



Technical Memorandum

November 25, 2023

To	CSX Transportation	Tel	
Prepared By	GHD	Email	
Reviewed By	GHD	Ref. No.	12628999
Approved By	GHD, CSX Transportation	Distributed By	GHD
Subject	Memo 5 – Summary of Real-Time Air Monitoring Results November 24, 2023, 17:00 to November 25, 2023, 04:59 Eastern Time Livingston, Kentucky – Train Derailment		

The purpose of this memorandum is to provide CSX Transportation (CSXT) with a summary of the real-time air monitoring activities, results, and observations from real-time air monitoring being performed at the location of a train derailment, and subsequent fire near the town of Livingston, Kentucky at approximate Mile Post (MP) 138.84 on the Cincinnati Corbin (CC) subdivision (Site). The derailment occurred on November 22, 2023, and involved approximately sixteen (16) mixed freight rail cars containing various commodities including multiple tank cars containing molten sulfur.

This memorandum summarizes the real-time air monitoring data collected between 17:00 Eastern Time (ET) on November 24, 2023, to 04:59 ET on November 25, 2023 (monitoring period). GHD collected remotely monitored real-time air monitoring data from stationary locations around the perimeter of the Site and within the surrounding community. GHD mobile industrial hygiene (IH) professionals also manually recorded real-time air monitoring data using hand-held instruments throughout the work areas, Site perimeter, and nearby community.

Real-time air monitoring was used primarily as a screening tool to quickly indicate the presence of elevated airborne concentrations of Site-specific constituents of interest (COI) associated with molten sulfur: flammability as a percentage of the lower explosive limit (%LEL), hydrogen sulfide, sulfur dioxide; in addition to COIs related to the subsequent fire: respirable particulate matter with a diameter of 2.5 microns or less (PM_{2.5}) and total particulate matter with a diameter of 10 microns or less (PM₁₀) and nitrogen dioxide. Oxygen was monitored in conjunction with flammability. Oxygen rich or deficient environments may shift the LEL or upper explosive limit (UEL) and cause erroneous readings for flammable gases.

Real-time air monitoring activities and strategies were performed in accordance with the Site-specific Air Monitoring Plan (AMP), developed by GHD, reviewed by a certified industrial hygienist (CIH), and provided to CSXT on November 22, 2023. On November 23, 2023 the AMP was amended and provided to CSX in order to provide additional SO₂ action levels for community monitoring.

Evaluation of readings relative to established action levels were based on an approximate 1-minute average of concentrations measured by the air monitoring instruments. When readings of a COI were sustained at a concentration at, or above, the action level for the appropriate time period (generally one minute), they were considered an exceedance. Conversely, instantaneous readings that dispersed quickly and were not sustained for over one minute represent transient concentrations and are not representative of ambient conditions over a sustained duration.

GHD identified the following Site activities with potential exposures to the Site-specific COI during the monitoring period:

- Tank car inspection, assessment, and relocation activities

- Fire extinguishing activities
- Ground disturbance activities

The remotely monitored and manually collected real-time air monitoring data and tactics are summarized below.

Remotely Monitored Real-Time Air Monitoring System

GHD has established a real-time remotely monitored air monitoring system to measure ambient air at locations with potential airborne exposures to the Site-specific COI. GHD deployed instruments **Honeywell AreaRAE monitors (AreaRAE)** equipped with a catalytic bead sensor specific for measuring %LEL, and electrochemical sensors specific for H₂S, SO₂, and oxygen.

Each remotely monitored real-time air monitoring instrument was deployed approximately 4.5 feet above the ground to represent the air quality within the typical breathing zone of personnel in the area. AreaRAE units continuously monitor airborne concentrations of COI and using radio telemetry transmit instantaneous readings (approximately every 20-60 seconds) to a host computer for simultaneous monitoring from a central location.

During the monitoring period, GHD maintained four (4) stationary instruments within the surrounding community of the Site.

- **Location 1:** AreaRAE 02225 – Church
- **Location 2:** AreaRAE 02056 – Rail Car Staging
- **Location 3:** AreaRAE 01871 – Rolloff Staging Area
- **Location 4:** AreaRAE 02103 – Residential Property

Remotely monitored stationary real-time air monitoring locations are shown on Figure 1. During this monitoring period, the remotely monitored air monitoring system recorded 19,971 real-time air monitoring readings for total SO₂, %LEL, H₂S, and oxygen. The details of each location, monitoring period, and a summary of the remotely logged monitoring data are summarized in Table 1.

Table 1 Remotely Monitored Real-Time Air Monitoring Data Summary

Location / Meter ID	Total Number of Readings ¹	COI Number of Readings Above Action Level (Action Levels) ²			
		SO ₂ (≥0.2 ppm)	%LEL (≥1%)	H ₂ S (≥0.5 ppm)	%Oxygen (≤19.5 or ≥ 23.5%)
AreaRAE 02225 – Church	6,873	3	0	0	0
AreaRAE 02056 – Rail Car Staging	6,358	3	0	0	0
AreaRAE 01871 – Rolloff Staging Area	6,020	0	0	0	0
AreaRAE 02103 – Residential Property	720	0	0	0	0
Definitions: COI – Constituent of interest SO ₂ – Sulfur dioxide LEL – Lower explosive limit H ₂ S – Hydrogen sulfide ppm – Parts per million % – percent ≥ – greater than or equal ≤ – less than or equal					
Notes: 1. AreaRAE units continuously monitor airborne concentrations of COI and transmit instantaneous readings (approximately every 20-60 seconds) to a computer for simultaneous monitoring using radio telemetry. 2. The evaluation of airborne concentrations relative to the established action levels for the associated COI were based on the approximate one-minute average. As such, the number of readings displayed may have represented transient concentrations but may not represent a one-minute action level exceedance.					

Manually Collected Real-Time Air Monitoring Data

Manually collected real-time air monitoring data was collected at breathing zone height (approximately 4.5 feet) using handheld instruments at the perimeter of the work areas, inside the work zones, and surrounding community. The purpose of the manually logged data was to characterize exposures in real-time during the various operations throughout the Site, as well as identify any potential fugitive emissions related to mitigation activities.

GHD used the following handheld instruments to measure airborne concentrations:

- **Honeywell MultiRAE instruments** equipped with a catalytic bead sensor specific for %LEL, and electrochemical sensors specific for SO₂, H₂S, and oxygen.
- **TSI DustTrak DRX (DustTrak)** aerosol monitors equipped with a light-scattering laser photometer to detect particulate matter.

The data collected from these handheld devices was logged into an electronic handheld data collection device. Real-time air monitoring readings were collected at positions upwind, downwind, and within the breathing zone of workers during the monitoring period at the Site. GHD mobile teams logged over 264 real-time air monitoring readings during the monitoring period.

A summary of the manually logged data for the monitoring period is provided below in Table 2. Locations of the manually logged data is shown on Figure 1 (attached).

Table 2 Manually Logged Real-Time Air Monitoring Data

COI	Action Level ¹	Reading Type	Result
Hydrogen Sulfide	≥0.5 ppm	Number of Readings	238
		Number of Readings Above Action Level	0
		Maximum Reading	<0.1 ppm
Sulfur Dioxide	≥0.2 ppm	Number of Readings	259
		Number of Readings Above Action Level	1
		Maximum Reading	8.0 ppm
Nitrogen Dioxide	≥0.2 ppm	Number of Readings	0
		Number of Readings Above Action Level	-
		Maximum Reading	-
Respirable Particulate Matter (as PM _{2.5})	≥2.5 mg/m ³	Number of Readings	103
		Number of Readings Above Action Level	0
		Maximum Reading	0.031
Respirable Particulate Matter (as PM ₁₀)	≥5 mg/m ³	Number of Readings	102
		Number of Readings Above Action Level	0
		Maximum Reading	0.04
%LEL	≥1% LEL	Number of Readings	264
		Number of Readings Above Action Level	0
		Maximum Reading	<1%
Oxygen	≤19.5 or ≥23.5%	Number of Readings	264
		Number of Readings Above Action Level	0

Definitions:

COI – Constituent of interest
 LEL – Lower explosive limit
 ppm – Parts per million
 % – percent
 mg/m³ – milligrams per cubic meter
 ≥ – greater than or equal
 ≤ – less than or equal
 PM 2.5 – Particulate matter 2.5 microns in diameter or less
 PM 10 – Particulate matter 10 microns in diameter or less

Notes:

1. The evaluation of airborne concentrations relative to the established action levels for the associated COI were based on the approximate one-minute average.

Real-Time Air Monitoring Data Evaluation and Summary of Results

The **remotely monitored** real-time air monitoring data for the monitoring period indicated the following:

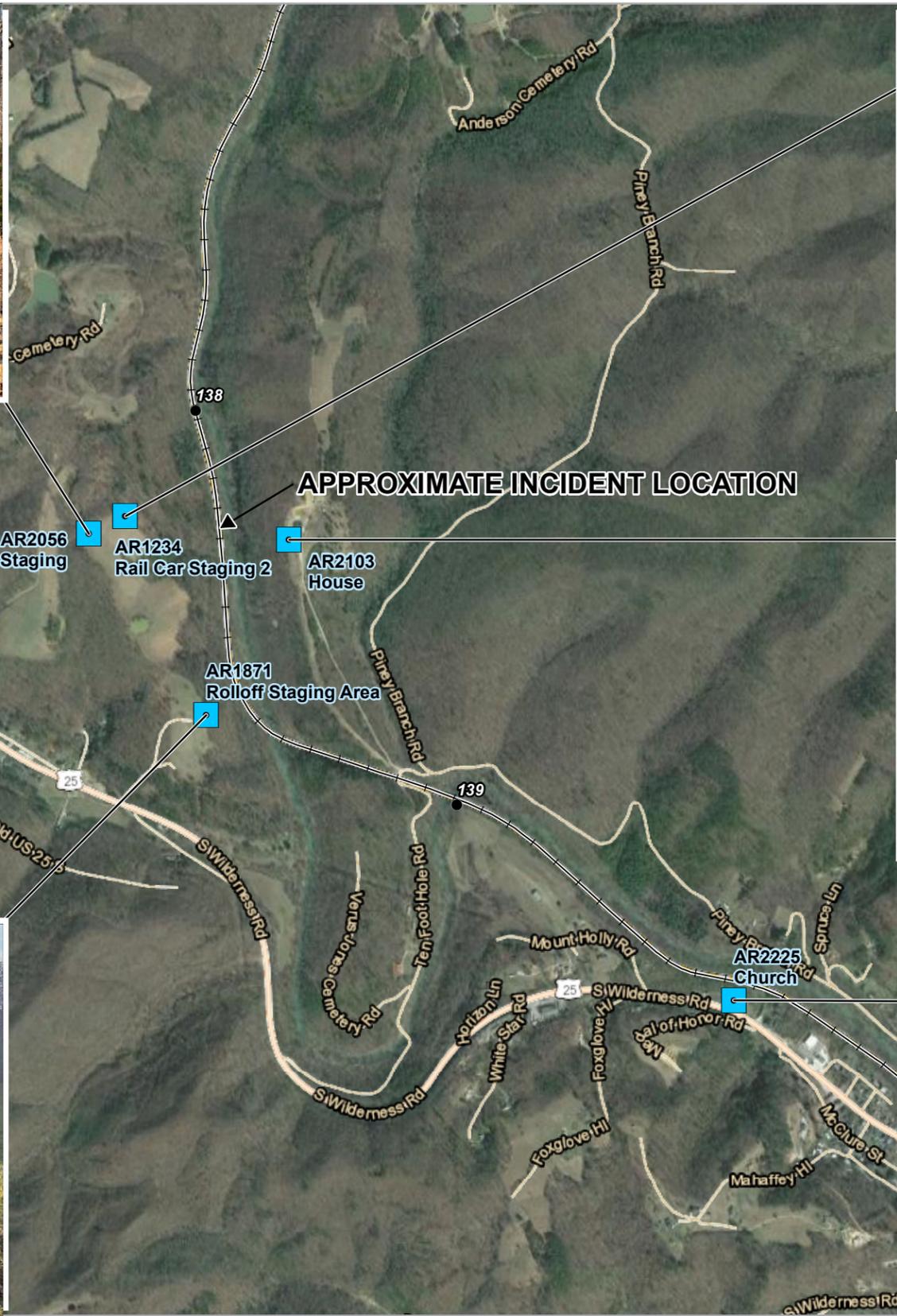
- **Hydrogen Sulfide (Action Level 0.5 ppm)**
 - No hydrogen sulfide readings were documented above the action level.
- **Sulfur Dioxide (Action Level of 0.2 ppm)**
 - The following readings were elevated above the action level:
 - AreaRAE 02225: At 04:14 ET, three (3) instantaneous readings were documented above the action level of 0.2 ppm at AreaRAE 02225 located at Livingston Pentecostal Church. The maximum reading was 0.2 ppm. The readings dispersed quickly and were not sustained over the approximate averaging period of 60-seconds. As such, the readings may have represented transient concentrations, and were not representative of ambient conditions over a sustained duration.
 - AreaRAE 02056: At 02:45 ET, three (3) instantaneous readings were documented above the action level of 0.2 ppm at Location 2. The maximum reading was 0.2 ppm. The readings dispersed quickly and were not sustained over the approximate averaging period of 60-seconds. As such, the readings may have represented transient concentrations, and were not representative of ambient conditions over a sustained duration.
- **%LEL (Action Level of 1% LEL)**
 - No %LEL readings were documented above the action level.
- **Oxygen (Normal Range 19.5-23.5%)**
 - No oxygen readings were documented outside the normal range.

The **manually** real-time air monitoring data for the monitoring period indicated the following:

- **Hydrogen Sulfide (Action Level 0.5 ppm)**
 - No hydrogen sulfide readings were documented above the action level.
- **Sulfur Dioxide (Action Level of 0.2 ppm)**
 - The following readings were elevated above the action level:
 - At 18:45, one (1) sustained reading was documented at 8.0 ppm, above the action level of 0.2 ppm. The reading was documented in the immediate vicinity of a tank car during movement of a molten sulfur car.
 - Mitigation measures implemented:
 - GHD recommended personnel in the work areas relocate to a location upwind of the tank car. Water was applied to the tank car and sulfur dioxide concentrations dissipated to below the sulfur dioxide action level after approximately three minutes.
- **Respirable Particulate Matter - as PM_{2.5} (Action Level 2.5 mg/m³)**
 - No PM 2.5 readings were documented above the action level.
- **Respirable Particulate Matter - as PM₁₀ (Action Level 5 mg/m³)**
 - No PM 10 readings were documented above the action level.
- **%LEL (Action Level of 1% LEL)**
 - No %LEL readings were documented above the action level.
- **Oxygen (Normal Range 19.5-23.5%)**
 - No oxygen readings were documented outside the normal range.

Quality Assurance and Quality Control

The information contained in this memorandum will be considered preliminary, as a final Quality Assurance / Quality Control (QA/QC) of the data has not been completed. At the completion of the project, a report will be prepared in which the data collected through real-time air monitoring will be compiled, summarized, and reported to CSXT. Data contained in the final report will have been through the final QA/QC process, will be reviewed by a GHD Certified Industrial Hygienist (CIH), and will be considered final.

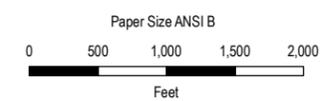


Legend

- Stationary Monitoring Location (5)
- Mile Post
- Track Centerline

NOTES:

1. > AL = Above Action Level 2
2. Action Level for Hydrogen Sulfide is ≥ 0.5 ppm
3. Action Level for Sulfur Dioxide is ≥ 0.2 ppm
4. Action Level for Nitrogen Dioxide is ≥ 0.2 ppm
5. Action Level for LEL is ≥ 1.0 %
6. Action Level for PM2.5 is ≥ 2.5 mg/m3
7. Action Level for PM10 is ≥ 5.0 mg/m3
8. Action Level for Oxygen is $\leq 19.5\%$ or $\geq 23.5\%$
9. AreaRAE readings are reported as 1-minute averages

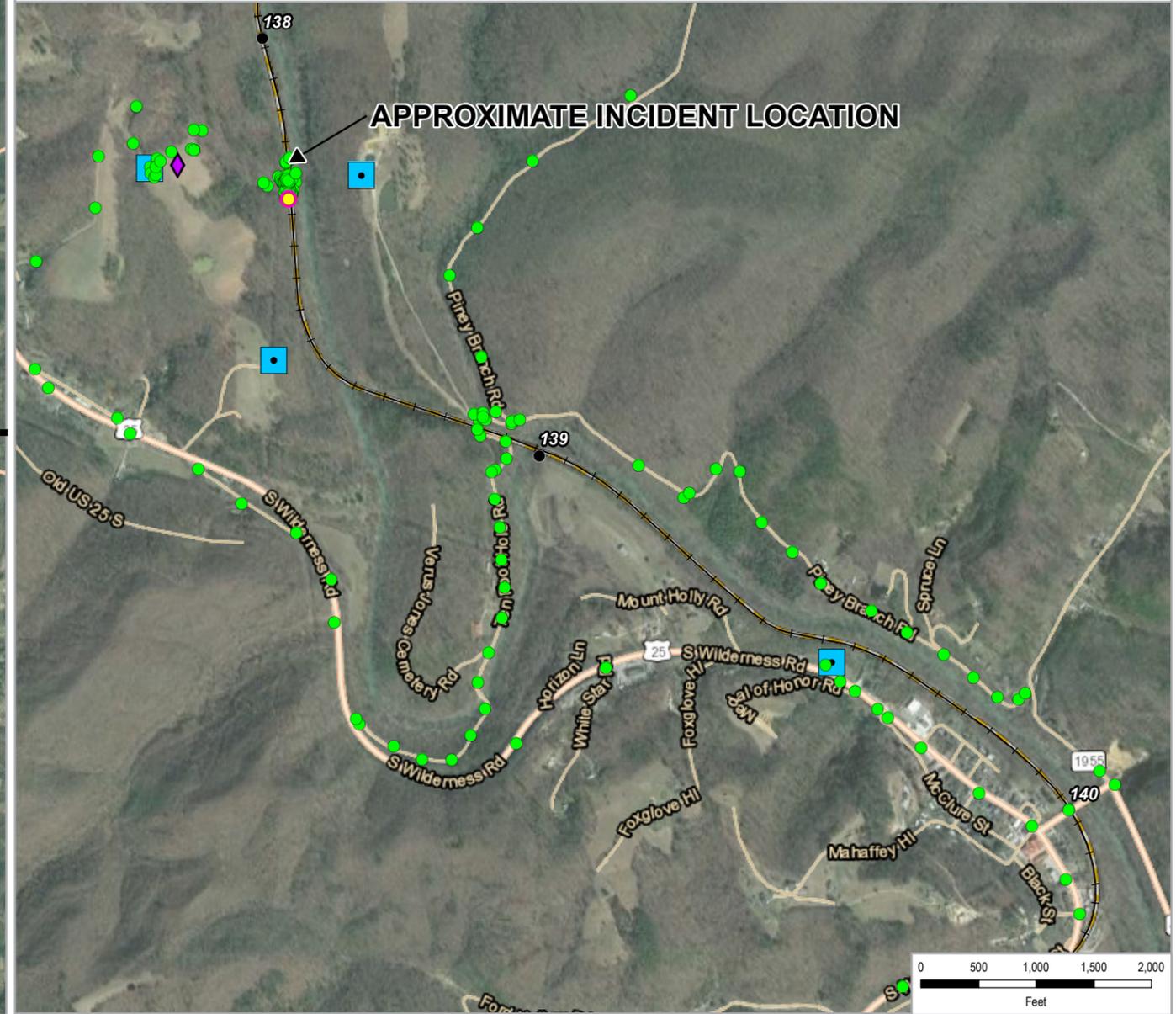
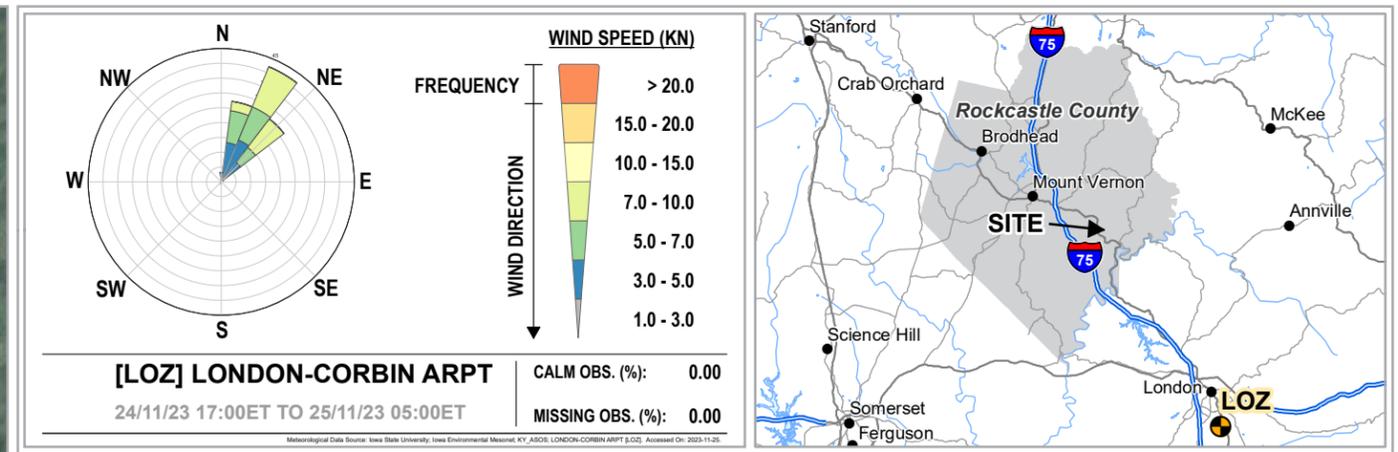
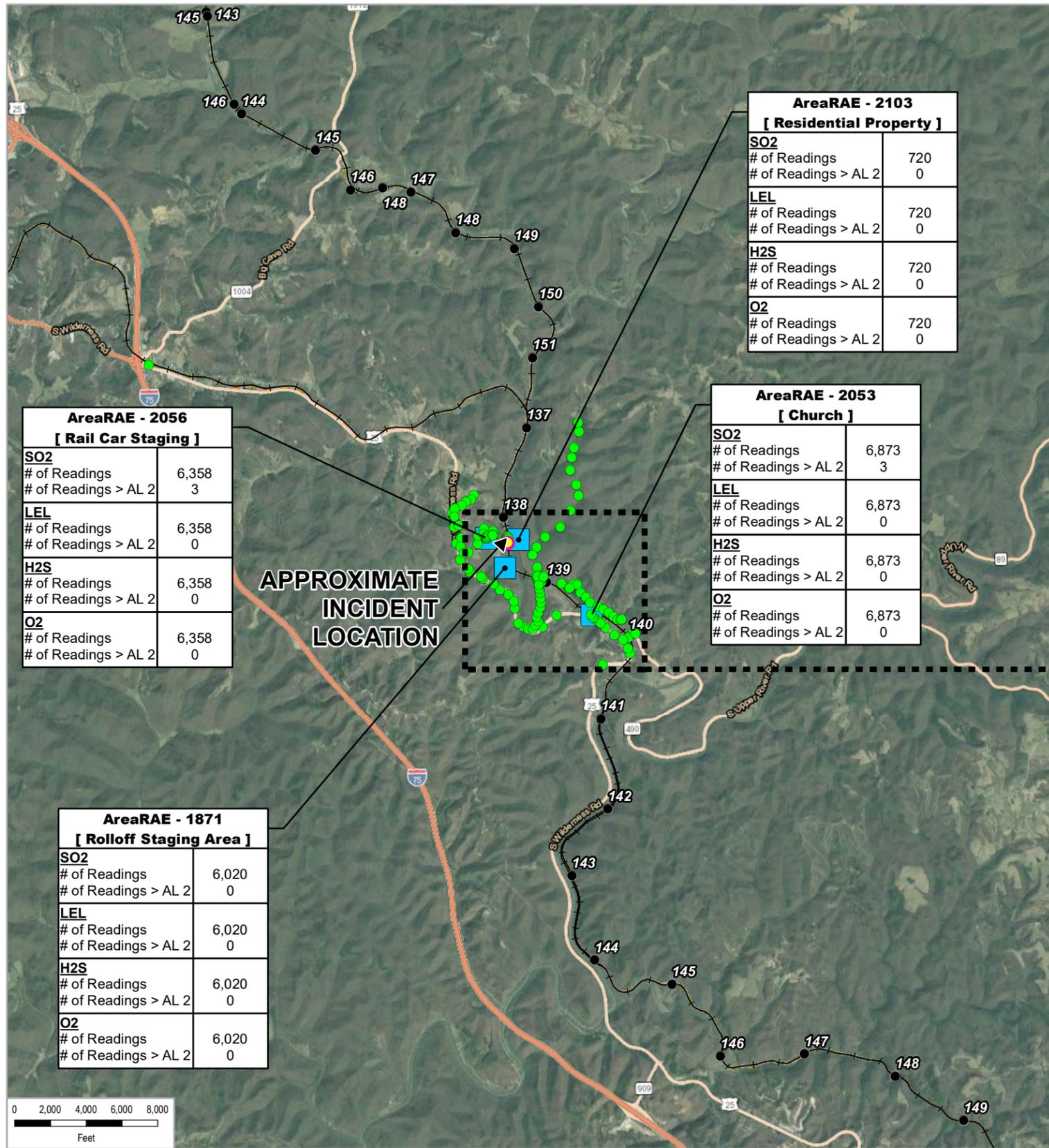


Map Projection: Lambert Conformal Conic
 Horizontal Datum: North American 1983
 Grid: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet

CSXT FIRE
CINCINNATI CORBIN SUB - MP 138.2
LIVINGSTON, KENTUCKY

2023/11/25 - 08:00 (ET)
AREARAE DEPLOYMENT LOCATIONS

Project No. 12628999
 Date Nov 25, 2023



- Legend**
- Real Time Air Monitoring Location (Above SO2 Action Level) (1)
 - Real Time Air Monitoring Location (Below Action Level) (263)
 - Stationary Monitoring Location (4)
 - GHD Host Location (1)
 - Weather Station (LOZ)
 - Mile Post
 - Track Centerline

- NOTES:**
- > AL = Above Action Level 2
 - Action Level for Hydrogen Sulfide is ≥ 0.5 ppm
 - Action Level for Sulfur Dioxide is ≥ 0.2 ppm
 - Action Level for Nitrogen Dioxide is ≥ 0.2 ppm
 - Action Level for LEL is ≥ 1.0 %
 - Action Level for PM2.5 is ≥ 2.5 mg/m3
 - Action Level for PM10 is ≥ 5.0 mg/m3
 - Action Level for Oxygen is $\leq 19.5\%$ or $\geq 23.5\%$

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet

GHD

CSXT FIRE
CINCINNATI CORBIN SUB - MP 138.2
LIVINGSTON, KENTUCKY
2023/11/24 - 17:00 TO
2023/11/25 - 04:59 (ET)
AIR MONITORING RESULTS SUMMARY

Project No. 12628999
Date Nov 25, 2023