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Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit

April 2017 through April 2018 (U)

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximate, approximately
ac	acre
ARP	A-Area Miscellaneous Rubble Pile
ASVE	active soil vapor extraction
CMI/RAIP	Corrective Measures Implementation/Remedial Action Implementation Plan
ft	feet, foot
ha	hectare
IC	institutional controls
kg	kilogram
lb.	pound
lb./hr	pounds per hour
µg/kg	microgram per kilogram
µg/L	microgram per liter
m	meter
mg/kg	milligram per kilogram
OOS	Out of Service
OU	operable unit
PCB/PAH	polychlorinated biphenyl/polycyclic aromatic hydrocarbon
PCE	tetrachloroethylene
PCR	Post-Construction Report
PER	Performance Evaluation Report
ppmv	parts per million by volume
RCRA	Resource Conservation and Recovery Act
RG	remedial goals
SCDHEC	South Carolina Department of Health and Environmental Control
scfm	standard cubic feet per minute
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SVE	soil vapor extraction
SVEU	soil vapor extraction unit
TCE	trichloroethylene
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VEW	vapor extraction well
VMW	vapor monitoring well
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company LLC

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1.0 INTRODUCTION

The A-Area Miscellaneous Rubble Pile (ARP) (731-6A) Operable Unit (OU) is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit/Comprehensive Environmental Response, Compensation, and Liability Act Unit in Appendix C of the Federal Facility Agreement for the Savannah River Site (SRS).

The ARP OU is located in the northwest part of the SRS within A Area and immediately east of M Area. It is approximately (~) 1.8 kilometers (1.1 miles) from the nearest site boundary (Figure 1). The unit covers ~1.35 hectares (ha [5.8 acres {ac}]) and is bounded on the southwest and southeast by outfall drainages that coalesce on the south side of the unit (Figure 2).

The ARP OU has been divided into three subunits: the Piles Area, the Ash Area, and the Trenches Area (Figure 2). The Piles Area (~0.93 ha [2.3 ac]) contains many small mounds (0.61- to 1.52-meter (m [2- to 5-feet {ft}] high) of construction debris that were disposed of directly on the ground surface. The Ash Area (~0.73 ha [1.8 ac]) contains buried construction debris and an ash layer of ~1.22 m (4 ft). The Trenches Area (~0.65 ha [1.6 ac]) contains construction debris in a 2.44- to 3.66-m (8- to 12-ft) deep T-shaped trench. A detailed facility description is provided in the *Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Report Work Plan Addendum for the A-Area Miscellaneous Rubble Pile (731-6A)* (WSRC 1998).

The purpose of this Performance Evaluation Report (PER) is to provide formal evaluation of collected operating data for the passive soil vapor extraction (SVE) system at the Trenches Area of the ARP OU through April 30, 2018. This report includes a summary of the operational data collected for the reporting period April 2017 through April 2018. No operational data was collected during the first two months of the reporting period because the system was undergoing modifications to transition from active to passive SVE. An evaluation of other components of the ARP OU remedy is discussed in Section 2.0.

2.0 REMEDIAL ACTIONS

The Remedial Action Objectives for each of the three ARP OU subunits as documented in the *Record of Decision Remedial Alternative Selection for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit* (WSRC 2003a) are listed below:

Remedial Action Objectives for the Piles Area:

- to protect the future industrial worker from exposure to arsenic and lead in the lead hot spot above their respective remedial goals (RGs) of 4.4 mg/kg and 400 mg/kg; and
- to protect the future industrial worker or resident from exposure to aroclor-1254 and benzo(a)pyrene in the polychlorinated biphenyl/polycyclic aromatic hydrocarbon (PCB/PAH) waste pile above their respective RGs of 1 mg/kg and 0.052 mg/kg.

Remedial Action Objective for the Ash Area:

- to protect the future industrial worker from exposure to elevated levels of arsenic in the surface soil above the RG of 4.4 mg/kg.

Remedial Action Objectives for the Trenches Area:

- to protect the future industrial worker from exposure to arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene and dibenzo(a,h)anthracene in the soil above their respective RGs of 4.4 mg/kg, 2.56 mg/kg, 0.256 mg/kg, 2.56 mg/kg, and 0.256 mg/kg; and
- to prevent leaching of trichloroethylene (TCE) and tetrachloroethylene (PCE) to groundwater above their respective maximum contaminant level of 5 µg/L (soil RGs for TCE and PCE are 0.0877 and 0.656 mg/kg, respectively).

The remedial actions taken for each of the three ARP OU subunits are described below:

- Piles Area – The hot spot removal final action has been successfully completed. Confirmatory sampling of the PCB/PAH and the lead hot spots conducted in accordance with the Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP)

(WSRC 2003b) verified removal of contaminants and demonstrated that the RGs had been achieved. Confirmatory sampling results are provided in the Post-Construction Report (PCR) (WSRC 2004). Refer to Section 4.1 and Table B-5 and Table B-6 of the PCR.

- Ash Area – The remedial action for the Ash Area, as detailed in the CMI/RAIP (WSRC 2003b) and PCR (WSRC 2004a), is institutional controls (ICs). The ICs final action is ongoing. ICs were implemented at the Ash Area and include the installation of access control warning signs around the contaminated area.

- Trenches Area – The final action consists of three components: the 0.3-m (1-ft) soil cover, an active SVE (ASVE) system, and ICs. The soil cover was installed between October and December 2003. Operation of the ASVE system commenced on April 26, 2004. The ASVE system transitioned to passive SVE on March 14, 2017. This report evaluates the effectiveness of the SVE remedial action at this subunit, found in Section 3.0 of this report.

Annual inspections are conducted at the ARP OU to verify that ICs are in place and to ensure that no deficiencies exist with the integrity of the soil cover at the Trenches Area subunit. The evaluation of the ICs and the soil cover are recorded on a Field Inspection Checklist, documented in the Five-Year Remedy Review Reports, and summarized below.

The ARP OU was inspected on January 22, 2018 (SRNS 2018). The ARP OU inspection confirmed that ICs were in place. However, active ant mounds were observed on the Trenches Area soil cover. Pesticide was applied to the active ant mounds on the day of the inspection.

2.1 ARP OU Trenches Area

Seven (7) ASVE wells (AMP001 vapor extraction well [VEW] through AMP007VEW) and twelve (12) monitoring wells (AMP001VMW through AMP012VMW) were installed in the ARP OU Trenches Area in February 2004. Full-scale operations began on April 26, 2004.

The 782-3M soil vapor extraction unit (SVEU) provided vacuum for the ARP SVE wells and for several other wells at the A-014 Outfall (RCRA remediation). The air flow from the ARP header was typically around 100 standard cubic feet per minute (scfm).

In June 2014, the United States Environmental Protection Agency (USEPA), South Carolina Department of Health and Environmental Control (SCDHEC), and United States Department of Energy (USDOE) agreed to transition to passive SVE due to a lack of a downward trend in VOC concentrations, diffusion limitations observed in the data for ~ eight (8) years, slow mass removal, and the cost and maintenance required to operate an ASVE system with limited benefit.

SRS transitioned from ASVE to passive SVE by disconnecting the seven (7) SVE wells from the 782-3M SVEU on March 14, 2017. MicroBlowers™ with BaroBalls™ were placed on these wells. Furthermore, the twelve (12) VMWs (previously used to measure vacuum) were also converted to a less energy intensive passive system with MicroBlowers™ and BaroBalls™ (Figure 3). The use of all nineteen (19) existing wells for passive extraction will ensure the effectiveness of transitioning the remediation to a passive remedy with respect to vacuum coverage and monitoring. The nineteen (19) passive SVE wells began operating on June 14, 2017. The nineteen (19) passive SVE wells will be sampled annually and reported in the annual ARP OU PER. A typical passive SVE well is shown in Figure 4.

The data collected for the reporting period April 2017 through April 2018 includes the pressure, flow rate, and concentration from the nineteen (19) VEWs. These data are sufficient to estimate the volatile organic compound (VOC) mass removed. This report includes a summary of the operational data collected from June 2017 through April 2018. No operational data was collected in April 2017 and May 2017 because the system was undergoing modifications to transition from active to passive SVE. As agreed to by the USEPA, SCDHEC, and USDOE, an addendum to the PCR (WSRC 2004) will be prepared to document the change in the power source from active to passive SVE and to include the additional soil and ash sampling data.

2.2 Operational Sampling Results

2.2.1 Compliance Monitoring

In accordance with SC Regulation 61-612.70.7(e)(5), a permitted facility is authorized to make changes within their facility without requiring a permit revision if the changes do not exceed the emissions allowable under the permit. In January 2017, the SRS submitted an operational flexibility request to SCDHEC to add the (19) passive VEWs to the Insignificant Activities list for

the Title V Air Permit. Insignificant Activity generally means any air emissions or air emissions unit that has the potential to emit less than 5 tons per year of any criteria pollutant. Emission data obtained from the nineteen (19) VEWs will continue to be reported to document compliance with the air discharge permit conditions contained in the Title V Air Permit (SCDHEC 2007).

2.2.2 Performance Monitoring

Performance monitoring samples were scheduled annually in accordance with sampling of SRS passive SVE systems. The performance monitoring objective is to measure system performance with respect to the rate of TCE and PCE reduction in the vadose zone. Performance monitoring is being used to establish total system capability, track the ARP OU emissions, and determine the overall effectiveness of the system. Data (PCE and TCE concentrations and flow rates) are collected (as listed in Table 1) at the nineteen (19) VEWs.

Performance monitoring data are tabulated in Table 2 and Table 3.

This data set was used to estimate the mass removed and the cumulative mass removed as depicted in Figures 5 and 6, respectively. These data points are estimations of removal since monitoring is performed annually, and with respect to data, are variable.

The mass removal calculations were conducted in a manner similar to that used in a study of SVE and air sparging (Holbrook et al. 1998) in which soil gas concentrations were converted to mass removal rates using the volumetric flow rate and the Ideal Gas Law, although there are several other satisfactory methods to compute mass removal. The generalized equation for mass removal is as follows:

(Equation 1)

M = Q x C x MW x T

where:

M	=	cumulative mass removed (lb.)	MW	=	molecular weight (grams/mole)
Q	=	extraction flow rate (cfm)	T	=	operational period (hr)
C	=	vapor concentration (ppmv)			

$$M = Q \cdot \left(C \cdot \frac{1\,ft^3}{10^6 \cdot ft^3} \right) \cdot MW \cdot \left(\frac{mole}{24.466 \cdot liter} \cdot \frac{28.3 \cdot liter}{ft^3} \cdot \frac{lb}{453.592 \cdot gm} \cdot \frac{60 \cdot min}{hr} \right) \cdot T$$

From April 2004 through April 2017, the active SVEU removed an estimated mass of ~64.3 kg (142 lbs.) of VOCs. From June 2017 through April 2018, the passive SVE systems removed an estimated mass of ~1.6 kg (3.6 lbs.) of VOCs.

The performance monitoring data indicates that the passive SVE system functioned adequately for the conditions and met air compliance objectives.

2.2.3 Process Monitoring

Process monitoring is performed to allow an understanding of the response behavior of the system and to evaluate the system's operational performance. Process monitoring is performed to determine if settings are appropriate or if modifications should be made to allow more efficient operation. The process monitoring at the ARP OU Trenches Area during this reporting period included pressure and flow rate.

The process data (Tables 2 and 3) indicate that the zone of influence reached the target area under the operational scheme. This is evidenced by the vacuum distribution (Table 2) in the extraction wells, which covered the entire trench. The vacuum distribution across the entire treatment area remained fairly uniform. VOC emissions were variable but contributed to source removal in the area.

3.0 CONCLUSIONS/RECOMMENDATIONS

The ARP OU passive SVE system removed ~1.6 kg (3.6 lb.) of VOCs during this reporting period. Vacuum levels at the monitoring wells indicate that the subunit was adequately influenced by the extraction well network. The extraction well network continued to remove contaminant mass from the subsurface.

The SVE concentrations are very low and have been steady for years, indicative of diffusion limitations in the contaminated soil/subsurface media. A review of the unit history and background indicates that the VOCs are restricted to the ash in the trench (WSRC 2003a). VOCs were not detected in any soil sample in the natural sediments below the ash in the Trenches subunit which is ~3.0-m (10-ft) deep with a depth to groundwater of ~39.6-m (130-ft) below ground surface. The

chlorinated VOCs are likely commingled with hydraulic/cutting oils that would hinder removal by ASVE due to partitioning and would reduce migration potential. The domed soil cover forms a relatively tight cover over the contaminated ash and limits rainfall infiltration. SRS believes that the diffusion limitations are mostly related to the limits associated with volatilization of the chlorinated organics from the hydraulic/cutting oils and possibly the ash material.

The RGs for this unit are 656 µg/kg PCE and 87.7 µg/kg TCE. Both the cover system and diffusion limitations reduce the potential for contaminant migration. However, the actual migration potential of the contaminants from the ash material to the groundwater is uncertain. The contaminant migration uncertainty was addressed by additional characterization of the ash layer and vadose zone soils in July 2018 in accordance with the *Sampling and Analysis Plan for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)* (SRNS 2015). The additional characterization activities will evaluate if the VOCs are partitioned in the hydraulic/cutting oils and provide information on the remaining VOC concentration in ash/soil.

A PCR Addendum will be submitted in October 2018. The PCR Addendum will document the change in the power source from active to passive SVE and include the additional soil and ash sampling data to determine if the RGs have been met. A path forward for operation of the SVE system will be documented in the PCR Addendum.

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FIGURES

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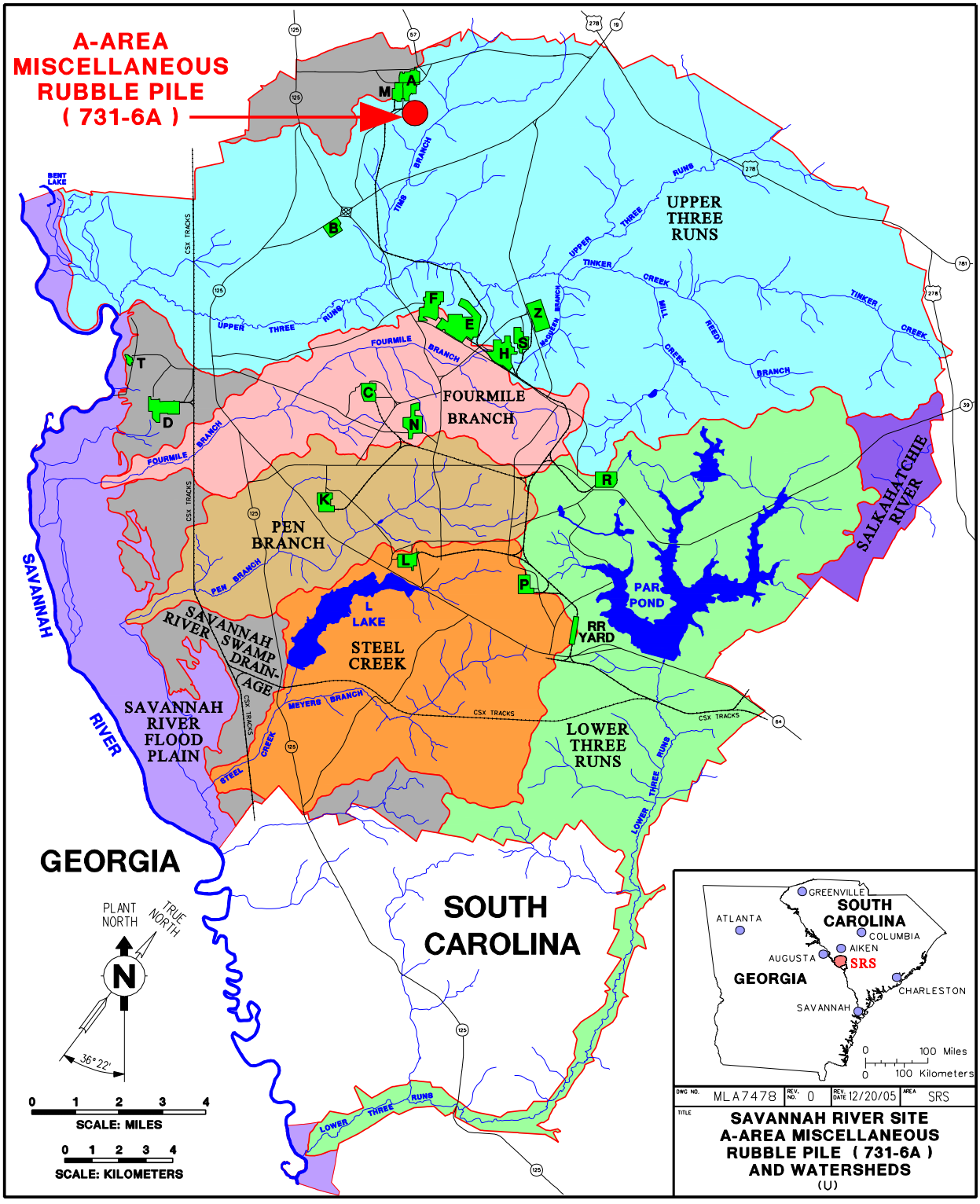

Figure 1. Location of the ARP OU at SRS

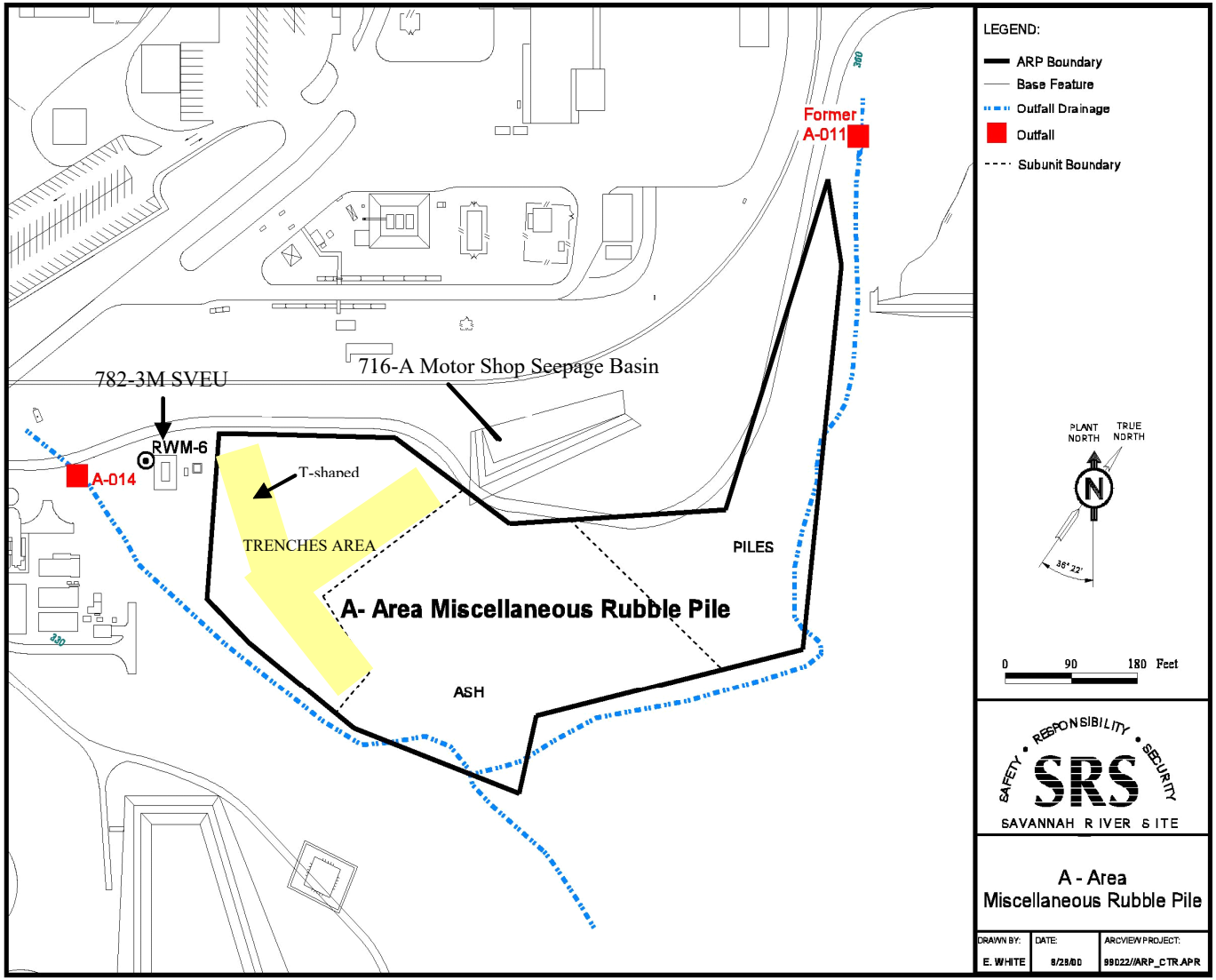

Figure 2. ARP OU (731-6A)

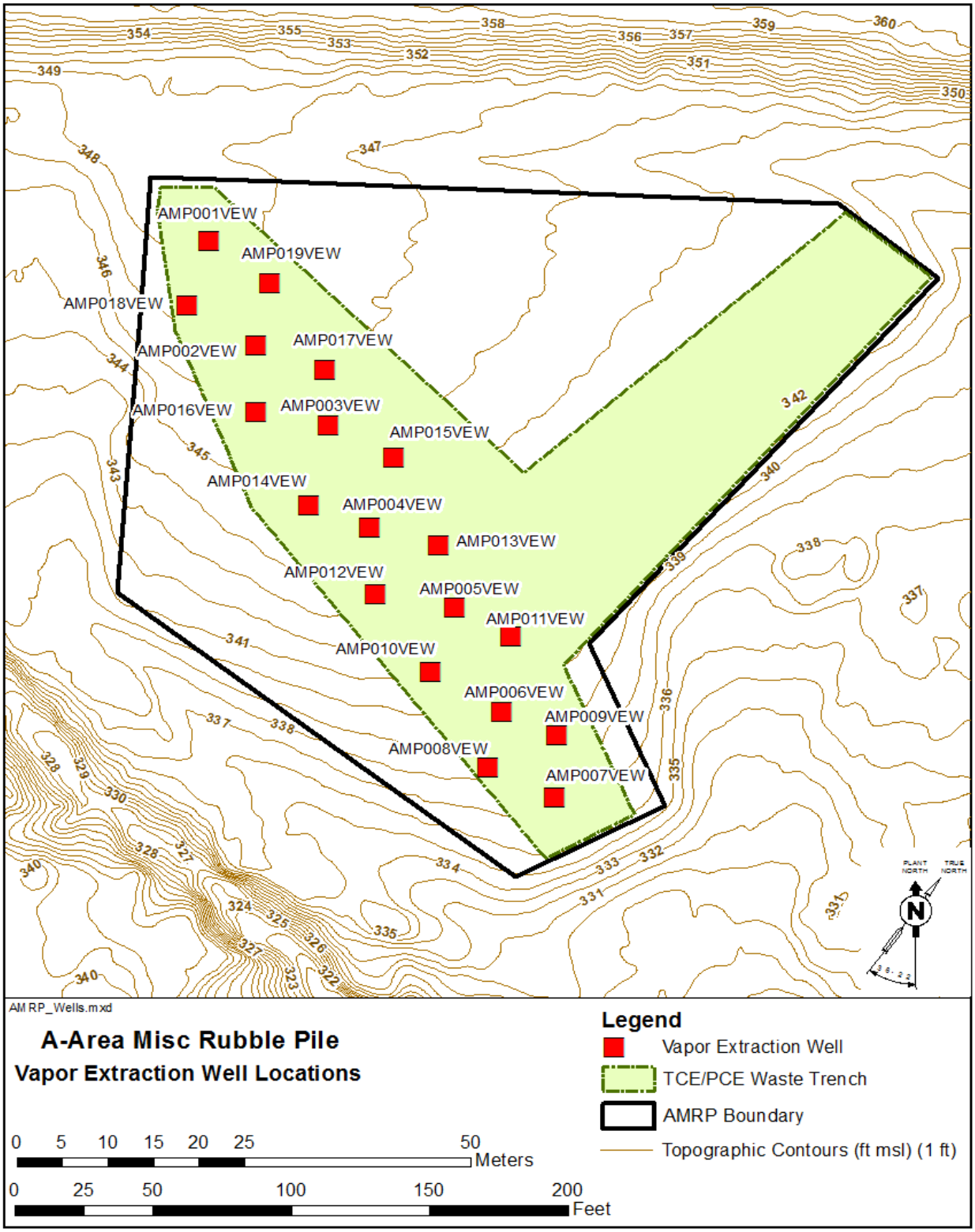

Figure 3. ARP OU Extraction and Monitoring Well Locations

Figure 4. Typical Passive SVE Well

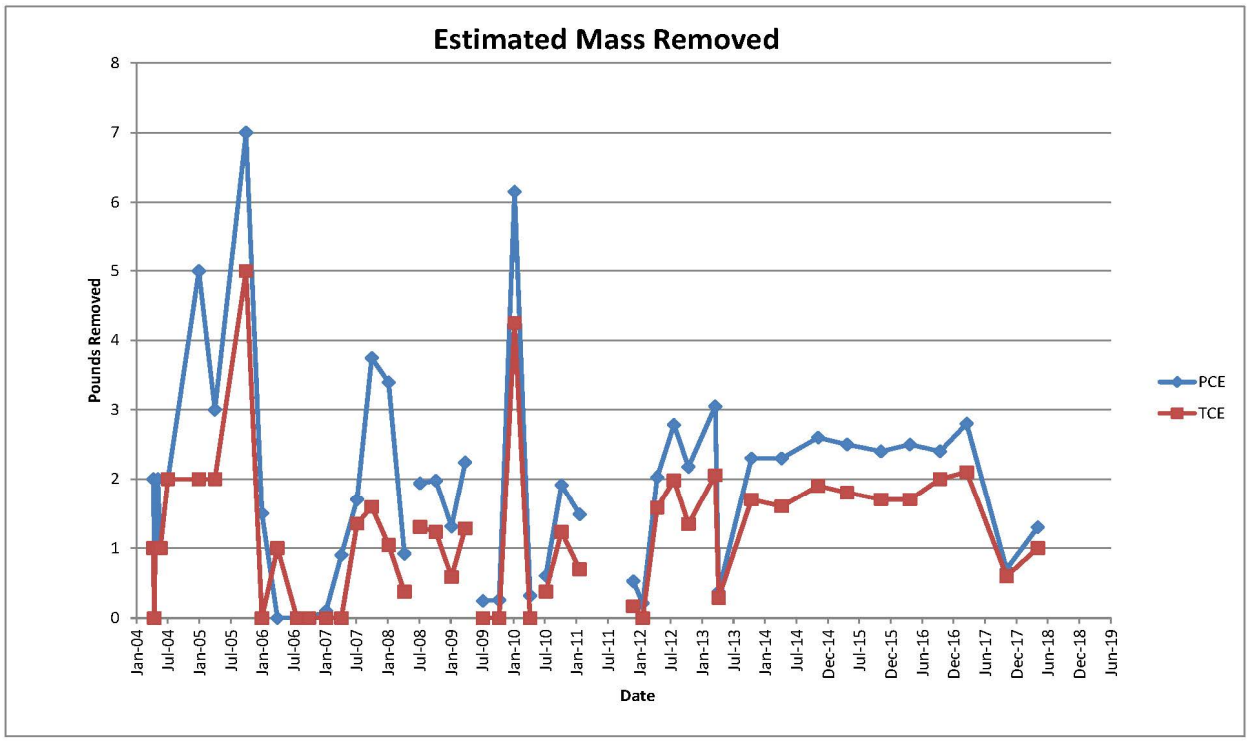

Figure 5. ARP SVE Wells Performance Monitoring – Estimated Mass Removed

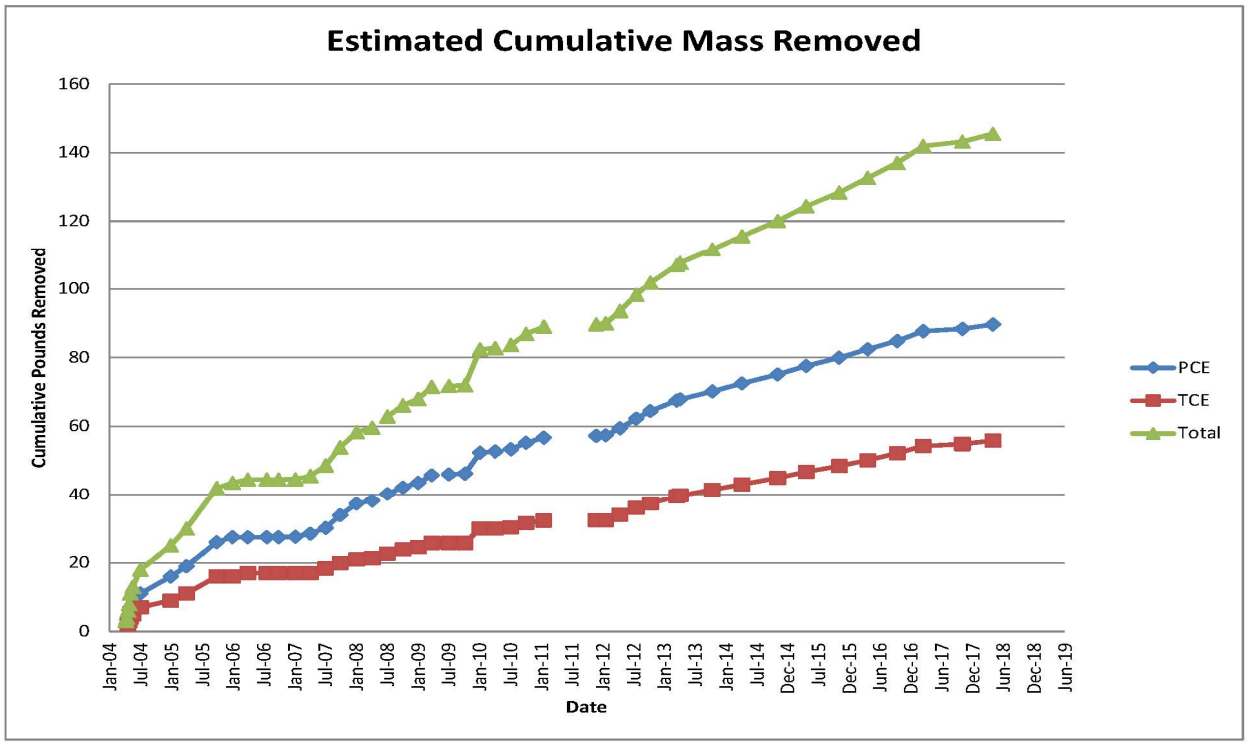

Figure 6. ARP SVE Wells Performance Monitoring – Estimated Cumulative Mass Removed

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TABLES

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Table 1. Passive SVE Wells – Monitoring Data

Sample Location	Laboratory GC *(ppmv)*		
	11/14/2017		
	PCE	TCE	Flow *(scfm)*
AMP001VEW	0.028 (U)	0.027 (U)	5
AMP002VEW	0.168	0.227	5
AMP003VEW	0.659	0.656	2
AMP004VEW	0.342	0.292	2
AMP005VEW	0.028 (U)	0.027 (U)	5
AMP006VEW	0.028 (U)	0.027 (U)	4
AMP007VEW	0.069	0.036 (J)	1
AMP008VEW	0.028 (U)	0.027 (U)	6
AMP009VEW	0.058	0.027 (U)	2
AMP010VEW	0.556	0.467	5
AMP011VEW	0.028 (U)	0.027 (U)	10
AMP012VEW	0.398	0.380	6
AMP013VEW	0.123	0.091	4
AMP014VEW	0.631	0.735	4
AMP015VEW	0.028 (U)	0.027 (U)	6
AMP016VEW	0.060	0.110	5
AMP017VEW	0.281	0.350	5
AMP018VEW	0.048 (J)	0.065	4
AMP019VEW	0.030 (J)	0.030 (J)	2

Notes:
U = non-detect
J = estimated value

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Table 2. Passive SVE Wells – Process Monitoring Data – Vacuum

Date	Vacuum *(inches water)*																		
	AMP001VEW	AMP002VEW	AMP003VEW	AMP004VEW	AMP005VEW	AMP006VEW	AMP007VEW	AMP008VEW	AMP009VEW	AMP010VEW	AMP011VEW	AMP012VEW	AMP013VEW	AMP014VEW	AMP015VEW	AMP016VEW	AMP017VEW	AMP018VEW	AMP019VEW
06/14/17	1.0	5.0	1.8	4.0	2.5	8.5	0.5	3.0	2.0	3.0	11.5	2.0	OOS	1.0	6.5	2.0	2.0	2.5	0.5
06/21/17	5.8	5.8	1.8	4.1	2.6	8.3	1.1	3.5	2.3	3.1	12.5	2.1	8.7	1.4	10.0	3.0	2.0	4.5	0.9
06/26/17	6.5	6.0	2.0	4.0	3.0	9.0	1.0	4.0	2.5	4.0	13.0	2.2	10.0	1.2	11.0	3.5	2.0	4.5	1.5
07/03/17	7.0	6.0	2.0	4.0	3.0	10.5	1.0	5.0	2.5	4.0	12.5	2.5	7.0	1.5	11.5	3.5	2.0	4.8	2.0
08/15/17	8.0	7.5	2.8	4.0	4.0	3.0	1.0	5.0	4.5	4.5	13.5	3.0	6.0	2.0	10.5	3.5	3.0	5.0	3.0
09/18/17	7.5	7.5	2.0	5.5	4.0	3.5	1.2	4.5	5.0	4.0	14.0	2.5	6.0	1.8	10.0	3.0	2.5	5.0	2.5
10/10/17	6.5	6.2	1.8	5.0	3.5	2.9	1.0	4.5	2.4	3.2	12.0	1.8	5.3	1.2	8.1	2.5	2.0	4.5	1.0
11/14/17	OOS	4.6	1.5	5.5	3.7	2.6	1.0	3.1	1.7	2.6	13.1	2.5	4.0	1.0	10.8	1.2	1.5	4.6	1.2
12/18/17	6.5	2.1	6.1	10.5	7.7	8.8	1.0	6.0	1.5	2.9	12.2	2.0	6.8	1.3	5.0	2.0	1.8	1.5	1.7
01/15/18	9.0	4.0	7.0	12.0	8.5	11.0	1.0	9.0	4.5	3.8	14.0	3.5	7.5	2.0	10.0	3.5	2.5	3.0	3.0
02/21/18	6.3	2.0	7.0	11.0	9.2	11.8	1.0	6.5	3.0	3.5	13.2	2.7	6.7	2.1	8.2	2.9	2.2	4.3	3.9
03/13/18	10.5	3.5	10.0	3.0	10.0	13.5	1.0	9.5	3.5	4.5	15.0	4.0	8.0	2.9	14.0	5.0	3.9	5.0	3.5
04/16/18	7.5	2.0	6.0	11.0	10.5	12.5	1.0	6.5	2.0	2.5	14.0	3.0	7.5	1.5	9.0	3.0	3.0	4.5	2.0

OOS = Out of Service

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Table 3. Passive SVE Wells – Process Monitoring Data – Flow

Date	Flow *(scfm)*																		
	AMP001VEW	AMP002VEW	AMP003VEW	AMP004VEW	AMP005VEW	AMP006VEW	AMP007VEW	AMP008VEW	AMP009VEW	AMP010VEW	AMP011VEW	AMP012VEW	AMP013VEW	AMP014VEW	AMP015VEW	AMP016VEW	AMP017VEW	AMP018VEW	AMP019VEW
06/14/17	7	7	1	2	1	6	1	2	3	10	2	7	OOS	5	6	9	6	8	1
06/21/17	5	5	2	2	4	5	1	2	2	8	5	7	5	5	8	7	5	7	1
06/26/17	6	7	4	2	2	5	1	2	2	8	2	7	3	8	5	8	5	7	1
07/03/17	4	5	1	4	1	6	1	5	2	8	10	7	6	3	4	6	5	6	1
08/15/17	6	10	4	2	2	2	3	2	2	8	4	8	4	4	15	5	5	5	3
09/18/17	6	9	2	5	4	4	2	6	2	8	10	7	4	6	5	7	5	6	3
10/10/17	5	5	1	3	2	1	2	2	2	7	2	6	3	4	4	6	4	7	1
11/14/17	OOS	5	2	2	5	4	1	6	2	5	10	6	4	4	6	5	5	4	2
12/18/17	5	1	8	7	8	8	2	9	1	7	7	4	8	7	5	8	3	3	9
01/15/18	24	3	10	18	10	17	10	13	1	13	20	9	15	8	9	6	5	7	8
02/21/18	11	2	7	12	4	6	5	9	1	7	15	7	11	8	10	7	4	6	6
03/13/18	15	2	8	4	12	12	6	10	1	9	15	7	12	6	16	9	3	8	6
04/16/18	5	3	8	9	12	6	4	3	2	6	4	6	10	7	5	8	6	7	6

OOS = Out of Service

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