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November 11, 2025

Mr. Joshua Rhoades
Manager, Permit Section
Illinois Environmental Protection Agency
Division of Land Pollution Control
Bureau of Land
2520 W. Iles Ave
Springfield, Illinois 62704

Former Public Works Yard Steam Enhanced Extraction – System Shutdown Advanced Notification
Roxana, Illinois
1191150002 – Madison County
Equilon Enterprises LLC d/b/a Shell Oil Products US
Log No. B-43R-CA-116, CA-117

Dear Mr. Rhoades:
AECOM Technical Services, Inc. (AECOM), on behalf of Equilon Enterprises LLC d/b/a Shell Oil Products US (Shell), is submitting this Corrective Measures Program (CMP) Phase IV notification. AECOM is providing this notification to inform IEPA that the Roxana Former Public Works Yard (FPWY) Steam Enhanced Extraction (SEE) System is projected to be permanently shut down, beginning with the shutdown of steam injection, on or after approximately November 25, 2025, based on achievement of the IEPA-approved shutdown criteria:

- The minimum target soil temperature of 80.2 °C
- And a linear mass recovery rate curve or decreasing recovery trends using Mann-Kendall analysis.

In accordance with Condition 19 of the IEPA letter dated 8/22/2022, vapor extraction will continue in the FPWY for 30 days following the shutdown of steam injection to prevent rebounding or migration of contaminants near the residential neighborhood adjacent to the FPWY.

SEE System Shutdown Criteria Background
The criteria were not approved in a single IEPA letter, but rather were approved, with some modifications, over multiple submittals and IEPA responses. Therefore, it is not possible to reference a single document in which all the approved shutdown criteria appear in their final form.

- The shutdown criteria were first proposed in the PWY SEE Workplan dated January 21, 2022.
    - Section 4.6 of workplan, page 12
- The 8/22/2022 IEPA letter rejected Criteria 3 and conditionally approved other criteria with modifications
    - Conditions 4.a through 4.g and 11
- Final Design Report and Construction Work Plan (FDRCWP) dated December 16, 2022, proposed modified shutdown criteria, and stated that Criteria 1 and Criteria 2 would both have to be met to allow for shutdown.
    - Shell responses to IEPA Conditions 4.a through 4.g and 11

- The 5/5/2023 IEPA letter approved the FDRCWP shutdown criteria but asked for further explanation regarding the Mann-Kendall analysis referenced in Criteria 2.
    - Conditions 4 and 5
- AECOM/Shell letter dated August 3, 2023, stated that if Criteria 1 were met then Criteria 2 would not need to be met.
    - Shell response to IEPA Condition 4
- The 1/26/2024 IEPA letter approved the AECOM/Shell August 3, 2023, letter without commenting any further on shutdown criteria.

Approved SEE System Shutdown Criteria

The SEE system may be permanently shut down when the minimum target soil temperature of 80.2 °C is achieved, plus one of the following criteria is met:

1) Achieve a mass recovery rate of 10% of the peak (4 consecutive sampling events over 14 days). Verify that system flow rate is not less than 70% of average.
2) Achieve a linear mass recovery rate curve or decreasing recovery trends using Mann-Kendall analysis. Verify that system flow rate is not less than 70% of average.
3) Criteria 3 will not be used to evaluate SEE shutdown. It is included here only to keep shutdown criteria numbering consistent with work plan and IEPA 8/22/2022 letter.
4) Class 1 groundwater objectives and other groundwater-related exposure route values are met within the entire dissolved plume within the bounds of the PWY.
    a. AECOM note – the SEE system was not designed to treat groundwater within the entire FPWY, so this criterion was not a goal.

There are two scenarios in which SEE may be shut down:

Scenario 1
- Minimum target soil temperature of 80.2°C is achieved; and
- Shutdown Criteria 1 is met

Scenario 2
- Minimum target soil temperature of 80.2°C is achieved; and
- Shutdown Criteria 2 is met

SEE System Performance Discussion

The FPWY SEE System has achieved Scenario 2. Additionally, Scenario 1 is anticipated to be achieved prior to the anticipated approximate shutdown date of November 25, 2025, as daily mass recovery rates continue to decline. **Table 1** below provides SEE system performance and mass removal data as of November 7, 2025.

Item	Description	Comments
Input Energy to Date	10,491.7 MWh	Energy applied to steam wells
Design Energy Target	8,804 MWh	Actual input energy exceeds design target.
Input Energy Density to Date	393.63 kWh/yd^3	Based on a heated volume of ~26,000 yd^3
Design Energy Density Target	389.00 kWh/yd^3	Actual input energy density exceeds design target.

Item	Description	Comments
Average Target Zone Temperature	82.5°C (on 11/9/2025)	Measured by digiTAM temperature sensors within the active treatment zone. Target temperature is 80.2°C.
Average Combined Vapor Extraction Rate	1,148 scfm	MPE wells flow + air stripper flow. Days when extraction did not occur are not factored in.
Cumulative water (steam) injected	4,226,212 gal	
VOC Mass Recovered in 2024	35,673 lbs	
VOC Mass Recovered in 2025	80,752 lbs	
Total VOC Mass Recovered	116,425 lbs	
Peak Mass Removal Rate	2,247 lbs/day	Occurred August 28, 2025
2025 Average VOC Removal Rate	362.1 lbs/day	Days when extraction did not occur are not factored in.

Table 1 – SEE System Performance and Mass Removal Data as of November 7, 2025

Target Temperature

The target temperature of 80.2°C (176.3°F) was chosen because it is the minimum depth-dependent co-boiling temperature of benzene and water. The subsurface temperature is monitored by a network of temperature wells. Multiple sensors are contained within each individual well. The temperature wells are located in centroid locations of triangles formed by the three nearest steam injection wells and are in the coldest portions of the heated volume (see **Attachment 1**). Each temperature well is located 8 ft or more from the nearest steam injection location, so the actual subsurface temperature is higher than what is measured by the sensors for the majority of the heated volume. It is estimated that the actual average temperature of the majority of the heated volume is approximately 100°C (212°F).

For the purpose of evaluating the target temperature goal, the average subsurface temperature within the treatment zone (extraction zone) has been measured since the beginning of SEE operations in 2024, as shown in **Chart 1** below. The target temperature of 80.2°C, as measured by the temperature sensor wells within the treatment zone, was first reached on October 25, 2025. Issues with the steam boiler necessitated a pause to steam injection the next day, and steam injection was resumed on October 30, 2025. Target temperature was reached again on November 5, 2025, and has been maintained since then.

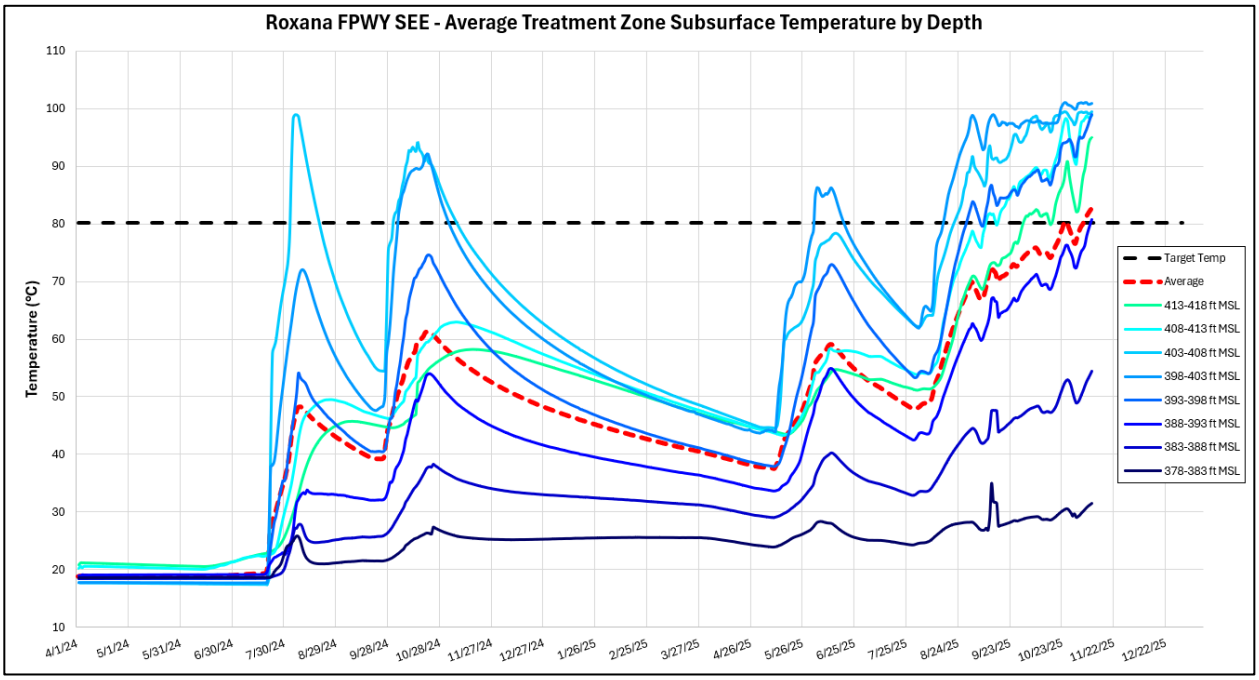


Chart 1 – Average Treatment Zone Subsurface Temperature by Depth as of November 9, 2025

Throughout this project, steam injection was only performed when both the liquid and vapor extraction components of the SEE system were operating, so that energy and resulting vapors would be contained within the FPWY.

Shutdown Criterion #1

Achieve a mass recovery rate of 10% of the peak (4 consecutive sampling events over 14 days). Verify that system flow rate is not less than 70% of average.

The discontinuous nature of steam injection and vapor and liquid extraction on this project has resulted in a mass recovery history that does not resemble a traditional bell curve. **Chart 2** below depicts VOC mass recovery.

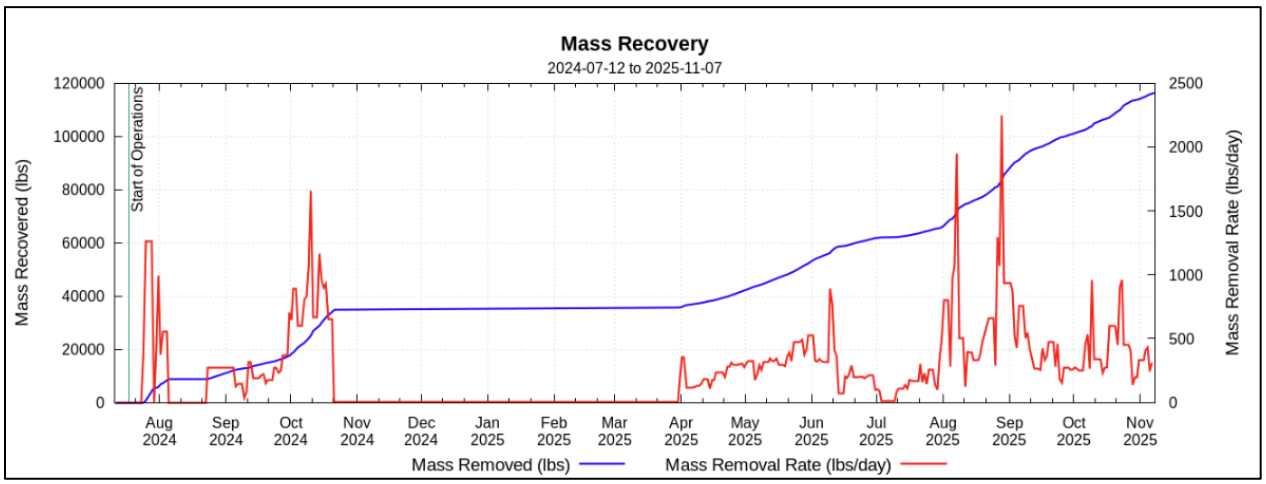


Chart 2 – SEE System VOC Mass Recovery as of November 7, 2025

The peak daily total VOC mass recovery rate of 2,247 lbs/day occurred on August 28, 2025; therefore, 10% of the peak is 224.7 lbs/day. As of November 7, 2025, the mass recovery rate was about 309.6 lbs/day, which is 13.7% of the peak. The average combined vapor extraction rate for the period October 12 to November 7, 2025 (the most recent 14 days in which daily readings were collected by the system operator) was 1,318 scfm, which is 114% of the average combined vapor extraction rate over the lifetime of the SEE system.

Shutdown Criterion #2

Achieve a linear mass recovery rate curve or decreasing recovery trends using Mann-Kendall analysis. Verify that system flow rate is not less than 70% of average.

Mann-Kendall analysis was used to evaluate SEE mass recovery. Analysis indicates that the mass recovery rate curve has a decreasing trend. If no VOC contamination were present outside the boundaries of the FPWY treatment area, a clear downward trend in the mass recovery curve would be expected as the quantity of target residual VOCs were depleted. However, due to the presence of outside contamination near the FPWY, particularly to the south/southeast (2020 Buckeye Partners LP gasoline release - IEPA Violation Notice L-2021-00084, LPC #1190905036 – Madison County), and the east (Wood River Refinery historical operations), the SEE system continues to capture additional VOC mass, even as the quantity of target residual VOCs within the FPWY is increasingly depleted. See **Attachment 2** for a more detailed discussion of the Mann-Kendall analysis of SEE mass recovery.

An electronic copy of this submittal is being sent separately directly to Dana Austin, Gary Ko, Takako Halteman, and Ali Al-Janabi with the IEPA.

If you have any questions please contact Buddy Bealer, Shell Senior Program Manager, at leroy.bealer@shell.com (484-632-7956), or Wendy Pennington at wendy.pennington@aecom.com (314-452-8929).

Sincerely,

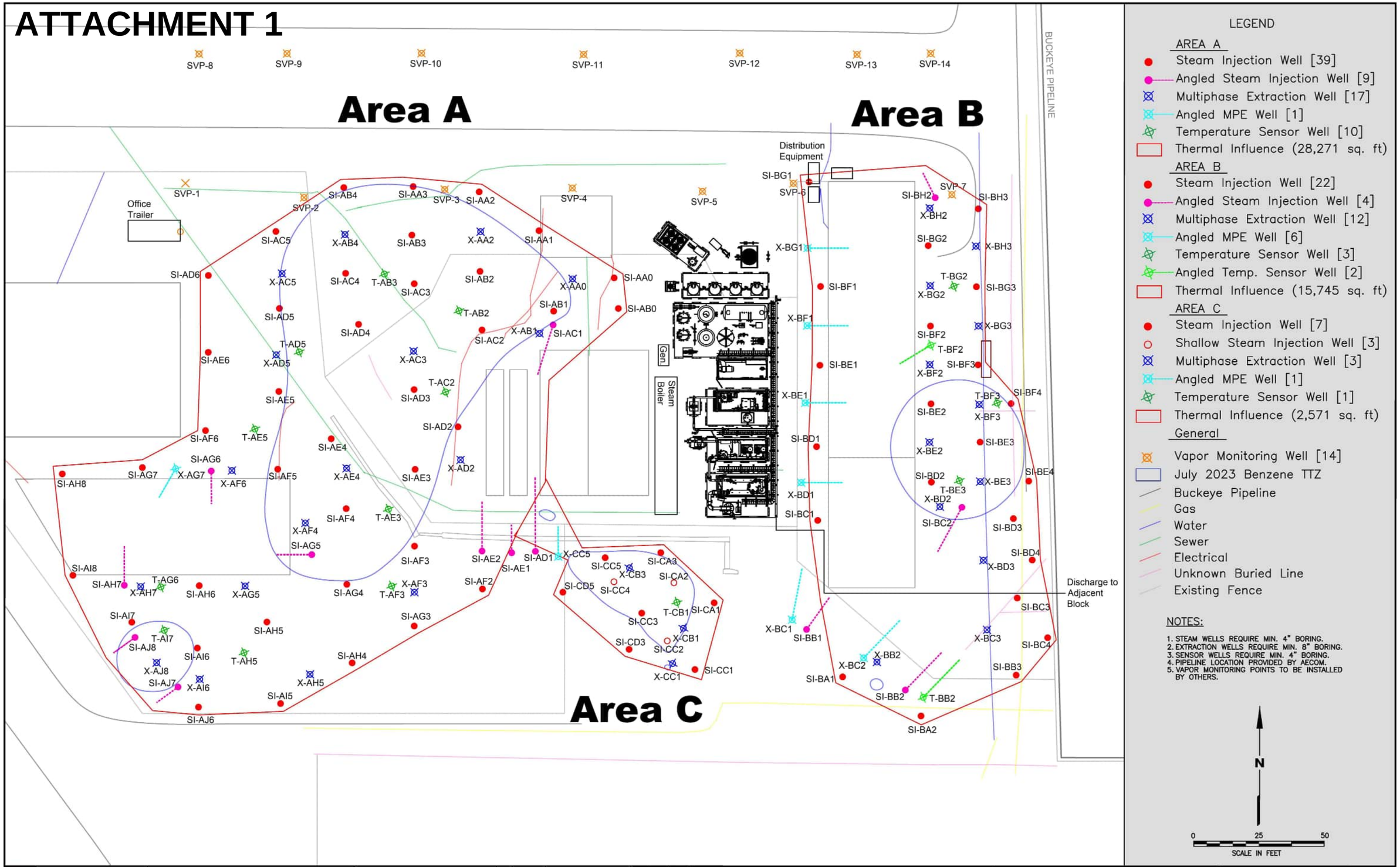
AECOM, on behalf of Shell Oil Products US

Samuel Fisher, CHMM Environmental Scientist	Wendy Pennington, PE Project Manager	Brett Howell, PG Geologist

Enclosures: Attachment 1 – SEE Well Field Layout (WFL-01)
Attachment 2 – Mann-Kendall Analysis of Vapor Phase VOC Recovery at Roxana Public Works Yard

cc: Buddy Bealer, Shell
Dana Austin, IEPA, Springfield
Gary Ko, IEPA, Springfield
Takako Halteman, IEPA, Springfield
Ali Al-Janabi, IEPA, Collinsville
Village of Roxana
Repositories – Roxana Public Library, website
Project File

ATTACHMENT 1



LEGEND

AREA A
- Steam Injection Well [39]
- Angled Steam Injection Well [9]
- Multiphase Extraction Well [17]
- Angled MPE Well [1]
- Temperature Sensor Well [10]
- Thermal Influence (28,271 sq. ft)

AREA B
- Steam Injection Well [22]
- Angled Steam Injection Well [4]
- Multiphase Extraction Well [12]
- Angled MPE Well [6]
- Temperature Sensor Well [3]
- Angled Temp. Sensor Well [2]
- Thermal Influence (15,745 sq. ft)

AREA C
- Steam Injection Well [7]
- Shallow Steam Injection Well [3]
- Multiphase Extraction Well [3]
- Angled MPE Well [1]
- Temperature Sensor Well [1]
- Thermal Influence (2,571 sq. ft)

General
- Vapor Monitoring Well [14]
- July 2023 Benzene TTZ
- Buckeye Pipeline
- Gas
- Water
- Sewer
- Electrical
- Unknown Buried Line
- Existing Fence

NOTES:

1. STEAM WELLS REQUIRE MIN. 4" BORING.
2. EXTRACTION WELLS REQUIRE MIN. 8" BORING.
3. SENSOR WELLS REQUIRE MIN. 4" BORING.
4. PIPELINE LOCATION PROVIDED BY AECOM.
5. VAPOR MONITORING POINTS TO BE INSTALLED BY OTHERS.

N

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SCALE IN FEET

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REV.	DATE (D/M/Y)	DESCRIPTION	DRAWN BY	ORG/ ENGR.	Aprovel Dist.
D4	2024/05/27	As-Built Well Survey Edits	CO		
D3	2024/05/24	As-Built Well Survey Edits	CO	CC	-
D2	2024/05/22	As-Built Well Survey	CO	CC	-
D1	2024/01/25	As-Built	CC	DR	-
C8	2023/09/07	UPDATED WELL COUNTS	GW	CW	CC
D5	2024/08/30	As-Built Sample Well Survey Edits	CC	CC	CC

LPE

DATE

APEGA PERMIT NUMBER: P09178

SCALE: NOT TO SCALE

TITLE: **SEE Well Field Layout**

CLIENT: **AECOM**

PROJECT: **Roxana Public Works Yard**
Roxana, Illinois

SHEET: **WFL-01**

ATTACHMENT 2

Mann-Kendall Analysis of Vapor-Phase VOC Recovery at Roxana Public Works Yard

A Mann-Kendall test can be used to determine if the rate of mass recovery at the Roxana SEE ISTR displays linear behavior. This statistical analysis can confirm that there is neither an upward, nor downward trend in the data. Confirming linear behavior indicates asymptotic conditions will be observed in the cumulative mass removed. The vapor-phase VOC recovery rate at the project, between October 21st, 2025, and November 7th, 2025, is presented in Figure 1 below.

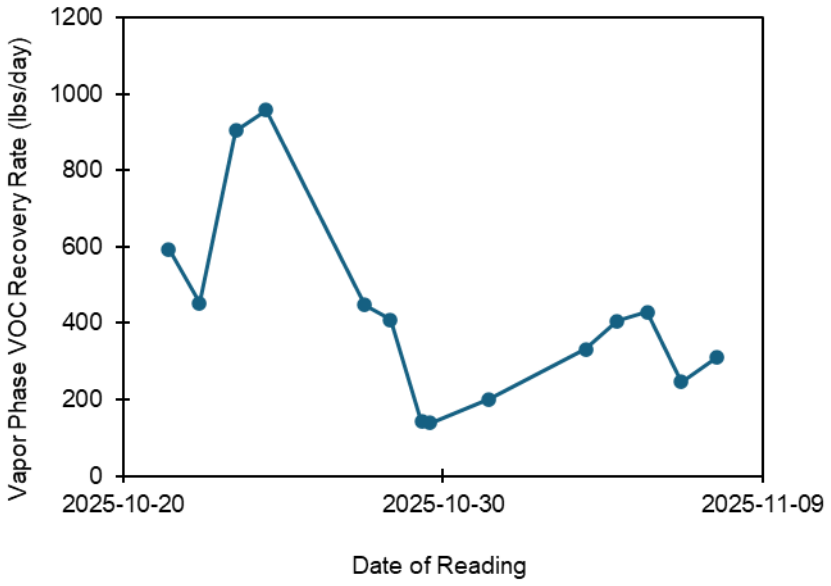

Figure 1: Vapor Phase VOC Recovery Rate October 21st, to November 7th, 2025

The average recovery rate during this period was 427 lbs/day. **This average is 19% of the peak observed rate of 2246 lbs/day**, recorded at the site on August 29th, 2025.

Further, the average rate of vapor extraction was 1318 scfm. **This flowrate is 114% of the average vapor flowrate across the project's uptime**.

Mann-Kendall tests use the null hypothesis that there is a trend in data, be upward or downward. Thus, linear behavior will be confirmed if the null hypothesis is rejected. The data, to be used in the Mann-Kendall analysis for VOC mass recovery rates at Roxana is in Table 1 below.

Table 1: Vapor Phase VOC Mass Recovery Rates

Date	Recovery Rate (lbs/day)
2025-10-21 10:15	593.5
2025-10-22 09:30	452.9
2025-10-23 12:35	904.3
2025-10-24 11:10	959.0
2025-10-27 13:16	448.1
2025-10-28 08:20	409.7
2025-10-29 08:00	141.4
2025-10-29 14:17	139.2
2025-10-31 10:30	201.6
2025-11-03 10:50	331.2
2025-11-04 10:20	406.6
2025-11-05 09:15	430.0
2025-11-06 10:30	246.2
2025-11-07 12:45	309.6

The Mann-Kendall test first requires computing the statistic:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sign(x_j - x_i)$$

With variance:

$$var = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{t} f_t(f_t-1)(2f_t+5)\right]$$

The test statistic S is converted into a standard normal variable:

$$Z = \begin{cases} \frac{S-1}{\sqrt{var}} & if\ S > 0 \\ 0 & if\ S = 0 \\ \frac{S+1}{\sqrt{var}} & if\ S < 0 \end{cases}$$

To determine if the hypothesis is to be accepted or rejected, the P value is found as:

$$p = 2(1 - \Phi(Z))$$

Where Φ(Z) is the cumulative distribution function of Z. Then, for 95% confidence there is neither an upward nor downward trend in the recovery rate, the p-value must be greater than 0.05 (to reject the null hypothesis). Completing this analysis for the recovery rates results in the following variable values.

Table 2: Mann-Kendal Test Variable Values

Test Variable	Value
S	-37
var	18.3
Z	-1.97
p-value	0.049

Since the p-value is smaller than 0.05, the hypothesis that there is an upward or downward trend is accepted. With a negative S value, it is indicated the trend is in a downward direction. This confirms that **the mass recovery rates across the 14 sampling events displayed a downward trend**, **at 19% of the project's peak observed rate.**