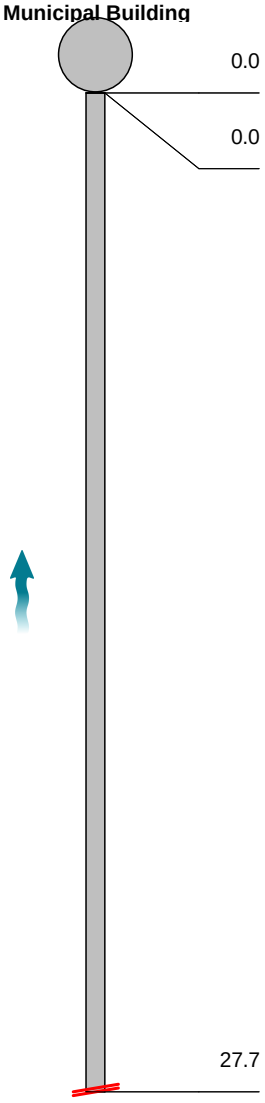
Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
8/3/2023	**579053**		**Kyle Zenobi**	**P0042689-052023**	South Channel Upstream-South Channel Municipal Building
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	No Pre-Cleaning	**Upstream**		**27.7 '**	**27.7 '**

City:	**East Palestine**	Drainage Area:		Upstream MH:	**South Channel Upstream**
Street:	**Rebecca St**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	South Channel Municipal Building
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Square**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**96 x 96 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			

Additional Info:



1:210	Distance	Code	Observation	Counter	Photo	Grade
	0.0	AEP	End of Pipe / South Channel Municipal Building	00:00:00	South Channel Upstream-	
	0.0	MWL	Water Level, 5% of the vertical dimension	00:00:05	South Channel Upstream-	
	27.7	MSA	Miscellaneous Survey Abandoned / To much debris to get crawler past	00:03:34		

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	0000	0000	0.0	0.0	0.0	0.0	0.0	0.0

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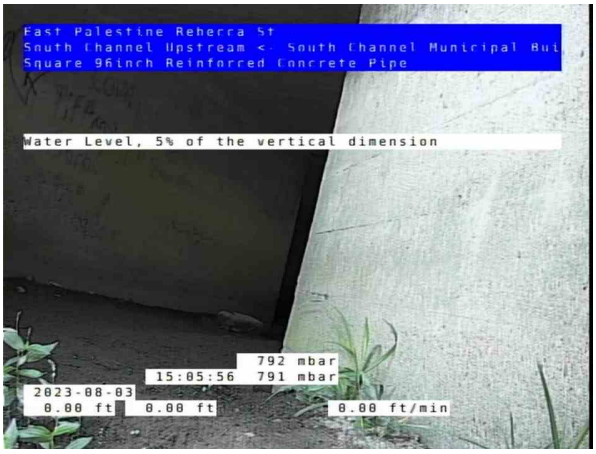
Section Pictures - 8/3/2023 - South Channel Upstream-South Channel

City	Street	Date	Lateral Segment Reference	Section No.
East Palestine	**Rebecca St**	**8/3/2023**	**South Channel**	**1**

South Channel Upstream-South Channel Municipal Building_cdfaf857-a329-47c7-8921-1e19a3b8e907_20230803_091018_508.jpg, 00:00:00, 0.00ft
End of Pipe / South Channel Municipal Building



South Channel Upstream-South Channel Municipal Building_67eea4d9-8af3-49ea-a6f2-951e00de471f_20230803_091028_646.jpg, 00:00:05, 0.00ft
Water Level, 5% of the vertical dimension

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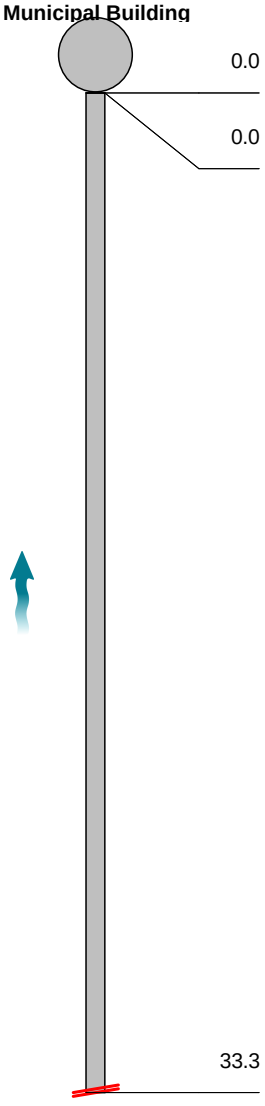
Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
8/3/2023	**579053**		**Kyle Zenobi**	**P0042689-052023**	North Channel Upstream-North Channel Municipal Building
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	No Pre-Cleaning	**Upstream**		**33.3 '**	**33.3 '**

City:	**East Palestine**	Drainage Area:		Upstream MH:	**North Channel Upstream**
Street:	**Rebecca St**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	North Channel Municipal Building
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Square**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**96 x 96 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			

Additional Info:



1:252	Distance	Code	Observation	Counter	Photo	Grade
	0.0	AEP	End of Pipe / North Channel Municipal Building	00:00:00	North Channel Upstream-	
	0.0	MWL	Water Level, 5% of the vertical dimension	00:00:06	North Channel Upstream-	
	33.3	MSA	Miscellaneous Survey Abandoned / Unable to get crawler past debris	00:04:19	North Channel Upstream-	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	0000	0000	0.0	0.0	0.0	0.0	0.0	0.0

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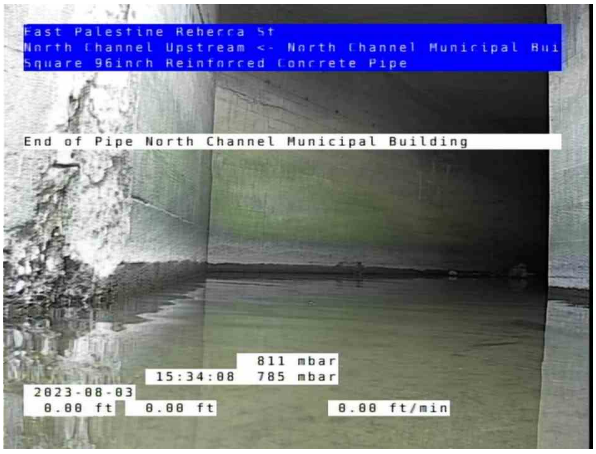
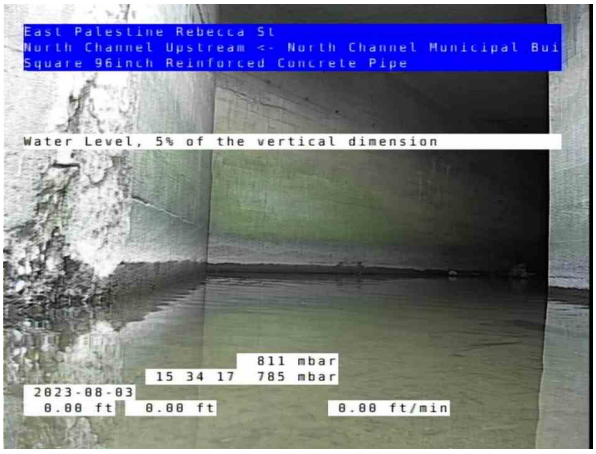
Section Pictures - 8/3/2023 - North Channel Upstream-North Channel

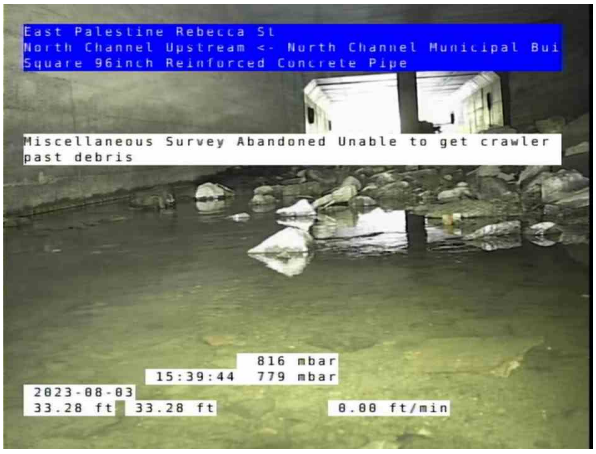
City	Street	Date	Lateral Segment Reference	Section No.
East Palestine	**Rebecca St**	**8/3/2023**	**North Channel**	**2**



North Channel Upstream-North Channel Municipal Building_6d5ae010-2633-4ac1-b9e7-a352cd0bdb35_20230803_093840_652.jpg, 00:00:00, 0.00ft
End of Pipe / North Channel Municipal Building



North Channel Upstream-North Channel Municipal Building_00be1484-3263-49f4-a62b-1a6f4d65f819_20230803_093850_296.jpg, 00:00:06, 0.00ft
Water Level, 5% of the vertical dimension



North Channel Upstream-North Channel Municipal Building_94be1f30-7cd0-4415-8a6f-ab66625ffbfe_20230803_094417_053.jpg, 00:04:19, 33.28ft
Miscellaneous Survey Abandoned / Unable to get crawler past debris

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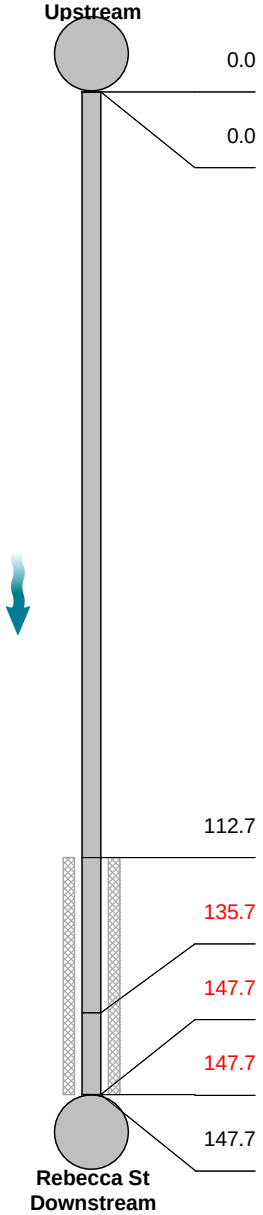
Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
8/3/2023	**579053**		**Kyle Zenobi**	**P0042689-052023**	**Rebecca St Upstream-Rebecca St Downstream**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	No Pre-Cleaning	**Downstream**		**147.7 '**	**147.7 '**

City:	**East Palestine**	Drainage Area:		Upstream MH:	**Rebecca St Upstream**
Street:	**Rebecca St**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**Rebecca St Downstream**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Square**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**96 x 96 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



1:1115	Distance		Code	Observation	Counter	Photo	Grade
	0.0		AEP	End of Pipe / Rebecca St Upstream	00:00:00	Rebecca St Upstream-	
	0.0		MWL	Water Level, 5% of the vertical dimension	00:00:04	Rebecca St Upstream-	
	112.7	S01	FM	Fracture Multiple from 1 o'clock to 5 o'clock, Start	00:06:46	Rebecca St Upstream-	
	135.7		B	Broken from 1 o'clock to 4 o'clock	00:09:27	Rebecca St Upstream-	S4
	147.7		B	Broken at 12 o'clock	00:11:00	Rebecca St Upstream-	S4
	147.7	F01	FM	Fracture Multiple from 1 o'clock to 5 o'clock, Finish	00:11:00		S4
	147.7		AEP	End of Pipe / Rebecca St Downstream	00:11:26	Rebecca St Upstream-	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
4900	0000	4900	36.0	0.0	36.0	4.0	0.0	4.0

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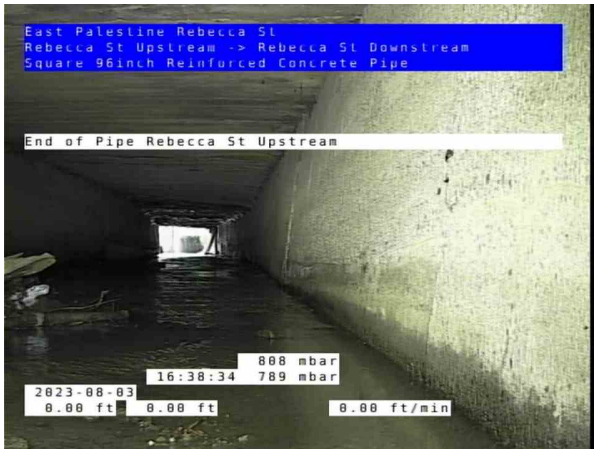
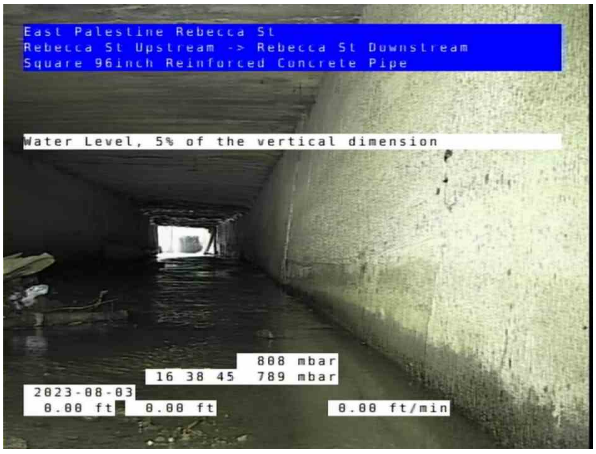
Section Pictures - 8/3/2023 - Rebecca St Upstream-Rebecca St Downstream

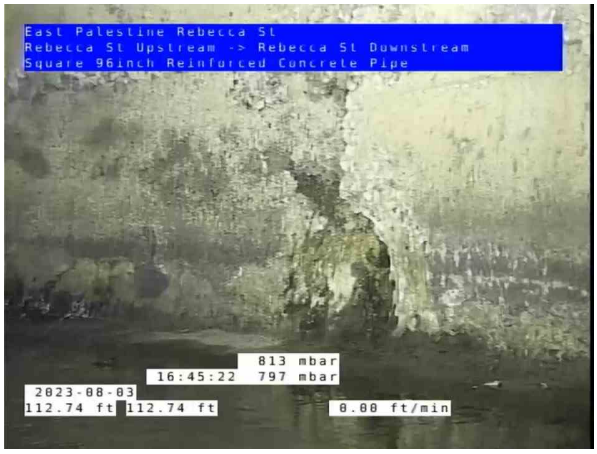
City	Street	Date	Lateral Segment Reference	Section No.
East Palestine	**Rebecca St**	**8/3/2023**	**Rebecca St**	**3**



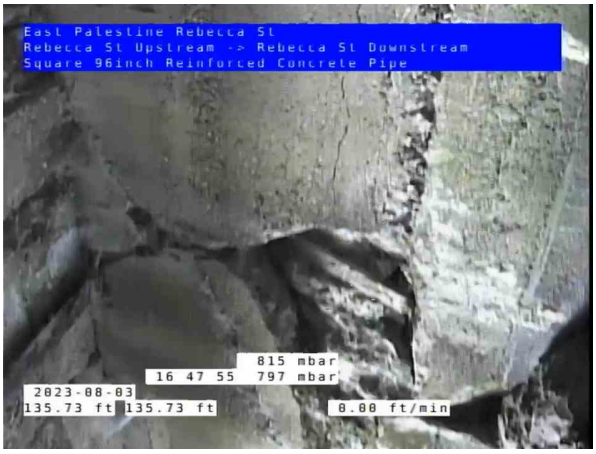
Rebecca St Upstream-Rebecca St Downstream_37994f9f-ed2a-4bba-bd1d-869a936dda98_20230803_104307_060.jpg, 00:00:00, 0.00ft
End of Pipe / Rebecca St Upstream



Rebecca St Upstream-Rebecca St Downstream_34a2e015-2605-4393-96a2-5e02a841f91b_20230803_104318_874.jpg, 00:00:04, 0.00ft
Water Level, 5% of the vertical dimension



Rebecca St Upstream-Rebecca St Downstream_00b267ff-80a7-4010-8d32-b657c569c33a_20230806_172205_377.jpg, 00:06:46, 112.73ft
Fracture Multiple from 1 o'clock to 5 o'clock, Start



Rebecca St Upstream-Rebecca St Downstream_57db7f96-8f3b-43a5-8bc1-e18a320c72a8_20230806_172244_483.jpg, 00:09:27, 135.69ft
Broken from 1 o'clock to 4 o'clock

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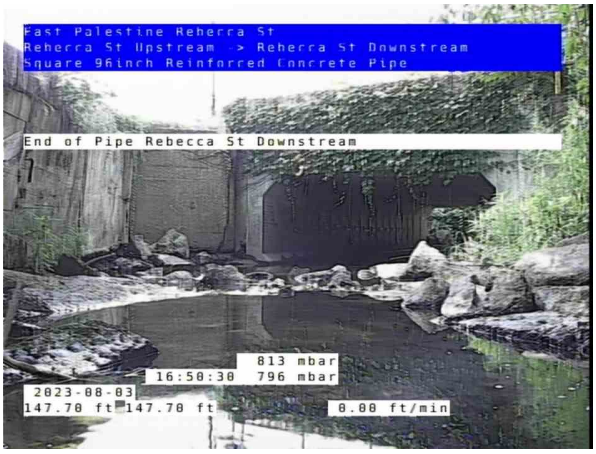
Section Pictures - 8/3/2023 - Rebecca St Upstream-Rebecca St Downstream

City	Street	Date	Lateral Segment Reference	Section No.
East Palestine	**Rebecca St**	**8/3/2023**	**Rebecca St**	**3**

Rebecca St Upstream-Rebecca St Downstream_7f3c0dfb-fbf7-4de7-a8ae-7320f8294c9c_20230806_172436_210.jpg, 00:11:00, 147.70ft
Broken at 12 o'clock



Rebecca St Upstream-Rebecca St Downstream_54fc9765-48cc-41bc-9157-3bb70cf7c0eb_20230803_105503_851.jpg, 00:11:26, 147.70ft
End of Pipe / Rebecca St Downstream

GPRS

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Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
8/3/2023	**579053**		**Kyle Zenobi**	**P0042689-052023**	Liberty St Culvert Upstream-Liberty St Culvert Downstream
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	No Pre-Cleaning	**Upstream**		**4.9 '**	**4.9 '**

City:	**East Palestine**	Drainage Area:		Upstream MH:	**Liberty St Culvert Upstream**
Street:	**Liberty St**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**Liberty St Culvert Downstream**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Square**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**96 x 96 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					

1:50	Distance	Code	Observation	Counter	Photo	Grade
Liberty St Culvert Downstream						
	0.0	AEP	End of Pipe / Liberty St Downstream	00:00:00	Liberty St Culvert Upstream-	
	0.0	MWL	Water Level, 5% of the vertical dimension	00:00:18	Liberty St Culvert Upstream-	
	4.9	MSA	Miscellaneous Survey Abandoned / Unable to get over deposted debris	00:02:35		

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	0000	0000	0.0	0.0	0.0	0.0	0.0	0.0

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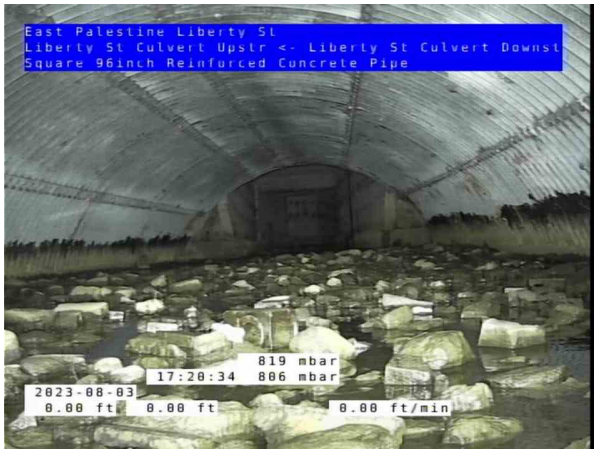
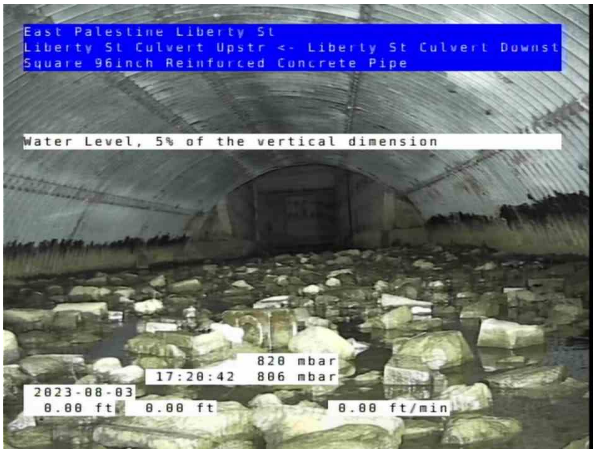
Kyle.Zenobi@gprsinc.com

Section Pictures - 8/3/2023 - Liberty St Culvert Upstream-Liberty St Culvert Downstream

City	Street	Date	Lateral Segment Reference	Section No.
East Palestine	**Liberty St**	**8/3/2023**	**Liberty St Culvert**	**4**



Liberty St Culvert Upstream-Liberty St Culvert Downstream_c3af6d16-33b3-4788-88b3-1f991373a502_20230803_112507_951.jpg, 00:00:00, 0.00ft
End of Pipe / Liberty St Downstream



Liberty St Culvert Upstream-Liberty St Culvert Downstream_ecc8eb4e-9d71-492d-a08c-606706c95575_20230803_112515_388.jpg, 00:00:18, 0.00ft
Water Level, 5% of the vertical dimension

Appendix B

Boston Dynamic Robot Information Sheet

Spot Robotics Platform

Boston Dynamics Spot

Spot is a quad-legged robot that can traverse more complex terrains than some other unmanned ground vehicles (UGVs). It has the ability to carry a significant amount of sensor payloads and communicate back to the Operator providing several data streams simultaneously.

Payloads

CTEH has the capability to outfit Spot units with a variety of payloads depending on the needs for the task. Spot is equipped with a high-definition pan, tilt, zoom (PTZ) camera with 30x optical glass, and thermal capabilities. In addition to the PTZ, it is also equipped with 360 degree viewing cameras that contain spotlights in all directions that can be utilized in low to no light conditions. There is also an additional option for a high resolution 360-degree camera that can recreate an RGB (standard image) walkthrough, digital twin similar to a virtual home walkthrough or Google Street view. Spot also carries a LIDAR puck for continuously mapping its environment that can be extracted as a point cloud to give an understanding of the layout and terrain within Spot's environment.

CTEH can also outfit Spot with air monitoring capability that can be telemetered to the Operator in real-time. If conditions were such that real-time telemetry challenges arise, this data can be captured using datalogging of the real-time instrument that can be processed and interpreted after the completion of the mission.

Finally, CTEH has a Spot unit outfitted with the Spot Arm. This unit has the same capabilities as mentioned above, but with the addition of an arm that may be utilized of real-world manipulation when feasible when completing a mission.

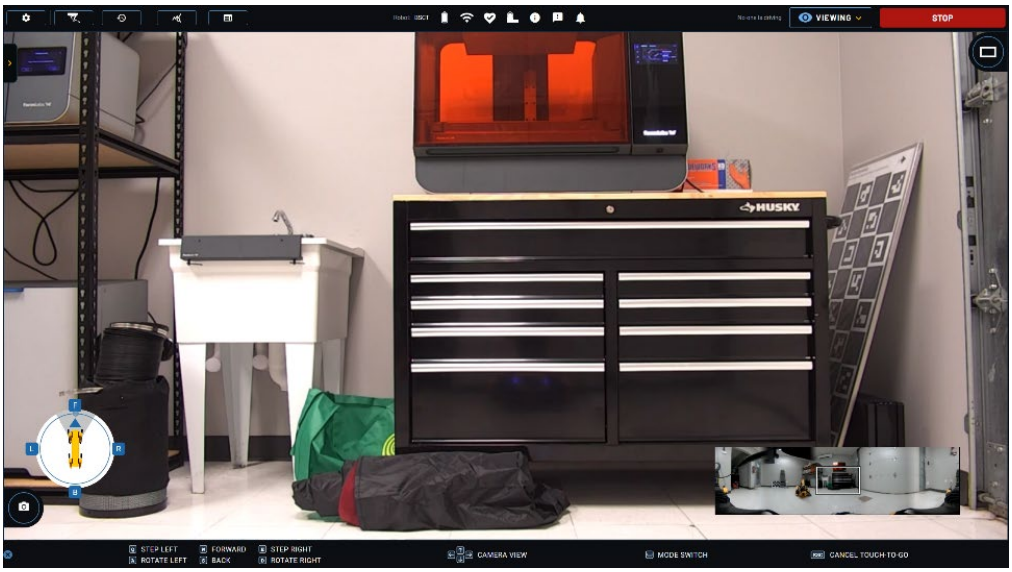
Spot pictured with optional payloads.

Communications, Data Collection, and Display

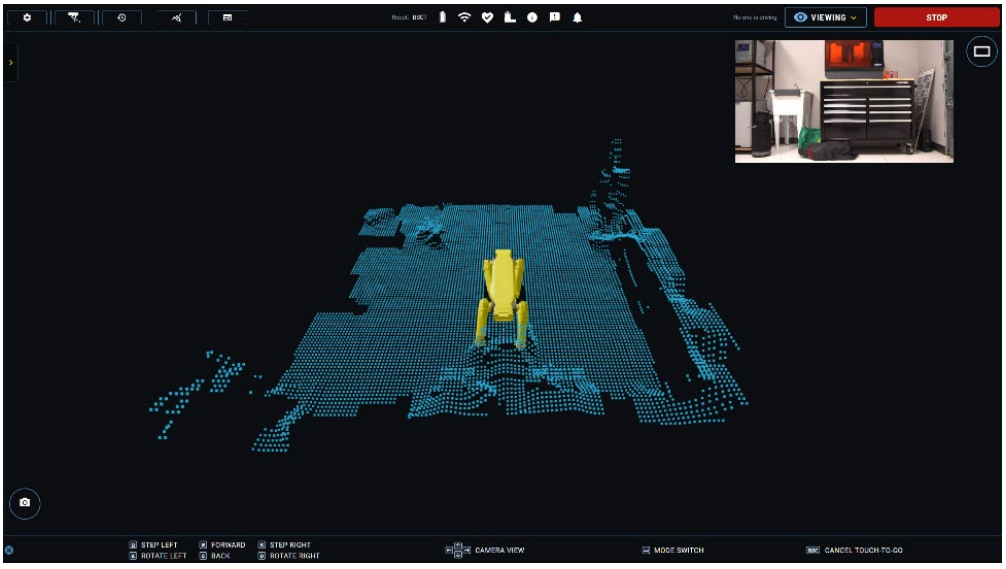
Spot is capable of operating and communicating data via Wi-Fi, 5G/LTE cellular connections. Tethering may also be utilized during missions when wireless connectivity challenges arise.

CTEH can process or deliver the information/data from the missions in a variety of ways. Utilizing Spot's platform dashboard, SCOUT, all data can be recorded from the missions for playback and export. This dashboard is used to view data, photos, maps, or any other collected data to display. For more traditional reporting, CTEH Operators can package specific deliverables based on the needs of our clients.

Spot image quality when navigating the unit. These cameras are toggled in a 360-degree manner.



Spot can produce real-time LIDAR scans when performing missions.



Spot Limitations

Spot limitations may include distances in communications for equipment (tethering can resolve this issue), pools of water that are too deep to traverse (>6-8”), reduction of movable space within the environment (tapering down of diameter or equivalent), and any tall steps or drops greater than ~18”. This list is not exhaustive, but it does represent the most commonly faced issues.

Safety and Retrieval

CTEH has implemented a safety tether line utilizing climbing rope pulled behind the robot. In any instance of shutdown or inability to go further or turn around, Spot can be winched from culvert system if needed.

Appendix C

Decision Tree for Ongoing Operations During Culvert Work

DECISION TREE FOR ONGOING OPERATIONS DURING CULVERT WORK

This decision tree outlines the collaborative efforts related to air monitoring and sampling in work and community areas and associated communications as it pertains to culvert characterization and cleanup activities. This decision tree and its associated actions will be implemented in accordance with the CTEH Air SAP and QAPP, which also outlines the instrumentation that will be used during culvert characterization and instrument detection limits. This decision tree and its associated actions will also be implemented in accordance with the EPA START's HAPSITE plans and protocols.

Key Analytes

- Vinyl chloride:
    - Community screening value: 20 ppb
        - Basis: Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) for intermediate inhalation
    - Occupational exposure guideline: 1 ppm
        - Basis: American Conference of Governmental Industrial Hygienists (ACGIH) time-weighted average Threshold Limit Value (TLV-TWA) and Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL)
- Butyl acrylate:
    - Community screening value: 20 ppb
        - Basis: Michigan Department of Natural Resources and Environment 24-hour average Initial Threshold Screening Level (ITSL)
    - Occupational exposure guideline: 2 ppm
        - Basis: American Conference of Governmental Industrial Hygienists (ACGIH) time-weighted average Threshold Limit Value (TLV-TWA)

Provisions to be Enacted

- Prior to cleanup activities, robot-assisted air monitoring will be conducted within the culverts to characterize atmospheric conditions inside culverts.
    - Robot-assisted air monitoring will be conducted for total VOCs, butyl acrylate, and vinyl chloride. In addition, a badge will be positioned on the robot for laboratory analysis of butyl acrylate and vinyl chloride. Air monitoring instrumentation to be used, detection limits, and associated actions are listed in Table 4.7 of the CTEH Air SAP v3.1, and air sampling methods to be used and associated detection limits are listed in Table 3.5 of the CTEH Air SAP v3.1.
    - *Note: Results of surface water and sediment sampling conducted both upstream and downstream of the culverts do not indicate the presence of butyl acrylate or vinyl chloride in surface waters or sediments. Therefore, butyl acrylate and vinyl chloride are not expected to be released from the sediment during culvert work.*
- During cleanup activities, the following provisions will be enacted in work areas:
    - Handheld air monitoring will be conducted within the culverts for total VOCs and other analytes as indicated by job hazard analysis (JHA) for confined space entry (e.g., oxygen, % LEL, hydrogen sulfide) and in the work area surrounding the culverts for total VOCs,

butyl acrylate, and vinyl chloride. Instrumentation to be used, detection limits, and associated actions for air monitoring in the work area surrounding the culverts are listed in Table 4.5 of the CTEH Air SAP v3.1.
    - The presence and character of any odors will be documented during handheld air monitoring.
    - Personal air samples for butyl acrylate and vinyl chloride will be collected on workers conducting operations within the culverts. Methods to be used and method detection limits are listed in Table 3.5 of the CTEH Air SAP v3.1.
- During cleanup activities, the following provisions will be enacted in community areas immediately surrounding the culvert work areas:
    - Handheld air monitoring will be conducted in community areas for total VOCs. The presence and character of any odors will be documented during handheld air monitoring. Instrumentation to be used, detection limits, and associated actions are listed in Table 4.6 of the CTEH Air SAP v3.1.
    - Air sampling will be conducted (4-6 locations) in the community surrounding the culvert work area using both canisters and stationary badges, for a panel of 75 VOCs, including vinyl chloride and butyl acrylate. Methods to be used and method detection limits are listed in Table 3.5 and Section 3.2.1 of the CTEH Air SAP v3.1.
    - The EPA START's HAPSITE will be available during culvert work activities and will follow the methods and actions outlined in the EPA START's HAPSITE plans and protocols.
        - If detections of butyl acrylate or odors consistent with butyl acrylate are observed within the culvert or in the work area surrounding the culvert, CTEH personnel will inform the EPA Operations Section Chief. At the direction of EPA Operations, the EPA START's HAPSITE will evaluate air quality in accordance with the EPA START's HAPSITE plans and protocols. These actions may include collecting grab samples for butyl acrylate and vinyl chloride at the nearest downwind community receptors.
    - Odor reports will continue to be investigated by Community Strike Teams, who immediately respond to the area of the odor report and conduct outdoor air monitoring using handheld instruments, deploy an air sample for butyl acrylate, and characterize and document odors in the area.
        - In addition, CTEH personnel will inform the EPA Operations Section Chief. At the direction of EPA Operations, the EPA START's HAPSITE will evaluate air quality in accordance with the EPA START's HAPSITE plans and protocols. These actions may include collecting a grab sample for butyl acrylate and vinyl chloride in the area of the odor report. Before the end of the work day, the EPA START's HAPSITE operators may evaluate site conditions and consider returning to the area where the odor was reported to collect a follow-up grab sample for butyl acrylate and vinyl chloride.

Decision Criteria

- VOC concentrations in community areas during handheld air monitoring continue to be below action levels, as outlined in the CTEH Air SAP and QAPP, or if above action levels, actions continue to be taken in accordance with the CTEH Air SAP and QAPP.

- Odor documentations during handheld air monitoring continue to show no detectable odors consistent with butyl acrylate in community areas. If odors consistent with butyl acrylate are observed in community areas, Community Strike Teams will continue to investigate the odors (see Provisions to be Enacted section above for further details).
- Concentrations of VOCs, vinyl chloride, and butyl acrylate in work areas during robot-assisted and handheld air monitoring continue to be below action levels, as outlined in the CTEH Air SAP and QAPP, or if above action levels, actions continue to be taken in accordance with the CTEH Air SAP and QAPP.
- In response to detections of butyl acrylate or odors consistent with butyl acrylate in the work area, CTEH personnel will inform the EPA Operations Section Chief. At the direction of EPA Operations, the EPA START's HAPSITE will evaluate air quality in accordance with the EPA START's HAPSITE plans and protocols. These actions may include collecting grab samples for butyl acrylate and vinyl chloride at the nearest downwind community receptors.
    - *Note: Based on surface water and sediment data, butyl acrylate is not expected to be released from the sediment during culvert work. Previous creek operations (i.e., air knifing, creek agitation and washing) did not rely on mobile laboratories, HAPSITE, or MINICAMS; rather, air characterization during previous creek operations was addressed using the other data streams outlined herein (e.g., handheld air monitoring, worker personal air sampling).*
- Air sampling results along the work area perimeter continue to show no detections of vinyl chloride or butyl acrylate that exceed the community screening values of 20 ppb.
- Investigation of odors reported by community members continues to show no detections of butyl acrylate in air samples.

Decision Tree

- The hours of culvert operations will be communicated to the CTEH Project Manager and the EPA Operations and Air Operations groups, including operators of the EPA START's HAPSITE.
- If butyl acrylate is detected (i.e., any detection above the instrument's limit of detection), or if odors consistent with butyl acrylate are detected, within the culvert or in the work area surrounding the culvert, CTEH personnel will inform the EPA Operations Section Chief. At the direction of EPA Operations, the EPA START's HAPSITE will evaluate air quality in accordance with the EPA START's HAPSITE plans and protocols. These actions may include collecting a grab sample for butyl acrylate and vinyl chloride at the nearest downwind community receptor, based on prevailing wind direction.
    - The identity and types of operations occurring will be identified, and site and environmental conditions (i.e., wind direction, temperature) will be examined. The nature of the detection or odor will be evaluated (i.e., an instantaneous peak measurement or consistently elevated measurements) to determine the trend of the measurements.
    - Real-time air monitoring using handheld instruments will continue within the culvert, in the work area, and in nearby community areas (including around the work area perimeter) to characterize the area, including documentation of any odors.
    - If it is determined that EPA START's HAPSITE will collect an initial grab sample, and if the initial grab sample yields a concentration of butyl acrylate or vinyl chloride below the

community screening value (20 ppb), the EPA START's HAPSITE operators may consider discontinuing monitoring at the receptor and returning to its standby location, and work operations will continue.

- If it is determined that EPA START's HAPSITE will collect an initial grab sample, and if the initial grab sample yields a concentration of butyl acrylate or vinyl chloride above the community screening value (20 ppb), the EPA START's HAPSITE operators may consider returning to the same downwind location and collecting three follow-up grab samples at 15-minute intervals to evaluate the average concentration over a one-hour period.
    - Engineering and/or administrative controls will be considered on a case-by-case basis, considering the site and environmental conditions within and around each culvert. Engineering and/or administrative controls may include the use of fans, air scrubbers, or temporarily shifting work to a different area (e.g., upwind). If fans or air scrubbers are utilized, handheld air monitoring and air sampling locations will be positioned to encompass locations downwind of the engineering control.
    - If it is determined that EPA START's HAPSITE will collect three follow-up grab samples at 15-minute intervals, and if the one-hour average concentration of butyl acrylate or vinyl chloride is below the community screening value (20 ppb as a one-hour average), the EPA START's HAPSITE operators may consider discontinuing monitoring at the receptor and returning to its standby location, and work operations will continue.
    - If it is determined that EPA START's HAPSITE will collect three follow-up grab samples at 15-minute intervals, and if the one-hour average concentration of butyl acrylate or vinyl chloride is above the community screening value (20 ppb as a one-hour average), the EPA Operations Section Chief will be notified, and work (or specific activities resulting in elevated readings) may be temporarily stopped until concentrations in grab samples return to below 20 ppb. Engineering and/or administrative controls will be considered on a case-by-case basis. In addition, Unified Command may evaluate the need to engage a community outreach team to discuss potential avenues for communication with downwind receptors (e.g., distribution of flyers or other information via website, use of hotlines to answer questions).

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