Norfolk Southern

Culvert Sediment Removal Report

East Palestine Train Derailment Site

December 21, 2023

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Acronyms and Abbreviations

%	percent
Arcadis	Arcadis U.S., Inc.
CO	carbon monoxide
CY	cubic yards
H_2S	hydrogen sulfide
LEL	lower explosive limit
NSRC	Norfolk Southern Railway Company
O_2	oxygen
Order	Administrative Order issued under Section 311(c) of the Clean Water Act
OSHA	Occupational Safety and Health Administration
SSO	site safety officer
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

1 Introduction

On behalf of Norfolk Southern Railway Company (NSRC), Arcadis U.S., Inc. (Arcadis) is submitting this report in accordance with Item 61 of the Administrative Order issued under Section 311(c) of the Clean Water Act (Order), the December 1, 2023 Directive, and December 18, 2023 Approval with Modification Letter to summarize the culvert sediment removal/cleaning activities that have been completed to date. Item 61 of the Order requires NSRC to submit a report describing the actions completed in accordance with the approved *Sulphur Run Culvert Sediment Removal Plan* (Removal Plan, Arcadis 2023b). The Removal Plan was initially submitted by Arcadis to the United States Environmental Protection Agency (USEPA) on November 1, 2023. The Removal Plan supports actions to remove sediment from five culverts (i.e., C0, C1, C2, C3, and C4) located along Sulphur Run within the Village of East Palestine, Ohio. NSRC received comments on the Removal Plan on November 6, 2023, and resubmitted on November 8, 2023. Approval with modifications was received by letter dated November 9, 2023. The modifications were completed, and the final Removal Plan was resubmitted on November 10, 2023. Sediment removal was completed in Culverts C0, C2, C3, and C4 between November 10 and December 15, 2023.

An addendum to the Removal Plan incorporating a supplemental assessment scope specific to Culvert C1 was approved with modifications on December 18, 2023. The modifications were completed, and the final addendum was submitted on December 19, 2023. This report is being submitted on December 21, 2023 to allow for inclusion of data associated with performance of that addendum.

1.1 Background

The Removal Plan required each culvert first be investigated remotely utilizing drone and robotic technologies to identify potential health and safety hazards and evaluate the integrity of the culverts. Information collected during these investigations included visual assessment of the culvert condition, air quality conditions, preliminary sediment depths, confirmation of a hard bottom, light detection and radar (Lidar) survey information, and the locations of lateral pipes and inlets that enter each culvert.

Utilizing the information captured during the initial health and safety and integrity assessments, proposed sediment removal activities for each culvert were reviewed with the Site Safety Officer (SSO), supporting safety staff, and representatives from the Operations Section, including field staff, prior to implementation. Prior to commencing cleaning activities, the initial conditions of the culvert were documented with photographs, provided in Appendix A. In general, the process for cleaning the culvert included the construction of a sandbag berm at the inlet and outlet of each culvert and the installation of bypass piping for bypass conveyance of stream flow through the work area. Once the berms were in-place, cleaning activities commenced utilizing a hi-vac truck that removed sediment, rock, and other debris (e.g., leaves) up to approximately 4 to 6 inches in diameter. Larger stone and concrete pieces were rinsed and vacuumed-off to remove sediment and left in-place due to the potential health and safety hazards associated with removing this material as further described below. Completion of culvert sediment removal activities was confirmed with USEPA representatives in the field, documented with photographs (Appendix A), and the sandbag berms and bypass piping were removed.

1.2 Air Monitoring Activities

Prior to the start of culvert cleaning activities, CTEH utilized a Spot® robot fitted with air monitoring equipment to characterize the atmospheric conditions inside each culvert. Each culvert was assessed for percent of the lower explosive limit (%LEL), hydrogen sulfide (H_2S), percent oxygen (%O_2), carbon monoxide (CO), and total volatile organic compounds (VOCs) using a MultiRAE Pro, and a Drager X-pid 9500 was used to assess for vinyl chloride and butyl acrylate. An air sampling badge was also positioned on the robot for laboratory analysis of butyl acrylate and vinyl chloride. Robot-assisted air monitoring inside culvert C1 was limited due to water level and connectivity concerns. To complete the air monitoring assessment along the full length of culvert C1, real-time air monitoring for the same parameters was approved by the USEPA and performed via human entry into the culvert. These assessments prior to the start of culvert cleaning activities did not detect any analytes of concern in any of the culverts, and %O_2 was consistently 20.9%. Badge results were non-detect for both vinyl chloride and butyl acrylate.

Air monitoring during culvert cleaning activities was conducted in accordance with Appendix C – Decision Tree for Ongoing Operations During Culvert Work in the Removal Plan (Arcadis 2023b). Air monitoring activities included handheld air monitoring within the culverts, in the work area around the culverts, and in community areas surrounding the culvert work area. Handheld air monitoring parameters within the culverts and in the culvert work area include %LEL, H_2S, %O_2, CO, total VOCs, and fine particulate matter. Worker personal air sampling for vinyl chloride and butyl acrylate was also performed for workers conducting culvert cleanup operations. In the community, handheld air monitoring is conducted for total VOCs during culvert cleaning activities. Additionally, air sampling is performed at four to six locations in the community immediately surrounding the culvert work area using co-located evacuated canisters and badges, which provide data on a panel of 75 VOCs, including vinyl chloride and butyl acrylate. Throughout the culvert cleaning activities, air monitoring and air sampling in the work area and nearby community did not indicate any actionable detections of analytes of concern.

2 Completed Investigation and Sediment Removal Activities

Culvert-specific information obtained during the initial investigation and the sediment removal activities completed to date are summarized below.

2.1 Culvert C0

Culvert C0 was inspected remotely utilizing both the drone and Spot® robot technology on November 10, 2023. The following information was determined through remote sensing:

- Culvert C0 is constructed of an approximate 40-foot-long, 6-foot diameter steel pipe that transitions to a 20-foot-long, 4.5-foot diameter reinforced concrete pipe.
- Culvert C0 appeared in good condition with no signs of significant deterioration.
- A hard bottom was confirmed in Culvert C0 throughout its length prior to cleaning.
- There were no inlets or lateral pipes entering this culvert.

Sediment removal activities were conducted on November 16, 2023. Minimal sediment was found in the culvert, less than 1 cubic yard (CY). Following cleaning activities, prior to removing the sandbag berms and bypass piping, USEPA representatives confirmed cleanup activities were adequately achieved. Appendix A contains initial condition photographs and completion photographs following sediment removal activities in Culvert C0.

2.2 Culvert C1

Due to the length of the Culvert C1, it was investigated by the drone on November 11, 12, and 15, 2023. Culvert C1 was also investigated by Spot® robot on November 12 and 13, 2023.

The following information was determined through remote sensing:

- Culvert C1 is constructed of three different culvert sections, from upstream to downstream, which consists of the following:
  - Section 1 - 415 feet of 10-foot-wide by 6-foot-tall concrete box culvert,
  - Section 2 - 170 feet of 10-foot-wide by 6-foot-tall corrugated metal arch pipe, and
  - Section 3 - 195 feet of 10 foot-wide by 10-foot-tall concrete box culvert.
- A fourth section, 50 feet of 15-foot-wide by 5-foot-tall corrugated metal arch, was present at the outlet. However, it appears the metal arch was installed as an insert during bridge maintenance under Liberty Street and lacks a hard bottom (i.e., the stream bottom extends through this section).
- Culvert C1 Sections 1 and 2 appeared in good condition with no signs of significant deterioration. Section 3 appears to be in fair to good condition, however, portions of Section 3 appear to have an eroded bottom as water can be seen flowing beneath the ledge on the sidewalls. It is not clear at this time if Section 3 has a constructed bottom or not as it had a consistent layer of sediment and stones blocking visibility of the culvert bottom.
- There is very little sediment, stones or debris in Section 1. There is measurable sediment in Sections 2 and 3, progressively increasing from upstream to downstream.
- There are 15 inlets into Culvert C1 ranging from 6-inch diameter to 24-inch diameter and consisting of various material types including polyvinyl chloride and metal.

Based on these findings, a verbal sediment removal plan for Culvert C1 was formulated and reviewed with the SSO, supporting safety staff, representatives from the Operations Section, and field staff representatives. This verbal plan was then reviewed during an on-line meeting with representatives from the Occupational Safety and Health Administration (OSHA) to obtain their recommendations related to health and safety considerations. During this review process, significant health and safety concerns were identified by OSHA. An on-site review was then conducted by OSHA on December 1, 2023. To address OSHA's concerns to limit work in the culvert to the extent practicable, supplemental field investigation activities were proposed to provide additional information on the culvert bottom conditions, assess the presence of sheens, evaluate sediment in the floor slab drop section of the culvert, and estimate the volume of sediment that may require removal. Addendum No. 1 to the Removal Plan (Arcadis 2023b) was submitted on December 18, 2023, which describes the supplemental culvert field assessment scope. The associated work was conducted on December 19, 2023 and is further discussed in the section below.

2.2.1 Supplemental Assessment

A qualitative assessment of sheens was conducted throughout the length of Culvert C1 on December 19, 2023. The assessment methods were conducted consistently with the Comprehensive Sheen and Sediment Investigation Work Plan – Sulphur Run and Leslie Run (CWA Investigation Plan, Arcadis 2023c). For the culvert, a transect disturbance was conducted at a minimum spacing of 50 feet where sediment was observed, and a score of 0 to 3 was assigned based on the sheen observed, shown on Figure 2-1. Table 2-1, attached, summarizes the transect distances, assigned sheen scores, measured sediment depth, and an assessment of the culvert bottom. It is estimated that a sediment volume of approximately 22 CY is present in portions of Culvert C1 that contain an engineered bottom. Of this volume, approximately 9 CY are located in areas that have a sheen assessment rated as 0; approximately 6 CY are located in areas that have a sheen assessment rated as 1; approximately 3 CY are located in areas that have a sheen assessment rated as 2; and approximately 3 CY are located in areas that have a sheen assessment rated as 3.

In addition to the qualitative sheen assessment, continuous video was recorded at the downstream end of the culvert to assess and document any changes in water conditions or sheen observations. No sheen was observed at the downstream end of the culvert throughout the duration of the sheen assessment.

2.3 Culvert C2

Culvert C2 was inspected remotely utilizing the drone on November 10, 2023 and by Spot® robot on November 11, 2023. The following information was determined through remote sensing:

- Culvert C2 is constructed of an approximate 150-foot-long, 10-foot-wide by 5-foot-tall concrete box culvert.
- Culvert C2 appeared in poor to fair condition with signs of deterioration of the ceiling and sidewalls of the culvert, especially towards the southern (outlet) end of the culvert.
- A hard bottom was confirmed in Culvert C2 throughout the length of the culvert prior to cleaning.
- There was one inlet to this culvert, a 4-inch diameter iron pipe.

Sediment removal activities were conducted on November 18, 2023. Approximately 4 CY of sediment, stones, and debris (e.g., leaves) was removed from Culvert C2. Following cleaning activities, prior to removing the sandbag berms and bypass piping, USEPA representatives confirmed the cleanup activities were adequately achieved. Appendix A contains initial condition photographs and completion photographs following sediment removal activities in Culvert C2.

2.4 Culvert C3

Culvert C3 was inspected remotely utilizing the drone and Spot® robot on November 11, 2023. The following information was determined through remote sensing:

- Culvert C3 is constructed of an approximate 210-foot-long, 18-foot-wide by 6-foot-tall concrete box culvert.
- Culvert C3 has one divider wall that stretches approximately 30 feet into the culvert from the downstream outlet inward, and a second divider wall projecting approximately 5 feet into the culvert from the inlet end.
- Culvert C3 had measurable sediment, especially along the southern side of the culvert and near the outlet.

- Culvert C3 appeared in fair to good condition. The upstream end appears to be a box culvert section that was inserted into the previous culvert. There are some signs of concrete deterioration near the outlet and select locations on the ceiling.
- A hard asphalt-like bottom was encountered beneath the sediment near the outlet, and transitions to a smooth concrete bottom near the inlet. There are four inlets near the upstream end of the culvert, consisting of 18-inch diameter polyvinyl chloride pipes. The first set of inlet pipes are 32 feet into the culvert from the upstream end, and the second set are an additional 32 feet. The inlets are from storm drains located in Market Street.

Sediment removal activities were initiated on November 27, 2023 and completed on December 15, 2023. Approximately 174 CY of sediment, stones, and debris (e.g., leaves) was removed from Culvert C3. Similar to Culvert C4, as described in Section 2.5, stone collection and transportation out of the creek posed a high potential for injury. It was determined, at the direction of USEPA representatives, that stones that were not vacuumed-up could be vacuumed-off to remove any gross sediment, rinsed, and redistributed within the culvert. Following sediment removal and rinsing activities, prior to removing the sandbag berms and bypass piping, USEPA representatives confirmed the cleanup activities were adequately achieved. Appendix A contains initial condition photographs and completion photographs following sediment removal activities in Culvert C3.

2.5 Culvert C4

Culvert C4 was inspected remotely utilizing the drone and robot technology on November 10, 2023. The following information was determined through remote sensing:

- Culvert C4 is constructed of an approximate 83-foot-long, 15-foot-wide by 6-foot-tall corrugated metal arch pipe.
- Culvert C4 appeared in good condition with no signs of significant deterioration.
- A hard bottom was confirmed in Culvert C4 throughout its length prior to cleaning.
- There were no inlets or lateral pipes entering this culvert.

Sediment removal activities were initiated on November 13, 2023 and completed on November 16, 2023. Approximately 14 CY of sediment, stones, and debris (e.g., leaves) was removed from Culvert C4. Health and safety concerns associated with removing stones that could not be vacuumed were evaluated following the removal of the sediment. Stone collection and transportation up the steep embankment posed a high potential for injury. It was determined, at the direction of USEPA representatives, that stones that were not vacuumed-up could be vacuumed-off to remove any gross sediment, rinsed, and redistributed within the culvert. Following sediment removal and rinsing activities, prior to removing the sandbag berms and bypass piping, USEPA representatives confirmed the cleanup activities were adequately achieved. Appendix A contains initial condition photographs and completion photographs following sediment removal activities in Culvert C4.

3 Sediment Removal and Material Disposal Summary

Throughout cleaning efforts, material in the hi-vac truck was emptied into dewatering roll-off boxes staged in Tank Farms 5 and 6. A total of 192 CY of sediment was removed from Culverts C0, C2, C3 and C4 along Sulphur Run, as presented on Table 3-1.

Table 3-1 Total Sediment Removal Volume

Culvert	Sediment Removed (CY)
C0	<1
C1	--
C2	3
C3	174
C4	14
Total	192

The total material removed represents a visual estimate of the dewatered solids from the roll-offs, which will be disposed of in accordance with East Palestine Waste Management Plan (Appendix L) that was approved by USEPA on April 18, 2023 (Arcadis 2023a). Liquid waste obtained from the work area within the culverts and from the dewatering roll-offs was off-loaded to the one-million-gallon Modular Tanks.

4 References

Arcadis. 2023a. Appendix L – East Palestine Waste Management Plan. East Palestine Train Derailment, Columbiana County, Ohio. April 18.

Arcadis. 2023b. Sulphur Run Culvert Sediment Removal Plan. East Palestine Train Derailment, Columbiana County, Ohio. November 8.

Arcadis. 2023c. Comprehensive Sheen and Sediment Investigation Work Plan – Sulphur Run and Leslie Run. East Palestine Train Derailment, Columbiana County, Ohio. December 19.

Tables

Table 2-1 Culvert C1 Supplemental Assessment
Culvert Sediment Removal Report
East Palestine Train Derailment

Site Name	Distance From Downstream (ft)	Culvert Width (ft)	Sediment Depth (in)	Estimated Sediment Volume (CY)	Sheen Category [a]	Stream Morphology	Bottom Conditions	Material Type
Outlet	0	15	--	--	--	--	--	--
C1-50	50	15	-- [b]	-- [b]	1	Riffle	No bottom	Sediment mixed with cobble/gravel
C1-100	100	10	-- [b]	-- [b]	2	Riffle	No bottom	Sediment mixed with cobble/gravel
C1-150	150	10	-- [b]	-- [b]	1	Riffle	No bottom	Sediment mixed with cobble/gravel
C1-200	200	10	-- [b]	-- [b]	3	Riffle	No bottom	Sediment mixed with cobble/gravel
C1-220	220	10	-- [b]	-- [b]	3	Riffle	Transition to corrugated pipe	Sediment mixed with cobble/gravel
C1-250	250	10	1	1	0	Pool	Corrugated pipe	Minimal sediment between ribs
C1-300	300	10	1.5	2	0	Pool	Corrugated pipe	Sediment and gravel
C1-350	350	10	2	3	3	Pool	Corrugated pipe	Minimal sediment between ribs
C1-400	400	10	2	3	2	Pool	Corrugated pipe	Fine sediment, little rock
C1-450	450	10	4	6	1	Pool	Concrete bottom	Sandy sediment
C1-500	500	10	4	6	0	Pool	Concrete bottom	No sediment
C1-550	550	10	0	0	0	Riffle	Concrete bottom	No sediment
C1-600	600	10	0	0	0	Riffle	Concrete bottom	No sediment
C1-650	650	10	0	0	0	Riffle	Concrete bottom	No sediment
C1-700	700	10	0	0	0	Riffle	Concrete bottom	No sediment
C1-750	750	10	0	0	0	Pool	Concrete bottom	No sediment
C1-800	800	10	0	0	0	Pool	Concrete bottom	No sediment
Inlet	818	--	--	--	--	--	--	--
			Total (CY)	**22**				

Notes:

[a] Scores are based on the following criteria:

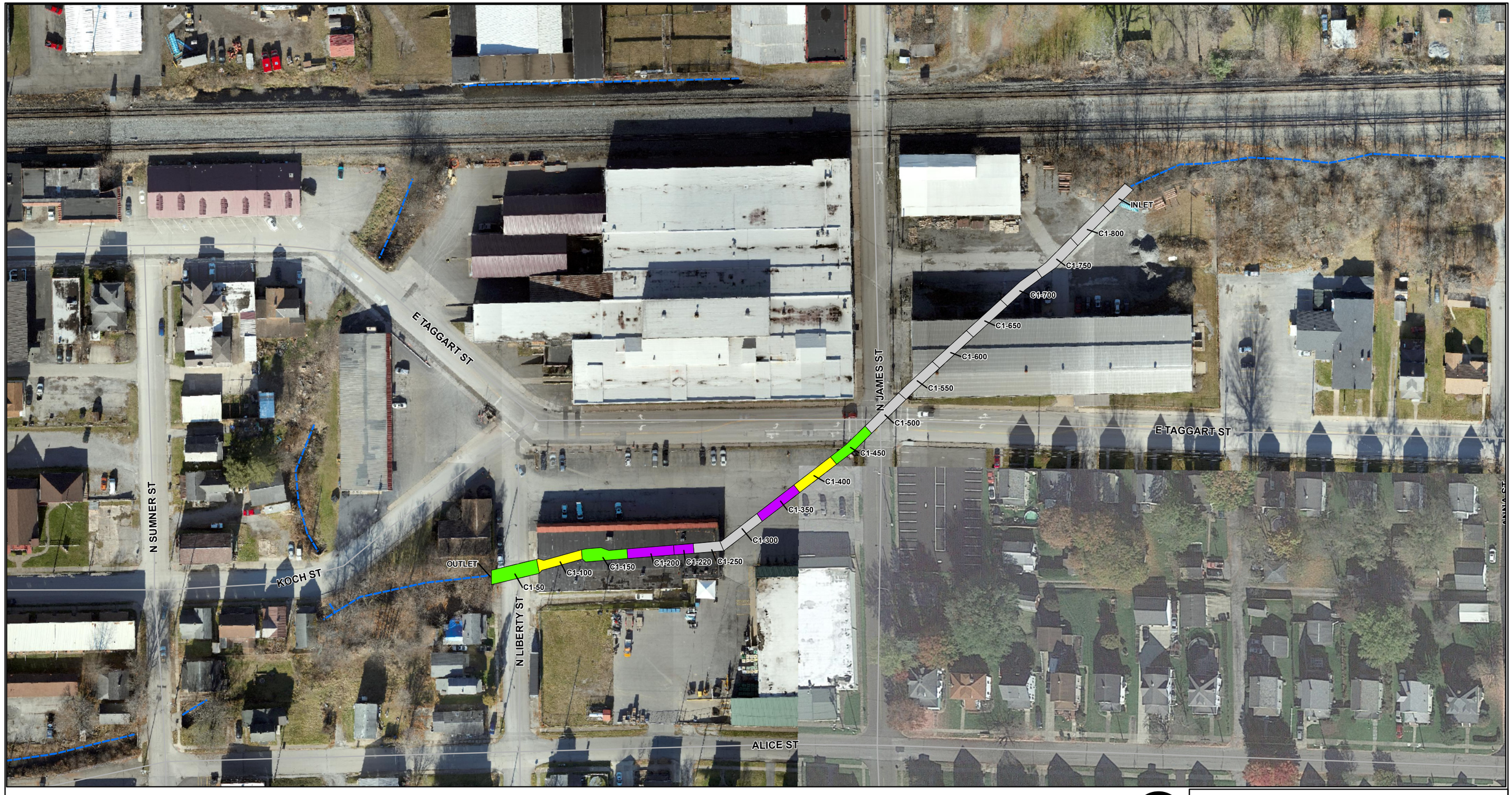
0 = No sheen
1 = Light sheen; assigned when a small presence of string-sheen is observed, and the majority of the stream bed area/culvert bottom does not produce sheen during disturbance
2 = Medium sheen assigned when there is a step-down in the presence of sheen stream/culvert-wide, with basketball-sized bubbles and no odor
3 = Heavy sheen assigned when there is a stream/culvert-wide prevalence of sheen or larger amounts of sheen produced with odor upon disturbance

[b] Estimated sediment depth/volume has not been determined. Hard bottom was not identified, despite pot holing more than 2 feet deep.

Acronyms and Abbreviations:

CY = cubic yards
ft = feet
in = inch

Figures



Legend

Qualitative Sheen Observations

- Score 0
- Score 1
- Score 2
- Score 3

Map Date: 12/21/2023

Drone image onsite dated: 12/09/2023
Drone image offsite dated: 12/09/2023

0 100 200
Feet

NORFOLK SOUTHERN
EAST PALESTINE, OHIO
CULVERT SEDIMENT REMOVAL REPORT

CULVERT C1
SUPPLEMENTAL ASSESSMENT

ARCADIS

FIGURE
2-1

Document Path: T:_ENV\NorfolkSouthern\EastPalestine_Feb5_2023\MXD\Culvert\Figure 2-1 Culvert C1 Supplemental Assessment.mxd

Appendix A

Photographic Log

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

Photograph: 1

Description: Culvert C0 before cleaning.

Date: 11/16/2023

Location: C0

Photograph: 2

Description: Culvert C0 after cleaning.

Date: 11/16/2023

Location: C0

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

Photograph: 3

Description: Culvert C0 after cleaning.

Date: 11/16/2023

Location: C0

Photograph: 4

Description: Culvert C2 before cleaning.

Date: 11/18/2023

Location: C2

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

Photograph: 5

Description: Culvert C2 before cleaning.

Date: 11/18/2023

Location: C2

Photograph: 6

Description: Culvert C2 after cleaning.

Date: 11/18/2023

Location: C2

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

Photograph: 7

Description: Culvert C4 before cleaning.

Date: 11/13/2023

Location: C4

Photograph: 8

Description: Culvert C4 before cleaning.

Date: 11/13/23

Location: C4

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

Photograph: 9

Description: Culvert C4 after cleaning.

Date: 11/16/2023

Location: C4

Photograph: 10

Description: Culvert C4 after cleaning.

Date: 11/16/23

Location: C4

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

Photograph: 11

Description: Culvert C3 before cleaning.

Date: 11/27/23

Location: C3

Photograph: 12

Description: Culvert C3 before cleaning.

Date: 11/27/23

Location: C3

Culvert Cleaning Photographic Log

Norfolk Southern Railway Company
East Palestine Derailment
East Palestine, OH

	**Photograph: 13** **Description:** Culvert C3 after cleaning with the redistributed vacuumed and rinsed stones. **Date:** 12/15/23 **Location: C3**
	**Photograph: 14** **Description:** Culvert C3 after cleaning. **Date:** 12/15/23 **Location: C3**

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