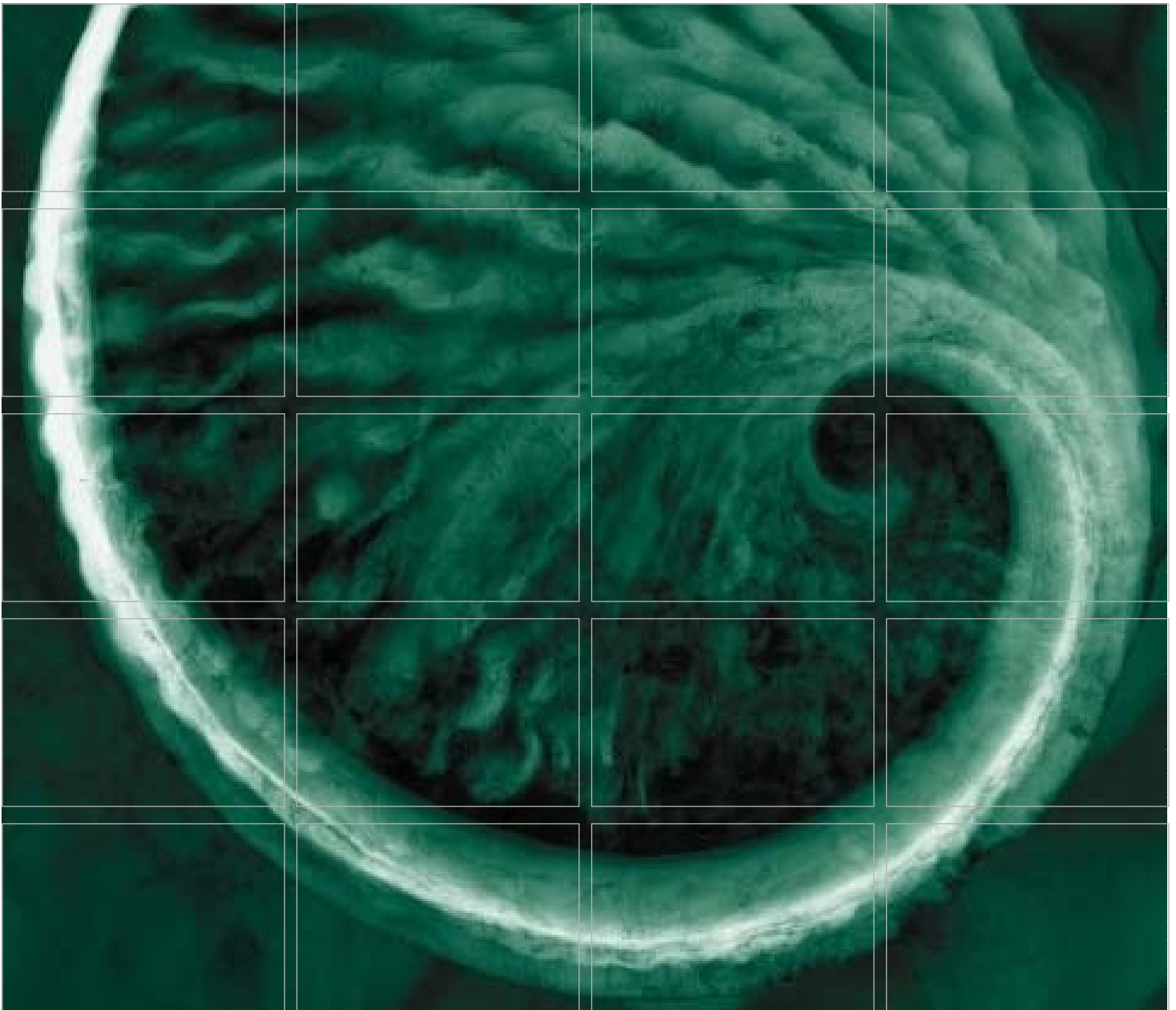




Interim Remedial Measure and Corrective Action Plan Operations, Maintenance, and Monitoring Report #6

**SMS #2006-3509
401 Gage Street
Bennington, Vermont**

**Prepared for:
Energizer Battery Manufacturing, Inc.
401 Gage Street
Bennington, Vermont 05201
(802) 442-6301**

**ERM Reference 0095267
7 August 2009**



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Environmental Resources Management

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FINAL REPORT

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Operations, Maintenance, and
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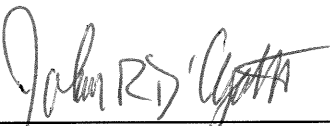
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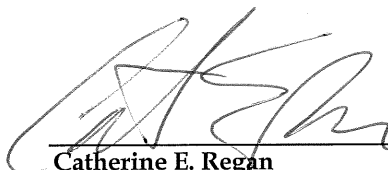
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TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
1.0 INTRODUCTION	1
1.1 OVERVIEW	1
1.2 SITE BACKGROUND	1
1.3 PURPOSE AND SCOPE	2
1.4 REPORT ORGANIZATION	3
2.0 REMEDIATION SYSTEM OPERATION AND MAINTENANCE	4
2.1 SOIL VAPOR EXTRACTION	4
2.1.1 Vapor Carbon Vessels	4
2.2 AIR SPARGING	5
2.3 GENERAL SYSTEM PARAMETERS	6
2.4 STEAM INJECTION	6
2.5 STEAM INJECTION - FUEL AND WATER USE	8
3.0 INDOOR AIR AND OUTDOOR AMBIENT AIR MONITORING	10
4.0 ACTIVE SOIL GAS MONITORING	11
5.0 GROUNDWATER MONITORING	12
6.0 RESULTS AND RECOMMENDATIONS	13
6.1 REMEDIATION SYSTEM OPERATION	13
6.1.1 IRM & CAP AS/SVE Systems	13
6.1.2 CAP Steam Injection System	13
6.2 SVE AIR MONITORING	14
6.3 ACTIVE SOIL GAS MONITORING	15

6.4	<i>GROUNDWATER MONITORING</i>	15
6.5	<i>RECOMMENDATIONS</i>	16
7.0	<i>REFERENCES</i>	17

LIST OF TABLES

<i>Table 1</i>	<i>SVE Wells – Vacuum Gauge Data</i>
<i>Table 2</i>	<i>SVE Wells – Differential Pressure and Flow Data</i>
<i>Table 3</i>	<i>SVE System - VGAC Cumulative Mass Removal</i>
<i>Table 4</i>	<i>Air Sparge Wells – Pressure Gauge Data</i>
<i>Table 5</i>	<i>Air Sparge Wells – Flow Data</i>
<i>Table 6</i>	<i>General System Parameters</i>
<i>Table 7</i>	<i>SVE System – AOC-1 Mass Removal</i>
<i>Table 8</i>	<i>Steam Injection System – Fuel and Water Use</i>
<i>Table 9</i>	<i>Summary of Active Soil Gas Analytical Results</i>
<i>Table 10</i>	<i>Summary of Groundwater Analytical Results</i>

LIST OF FIGURES

<i>Figure 1</i>	<i>Site Locus Map</i>
<i>Figure 2</i>	<i>Site Plan</i>
<i>Figure 3</i>	<i>IRM & CAP Well Locations</i>
<i>Figure 4</i>	<i>SVE System - VGAC Cumulative Mass Removal</i>
<i>Figure 5</i>	<i>Steam System - Cumulative Steam Use</i>
<i>Figure 6</i>	<i>TMP-1 – Time Series Temperature Plot</i>
<i>Figure 7</i>	<i>TMP-2 – Time Series Temperature Plot</i>
<i>Figure 8</i>	<i>TMP-3 - Time Series Temperature Plot</i>
<i>Figure 9</i>	<i>TMP-53 - Time Series Temperature Plot</i>
<i>Figure 10</i>	<i>TMP-56 - Time Series Temperature Plot</i>
<i>Figure 11</i>	<i>TMP-57 - Time Series Temperature Plot</i>
<i>Figure 12</i>	<i>TMP-59 - Time Series Temperature Plot</i>
<i>Figure 13</i>	<i>TMP-61 - Time Series Temperature Plot</i>
<i>Figure 14</i>	<i>TMP-64 - Time Series Temperature Plot</i>
<i>Figure 15</i>	<i>PCE and TCE Concentrations in Active Soil Gas Samples – June 2009</i>
<i>Figure 16</i>	<i>PCE Active Soil Gas Time Series Plots</i>
<i>Figure 17</i>	<i>TCE Active Soil Gas Time Series Plots</i>
<i>Figure 18</i>	<i>PCE & TCE in Groundwater Samples – June 2009</i>
<i>Figure 19</i>	<i>PCE Groundwater Time Series Plots (pages 1-3)</i>
<i>Figure 20</i>	<i>Estimated Extent of Steam Bubble</i>

LIST OF APPENDICES

Appendix A Air Analytical Results (SVE & Soil Gas)

Appendix B Groundwater Analytical Results

EXECUTIVE SUMMARY

Environmental Resources Management (ERM) has prepared this Operations, Maintenance, and Monitoring (OM&M) Report #6 for the Interim Remedial Measure (IRM) and Corrective Action Plan (CAP) remediation systems on behalf of Energizer Battery Manufacturing, Inc. (Energizer) for the Energizer facility at 401 Gage Street, Bennington, Vermont (the "Site"). The Vermont Department of Environmental Conservation (VTDEC), Sites Management Section has assigned the Site Number 2006-3509.

The IRM remediation system was designed and installed to contain tetrachloroethene (PCE) and trichloroethene (TCE) impacts to groundwater and soil gas along the northern Site property line. The CAP remediation system was designed and installed to abate PCE and TCE impacts to soil, groundwater, and soil gas in selected Areas of Concern (AOCs) at the Site. The remedial objective is to achieve applicable regulatory cleanup standards at the Site property line.

The IRM system consists of air sparging (AS) and soil vapor extraction (SVE) components. The CAP system consists of integrated steam injection, AS, and SVE components. The IRM and CAP systems have been operating since September 2007 and April 2008, respectively.

The purpose of this report is to document the OM&M data collected for the IRM and CAP remediation systems during the period of April through June 2009.

1.0 INTRODUCTION

1.1 OVERVIEW

Environmental Resources Management (ERM) has prepared this Operations, Maintenance, and Monitoring (OM&M) Report #6 for the Interim Remedial Measure (IRM) and Corrective Action Plan (CAP) remediation systems on behalf of Energizer Battery Manufacturing, Inc. (Energizer) for the facility located at 401 Gage Street in Bennington, Vermont (the "Site"). The Vermont Department of Environmental Conservation (VTDEC), Sites Management Section has assigned the Site Number 2006-3509. This OM&M Report #6 documents relevant remediation and monitoring activities conducted from April through June 2009. A Site Locus Map is provided as Figure 1.

1.2 SITE BACKGROUND

In February 2006, ERM conducted a limited soil and shallow groundwater investigation to determine if chlorinated solvents were present in the subsurface in the vicinity of an active vapor degreaser located in the northeast corner of Plant I (Figure 2). Operation of this degreaser was subsequently discontinued in 2007. The results of this initial investigation indicated that both tetrachloroethene (PCE) and trichloroethene (TCE) were present in soil and groundwater in the vicinity of the degreaser (ERM, 2006). Energizer verbally notified VTDEC of the findings of the initial investigation on 6 March 2006. Subsequently, written notification was provided to the VTDEC on 16 March 2006.

During 2006 and early 2007, ERM conducted a dynamic Triad site investigation in accordance with the VTDEC Site Investigation Procedure (VTDEC, 2005). In June 2007, ERM submitted a Site Investigation Report (SIR) (ERM 2007a) to the VTDEC documenting the methods, results, and conclusions of the site investigation. The SIR concluded that remediation and/or management of Site soil, groundwater and soil gas was necessary.

Site investigation activities focused on delineation of the extent of PCE and TCE impacts in soil, groundwater and soil gas. ERM has identified six potential Areas of Concern (AOCs), which correspond to areas of former solvent usage at the facility (Figure 2):

- AOC-1: Former degreaser area;
- AOC-2: Former machine shop;
- AOC-3: Current production area;
- AOC-4: Former loading dock area;
- AOC-5: Former drain line; and
- AOC-6: Former process area sump.

The Corrective Action Feasibility Investigation (CAFI) was submitted to the VTDEC as part of the SIR. The CAFI documented a formal evaluation of potential Site remedial alternatives. Based on the results of the CAFI, ERM recommended implementation of the following remedial alternatives:

- A containment remedy consisting of focused shallow soil excavation and air sparge/soil vapor extraction (AS/SVE) along the northern Site boundary; and
- A source abatement remedy consisting of a combination of AS/SVE, steam-enhanced SVE, and possibly in-situ chemical oxidation (ISCO).

The containment remedy design is documented in the CAFI as an IRM. The source area abatement remedy design is documented in the CAP (ERM 2007b). A Final Construction Report (ERM, 2008a) was submitted on 20 June 2008 to document the construction of the IRM and CAP remediation systems.

Quarterly OM&M reports were submitted on:

- 20 June 2008 - OM&M Report #1 (ERM, 2008b);
- 8 August 2008 - OM&M Report #2 (ERM, 2008c); and,
- 6 November 2008 - OM&M Report #3 (ERM, 2008d).
- 30 January 2009 - OM&M Report #4 (ERM, 2009a).
- 30 April 2009 - OM&M Report #5 (ERM, 2009b)

1.3

PURPOSE AND SCOPE

The purpose of this report is to document the OM&M data collected for the IRM and CAP remediation systems from April through June 2009. The following activities were conducted during this reporting period:

- Continued operation of the IRM and CAP AS/SVE system;
- Continued full-scale CAP steam operation;
- Conducted OM&M of the IRM and CAP remediation systems; and,
- Completed monthly and quarterly soil gas and groundwater monitoring.

1.4 *REPORT ORGANIZATION*

The remainder of this report is divided into the following sections:

- Section 2.0 – Remediation System Operation and Maintenance
- Section 3.0 – Indoor and Outdoor Ambient Air Sampling
- Section 4.0 – Active Soil Gas Monitoring
- Section 5.0 – Groundwater Monitoring
- Section 6.0 – Results and Recommendations

2.0 *REMEDIATION SYSTEM OPERATION AND MAINTENANCE*

2.1 *SOIL VAPOR EXTRACTION*

There are 18 SVE wells (SVE-1 through SVE-18) that are part of the IRM system (Figure 3). Start-up of these wells occurred in September 2007. There are an additional 12 SVE wells (SVE-19 through SVE-27; SVE-30, SVE-31, and SVE-32) associated with the CAP system (Figure 3), which became operational in January 2008.

Vacuum, flow and differential pressure readings from the SVE system collected during this reporting period are summarized in Tables 1 and 2.

There are three 5,000-pound VGAC (i.e. carbon) vessels (VGAC-301, -302, and -303) on-site to treat extracted soil vapor. Two vessels are operated in series at one time, with the third vessel on stand-by.

Monthly grab air samples were collected from the inlet, midpoint and outlet air streams of the carbon vessels using clean, individually laboratory-certified, stainless steel Summa-type canisters. The air samples were analyzed by Alpha Woods Hole Laboratories of Westborough, Massachusetts (Alpha) for chlorinated volatile organic compounds (CVOCs) by Method TO-15. These data are used to estimate the contaminant mass removed by the SVE system over time.

Laboratory analytical results of the off-gas treatment system samples for this reporting period are summarized in Table 3. Laboratory analytical reports for these air samples are attached as Appendix A. A graph showing total CVOCs removed since system start-up is provided as Figure 4.

2.1.1 *Vapor Carbon Vessels*

Vessels VGAC-3 and VGAC-1 were operational from 16 to 30 April 2009. VGAC-3 had been operational as the lag vessel from 30 October 2008 to 16 April 2009 and was then realigned as the lead vessel to check if there was any remaining capacity for carbon removal. Based on the data collected on 17 April 2009, it was determined that the carbon in VGAC-3 was spent as system midpoint PCE concentrations exceeded VTDEC-approved threshold change out criteria documented in the letter report to the VTDEC on 16 December 2008 (ERM, 2008e). The carbon vessels were

reconfigured on 30 April 2009 such that VGAC-1 and VGAC-2 were on-line. Data collected on 17 June 2009 indicated that PCE effluent concentrations again exceeded VTDEC-approved change out threshold criteria. Preparations were initiated to replace carbon in VGAC-3 in order to support an additional reconfiguration. In addition, steam flow rates were reduced in SIW-10, -13 and -14 starting 25 June 2009 to facilitate reduction in SVE off-gas air temperatures and increase carbon efficiency.

On 29 June 2009, pressure build up within the lag VGAC vessel (VGAC-2) resulted in a portion of the carbon being discharged through the effluent piping and out the exhaust stack. Upon discovery of the carbon, the Facility notified ERM and began cleanup of the carbon. Contact with the VTDEC was initiated on 30 June 2009 and a conference call was conducted on 2 July 2009. A letter documenting the carbon discharge was submitted to the VTDEC on 6 July 2009 (ERM, 2009c).

To minimize the potential for additional carbon discharge during the engineering analysis, Energizer has received verbal approval from the VTDEC, via teleconference on 2 July 2009, to bypass the VGAC vessels and emit vapor from the remediation system directly to the exhaust stack. This decision was made based on review of PCE and TCE concentrations in the vapor influent samples since November 2008, which indicated that concentrations of these compounds have continually been below air emission criteria protective of Vermont ambient air quality.

ERM completed a root-cause analysis and engineering review regarding this issue, which is documented in a letter to the VTDEC, dated 30 July 2009.

2.2 *AIR SPARGING*

There are currently 54 AS wells operating in association with the IRM and CAP systems (Figure 3). There are also five inactive AS wells in AOC-2 (AS-69, AS-70, AS-71, AS-74 and AS-75), which can become operational, if needed.

Pressure and flow readings from the AS system during this reporting period are summarized in Tables 4 and 5, respectively.

On 5 May 2009, AS-53 was taken out of service because steam began to flow into the well from the subsurface during a maintenance shutdown. The temperature increase was reported and the well was isolated from the remediation system.

AS system pulsing was implemented at various times during this reporting period to enhance contaminant mass removal. Flow rates were decreased by 1 to 2 standard cubic feet per minute (scfm) per well for a period of time and then returned to baseline. Pulsing time periods varied and included:

- a two-week pulse initiated on 24 March 2009;
- three-day pulses initiated on 18 April 2009 and 25 April 2009; and
- a one-week pulse initiated on 3 June 2009.

2.3 *GENERAL SYSTEM PARAMETERS*

Additional system measurements were collected to monitor the operation of the AS/SVE remediation equipment. The measurements included:

- temperature of the AS and SVE blower effluent; and
- temperature and pressure of the non-contact cooling water; and
- effluent air at the air-to-water heat exchangers.

A summary of these measurements for this reporting period is provided in Table 6. Air velocity transmitter readings for this reporting period have not been provided as the high humidity of the air caused the transmitters to read incorrectly. The flow meter readings for water to the SVE heat exchanger was discontinued as the meter no longer records flow. Water used in both heat exchangers will be captured by the facility flow meter prior to discharge.

2.4 *STEAM INJECTION*

There are 14 steam injection wells (SIW-8 through SIW-21) associated with the CAP system to accelerate contaminant mass removal. The following steam injection wells were operating during this reporting period: SIW-8, SIW-9, SIW-10, SIW-11, SIW-13, SIW-14, SIW-15 and SIW-16 (Figure 3).

Total steam injection mass per well per week was recorded using steam flow totalizers. The cumulative steam injection per well is summarized in Figure 5.

On 16 May 2009 the steam system's pressure set point was increased from 35 pounds per square inch (PSI) to 40 PSI. This adjustment was made in an effort to further enhance the efficacy of the remediation system by increasing steam injection flow rates and enlarging the area of influence (i.e., steam bubble). In particular, this adjustment was made to enhance removal of contaminant mass that appears to be present beneath the gel room, which is an active manufacturing area (i.e., this area was inaccessible for installation of remediation wells) located immediately west of the former degreaser room. The steam injection system was not designed to treat the area beneath this room. However, the continued presence of elevated PCE concentrations in effluent air samples collected from SVE-22 and SVE-26, which are located adjacent to this room, suggested that the current system is affecting enhanced contaminant removal beneath this room. Therefore, the steam injection flow rates were enhanced in an effort to effect additional remediation beneath the gel room.

The increased steam injection flow rates resulted in increased vapor off-gas temperatures, which ultimately exceeded the designed specifications of the SVE system. Therefore, injection flow rates at SIW-10, -13 and -14 were manually decreased on 25 June 2009 and the entire system was returned to previous operating conditions on 2 July 2009.

To determine the subsurface temperatures during steam injection, temperature sensors were installed at various depths in 13 locations (TMP-1, TMP-2, TMP-3, TMP-11, TMP-12, TMP-13, TMP-46, TMP-53, TMP-56, TMP-57, TMP-59, TMP-61, and TMP-64).

The temperature readings for this reporting period are summarized as temperature versus time graphs in Figures 6 through 14. Temperature graphs are shown only for temperature points within and in close proximity to the AOC where steam injection is occurring. These temperature points are TMP-1, TMP-2, TMP-3, TMP-53, TMP-56, TMP-57, TMP-59, TMP-61 and TMP-64.

On 3 June 2009, the temperature sensor at TMP-3 was taken out of service due to a defective battery. The sensor was reinstalled on 26 June 2009. All other thermocouples continue to function properly.

Soil gas samples were collected from seven SVE wells (SVE-1 and SVE-22 through 27) located within AOC-1 on a monthly basis to estimate the localized mass of contaminants removed during steam injection. The air samples were analyzed by Alpha for CVOCs by Method TO-15. Laboratory analytical results for this reporting period are summarized in

Table 7. Laboratory analytical reports for these air samples are attached as Appendix A.

During the April 2009 sampling round, a modification was made to the SVE well sampling set. SVE-4 and SVE-5 were sampled to facilitate estimation of the contaminant mass removed west of AOC-1. SVE-27 was not sampled during the April sampling round as continuous low PCE and TCE concentrations in this well indicate that limited mass removal is occurring in the area south of the former degreaser. In addition, SVE-3 was not sampled during this reporting period as continuous low PCE and TCE concentrations in this well indicate that limited mass removal is occurring at this location.

Groundwater extraction wells EW-1, EW-3, EW-4, and EW-5 remain out of service. The horizontal extent of the steam bubble has reached the extraction well locations and displaced the groundwater. The wells no longer pump water and have thus been shut down and isolated from the remediation system at the well heads.

2.5 *STEAM INJECTION - FUEL AND WATER USE*

Table 8 reports the fuel and water used to generate steam injected into the steam injection wells during this reporting period. Data used to complete these calculations was taken from the steam totalizer readings collected weekly from each operating steam injection well.

Water use is calculated using the assumption that 1 pound of steam is approximately equivalent to 1 pound of water. Fuel usage is estimated using the following fuel assumptions:

- Latent heat of vaporization (LHV) = 905.25 British thermal units/pound (BTU/lb)
- Heat value of No. 4 fuel oil (HV)= 145,000 BTU/gallon (gal)
- Boiler efficiency (BE) = 85%
- Boiler water enthalpy (BWE) at 60 pounds per square inch gauge (psig) = 276.79 BTU/lb
- Makeup water enthalpy (MWE) at 60 degrees Fahrenheit (°F) = 28.08 BTU/lb

Using the above assumptions, fuel use is calculated based on the energy balance required to convert water to saturated steam. The latent heat of vaporization (energy needed to convert water to steam) is added to the enthalpy of the warm boiler water and subtracted from the enthalpy of the cold makeup water to calculate the energy needed per pound of steam. This energy is converted into gallons of fuel using the assumed energy capacity of No. 4 fuel oil and the assumed boiler efficiency. The equation is written as follows:

$$\frac{\text{Gal of Fuel}}{\text{lb of Steam}} = \frac{(LHV + BWE - MWE)}{HV \times BE}$$

3.0

INDOOR AIR AND OUTDOOR AMBIENT AIR MONITORING

No indoor or outdoor ambient air sampling activities were conducted during this reporting period.

Quarterly active soil gas samples were collected on 16 June 2009. Samples were collected at three active soil gas locations (ASG-13, -32 and -33).

Prior to collection of the soil gas samples, the soil gas probes and tubing were purged of a minimum of three tubing volumes at a rate not exceeding 0.2 liters per minute. Helium was used as a tracer gas to determine whether ambient air was being drawn into the sampling zone. Samples were collected using clean, laboratory-certified, 6-liter, Summa-type canisters with 2-hour calibrated regulators connected to the dedicated polyethylene tubing with a “swagelok®-type” fitting.

During the past two quarterly sampling events, a sample from ASG-14 could not be obtained due to an obstruction in the sample tubing. This sampling point is determined to be damaged and the alternative downgradient sample location of ASG-13 was chosen as a replacement. ASG-13 will continue to be monitored on a quarterly basis.

Soil gas samples were submitted to Alpha for analysis of CVOCs using EPA Method TO-15. Results were reported for site-specific target analytes. Table 9 presents a summary of active soil gas sample results for all wells sampled during this reporting period. Figure 15 shows PCE and TCE results from this reporting period. Time-series plots of PCE and TCE active soil gas concentrations for the wells sampled during the quarterly sampling event are included as Figures 16 and 17, respectively. Laboratory analytical reports are attached as Appendix A.

The SIR (ERM, 2007a) presented detailed groundwater elevation data for the site. Quarterly groundwater samples were collected from monitoring wells ERM-12, ERM-13, ERM-14, ERM-16, ERM-17, ERM-18, ERM-19 and ERM-20 on 17 June 2009. Samples were collected using low-flow sampling techniques and submitted to Alpha for analysis of CVOCs by EPA Method 8260.

Table 10 presents a summary of groundwater sample results for the eight wells sampled during this reporting period. Figure 18 shows the PCE and TCE results from this reporting period. Time-series plots of PCE groundwater concentrations for the eight wells sampled during this reporting period are included as Figure 19. Laboratory analytical reports are attached as Appendix B.

6.0 RESULTS AND RECOMMENDATIONS

6.1 REMEDIATION SYSTEM OPERATION

6.1.1 IRM & CAP AS/SVE Systems

Based on the OM&M data collected during this reporting period, the following conclusions can be made regarding operation of the remediation systems:

- Based on SVE system vacuum data and AS system injection data, the SVE system has capacity to capture the volume of vapor being injected by the AS system and vapor generated by the steam injection system.
- The VGAC is no longer effective in treating the SVE off-gas due to high temperatures and high moisture content. The SVE off-gas concentrations are below threshold emission concentrations protective of Vermont ambient air criteria. Therefore, SVE off-gas is currently being emitted to the effluent stack, bypassing the VGAC vessels.
- The remediation equipment (i.e., blowers, moisture separators, heat exchangers) is currently operating as designed and has adequate capacity for operating the IRM AS and SVE wells. However, the system is not capable of sufficiently reducing vapor temperatures and moisture content associated with elevated operation of the CAP steam injection system. This issue was addressed in a letter submitted to the VTDEC, dated 30 July 2009.
- Pulsing the AS system increased PCE concentrations at SVE-23 and SVE-24 during this reporting period. Concentration increases due to pulsing were smaller in influence and smaller in magnitude compared to the previous reporting period (Table 7).

6.1.2 CAP Steam Injection System

Full-scale steam injection has been ongoing during this reporting period. The following conclusions can be made regarding the operation of the steam system:

- The steam injection system was pushed to its operational limits by increasing the pressure set point and steam injection flow rates. The attempt to achieve remediation influence beyond the designed remediation area caused increased vapor temperatures within the SVE system and decreased efficiency of the VGAC.
- The steam injection rate per well ranged between 150 and 550 lb/hr prior to the pressure set point increase on 16 May 2009 and between 250 and 740 lb/hr after the pressure set point increase.
- Subsurface temperatures have been generally increasing or stable indicating ongoing convective and conductive heating (Figures 6 to 14).
- Continued high temperatures at TMP-1, -3, -53, -56, -57, -59, and -61 indicate maintenance of the steam bubble within the footprint of AOC-1, as shown in Figure 20.
- Increases in temperature at TMP-57, -59 and -61 after 16 May 2009 indicate direct influence from the increased steam injection pressure set point (Figures 11, 12 and 14).
- Fuel and water use is slightly higher compared to usage during the last reporting period as a result of the increased steam flow rates observed after 16 May 2009 (Table 8). Increased steam flow in SIW-9 beginning in April 2009 is due to overnight steaming of this well to facilitate temperature increases at TMP-64.

6.2 *SVE AIR MONITORING*

The following conclusions can be made relative to the VGAC and the SVE well-head sampling completed during this reporting period:

- PCE concentrations in soil gas measured in all SVE wells within AOC-1 (SVE-1, -22, -23, -24, -25, -26 and -27) have decreased since the end of the last reporting period (Table 7). Relatively slight increases in mass removal rates (SVE-23 and -24) occurred in conjunction with AS system pulsing.
- TCE concentrations in soil gas measured in SVE-22, -23, -24, -25, -26 and -27 have decreased slightly and concentrations of TCE have increased slightly in SVE-1 (Table 7).

- The VGAC air sampling results indicate that PCE mass removal rates have decreased compared to the previous reporting period and TCE mass removal rates have remained generally the same (Figure 4).
- June 2009 VGAC effluent air sampling concentrations of PCE (455 ug/m³) increased above VTDEC-approved carbon change out threshold criteria (423 ug/m³) (Table 3). PCE and TCE effluent concentrations remain below Vermont ambient air criteria.
- Carbon from VGAC-2 was discharged through the effluent stack due to pressure accumulation inside the vessel. Carbon was removed from the system on 9 July 2009, as approved by the VTDEC during teleconference on 2 July 2009.

6.3 *ACTIVE SOIL GAS MONITORING*

The following conclusions can be made relative to the active soil gas sampling completed during this reporting period:

- Quarterly sampling activities in June 2009 indicated PCE concentrations at ASG-32 and ASG-33 to be increasing compared to the previous reporting period (Table 9).
- Increased PCE concentrations in soil gas at ASG-32 and ASG-33 coincide with increased pressure and flow rates of the steam injection wells.
- A soil gas sample at ASG-13 was taken during the quarterly sampling event as a replacement for ASG-14 and PCE concentrations decreased relative to the baseline sampling event (Figure 16).

6.4 *GROUNDWATER MONITORING*

The following conclusions can be made relative to the groundwater sampling completed during this reporting period:

- PCE concentrations in seven of the eight groundwater wells (ERM-12, -13, -14, -15, -16, -17, and -20) have decreased compared to concentrations detected during the previous reporting period (Table 10 and Figure 19).

- PCE concentrations in ERM-19, have increased slightly compared to concentrations detected during the previous reporting period (Table 10).
- PCE concentrations measured in June 2009 are the lowest summer PCE concentrations observed to date (Table 10).
- TCE concentrations have decreased in ERM-12 and ERM-17, and remained consistent in ERM-13 and ERM-16, when compared to data from the previous quarter. TCE concentrations in ERM-14, -15, -19 and -20 are non-detect.

6.5 *RECOMMENDATIONS*

The following are recommended for the next reporting period:

- Continue operation and maintenance of the IRM and CAP systems under current operating parameters;
- Monitor effluent stack concentrations on a weekly basis to verify that PCE and TCE concentrations are below Vermont ambient air quality criteria;
- Continue to monitor monthly SVE system mass removal rates as an indicator of steam injection performance;
- Discontinue pulsing the AS system as the effectiveness has diminished since implementation in March 2009;
- Continue quarterly active soil gas sampling at ASG-13, ASG-32, and ASG-33 to assess soil gas conditions; and,
- Continue quarterly groundwater monitoring at ERM-12, ERM-13, ERM-14, ERM-15, ERM-16, ERM-17, ERM-19, and ERM-20 to assess groundwater conditions.

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