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July 19, 2023

Mr. Eric Clanton
Hazardous Waste Specialist
Montana Department of Environmental Quality
Waste Management Bureau
P.O. Box 200901
Helena, MT 59620-0901

RE: Response to DEQ's Questions / Comments on the AOC-16 Interim Measure 3rd Quarter 2022 Monitoring Report No. 3 and Submittal of a Revised 3rd Quarter 2022 Monitoring Report

Dear Mr. Clanton,

This letter serves to provide the Montana Department of Environment and Quality (DEQ) with responses to the questions / comments raised during the MDEQ's review[1] of the AOC-16 Interim Measure 3rd Quarter 2022 Monitoring Report No. 3 dated February 2, 2023.

Responses to the DEQ's questions / comments are provided below and a revised 3rd Quarter 2022 Monitoring Report is also attached incorporating the requested changes.

DEQ Comment 1: Section 2.1.2, bulleted section: Please correct the valve ID number. Also, it is unclear which blowers were shut down and which continued to operate; please revise.

CMR Response: The text in Section 2.1.2 has been modified to clarify the correct valve number (FV-23504A) and correct blower that was shutdown (BL2331). Blower BL2332 for dual-phase extraction (DPE) wells DPE-1 through DPE-4 continued to operate.

DEQ Comment 2: Section 2.2.1, page 4, Liquids section, 1st paragraph: Why did the change in laboratory cause individual EPH fractionation results to not be reported? Also, why was there a change in the laboratory used? Please provide an explanation in the report text.

CMR Response: The laboratory analysis of EPH and VPH was switched from the Pace Analytical facility located in West Columbia, South Carolina to the Pace National Laboratory in Mount Juliet, Tennessee to remedy previous delays in historically reporting these analyses. This explanation

[1] DEQ AOC-16 Interim Measure 3rd Quarter 2022 Monitoring Report No. 3 comment letter dated May 1, 2023.

has been added to the report text. The two laboratories used have different procedures for performing and reporting the fractionation analysis that were not clearly communicated. The Pace National laboratory in Mount Juliet initially only performs the EPH screening analysis and does not report individual fractionation unless requested, whereas the West Columbia, South Carolina laboratory reports both EPH screening and fractionation analysis upon receipt of the sample.

DEQ Comment 3: Section 2.2.1, page 5, 1st sentence at the top of the page: For purposes of relative comparison/visualization, what is the total height of the sight glass and what is the average height of the operating liquid level within the sight glass? Alternatively, what is the rough ratio of LNAPL to water as seen in the sight glass? DEQ understands that the sight glass is a non-quantitative visual of the knock-out tank contents; answers to one or more of these questions helps to put the height of the LNAPL into better perspective.

CMR Response: A photo of the sight glass is provided below. The ratio of water to LNAPL has been estimated to be approximately 20 to 1. This estimate is based on periodic visual observations during O&M site visits and regularly fluctuates based on the volume of water entering the system at any given time. Therefore, visual observations of LNAPL in the sight glass is not considered a good semi-quantitative measurement of system operations and performance. For this reason, measurements of LNAPL in the site glass have not been documented and it is not a parameter included in the OM&M Plan.

DEQ Comment 4: Section 2.2.4, page 6, Vapor Influent Flow Rate and Applied Vacuum section, second half of the 1st paragraph: Please revise this section as necessary to be consistent with the revisions made per comment #1 above. It is unclear which blowers were shut down.

CMR Response: The text in section 2.2.4 is accurate as written as blower BL2331 was shutdown. The text in Section 2.1.2 has been modified to clarify the correct valve number (FV-23504A) consistent with Response to MDEQ Comment 1.

DEQ Comment 5: Table A, page 13: Please add a column to indicate both the current monitoring frequency and the proposed/recommended future monitoring frequency. The report appears to recommend or request that the subsurface vacuum monitoring be reduced from monthly to semiannually. Please provide a clearer justification for the reduction in subsurface vacuum monitoring frequency in the text of the report.

CMR Response: A column showing the year 1 monitoring frequency has been added to Table A. Note that LNAPL thickness/groundwater gauging was also missing from the table and has been added along with a proposed reduction in monitoring frequency to semi-annually.

There are only three monitoring wells within the potential radius of influence of the DPE system for measuring groundwater elevation and vacuum: MW-22 located 26 feet from DPE-3, MW-64 located 21 feet from DPE-6, and MW-104 located 13 feet from DPE-3. MW-104 is also 22 feet from DPE-4 and is within the primary recovery trench where the maximum has been measured. Based on the data collected to date and limited locations of adjacent monitoring wells for subsurface vacuum measurements, the periodic vacuum measurements do not provide insight into whether the DPE system is meeting the IM goals nor do they provide insight into potential system operations modifications for improved performance. Alternate metrics such as vacuum and flow rate at the manifold, individual DPE well liquid elevations, and SRCO exit temperature serve as better metrics to optimize system operations including individual well flow adjustments; therefore, a reduction in monitoring frequency is proposed.

DEQ Comment 6: Figure 6: The report text indicates that subsurface vacuum readings were taken monthly; however, only July and August readings are included in Figure 6. Please clarify in the report text how many subsurface vacuum readings were taken during 3rd quarter 2022 and/or update Figure 6 to include data from September readings (if any).

CMR Response: The 2022 OM&M plan prescribes monthly measurements; however, in September 2022, facility personnel who are assisting in the data collection efforts were not able to collect monthly measurements due to performing other activities associated with on-site refinery turnaround. To address the issue, CMR is moving forward with hiring additional environmental staff to assist with O&M activities. The text in Section 2.2.3 has been modified to reflect that two subsurface vacuum measurements were collected.

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DEQ Comment 7: Why was a Dual Phase Extraction (DPE) System vapor sample not collected in September? Please provide an explanation in the text of the report and in footnote 4 of Appendix B.

CMR Response: See response to Comment 6 above. This explanation has been added to Section 2.2.1 and Appendix B.

Please contact me at your earliest convenience if you have any questions.

Sincerely,

Mike Gipson
Environmental Specialist

cc: Joe Dauner, CMR

Attachment: AOC-16 Interim Measure 3rd Quarter 2022 Monitoring Report No. 3 (Revision 1)

AOC-16 INTERIM MEASURE
3RD QUARTER 2022
MONITORING REPORT NO. 3
(REVISION 1)

CALUMET MONTANA REFINING, LLC
GREAT FALLS, MONTANA

July 19, 2023

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ACRONYMNS AND ABBREVIATIONS

AOC-16	Area of Concern-16
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
CMR	Calumet Montana Refining, LLC
COC	constituent of concern
DEQ-7 HHS	Montana Department of Environmental Quality-7 Human Health Standards
DO	dissolved oxygen
DPE	dual-phase extraction
EPH	extractable petroleum hydrocarbon
gpm	gallons per minute
IM	Interim Measures
in-Hg	inches of mercury
LEL	lower explosive limit
LNAPL	light non-aqueous phase liquid
µg/L	microgram per liter
MDEQ	Montana Department of Environmental Quality
mg/L	milligrams per liter
mL/min	milliliters per minute
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolts
NTu	nephelometric turbidity unit
OM&M	operations, maintenance, and monitoring
ORP	oxidation reduction potential
Pace	Pace Analytical Services, LLC
PID	photoionization detector
PLC	programmable logic controller
PRT	primary recovery trench
PTT	passive treatment trench
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QMR	Quarterly Monitoring Report
RBSL	Risk-Based Screening Levels
RCRA	Resource Conservation Recovery Act
RFI	RCRA Facility Investigation
Ramboll	Ramboll US Consulting, Inc.
ROI	radius of influence
SCFM	standard cubic per minute
SRCO	Self-Recuperative Catalytic Oxidizer
SVOC	semi-volatile organic compound
TPH	total petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon
WWTP	wastewater treatment plant

SIGNATORY PAGE

I certify under penalty of law that this document and all attachments were prepared under my direct supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature:	NA
Name:	Carlos Centurion
Title:	Vice President – Calumet Montana Refining, LLC
Date:	July 19, 2023

EXECUTIVE SUMMARY

Ramboll US Consulting, Inc. (Ramboll), on behalf of Calumet Montana Refining, LLC (CMR), has prepared this Area of Concern-16 (AOC-16) Interim Measure (IM) 3rd Quarter 2022 Monitoring Report (QMR) No. 3 to summarize the operations of the AOC-16 Dual Phase Extraction (DPE) system and the Passive Treatment Trench (PTT). This QMR has been prepared in accordance with Section 6.2 of the Operations Maintenance and Monitoring (OM&M) Plan for the AOC-16 IM.

During the 3rd quarter of routine operation, the DPE system operated approximately 88% of the available time and extracted and discharged approximately 38,864 gallons of total fluids to CMR's wastewater treatment plant (WWTP). During this reporting period the DPE system also removed approximately 207 pounds of petroleum vapors. It also removed approximately 1.38 pounds of volatile organic compounds (VOCs), 5.9 pounds of semi-volatile organic compound (SVOCs), 11.4 pounds of volatile petroleum hydrocarbons (VPH), and 498.6 pounds of extractable petroleum hydrocarbon (EPH) in the form of liquid effluent. Initial mass removal rates indicate that the DPE system is accomplishing the AOC-16 IM objectives of recovering free phase Light Non-Aqueous Phase Liquids (LNAPL) mass and reducing the LNAPL within the vadose and saturated zone soil matrix.

An estimated volume of 33.96 gallons of LNAPL was recovered from the trench via passive skimmers during the reporting period. Due to measurable amounts of LNAPL in the wells located within the western end of the trench, the LNAPL recovery trench was extended 25 feet to the west and six additional LNAPL recovery wells were installed between July 25, 2022 and July 29, 2022 as documented in the AOC-16 IM Construction Documentation Report, Addendum 1 (CMR, 2022) to protect the PTT from potential LNAPL infiltration.

Quarterly groundwater sampling was conducted at the PTT performance monitoring wells on August 31, 2022. Sampling was conducted at upgradient well MW-41S, PTT well MW-106, and downgradient compliance well MW-105. Samples collected from these monitoring wells were analyzed for petroleum constituents of concern (COCs) – VOCs, SVOCs, VPH, and EPH.

The monitoring well upgradient of the passive treatment trench (MW-41S) and the monitoring well downgradient of the PTT (MW-105) reported benzene concentrations exceeding the DEQ-7 Human Health Standards – Groundwater (DEQ-7 HHS) and the Risk-Based Screening Levels (RBSLs). Concentrations remain within historical ranges at both of these wells. VOCs including benzene, and SVOCs, were not detected from the location (MW-106) installed within the trench. Low levels of C5-C8 Aliphatic and total petroleum hydrocarbons were detected at MW-106 and will continue to be monitored over time.

OM&M of the IM will continue to document the performance of the IM's and will include periodic performance reporting to the Montana Department of Environmental Quality (MDEQ) to ensure the IM objectives are being met. Further investigation/evaluation at the AOC-16 Truck Rack Source Area will be completed as part of the upcoming Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) activities. The results from the RFI and ongoing IM performance monitoring will be evaluated to determine if operational modifications are necessary or if a request to the MDEQ to cease recovery and place the DPE system in standby mode is warranted.

1. INTRODUCTION

Ramboll US Consulting, Inc. (Ramboll), on behalf of Calumet Montana Refining, LLC (CMR), has prepared this Area of Concern-16 (AOC-16) Interim Measure (IM) Quarterly Monitoring Report (QMR) No. 3 for the Calumet Great Falls Montana Refining facility located at 1900 10th Street NE, Great Falls, Montana to summarize the third quarter of operations (July 1 through September 30, 2022) for the AOC-16 IM remedy selected to address petroleum releases at AOC-16.

The CMR refinery is comprised of 82.7 acres of industrial/refinery operations and office buildings. The refinery produces gasoline, middle distillates, and asphalt for distribution in Washington, Montana, Idaho, and Alberta, Canada. AOC-16, referred to as the “Gasoline and Light Oil Loading Rack” or “truck loading rack,” is located within an approximately 7.6-acre parcel to the east of the active refinery and is owned by CMR (Figure 1).

Activities were completed in accordance with the Corrective Action Order on Consent issued to Montana Refining Company, Inc. by the Montana Department of Environmental Quality (MDEQ) to govern the performance of Resource Conservation Recovery Act (RCRA) corrective action activities at the site. In 2016, petroleum related vapors were detected in an offsite residential property along 11th Street NE. The MDEQ issued an IM letter on October 11, 2016, directing CMR to address imminent threats to human health and/or the environment stemming from petroleum release near CMR’s Loading Rack (MDEQ, 2016). Immediate action consisting of relocating and filling an existing sanitary sewer to prevent migration of contaminants was undertaken. Between 2016 and 2019, in coordination with the MDEQ, investigation activities were undertaken, and alternative remedies were evaluated to address the petroleum release near the Loading Rack. Ultimately, an IM remedy approach was recommended consisting of dual-phase extraction (DPE) in the existing primary recovery trench (PRT) in the Truck Rack Area and Light non-aqueous phase liquid (LNAPL) recovery and a passive treatment trench (PTT) just north of North River Road.

Construction of the AOC-16 IM remedies commenced in July 2021 and were completed in October 2021 as documented in the *AOC-16 Interim Measures AOC-16 IM Construction Documentation Report* (CMR, 2022). Construction activities included the installation of following IM remedies:

- DPE remediation system in the Truck Rack Area, and
- LNAPL recovery trench and PTT utilizing colloidal activated carbon at an area along North River Road.

Commissioning of the AOC-16 IM was conducted from October 2021 through December 2021 and routine operations of the DPE system commenced on January 1, 2022.

Corrective action remedial goals were developed as part of the AOC-16 Interim Measures Evaluation Report (CMR, 2019) to protect human health and the environment. The AOC-16 IM goals specific to each treatment area include:

- Truck Rack Area (DPE System)
  - Recover free phase LNAPL mass present in the area south of the Truck Rack to stabilize the LNAPL plume.
  - Reduce LNAPL within the vadose and saturated zone soil matrix to stabilize the dissolved phase plume.

- North River Road Area (LNAPL recovery trench and PTT)
  - Mitigate dissolved phase groundwater impacts migrating from the Truck Rack Area towards the Missouri River.

This AOC-16 IM 3rd Quarter 2022 Monitoring Report No. 3 summarizes the sampling results, operations, and performance monitoring data that were gathered for the AOC-16 IM from July 1 through September 30, 2022, and presents: 1) system runtime for the DPE System; 2) DPE system operational data; 3) identification of operational problems, the length of any shutdowns, and a summary of actions taken to rectify or prevent these problems; 4) influent vapor and liquid sampling results and estimated contaminant mass removal rates for the DPE system; 5) fluid levels, including LNAPL thickness measurements in the LNAPL recovery trench upgradient of the PTT; and 6) groundwater concentrations of constituents of concern (COC) and biological parameters in the PTT point of compliance well (MW-105) and PTT well (MW-106). The activities outlined in this report were performed in accordance with the OM&M Plan (CMR, 2021b).

2. DPE SYSTEM OPERATIONS SUMMARY

2.1 System Runtime

During the period of July 1, 2022 through September 30, 2022, the DPE system was in operation approximately 88% of the time and extracted and discharged approximately 38,864 gallons of total fluids to CMR's wastewater treatment plan (WWTP). A summary of the routine and non-routine system shutdowns is discussed below.

2.1.1 Planned Shutdowns for Routine and Corrective Maintenance

Brief shutdowns of the DPE system were performed to conduct maintenance activities, including filter and level switch cleaning, monthly preventative maintenance, and inspection of equipment.

2.1.2 Non-Routine / Unplanned Shutdowns

A summary of the non-routine system shutdowns is presented below:

- On August 5 the system was shutdown briefly due to automated butterfly valve FV-23504A malfunction. Initial troubleshooting was not able to resolve the issue, so half of the DPE system (DPE-5 through DPE-8 and blower BL2331) was shutdown. The other half of the DPE system (DPE-~~4~~ 1 through DPE-~~8~~ 4 and blower ~~BL2331~~BL2332) continued to operate. Malfunction of FV-23504A is potentially due to valve seal/seat deterioration. The butterfly valve will be replaced during the fourth quarter of 2022.

2.2 System Operation and Monitoring

DPE system performance monitoring and sampling were conducted in accordance with the OM&M Plan (CMR, 2021b and CMR, 2021c) to document system operation effectiveness. It included monitoring of operations data, periodic vapor and effluent sampling to document contaminant mass recovery, monitoring well gauging, and sub-surface vacuum measurements. These parameters are discussed in the following sections.

2.2.1 DPE Influent and Effluent Sampling Results

Monitoring of contaminant mass removal is the primary metric for optimizing DPE system performance and gauging the AOC-16 IM objective of free-phase LNAPL mass recovery and LNAPL plume stabilization.

Vapor

Vapor/air extraction flow rates were continuously monitored and recorded by the system programmable logic controller (PLC) and influent vapor sampling was periodically conducted to evaluate mass removal.

The concentrations of volatile organic compound (VOCs) in the vapor phase were measured periodically on each DPE influent line (DPE-1 through DPE-8) using a photoionization detector (PID) to measure relative vapor concentrations from each DPE well. PID measurements were also collected from sample port SP-301 on the inlet side of the blowers. PID measurements from the DPE wells and SP-301 port are summarized on Figures 2A and 2B.

Vapor samples were also collected ~~monthly~~ in July and August from SP-301 and submitted to Pace Analytical Services (Pace) located in Minneapolis, Minnesota. These samples were analyzed for VOCs by the United States Environmental Protection Agency (USEPA) Method TO-15. Analytical results for detected compounds from the influent vapor samples are summarized in Table 2. Laboratory reports are included in Appendix A1. Historical analytical results and mass removal are included in Appendix B. In September 2022, facility personnel who are assisting in the data collection efforts were not able to collect the monthly sample due to performing other activities associated with on-site refinery turnaround. To address the issue, CMR is moving forward with hiring additional environmental staff to assist with O&M activities.

Concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX), n-hexane, and n-heptane in effluent vapor over time are shown on Figure 3. These compounds were selected to evaluate vapor effluent concentration trends as their concentrations were the highest as compared to other VOCs during the start-up sampling. As expected, concentrations of BTEX, n-hexane, and n-heptane decreased approximately one to two orders magnitude between startup in October 2021 and September 2022.

The combination of vapor flow rates, system runtime, and vapor VOC concentrations were used to calculate the mass of contaminants removed. During the reporting period, the DPE system removed approximately 207 pounds of VOCs in the vapor phase as shown on Figure 4. Note that the reduction in mass recovery rate shown on Figure 4 during this reporting period is primarily driven by the reductions in flow rate due to the automated butterfly valve FV-23504A malfunction. Influent vapor concentrations (Table 2 and Figure 3) remain generally consistent with previous sampling events.

Both, the inlet piping to the vacuum blowers and the Self-Recuperative Catalytic Oxidizer (SRCO) unit, are equipped with dilution valves to dilute soil vapor entering the system and to control the temperature of the catalyst bed and process inlet and outlet air temperature. During the reporting period, dilution of the influent vapor feed was required (dilution valve position to the blowers ranging from 0% to 65% open and dilution valve position to the SRCO between 0 and 100% open) to maintain the post-catalyst process air temperature within the operating limits of 650 and 950 degrees (°F). Although influent VOC concentrations have decreased overtime, the need for continued dilution of the process vapor serves as a line of evidence that influent vapor VOC concentrations remain high. As influent vapor concentrations remain high, continued full-time operation of all eight DPE wells is recommended.

Liquid

Monthly effluent samples of groundwater were collected from the discharge side of the transfer pump and submitted to Pace located in West Columbia, South Carolina for analysis of VOCs, semi-volatile organic compounds (SVOCs), volatile petroleum hydrocarbons (VPH), and extractable petroleum hydrocarbons (EPHs). For the August 2022 sampling, VPH and EPH were analyzed by the Pace National Laboratory located in Mount Juliet, Tennessee. The alternative laboratory was used to improve turnaround time. Note that due to the change in laboratory, the individual EPH fractionation results were not reported for the August ~~Sampling~~ sampling event due to differences in performing and reporting the fractionation analysis that were not clearly communicated~~t~~. For future sampling events, both the total EPH screening value and fractionation will be reported. Analytical results from the effluent sampling are summarized in Table 3. Laboratory reports are included in Appendix A2. Historical analytical results and mass removals are included in Appendix C.

The combination of fluid recoveries and contaminant concentrations were used to calculate the mass of contaminants removed in the dissolved phase. In the dissolved phase during the reporting period, the DPE system removed approximately 1.4 pounds of VOCs, 5.9 pounds of SVOCs, 11.4 pounds of VPH, and 498.6 pounds of EPH.

Separate phase LNAPL recovery is not quantified. Total fluids (combined LNAPL and water) in the effluent are pumped to the refinery's on-site WWTP where oil-water separation occurs. However, visual observations of LNAPL in the DPE system knockout tank (T-23100) sight glass serve as a qualitative indicator of LNAPL recovery. During the reporting period, approximately 6 to 12 inches of LNAPL was observed within the knock-out tank sight glass.

As shown on Figure 4, total VOC, SVOC, VPH, and EPH mass removed in the vapor and dissolved phase since DPE system startup in October 2021 and through September 30, 2022, is calculated to be approximately 2,782 pounds, 9.3 pounds, 70 pounds, and 856 pounds, respectively.

2.2.2 Groundwater Elevations

Monitoring wells in AOC-16 area (MW-22, MW-41S, MW-41D, MW-53, MW-57, MW-59S, MW-59D, MW-63, MW-64, MW-102, MW-103, MW-104, MW-105, and MW-106) were gauged periodically during the third quarter of 2022. The depth to water and if observed, separate-phase LNAPL thickness measurements, were recorded. These measurements are presented in Table 4.

During the third quarter of operation, groundwater levels at the Truck Loading Rack Area (MW-53, MW-57, MW-63, MW-64, MW-102, MW-103, and MW-104) dropped by approximately 1.5 feet whereas at the North River Area (MW-41S, MW-41D, MW-59S, MW-59D, MW-105, and MW-106) groundwater levels were stable (0.03 – 0.4 feet change in elevation). Groundwater contours are provided on Figure 5. Based on these observations, the drawdown in the Truck Loading Rack Area is likely attributed to DPE system.

2.2.3 Sub-Surface Vacuum

Sub-surface vacuum measurements were recorded ~~monthly~~ collected in July and August at three monitoring wells (MW-22 located 26 feet from DPE-3, MW-64 located 21 feet from DPE-6, MW-104 located 13 feet from DPE-3, and 22 feet from DPE-4). These measurements are shown on Figure 6. Based on the measurements, vacuum was not observed at any monitoring wells during this period, so the current radius of influence (ROI) appears to be less than 13 feet. Due to high influent VOC concentrations (Table 2 and Figure 3), the system continues to be operated in a controlled manner so that the influent LEL and SRCO operating temperature could be maintained at a safe operating point. By operating the system in a controlled manner, the observed vapor influent flow and applied vacuum were lower than the design parameters. Additionally, only four DPE wells were operated in August and September due to the butterfly valve malfunction. Subsurface vacuum will continue to be monitored to document the estimated zone of influence of the DPE system.

2.2.4 Overall System Performance and Optimization

This section compares the primary design parameters to the observed/measured values during the reporting period to evaluate the system performance. These parameters are discussed in detail in following sections and summarized in Table 1.

Liquid Extraction Rate

The average design flow rate for the DPE system is between 0.25 gallons per minute (gpm) during steady-state operation and 21 gpm during rainfall events. The combination of fluid recoveries and system run time was used to calculate liquid flow rate during the reporting period. The DPE system extracted fluids at an average rate of 0.34 gpm which is within the design flow rate.

DPE System ROI

The DPE system design ROI is between 20 and 30 feet. As discussed in Section 2.2.3, the current ROI appears to be less than 13 feet, which is likely due to the system operating at a lower applied vacuum and in a controlled manner. Additionally, only four DPE wells were operated in August and September due to the butterfly valve malfunction. As influent vapor concentrations continue to decrease, the applied system vacuum will be increased which will increase the ROI.

Vapor Influent Flow Rate and Applied Vacuum

The design vapor influent flow rate and applied vacuum are 200 standard cubic per minute (SCFM) and 17 inches of mercury (in-Hg), respectively. During the month of July 2022 when all 8 wells were operating, the observed vapor influent flow was approximately 155 SCFM and the applied vacuum was approximately 8.4 in-Hg. In August 2022, automated butterfly valve FV-23504A malfunctioned. Half of the manifold corresponding to DPE-4 through DPE-8 and one blower (BL2331) were shutdown while troubleshooting was performed. During August and September 2022, with four DPE wells operating the system flow rate averaged 57.5 SCFM and the applied vacuum was approximately 9.0 in-Hg.

Prior to the butterfly valve malfunction, vacuum at DPE wells DPE-1, DPE-2, DPE-4, and DPE-7 remained within the historical range, whereas at DPE wells DPE-3, DPE-5, and DPE-6 stayed low. Additional troubleshooting, including verification of the pressure instrumentation calibration and manual draining of the headers, is ongoing to address the low vacuum measurements at these wells. As noted in previous reports, DPE-8 was not recording vacuum. Troubleshooting efforts indicated a data recording error which was corrected. During this reporting period, average vacuum at DPE-8 was 2.5 inches of water (0.18 in-Hg).

SRCO Performance Monitoring

The SRCO has a design destruction efficiency of 99% per manufacturer's specifications. To show compliance with the air permit, the SRCO pre- and post-catalyst process air temperature is monitored. The process air temperature across the catalyst must be greater than 650°F to ensure a destruction efficiency of 99%. The SRCO temperature monitoring results during the reporting period is shown on Figure 7. As shown on Figure 8, the post-catalyst process air temperature remained above 650°F while the system was in operation.

Overall, the system is operating as designed. DPE system optimization will be conducted, as needed, based on DPE well vapor concentrations, mass removal, and liquid extraction rates.

3. LNAPL RECOVERY TRENCH AND PTT

3.1 LNAPL Monitoring

The 11 original LNAPL collection wells located in the LNAPL recovery trench and 6 additional LNAPL trench extension collection wells were gauged periodically throughout this reporting period (Figure 1). Fluid levels collected from the LNAPL wells are summarized in Table 5.

3.1.1 Passive LNAPL Skimmer Installation

Passive skimmers LNAPL skimmers are deployed in eight recovery wells –LNAPL-2, LNAPL-4, LNAPL-5, LNAPL-7, LNAPL-8, LNAPL-10, and LNAPL-11. Passive skimmers were drained periodically and the LNAPL volume recovered at each location was recorded. During the reporting period, approximately 33.96 gallons of LNAPL was removed from the LNAPL trench via passive skimmers. Since installation of the LNAPL recovery wells in October 2021 through September 30, 2022, a total of 103.63 gallons of LNAPL has been passively recovered from the LNAPL trench.

Given the continued observed LNAPL thickness in the LNAPL recovery trench (varying from 0 to 0.79 feet during this quarter) passive recovery should be continued. Based on current filling rates, it is recommended that the passive canisters be emptied twice per week. If passive skimming and manual emptying is not successful at keeping LNAPL thicknesses to trace levels, a different recovery method such as an active skimming system will be considered.

3.1.2 Proposed LNAPL Trench Extension

Following the installation of the initial 50-foot long LNAPL recovery trench in 2021, measurable LNAPL thickness was recorded within the western half of the LNAPL recovery trench initially at locations LNAPL-10 and LNAPL-11. No monitoring or LNAPL wells were present west of LNAPL-11 to determine the extent of the LNAPL in this area. As the PTT extended farther to the west than the LNAPL trench, any LNAPL beyond the western end of the LNAPL recovery trench could compromise the integrity of the PTT. As such, the LNAPL recovery trench was extended to the west to enable recovery of LNAPL in this area. The 25-foot LNAPL recovery trench extension was completed between July 25, 2022 and July 29, 2022. Documentation of the construction activities were provided in the *AOC-16 IM Construction Documentation Report Addendum 1* (CMR, 2022c). Since installation of the trench in July 2022, LNAPL has not been identified in the newly installed LNAPL recovery wells LNAPL-12 through LNAPL-17 (Table 5).

3.2 Groundwater Monitoring

The primary goal of the PTT is to mitigate dissolved phase groundwater impacts from migrating towards the Missouri River. Quarterly groundwater sampling was conducted on August 31, 2022, at upgradient well MW-41S, PTT well MW-106, and compliance well MW-105 (Figure 1).

3.2.1 Monitoring Well Sampling

Monitoring wells MW-41S and MW-106 were purged dry on August 30, 2022. Approximately 4 to 5 well volumes were purged from MW-106. The wells recharged over a 24-hour period and a groundwater sample was collected on August 31, 2022. During the purge, field measurements were collected for water quality parameters, including dissolved oxygen (DO), pH, specific conductance, temperature, turbidity, and oxidation reduction potential (ORP). The field measurements were recorded every 5 minutes during well purging. The physical and chemical field measurements collected when purging the monitoring wells are summarized in the groundwater sampling logs in Appendix D.

Due to the low recovery observed at MW-105, only a partial bottle set was collected following the 24-hour recovery period. A full sample set was collected at monitoring well MW-106 and MW-41S.

After all the samples were collected, they were sealed, labeled, and placed on ice, pending delivery under chain-of-custody procedures to Pace located in West Columbia, South Carolina. The groundwater sample were analyzed for VOCs (via USEPA Method SW8260D), SVOCs (via USEPA Method SW 8270D) by the Pace South Carolina Laboratory. Samples for analysis of MDEQ VPH (via Method MDEQ VPH), and MDEQ EPH (via Method MDEQ EPH) were analyzed by the Pace National Laboratory located in Mount Juliet, Tennessee. Note that due to the change in laboratory, the individual EPH fractionation results were not reported for the August Sampling event. For future sampling events, both the total EPH screening value and fractionation will be reported.

The wells did not yield enough volume to facilitate the collection of field duplicate samples or matrix spike/matrix spike duplicate (MS/MSD) samples. One trip blank was submitted along with each laboratory cooler for quality assurance/quality control (QA/QC) purposes. Methods and procedures for collecting, handling, and analyzing samples are provided in the Quality Assurance Project Plan (QAPP) (CMR, 2018). Treatment and disposal of purge water generated during monitoring well sampling was handled consistent with existing project procedures.

3.2.2 Groundwater Analytical Results – August 2022

The groundwater analytical results for detected compounds from the August 2022 sampling event are provided in Table 6. Previous quarterly groundwater sampling results from October 2021, March 2022, and June 2022 are also provided in Table 6 for comparison purposes. Analytical compounds that met or exceeded the respective MDEQ -7 HHS (May 2017) and/or MDEQ Tier 1 Groundwater Risk-Based Screening Levels (RBSLs) are bolded and/or shaded, respectively, for reference. Laboratory reports are included in Appendix A3.

The following subsections provide a summary of the analytical parameters detected in the monitoring wells in August 2022 and compare those detections to the DEQ-7 HHS in groundwater and RBSLs.

VOCs

Of the VOCs detected during the August 2022 groundwater sampling event at AOC-16, only benzene was detected more than the respective groundwater screening standard.[1]

The monitoring well upgradient of the passive treatment trench (MW-41S) reported benzene at 140 micrograms per liter (µg/L). Benzene was not detected from the location (MW-106) installed within the trench. The monitoring well (MW-105) installed downgradient of the passive treatment trench reported benzene at 85 µg/L. The benzene detections at both MW-41S and MW-105 exceeded the DEQ-7 HHS and RBSL of 5 µg/L. Note that prior to the installation of the IM, upgradient well MW-41S and downgradient well MW-106 have historically had benzene detections exceeding the DEQ-7 HHS and RBSLs (5 ug/L).

[1] All VOC results reported in this section are from USEPA Method 8260B.

SVOCs

All SVOCs were detected at concentrations less than the DEQ-7 HHS and RBSLs. The low-level exceedances of benzo(a)pyrene within the PTT recorded in March 2022 were not recorded during the August 2022 sampling event.

TPH, VPH, and EPH

The upgradient monitoring well (MW-41S) had detectable concentrations of total petroleum hydrocarbons (TPH) via method MTDEQ VPH of 3,190 µg/L with a C5-C8 Aliphatic concentration of 1,140 µg/L exceeding the RBSL of 650 µg/L. Within the trench (MW-106), TPH via method MTDEQ VPH was detected at concentration of 189 µg/L . C5-C8 Aliphatics were also detected within the trench at a concentration of 153 µg/L less than the RBSL of 650 µg/L. Downgradient of the PTT (MW-105), the TPH concentration was 1,050 ug/L with a C5-C8 Aliphatic concentration of 517 µg/L below the RBSL of 650 µg/L.

3.2.3 Evaluation of Concentration Trends Over Time

To evaluate concentration trends over time, the concentrations of benzene and TPH were plotted for each of the three passive treatment trench monitoring wells. Baseline sampling data from June 2020 through October 2021 are included on Figures 9A through 9C along with post-remediation data. This historical data was previously reported in 2020/2021 Annual Groundwater Sampling Summary Report (CMR, 2021a) and Construction Documentation Report (CMR, 2022). Benzene and C5-C8 Aliphatics were selected as indicator compounds because they were the two compounds that exceed DEQ-7 HHSs and/or RBSLs during the baseline sampling event in October 2021. While there are no DEQ-7 HHSs and RBSLs for TPH, TPH represents a range of hydrocarbons and serves as an overall indicator of contaminant loading to the PTT.

The benzene, C5-C8 Aliphatics and TPH sampling results at upgradient well MW-41S showed the following changes between October 2021 and August 2022:

- Benzene decreased from 1,900 µg/L in October 2021 to 140 µg/L in August 2022.
- TPH decreased from 6300 µg/L to 3,190 µg/L.
- C5-C8 Aliphatic have remained approximately the same (1,500 µg/L in October 2021 to 1,460 in August 2022).

The benzene, C5-C8 Aliphatics and TPH sampling results at well MW-106 located in the PTT showed the following changes between October 2021 and August 2022:

- Benzene has not been detected during any sampling events.
- TPH had not been detected in previous sampling events but was detected at concentration of 189 µg/L in August 2022.
- C5-C8 Aliphatic had not been detected in previous sampling events but were detected for the first time in August 2022 a concentration of 153 µg/L, less than the RBSL of 650 µg/L.

The benzene, C5-C8 Aliphatics and TPH sampling results at well MW-105 located downgradient PTT showed the following changes between October 2021 and August 2022:

- Benzene has decreased from 250 µg/L in October 2021 to 85 µg/L in August 2022. Trends generally appear to be decreasing with time since the installation of the PTT.
- TPH has decreased from 1,900 µg/L in October 2021 to 1,050 µg/L. Trends generally appear to be decreasing with time since the installation of the PTT.

Analytical results from groundwater samples collected from monitoring wells located up-gradient, down-gradient and from within the PTT indicate that the concentration of dissolved phase petroleum constituent of concern (COCs) decreased across the PTT initially meeting the goal of the PTT to mitigate the dissolved phase groundwater impacts from migrating from the Truck Rack to the Missouri River. Initial indications show decreasing concentrations at both up-gradient and down-gradient monitoring wells. Given the limited available data, additional sampling will be performed to monitor these trends over time.

Given the low hydraulic conductivities in the vicinity of the PTT, reductions in contaminant concentrations at the performance monitoring well MW-105 location are expected to occur over time as a result of the PTT installation.

Biodegradation Parameters

Field parameters including pH, conductivity, turbidity, ORP, and dissolved oxygen are provided in Table 7. The PTT is designed to reduce adsorbed COCs. Low dissolved oxygen (generally less than 0.5 mg/L) and low or negative ORP values serve as indicators of the presence of reducing conditions. The lower the ORP and DO, the greater the potential for a reducing and anaerobic environment. At the PTT well (MW-106), DO values remained constant and generally low (0.00 to 0.85 mg/L) and ORP remained low and constant (between 13 mV in October 2021 and 34 mV in August 2022) indicative of reducing conditions. In the down gradient well (MW-105), DO ORP remained consistent indicative of reducing conditions between October 2021 and August 2022. Additional analytical (alkalinity, biochemical oxygen demand [BOD], carbon dioxide, iron, manganese, nitrate, sulfate, and methane) was collected for biodegradation parameters during the October 2021 baseline sampling event and the June 2022 semi-annual sampling event. In accordance with the OM&M Plan, biodegradation parameters will only be collected on a semi-annual basis and were not sampled for during the August 2022 sampling event.

4. CONCLUSION AND RECOMMENDATIONS

During this reporting period from July 1, through September 30, 2022, the DPE system operated approximately 88% of the available time.

DPE System Performance

Initial mass removal rates indicate that the DPE system in the Truck Rack Area is meeting the AOC-16 IM goals of recovering free phase LNAPL mass and reducing the LNAPL within the vadose and saturated zone soil matrix.

During the reporting period, the DPE system removed approximately 207 pounds of VOCs in the vapor phase, and 1.4 pounds of VOCs, 5.9 pounds of SVOCs, 11.4 pounds of VPH, and 498.6 pounds of EPH in the liquid phase. Since startup in October 2021, total VOC, SVOC, VPH, and EPH mass removed in the vapor and dissolved phase since DPE system startup in October 2021 and through September 30, 2022, is calculated to be approximately 2,782 pounds, 9.3 pounds, 70 pounds, and 856 pounds, respectively. Also, 6 to 12 inches of LNAPL was observed in the sight glass of the knock-out tank. Total influent vapor VOC concentrations remained high and dilution air continues to be required to maintain the SRCO temperature. As influent vapor concentrations remain high and asymptotic mass recovery has not been observed, continued full-time operation of all eight DPE wells is recommended. Continued operation of the DPE system is expected to further reduce LNAPL mass leading to stabilization of the dissolved phase plume.

During the reporting period DPE system was operated in a manner to control vapor concentrations in the influent process vapor stream so that the influent LEL and SCRO operating temperature could be maintained at a safe operating point. The high vapor concentrations necessitating dilution was expected and indicates that the system is targeting the zone of contamination. As the DPE system continues to operate, vapor influent concentrations have been decreasing and less dilution air has been needed. Over the course of the reporting period, the dilution valves were incrementally closed, the pressure control valve was tightened, and blower capacity was increased. This optimization process will continue going forward.

The SRCO temperature remained greater than 650°F indicating at least 99% destruction efficiency of the extracted petroleum vapors prior to being discharged to the atmosphere.

During operation, maintenance activities will be performed and documented to ensure optimal performance of the system. DPE system optimization will be performed based on DPE well vapor concentrations, mass removal, and liquid extraction rates. As influent vapor concentrations decrease, it is recommended that the volume of dilution air be further reduced, thereby increasing the overall applied vacuum and recovery of LNAPL mass.

LNAPL Trench Performance

The LNAPL trench installed upgradient of the PTT is successfully recovering and preventing the migration of LNAPL into the PTT.

For more effective LNAPL recovery, CMR deployed passive skimmer in the LNAPL recovery wells with measurable LNAPL in February 2022. An estimated volume of 33.96 gallons of LNAPL was recovered via passive skimmers during this reporting period. Since installation, an estimated volume of 103.63 gallons of LNAPL have been recovered from the LNAPL recovery trench. Given the continued observed

LNAPL thickness in the LNAPL recovery trench (varying from 0 to 0.79 feet during this quarter) passive recovery should be continued. Based on current filling rates, it is recommended that the passive canisters be emptied twice per week. If passive skimming and manual emptying is not successful at keeping LNAPL thicknesses to trace levels, a different recovery method such as an active skimming system will be considered.

The LNAPL recovery trench was extended 25 feet to the west and six additional LNAPL recovery wells were installed within the trench extension to protect the western half of the PTT from potential LNAPL infiltration. The LNAPL trench extension was completed in the third quarter of 2022.

PTT Performance

Analytical results from groundwater samples collected from monitoring wells located up-gradient, down-gradient and from within the PTT indicate that the concentration of dissolved phase petroleum COCs decreased across the PTT initially meeting the goal of mitigating the dissolved phase groundwater impacts from migrating from the Truck Rack to the Missouri River. Benzene remains below analytical detection limits in the PTT monitoring well MW-106. Low levels of C5-C8 Aliphatic (153 µg/L) and TPH (189 J µg/L) were detected for the first time in August 2022 in the PTT monitoring well MW-106. Concentrations of C5-C8 Aliphatics and TPH will continue to be monitored with time in the PTT to evaluate loading of C5-C8 Aliphatic hydrocarbons and TPH at the PTT. Initial indications show decreasing concentrations at both up-gradient monitoring well MW-41S and down-gradient compliance monitoring well MW-105. Given the low hydraulic conductivities in the vicinity of the PTT, reductions in contaminant concentrations at the performance monitoring well MW-105 location are expected to occur over time as a result of the PTT installation.

OM&M of the interim measures will continue to document the performance of the IM's and will include periodic performance reporting to the MDEQ to ensure the IM objectives are being met. Further investigation/evaluation of the petroleum impacts at the AOC-16 Truck Rack Area will be completed as part of the upcoming RCRA RFI activities. The results from the RFI and ongoing IM performance monitoring will be evaluated to determine if operational modifications are necessary or if a request to the MDEQ to cease recovery and place the DPE system in standby mode is warranted.

Sampling Frequency Evaluation

As noted in the OM&M Plan (CMR, 2021b), the sample collection frequency for both DPE system performance monitoring and LNAPL Trench and PTT Performance monitoring was to be re-evaluated following one year of operation. Based on the data collected to date, only minor changes (subsurface vacuum and LNAPL thickness/groundwater elevation) are recommended to the sampling frequency. Based on a review of the first year of operational data, due to the placement of the wells, collecting subsurface vacuum readings and monitoring well gauging on a monthly frequency do not provide insights into whether the DPE system is meeting the IM goals nor do they provide insights into potential system operations modifications for improved performance; therefore, a reduction in monitoring frequency is proposed The recommended sampling frequency is provided in Table A. The frequency should be re-evaluated following the second year of operation.

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Table A: Proposed Performance Monitoring Frequency

Monitoring Activity	Sampling Location	Year 1 Monitoring Frequency	Proposed Year 2 Monitoring Frequency
Influent Vapor Monitoring with PID	Wells DPE-1 through DPE-8 at sampling ports SP-1 through SP-8 and SP301	Monthly	Monthly
Influent Vapor Monitoring with laboratory analysis of TO-15	SP301	Monthly	Monthly
Liquid phase effluent sample with laboratory analysis of VOCs, SVOCs, VPH, and EPH	SP200	Monthly	Monthly
Subsurface Vacuum	MW-22, MW-64, and MW-104	Monthly	Semi-Annually
LNAPL Thickness/Groundwater Elevation	MW-22, MW-41S, MW-41D, MW-53, MW-57, MW-63, MW64, MW-57, MW-59S, MW-59D, MW-102, MW103, MW-104, MW-105, and MW-106	Monthly	Semi-Annually
Gauging of LNAPL Recovery Wells in LNAPL Trench	LNAPL-1 through LNAPL-17	Weekly	Weekly
Groundwater sampling and analysis for petroleum COCs	MW-41S MW-105 MW-106	Quarterly	Quarterly
Groundwater sampling and analysis for biodegradation dynamics of petroleum COCs	MW-105 MW-106	Semi-Annually	Semi-Annually

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5. REFERENCES

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CMR. 2022c. AOC-16 IM Construction Documentation Report Addendum 1. October.

MDEQ. 2016. Immediate Interim Measures Petroleum Release Near CMR's Loading Rack. October 11.

FIGURES

TABLES

APPENDIX A
LABORATORY ANALYTICAL REPORTS

A1: Dual-Phase Extraction Vapor Analytical Results

A2: Dual-Phase Extraction Effluent Liquid Analytical Results

A3: Passive Treatment Trench Groundwater Analytical Results

APPENDIX B

HISTORICAL ANALYTICAL RESULTS AND CONTAMINANT MASS REMOVAL - VAPOR

APPENDIX C

HISTORICAL ANALYTICAL RESULTS AND CONTAMINANT MASS REMOVAL - LIQUID

APPENDIX D

GROUNDWATER SAMPLING PURGE LOGS