Multi-Phase Extraction Pilot Test
Interim Remedial Action
Ephrata Landfill

Prepared for

Grant County Public Works **City of Ephrata**

February 2018

Prepared by
Parametrix
In association with
Pacific Groundwater Group

This Page Intentionally Left Blank

Multi-Phase Extraction Pilot Test
Interim Remedial Action
Ephrata Landfill

Prepared for

Grant County Public Works
124 Enterprise Street SE
Ephrata, WA 98823

and

City of Ephrata
121 Alder Street SW
Ephrata, WA 98823

Prepared by

Parametrix
719 2nd Avenue, Suite 200
Seattle, WA 98104
T. 206.394.3700 F. 1.855.542.6353
www.parametrix.com

In association with

Pacific Groundwater Group
2377 Eastlake Avenue East, Suite 200
Seattle, WA 98102
206.329.0141
www.pgwg.com

February 2018 | 553-1860-012

CITATION

Parametrix and Pacific Groundwater Group. 2018. Multi-Phase Extraction Pilot Test Interim Remedial Action Ephrata Landfill. Prepared by Parametrix, Seattle, WA. February 2018.

CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seals, as licensed professionals to practice as such, are affixed below.

BRIAN PIPPIN
30383

02-15-18

Prepared by Brian Pippin
Professional Engineer
Washington State No. 30838

Hydrogeologist
2651

Dawn Chapel

Dawn Chapel

Prepared by Dawn Chapel
Associate Hydrogeologist
Washington State Hydrogeologist No. 2651

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

TABLE OF CONTENTS (CONTINUED)

FIGURES

APPENDICES

This Page Intentionally Left Blank

ACRONYMS

acfm	actual cubic feet per minute
AO	Agreed Order DE 3810
AS	air sparge
CFC	chlorofluorocarbons
cfm	cubic feet per minute
CH_4	methane
City	City of Ephrata
cm	centimeter(s)
cm^2	square centimeter(s)
County	Grant County
DAF	dissolved air floatation
Ecology	Washington State Department of Ecology
FS	feasibility study
ft	foot/feet
ft/d	foot/feet per day
GAC	granulated activated carbon
GC/MS	gas chromatography/mass spectrometry
gpm	gallon(s) per minute
Hg	mercury
HMI	human machine interface
IRA	interim remedial action
L	leakage
LEL	lower explosive limit
LFG	landfill gas
LNAPL	light non-aqueous phase liquid
LTT	liquid treatment train
MPE	multi-phase extraction
MTCA	Model Toxics Control Act
MW	monitoring well
O_2	oxygen
O&M	operation and maintenance
OWS	oil-water separator
P1	P1 zone
P2	P2 zone
Parametrix	Parametrix, Inc.
PGG	Pacific Groundwater Group
PID	photoionization detector
PLC	programmable logic controller
ppb	part(s) per billion
ppm	part(s) per million
RCW	Revised Code of Washington
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
ROI	radius of influence
scf	standard cubic foot/feet

ACRONYMS (CONTINUED)

scfm	standard cubic foot/feet per minute
SQER	small quantity emission rate
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
T	transmissivity
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TPH-G	gasoline-range total petroleum hydrocarbons
µg/L	microgram(s) per liter
$\mu g/m^3$	microgram(s) per cubic meter
UV	ultraviolet
VAE	vacuum-assisted extraction
VOC	volatile organic compound
VTT	vapor treatment train
WAC	Washington Administrative Code

1. INTRODUCTION

This report summarizes the recently completed multi-phase extraction (MPE) pilot test interim remedial action (IRA) at the Ephrata Landfill in Grant County, Washington. The layout of the MPE pilot test infrastructure is shown in Figure 1. The purpose of the pilot test was to evaluate the effectiveness of dewatering and ensuing vapor extraction from a shallow, contaminated groundwater-bearing zone, identified as the P1 zone (P1). The pilot test results inform and support the completion of a remedial investigation and feasibility study (RI/FS) for the site.

The RI/FS was developed under Agreed Order DE 3810 (AO), which took effect on January 30, 2007, between Grant County (County), the City of Ephrata (City), and the Washington State Department of Ecology (Ecology). The MPE pilot test IRA was completed under AO Amendment No. 2, which took effect on January 19, 2016. The AO, as amended, provides the administrative framework for developing the feasibility study (FS), conducting and documenting the remedial investigation (RI), and conducting several IRAs, including the MPE pilot test.

The MPE pilot test IRA was performed consistent with the AO, as amended, and in compliance with the Model Toxics Control Act (MTCA), Chapter 70.105D Revised Code of Washington (RCW), and its implementing regulations, Chapter 173-340 Washington Administrative Code (WAC), including WAC 173-340-350, which specifies procedures for conducting IRAs.

1.1 Site Background

Ephrata Landfill is located approximately 3 miles south of the City of Ephrata on the east side of Highway 28 in the western portion of Section 33, Township 21 North, Range 26 East, Willamette Meridian. An old, unlined landfill (original landfill) is situated on the north part of the landfill property and a new, lined landfill (new landfill) occupies the south part of the property.

Filling began in 1942 in the northwest portion of the original landfill and expanded south and east until the new landfill was opened in 2004. The original landfill was capped in a 2008 IRA under the AO. The new landfill remains the primary solid waste disposal facility for Grant County.

In 1975, approximately 2,350 drums containing industrial waste were stacked at the north end of the original landfill. The drums were buried as the original landfill was filled. Releases from the buried drums became the focus of site cleanup and are thought to be the main source of hazardous substances in the P1. The drums and surrounding contaminated soils were removed in a 2008 IRA under the AO.

1.2 MPE Pilot Test Background

The P1, further described in Section 3, is the uppermost water-bearing layer in basalt (Wanapum Formation) at the north end of the site. Figures 2a and 2b show cross sections through the area. Groundwater in the P1, just south of where the drums and contaminated soil were removed in 2008, contains some of the highest concentrations of volatile organic compounds (VOCs) on site. The objective of the pilot test was to evaluate the effectiveness of dewatering the P1 in this area, creating a vadose zone for soil vapor extraction (SVE), and removing liquid and vapor phase contaminants.

Several existing P1 monitoring wells (MWs) were utilized in the pilot test, both for extraction (e.g., MW-34p1) and observation (e.g., MW-36p1 and MW-37p1). These and other facilities are shown in Figure 1. The new features installed for the pilot test included several new P1 extraction and observation wells, a piping system, vapor and liquid treatment systems, and an evaporation pond. Although the new facilities were installed to perform the pilot test, they are suitable for long-term use. The MPE system is further described in Section 2 and Appendix A.

The MPE pilot test Phase 2 Work Plan (Parametrix, Inc. [Parametrix] 2017a) was developed with assistance from Pacific Groundwater Group (PGG) based on their observations and tests of the new P1 wells. The Phase 2 Work Plan comprised four testing steps that were implemented over 4.5 months. The test period allowed for variable P1 response due to generally low and variable water permeability, as discussed in Section 3, and uncertain dewatering time frames. Observations during each step are further described in Section 4.

1.3 Summary of MPE Pilot Test Results

The summary below demonstrates that the P1 dewatering was successful and that significant vapor flow and contaminant removal was achieved. Pilot test results are discussed in detail in Sections 4, 5, and 6.

- An approximately 4.5-month pilot test, starting on May 23, 2017, was conducted in steps. Step 1 was an initial 2-week baselining phase, and Step 2 was a 3-week dewatering phase. These were followed by Step 3, a 10-week vacuum-assisted extraction (VAE) dewatering phase to create an extended vadose zone in the P1. Step 4 was a 4-week SVE phase to evaluate different vacuums and vapor responses.
- Total groundwater extraction rates peaked at about 3.5 gallons per minute (gpm) with the first application of vacuum, then decreased to near zero as dewatering progressed. A total of 87,000 gallons of groundwater were extracted, treated, and disposed.
- The radius of influence (ROI) measured by groundwater drawdown during pumping from MW-65p1 (prior to the MPE pilot test) averaged about 100 feet (ft), but varied greatly depending on radial direction from the pumping center and individual well responses. Groundwater drawdown during the MPE pilot test occurred throughout the local P1 observation well network, but outside the dewatered area, the P1 remained largely saturated with groundwater, which acted as a lateral boundary to vapor movement.
- Groundwater levels in several P2 zone (P2) and Roza aquifer wells that were regularly monitored during the pilot test showed no discernable response to P1 dewatering or applied vacuums.
- Applied vacuums ranged from 3.5 inches mercury (Hg) to 12.5 inches-Hg (upper limit of current system). Effects of vacuum were small, but observable, at almost all P1 observation wells. The ROIs were about 33 ft and 50 ft, respectively, during the single-well tests (Step 4). The ROI measured by vacuum in observation wells was not sensitive to the applied vacuum.
- P1 vapor extraction was successful in two of the three MPE wells (MW-34p1 and MW-68p1). Unique conditions in well MW-65p1 caused the pump to not operate properly when that well was under vacuum (see Section 4.5). Such conditions could exist in other P1 wells and should be anticipated during MPE expansion design (see Section 6.5).
- Vapor flow rates from MW-34p1 and MW-68p1 were up to 80 standard cubic feet per minute (scfm) and were sensitive to applied vacuum. Specific capacity for vapor flow decreased with increasing vacuum (wells were less efficient at higher vacuum). The maximum specific capacity of MW-34p1, the most productive extraction well was 7.3 scfm/inch-Hg measured when operating at 3.5 inches-Hg. A lower specific capacity is recommended for design of an expanded system, since the pilot extraction well yields are biased high and do not represent the average expected yield over a larger area.

- The intrinsic permeability of the soil and rock moving vapor to the extraction wells is much higher than the intrinsic permeability of the soil and rock that moves groundwater to wells. Different pathways for groundwater and vapor are indicated.
- A total of 7,100,000 standard cubic feet (scf) of vapor were extracted, treated, and vented.
- Extracted vapor included an average of 11 percent landfill gas (LFG) and 20 percent atmospheric air. These components confirm vertical downward flow (leakage) of LFG and air into the P1 and toward the extraction wells. Future operations may consider using vent wells to enhance horizontal vapor flow in the P1.
- Total VOC concentrations in P1 vapor decreased from about 3,000,000 micrograms per cubic meter (µg/m^3) to 100,000 µg/m^3 over the first 2 months of operation, then remained stable. This excludes one high outlier of 15,000,000 µg/m^3, the July 10 sample, which was collected a week after starting the vacuum system. Vapor VOC concentrations were higher in MW-68p1, the extraction well closest to the drum area. New extraction wells in and near the drum area may be warranted. Toluene, xylene, and ethylbenzene collectively accounted for 20 to 90 percent of the total detected VOCs in P1 vapor.
- Total VOC concentrations in extracted groundwater ranged from about 1,000 to 50,000 micrograms per liter (µg/L), excluding one high outlier of 700,000 µg/L, the July 5 sample, which was collected a few days after starting the vacuum system. Concentrations showed a decreasing trend over time in MW-34p1, but not in MW-68p1. Except for the high outlier, groundwater VOC concentrations were higher in MW-68p1. Toluene, xylene, and ethylbenzene collectively accounted for 50 to 90 percent of the total detected VOCs in P1 groundwater.
- Total VOC mass removal rates were one to two orders of magnitude higher in vapor than in groundwater. During the test, 130 to 270 kilograms of total VOCs were removed in P1 vapor and 4 to 47 kilograms of total detected VOCs were removed in P1 groundwater, depending on the inclusion of high outlier sample results in the calculations (July 10 for vapor and July 5 for groundwater).
- The oil water separator (OWS), which is the first step in the liquid treatment train (LTT), was ineffective in separating any light non-aqueous phase liquid (LNAPL) emulsified in groundwater. Except for a slight oil sheen in P1 groundwater noted during some sampling and water level measuring events, a separate LNAPL phase was not observed during the pilot test. LNAPL might have been emulsified in groundwater to varying extent during the pilot test. The liquid and vapor phase VOC outliers mentioned above may have resulted from LNAPL movement in the P1 following the application of vacuum.
- The air sparge (AS) tank removed approximately 78 percent of total VOC mass from groundwater at the initial higher mass flow rates, progressing to near 100 percent total VOC removal once mass flow rates had decreased to approximately 0.010 gram per minute. The resulting vapor phase VOCs were effectively captured by granulated activated carbon (GAC) unit 3 (GAC3), which treats off-gas from the LTT.
- The vapor treatment train (VTT), mainly GAC1 and GAC2, removed most VOCs from the extracted vapor; however, the initial heavy loading of high vapor VOC concentrations resulted in periods of contaminant breakthrough. GAC was replaced twice during the pilot test.
- Approximately 109 pounds of VOCs were released to atmosphere during the pilot test, including 1 pound from the evaporation pond and 108 pounds from GAC2 during periods of breakthrough.

- The pilot test suggests design considerations for expanded remedial actions, including (1) focus on vapor phase VOC removal from the P1, (2) assume that lower permeability areas of the P1 may be involved, (3) operate at low vacuum and consider a different blower for that purpose, (4) install at least 6-inch diameter wells spaced no more than 40 ft apart, (5) test new wells before making permanent connections, and (6) consider additional liquid treatment steps.
- The grant-eligible pilot test costs, including professional services, well installation, MPE system construction, analytical costs, other direct costs (i.e., mileage, supplies, lodging, meals), and County costs totaled $4,584,565. The total grant funding allocated for this work was $3,933,490, which includes the PLP's share (25%) and state share (75%), leaving a balance of $651,075 not presently funded. New grant funding allocations could potentially apply retroactively to the balance of grant-eligible pilot test costs not previously funded.

1.4 Report Organization

The remainder of this report is organized as follows:

Section 2 – MPE Pilot System Summary: Describes the observation and extraction wells associated with the pilot test and treatment and control system.

Section 3 – P1 Zone Description: Summarizes P1 characteristics based on prior work and the pilot test.

Section 4 – MPE Pilot Test Steps and P1 Response: Summarizes the progression of the pilot test through the test steps and the P1 response.

Section 5 – Contaminant Monitoring and Mass Removal during the MPE Pilot Test: Summarizes field and analytical results, mass removal rates in liquid and vapor, and the effectiveness of treatment systems to remove contaminant mass.

Section 6 – Implications for Remedial Design: Summarizes key design parameters and baseline recommendations for further implementation, including well spacing and vacuum, and modifications to treatment systems.

Section 7 – MPE Pilot Test IRA Cost Summary: Breaks down costs associated with the IRA.

Section 8 – References.

Due to multiple reference locations, tables and figures referenced throughout this report are collectively located after Section 8.

2. MPE PILOT SYSTEM SUMMARY

The MPE pilot system comprises:

- P1 groundwater and vapor extraction wells
- P1, P2, and Roza aquifer observation wells
- Liquid and vapor treatment systems
- Conveyance piping between the well field and treatment facilities
- A support building with storage and work space
- A lined evaporation pond
- Conveyance piping between the treatment facilities and evaporation pond

The MPE system layout is shown in Figure 1 and a treatment system schematic is shown in Figure 3. Detailed system information is provided in Appendix A, including:

- The system description
- Construction drawings
- Construction record drawings and survey information
- System operation and maintenance (O&M) manuals

A summary of the wells and the treatment and control system is provided below.

2.1 Wells

Multiple wells were used for extraction and monitoring during the pilot test, including wells installed during the RI (PGG 2010) and new wells installed for the pilot test (PGG 2017). A summary of wells and associated equipment is shown in Table 1. Well locations are identified in Figure 1, and observation well distances from the extraction wells are provided in Table 2. Figures 2a and 2b show representative cross sections through the well field. Table 3 includes a summary of monitoring points, parameters, and frequency of data collection during the pilot test. Well logs for the wells used during the pilot test are provided in Appendix B. Additional information pertaining to the different well types is discussed below.

2.1.1 Observation Wells

Water levels and vacuum were monitored in P1 observation wells MW-36p1, MW-64p1, MW-66p1, MW-67p1, MW-69p1, and MW-70p1.

P1 observation wells MW-64p1, MW-66p1, MW-69p1, and MW-70p1 were equipped with pressure transducers and transmitters for automatic monitoring of water levels and vapor pressure every minute during the pilot test. MW-36p1 was equipped with a vapor pressure gage. A water level pressure transducer was placed near the bottom of each well, and a vapor pressure transducer was placed at the top of each well. MW-36p1 and MW-67p1 water levels were also measured daily with a hand-held meter. Gage vacuum was also recorded daily from MW-36p1. All P1 observation wells were closed to atmospheric pressure (shut in) during the test, except for brief periods when water levels were being checked manually.

Water levels were also manually recorded daily from drum area backfill, the P2 (water-bearing zone below the P1), and the Roza aquifer (first aquifer beneath the Site; below the P1 and P2 perched zones and typically about 50 to 60 ft below ground surface) using these monitoring wells:

- Drum area backfill: MW-32a
- P2 wells: MW-33p2, MW-35p2, and MW-38p2
- Roza aquifer wells: MW-29b, MW-30b, and MW-31b

2.1.2 P1 Extraction Wells

P1 wells MW-34p1, MW-65p1, and MW-68p1 were used for liquid and vapor extraction during the pilot test. These three wells were selected for extraction because previous testing indicated higher aquifer transmissivity at these well locations compared to other P1 wells (PGG 2017). Each extraction well was equipped with a bottom loading pneumatic submersible pump and connected to liquid and vapor treatment systems.

The pumps are approximately 2 ft long with a minimum activation level of 15.3 inches above the bottom of the pump. The pumps were set just above the bottom of the wells. MW-65p1 and MW-68p1 were constructed with a 2-ft sump below the bottom of the P1 to maximize dewatering potential (PGG 2017). MW-34p1 was installed earlier and does not have a sump. The pumps discharge 0.11 to 0.16 gallon per cycle depending on total discharge head and air pressure supplied to the pumps. Each pump is capable of discharging approximately 6 to 9 gpm to the treatment facilities under ordinary operating conditions and with ample drainage to the well.

Vapor extraction uses an adjustable vacuum setting with a nominal range of 0 to 14 inches-Hg at the VAE pump inlet. The wells are connected to the vacuum system through shared pipe between the LTT and well field where it splits to individual wells. There is a valve at each well for throttling and isolation.

Each well is equipped with a vapor pressure transducer inside the casing at the top of the well and a water level transducer in the bottom of the well, immediately above the pump; thus, water levels below the top of the pump could not be monitored. The transmitters for these are mounted outside the casing on or near the well cap. Vapor pressure and water level were recorded automatically. Additionally, each pump has a counter at the wellhead that records the cumulative number of pump cycles. Pump cycle counts were manually recorded and timed four times per day. There are also vapor and liquid sample collection ports at each wellhead.

2.2 Treatment and Control System

Extracted liquid and vapor are conveyed to the treatment system, comprising an LTT and VTT, which are both housed in intermodal containers. The VTT container also houses MPE system controls and compressed air supply.

The LTT is designed to reduce groundwater contaminant concentrations through LNAPL extraction in the OWS with further VOC reduction in the AS. Vapor from the AS (i.e., mainly air with some VOCs) is directed to GAC3 to remove VOCs prior to discharge to atmosphere. The treated liquid is discharged to the certified evaporation pond (Parametrix 2017b) for containment of solids and evaporation of liquid and remaining VOCs. Liquid sample ports in the LTT monitored during the pilot test occur at the OWS influent, OWS effluent, and AS effluent. Vapor sample ports in the LTT monitored during the pilot test occur before and after GAC3 (GAC3 influent and GAC3 effluent, respectively).

The VTT is designed to reduce vapor phase contaminant concentrations through liquid knockout and filtration of VOCs through two GAC filters in series (GAC1 and GAC2). The treated vapor is discharged to atmosphere. Vapor sample ports monitored during the pilot test occur at the GAC1 influent, GAC1 effluent, and GAC2 effluent.

A programmable logic controller (PLC) with a human machine interface (HMI) is located in the VTT and is used for system operation control and data recording. Data recorded by the PLC include:

- Vapor pressures at each instrumented well
- Water levels at each instrumented well
- Total liquid extraction rate
- Total vapor extraction rate
- SVE blower pressure, speed, temperature, and vacuum

The PLC also records other system information, as detailed in Appendix A.

This Page Intentionally Left Blank

3. P1 ZONE DESCRIPTION

The target zone for the MPE pilot test was the P1, which occurs at a depth of about 25 to 35 ft in the Wanapum basalt. The P1 is the shallowest perched groundwater zone below the drum area. The 1- to 5-ft-thick zone is an undulating layer of highly fractured and/or soft weathered basalt with variable permeability and is laterally discontinuous. It is separated from the underlying P2 by a relatively hard, unweathered basalt aquitard typically 7 to 10 ft thick in the vicinity of the MPE pilot test area. The P1 just south of the drum area is the most contaminated part of the site. Figures 2a and 2b show cross sections through the area.

In the pilot test area, the P1 is laterally continuous and saturated with groundwater at most times (i.e., seasonally confined). The P1 is interrupted to the north by coarse backfill in the drum area. Figure 4 is a map of the P1 water level above the physical top of the P1 prior to the start of the test. The map shows the degree of confinement and extent and thickness of P1 vadose zone in the test area prior to the start of the test. Aquifer pumping tests (PGG 2017) and the pilot test reported herein demonstrate lateral continuity in the aqueous and vapor phases in the pilot test area.

As dewatering proceeds in the P1, confined portions of the P1 become unconfined and the vadose zone thickness increases and expands. However, any low areas in the P1 could become isolated, and pooled water could remain despite continued pumping from extraction wells. Such isolated low areas could create barriers to gas flow. Lateral gas flow will also be bounded by saturation (i.e., areas not dewatered) and pinch-outs in the P1. The P1 has hydraulic continuity with the drum area backfill, just north of the pilot test area.

4. MPE PILOT TEST STEPS AND P1 RESPONSE

This section discusses the MPE pilot test steps and the physical response of the P1 indicated by changes in water levels, vacuum pressures, and groundwater and vapor extraction rates. Results of contaminant monitoring in vapor and liquid phases are discussed separately in Section 5. Pilot test steps are summarized in Table 4 and outlined below, followed by a detailed discussion of each step.

Step 1 – Define Pre-test Conditions: P1 water levels were monitored from May 26 to June 12, following MPE equipment testing and commissioning. This step allowed the P1 to stabilize and established baseline conditions prior to the active pilot test steps.

Step 2 – Dewatering with No Vacuum: This step was performed from June 12 to July 3 to evaluate P1 dewatering without vacuum.

Step 3 – VAE: This step was performed from July 3 to September 12 and involved adding and then increasing MPE system vacuum in stages (3.5, 7.0, and 12.5 inches-Hg gage vacuum) to evaluate P1 response.

Step 4 – SVE Test: This step was performed from September 12 to October 10 and included vacuum step-up and step-down response monitoring with all three extraction wells in operation, followed by individual well testing at a nominal 12.5 inches-Hg vacuum.

Data collection during the pilot test included monitoring of numerous system parameters and frequent measurements of vapor and liquid concentrations. Table 3 provides a list of monitoring stations and parameters collected manually during the pilot test, as well as a list of automated monitoring points, parameters, and recording frequencies.

During all the steps that vacuums were applied to extraction wells, all P1 wells (extraction and observation) were closed to atmospheric pressures (shut in), except for brief periods when water levels were manually collected.

4.1 Step 1: Define Pre-test Conditions

The MPE system commissioning and testing, which ended on May 26, involved operation of the well pumps and vacuum system. Since commissioning stressed the P1, groundwater levels were allowed to recover, which enabled assessment of natural background trends prior to the active pumping and vapor extraction test steps. Step 1 ended on June 12, when pumping from MW-65p1 started.

Observations during Step 1 were:

- Pre-test water levels in the P1 were historically high at the start of the test (by about 2 ft) following an exceptionally wet winter in 2016/2017. The P1 is seasonally confined, and water levels in most wells were higher than the top of the P1 at the start of the test. Figure 5 shows P1 water levels during the pilot test. Pre-test monitoring indicated P1 water levels were declining at a rate of about 0.03 to 0.04 ft per day (ft/d) prior to the start of the active test.
- The water level in MW-32a (completed in drum area backfill) was also seasonally high and slowly declined at a rate of 0.04 ft/d during Step 1. Groundwater within the drum area backfill is thought to be hydraulically connected with the P1 in adjacent basalt. Figure 6 shows the MW-32a water level during the pilot test

- Water levels in the P2 wells also slowly declined at rates of 0.01 to 0.02 ft/d in MW-33p2 and MW-38p2, and 0.006 ft/d in MW-35p2 during Step 1. Figure 6 shows the water level changes in these wells during the pilot test.
- Water levels in the Roza aquifer wells MW-29b, MW-30b, and MW-31b were relatively stable, with no apparent trend during Step 1. Figure 6 shows the Roza aquifer water level changes during the pilot test.

4.2 Step 2: Dewatering with No Vacuum

Once the Step 1 observations were fairly consistent, pumping from P1 extraction wells was started at atmospheric pressure (i.e., well caps vented, VAE system off). The purpose of this step was to assess the extent of P1 dewatering without application of vacuum. During Step 2, P1 extraction wells were brought online sequentially, starting with MW-65p1 on June 12. Pumping from MW-34p1 started on June 19, and MW-68p1 was added on June 26. Responses of groundwater levels to pumping are shown in Figures 5 and 6. Step 2 ended on July 3, when vacuum was first applied to the three extraction wells at the start of Step 3. Figure 7 shows total liquid extraction rates and percentage of flow from each well during the pilot test, and Figure 8 shows the cumulative total liquid volume extracted.

The following observations were made during Step 2:

- The total combined flow rate from all three extraction wells ranged from 0.9 to 3.0 gpm, and the cumulative total volume of liquid extracted during Step 2 was 52,000 gallons.
- The MW-65p1 water level dropped about 3 ft during the first day of pumping until it was at or below the level of the transducer, which was located at the top of the pump. Water levels in MW-65p1 remained below the transducer for the remainder of the test, except when the well was open to vacuum and the pump was not working, as discussed in Section 4.5.
- The water level in MW-34p1 dropped about 1 ft during the week that MW-65p1 was pumping alone, then abruptly by about 4 more ft when the MW-34p1 pump was started on June 19. It dropped about another 1 ft by June 26 and was at or below the transducer when MW-68p1 began pumping.
- The MW-68p1 water level dropped about 2 ft during pumping from MW-65p1 and MW-34p1. When the MW-68p1 pump started on June 26, it dropped abruptly by about 3 more ft and was at or below the level of the transducer. The water level in MW-68p1 remained below the transducer level after June 26.
- Water levels in the P1 observation wells dropped throughout Step 2, with varying response to pumping from the extraction wells. The water level in MW-32a (completed in drum area backfill) was decreasing before pumping started, but an additional 0.5 ft of drawdown is attributed to pumping of MW-65p1 and MW-34p1 (June 12 to June 26). The water level in MW-32a was then fairly stable for the remainder of the pilot test.
- By the end of Step 2, water levels in P1 wells were below the top of the P1 in all monitoring wells except MW-36p1 and MW-64p1, which are the farthest from the test area. The thickness of the newly created vadose zone was greatest near MW-69p1 (4.3 ft) and MW-68p1 (> 6.7 ft). Figure 9 shows the P1 vadose zone that developed.
- Water levels in the P2 and Roza aquifer wells showed no measurable response to P1 dewatering.

4.3 Step 3: VAE

The purpose of the VAE was to evaluate the extent to which application of vacuum might increase dewatering of the P1, assess P1 responses to different vacuums, and provide data to guide decisions on how to conduct the SVE test in Step 4. The VAE system was started on July 3, with the three extraction wells continuing to pump. The VAE started at a system setting of 3.5 inches-Hg gage vacuum, which was later increased to 7.0 inches-Hg on August 6, and then to 12.5 inches-Hg on August 14. Step 3 ended on September 12, when vacuum step-up and step-down testing started in Step 4. Figure 10 shows P1 well gage vacuums from July 3 through the end of the pilot test on October 10.

Because the vapor pressure transducers in P1 wells measured absolute pressures, atmospheric pressures were used to calculate gage vacuum pressures. Although no atmospheric pressure transmitter or gage was installed for the pilot test, there was never any response to applied vacuums in observation well MW-70p1. MW-70p1 data were therefore substituted for atmospheric pressures.

The following general observations during Step 3 apply for all three system vacuum settings:

- Application of vacuums increased water level drawdown in all P1 observations wells.
- Extraction well MW-65p1 experienced some erratic behavior (Section 4.5) and was mainly used as an observation well during Steps 3 and 4.
- The P1 observation wells showed < 0.1 to 0.5 inch-Hg vacuum response compared to the approximately 3 to 12 inches Hg vacuum applied at the extraction wells (Figure 10). As an observation well, MW-65p1 showed significantly more vacuum response than other observation wells (about 1 to 2 inches-Hg).
- Vacuum responses at observation wells increased slightly with increased applied vacuum at MPE wells, but overall ROI for vapor was not very sensitive to applied vacuum. Observation well drawdowns for each applied vacuum are summarized in the following subsections.
- Other than at MW-70p1, observation wells responded within minutes to extraction well vacuum changes then remained fairly stable (Figure 10). Vapor flow rates ranged from about 30 to 80 standard cubic feet per minute (scfm) during Step 3 (Figure 11). Combined vapor flow rates increased with each higher vacuum, although the relationship between vapor flow (corrected to standard temperature and pressure) and vacuum was not constant (the efficiency of the system decreased with higher vacuums, as discussed in Section 6.3).
- Vapor VOC concentrations decreased during the test, with inconsistent, and generally small, responses to changing vacuums. Extracted vapor contaminant concentrations are discussed in detail in Section 5.1.2.
- There was no observable response in MW-32a, P2 wells, or Roza aquifer wells (Figure 6) during the low-vacuum test. The slow decline in water levels in Roza aquifer well MW-29b began in mid-July and continued throughout and after the pilot test. The observations in MW-29b appear to be a background trend.

Observations during each system vacuum setting during Step 3 are summarized in the following subsections.

4.3.1 Low Vacuum (3.5 inches-Hg)

The MPE system was operated at 3.5 inches-Hg gage vacuum from July 3 to August 6. All three extraction wells were initially used for liquid and vapor extraction; however, MW-65p1 started pumping erratically during the low-vacuum stage and was closed to SVE between July 12 and July 24 and then again on August 3 for much of the remainder of the pilot test. MW-65p1 observations are discussed further in Section 4.5.

Observations from low-vacuum application were:

- The total liquid discharge rate increased to 3.5 gpm with the application of vacuum, then fell to about 0.1 gpm by the end of the low-vacuum test (Figure 7). About 90 percent of the total liquid extracted from the P1 over the course of the entire pilot test occurred during Step 2 and this low-vacuum portion of Step 3 (Figure 8).
- The total vapor flow ranged from about 30 to 50 scfm, with little apparent trend (Figure 11). The 10-scfm increase in vapor flow between July 24 and July 31 was related to temporarily applying the SVE to well MW-65p1 while troubleshooting the pump.
- Water levels in extraction wells MW-34p1, MW-65p1, and MW-68p1 remained at or below the transducer level during the low-vacuum test, except when MW-65p1 was open to SVE and water levels in MW-65p1 increased by about 1 ft (with some variability) above the transducer (Figure 5).
- Water levels in P1 observation wells dropped relatively quickly by about 0.5 to 2 ft when vacuum was first applied to the extraction wells. Water levels in all but two P1 observation wells stabilized for the rest of the low-vacuum test, while water levels in MW-64p1 and MW-36p1 continued to decline (Figure 5).
- As shown in Figure 12, by the end of the low-vacuum test, water levels were below the top of the P1 in all wells except MW-64p1. Water levels were also below the interpreted bottom of the P1 in all wells except MW-64p1, MW-67p1, and MW-70p1.
- The P1 vadose zone expanded outward over much of the pilot test area by the end of the low-vacuum test, with the thickest vadose zone centered on MW-69p1 (6.4 ft) and MW-68p1 (> 6.7 ft), as shown in Figure 12.
- During the low-vacuum period, vacuums at MW-34p1 and MW-68p1 averaged about 3.5 inches-Hg with daily variations due to temperature changes (Figure 10).
- Vacuums at P1 observation wells ranged from < 0.1 inch-Hg farthest from the extraction wells to about 0.3 inch-Hg closest to the extraction wells. Response at MW-65p1 was an exception, where vacuum was about 1 inch-Hg (Figure 10).
- The vacuum in MW-66p1 increased slightly during the times that MW-65p1 was also open to SVE (Figure 10).

4.3.2 Medium Vacuum (7.0 inches-Hg)

The MPE system was operated at 7.0 inches-Hg gage vacuum from August 6 through August 14. MW-34p1 and MW-68p1 were used for liquid and vapor extraction. MW-65p1 was closed to pumping and SVE and served as an additional observation well.

The following observations were made from this medium-vacuum period:

- Total liquid discharge increased briefly from 0.1 to 0.3 gpm when the vacuum was increased to 7.0 inches-Hg, but then dropped back to about 0.2 gpm and gradually declined to about 0.1 gpm (Figure 7).
- Total vapor flow was stable (within a range of 60 to 64 scfm) during the medium-vacuum test (Figure 11).

- P1 water levels in extraction wells MW-65p1, MW-34p1, and MW-68p1 remained at or below the transducer level (Figure 5).
- Water levels in MW-66p1, MW-69p1, and MW-70p1 dropped by several inches when the vacuum was increased and then stabilized relatively quickly (Figure 5).
- In contrast, water levels in MW-64p1, MW-67p1, and MW-36p1 steadily dropped 0.5 ft during this test period (Figure 5). Toward the end of the test, the water level in MW-36p1 was near the bottom of the well and stabilized for the remainder of the test.
- By the end of the medium-vacuum test, water levels were below the top of the P1 in all wells except MW-64p1, and water levels were below the interpreted bottom of the P1 in all wells except MW-64p1 and MW-70p1.
- The thickness of the P1 vadose zone continued to increase over much of the pilot test area.
- During the medium-vacuum period, vacuums at MW-34p1 and MW-68p1 averaged about 6.6 to 6.7 inches-Hg with daily variations due to temperature changes (Figure 10). Vacuums at P1 observation wells increased slightly, ranging from < 0.1 inch-Hg farthest from the extraction wells to about 0.5 inch-Hg closest to the extraction wells. Response at MW-65p1 was an exception, where vacuum was about 1.5 inches-Hg (Figure 10).

4.3.3 High Vacuum (12.5 inches-Hg)

The MPE system was operated at 12.5 inches-Hg vacuum from August 14 through September 12. MW-34p1 and MW-68p1 were used for liquid and vapor extraction. MW-65p1 primarily served as an additional observation well; however, it was fully open to SVE August 18 to August 19 and partially open to SVE September 11 to the end of the high-vacuum test to troubleshoot irregularities (Section 4.5). There were also short periods of complete system shutdown due to one power outage and GAC change-outs at the VTT.

Observations from the high-vacuum period were:

- Total liquid discharge increased briefly from about 0.1 to 0.3 gpm when the vacuum was increased to 12.5 inches-Hg, then dropped to about 0.2 gpm and continued to decrease to a little less than 0.1 gpm by the end of the high-vacuum test (Figure 7).
- Total vapor flow initially increased to 80 scfm and then slowly declined to about 70 scfm during the high-vacuum test (Figure 11).
- P1 water levels in extraction wells MW-65p1, MW-34p1, and MW-68p1 remained below the transducer level during the high-vacuum test, except in MW-65p1, when that well was fully open to SVE from August 18 to August 19, resulting in water levels rising about 5 ft, and then again on September 11 to the end of the test, when MW-65p1 was open partially to SVE and water levels rose about 0.5 ft (Figure 5).
- Water levels in MW-66p1 and MW-69p1 dropped by a few inches when the vacuum was increased and then stabilized, except for small variations due to periods of complete system shutdown (Figure 5).
- In contrast, the water level in MW-70p1 dropped by almost 3 ft during the high-vacuum test, with large responses to periods of complete system shutdown. The declining trend in MW-70p1 reversed about September 8, when water levels started to increase before the end of the test on September 12 (Figure 5). Despite the water level changes, MW-70p1 showed no pressure response to system vacuum changes and continued to be used as a proxy for atmospheric pressure.

- Water levels in MW-64p1 and MW-67p1 continued to decline throughout the high-vacuum test at the same rate of decline observed during the medium-vacuum test. Water levels in MW-36p1 remained constant near the bottom of the well (Figure 5).
- By the end of the high-vacuum test, water levels were below the top of the P1 in all wells, and water levels were below the interpreted bottom of the P1 in all wells except MW-64p1. The maximum drawdown in P1 water levels occurred at the end of the high-vacuum test.
- The thickness of the P1 vadose zone increased over much of the pilot test area, with the thickest vadose zone centered on MW-68p1 and MW-69p1 (about 7 ft), as shown in Figure 13.
- During the high-vacuum period (nominal 12.5 inches-Hg), vacuums at MW-34p1 and MW-68p1 started at about 10.75 inches-Hg, then slowly increased to about 11.5 inches-Hg by September 5. They were stable for the remainder of the test, except for daily variations due to temperature changes (Figure 10).
- The vacuum in MW-68p1 was about 0.25 inch-Hg higher than MW-34p1 during the high-vacuum test (Figure 10). Such a difference was not observed at lower vacuums.
- Vacuums at P1 observation wells increased slightly, but still ranged from < 0.1 inch-Hg farthest from the extraction wells to about 0.5 inch-Hg closest to the extraction wells. MW-65p1 remained an exception, with the largest vacuum response at about 1.5 to 2 inches-Hg (Figure 10). Toward the end of the test, the SVE valve was partially opened to MW-65p1, and the vacuum in MW-65p1 increased to about 4.25 inches-Hg.

4.4 Step 4: SVE Test

The SVE portion of pilot testing was started on September 12. The SVE test started by reducing the system setting to 3.5 inches-Hg gage vacuum, followed by a step-up to 12.5 inches-Hg on September 19 until September 21. Step 4 then continued with individual well testing with isolated vacuum of 12.5 inches-Hg at each extraction well: MW-34p1 from September 21 to September 26, MW-68p1 from September 26 to October 3, and MW-65p1 from October 3 to October 10.

Observations during each system vacuum setting during Step 4 are summarized in the following subsections.

4.4.1 Step-down (3.5 inches-Hg)

The MPE system was operated at 3.5 inches-Hg vacuum from September 12 through September 19. MW-34p1 and MW-68p1 were used for liquid and vapor extraction for the duration. MW-65p1 was partially open to vacuum to troubleshoot the irregularities associated with the well pumping (Section 4.5). The primary purpose of this step-down was to assess whether vapor VOC concentrations would increase in response to lower vapor velocities as the vacuum was decreased. A small increase in VOC concentrations was observed, but overall the response was relatively insignificant, as discussed further in Section 5.1.2.

The following observations were made during the step-down test:

- Total vapor flow initially decreased from about 70 to 35 scfm when decreasing from 12.5 to 3.5 inches-Hg. Vapor flow rates then slowly declined (with daily variability) to about 33 scfm by the end of the step-down test (Figure 11).
- Vacuums at extraction wells MW-34p1 and MW-68p1 decreased immediately to about 3 to 3.5 inches-Hg and then stabilized (Figure 10). The vacuum at MW-65p1 was variable at first

while the SVE valve was adjusted manually. Eventually, the vacuum at MW-65p1 stabilized to about 2.5 inches-Hg with the valve partially open (Figure 10).

- Vacuums at P1 observation wells also decreased and generally ranged from < 0.1 inch-Hg farthest from the extraction wells to about 0.2 inch-Hg closest to the extraction wells (Figure 10). Vacuum responses were relatively quick (within minutes), and then fairly stable in most wells. The vacuum at observation well MW-66p1 responded within minutes, but then slowly decreased from about 0.2 to 0.1 inch-Hg during the step-down phase.
- Total liquid discharge decreased from about 0.1 gpm to essentially zero gpm when the vacuum was decreased to 3.5 inches-Hg (Figure 7).
- Water levels in extraction wells MW-34p1 and MW-68p1 remained below the transducer during the step-down test, and the water level in MW-65p1 remained about 0.5 ft above the transducer (Figure 5).
- Water levels in MW-66p1, MW-69p1, and MW-70p1 all increased with a step-down in vacuum. Water levels in MW-66p1 and MW-69p1 increased gradually by about 1 ft, while the water level in MW-70p1 increased rapidly by 2 ft and then gradually by another 1 ft over the remainder of the step-down test (Figure 5).
- Water levels in MW-64p1 continued to slowly decline during the step-down test, while the declining water level in MW-67p1 started to stabilize and then slowly increase. The water level in MW-36p1 remained constant near the bottom of the well (Figure 5).
- Water levels in P1 observation wells remained below the bottom of the P1 during the step-down test, except in MW-64p1 and MW-70p1, where water levels rose above the bottom of the P1 but remained below the top of the P1.
- There was no observable response in MW-32a, P2 wells, or Roza aquifer wells during the step-down test (Figure 6).

4.4.2 Step-up (12.5 inches-Hg)

The MPE system was increased to 12.5 inches-Hg vacuum from September 19 through September 21. MW-34p1 and MW-68p1 were used for liquid and vapor extraction for the duration. MW-65p1 was partially open to vacuum to troubleshoot irregularities associated with the well pumping (Section 4.5). The purpose of the step-up test was to re-establish high-vacuum conditions in the P1 before individual well testing at 12.5 inches-Hg.

The following observations were made during the step-up test:

- Total vapor flow increased from 33 to about 65 scfm, which is slightly lower than the 70 scfm observed at the end of the Step 3 high-vacuum test (Figure 11).
- Vacuums at extraction wells MW-34p1 and MW-68p1 instantly increased to about 11.5 inches-Hg, then slowly decreased to about 10.5 inches-Hg by the end of the test (Figure 10). These levels are similar to the prior Step 3 high-vacuum test. The vacuum at MW-65p1 initially decreased to 1.5 inches-Hg while closed to SVE (similar to the prior Step 3 high-vacuum test), increased instantly to 4 inches-Hg when the valve was partially opened, and then gradually increased and stabilized at 4.5 inches-Hg.
- Vacuums at P1 observation wells also increased relatively quickly (within minutes) and generally ranged from < 0.1 inch-Hg farthest from the extraction wells to about 0.3 inch-Hg closest to the extraction wells. This is slightly less than the 0.5 inch-Hg observed in the closest wells during the Step 3 high-vacuum test (Figure 10).

- Water levels in extraction wells MW-34p1 and MW-68p1 remained below the transducer, while the water level in MW-65p1 eventually rose to 1 ft above the transducer when opened to SVE (Figure 5).
- Water levels in MW-66p1, MW-69p1, and MW-70p1 all dropped about 0.5 to 0.75 ft with a step-up in vacuum (Figure 5). Like the step-down test, the water level response in MW-70p1 was the fastest. Water levels continued to slowly decrease throughout the step-up test, but did not decrease back to the maximum drawdown observed at the end of the high-vacuum test during Step 3.
- The declining water level trend in MW-64p1 continued slowly, with no apparent response to the step-up in vacuum (Figure 5). In MW-67p1, there was a pause in the increasing water level trend that had started during the step-down test. Water levels in MW-36p1 remained constant near the bottom of the well.
- Water levels in P1 observations wells remained below the bottom of the P1 during the step-up test, except in MW-64p1 and MW-70p1, where water levels remained between the bottom and top of the P1.
- There was no observable response in MW-32a, P2 wells, or Roza aquifer wells during the step-up test (Figure 6).

4.4.3 Individual SVE Well Testing

The purpose of the SVE test step was to assess individual MPE well performance. This was done by operating each MPE well sequentially, with the other two MPE wells isolated from system vacuum by fully closing the VAE valves. Air was supplied to all three MPE well pumps throughout the individual well testing. Water level monitoring in MW-32a, P2 wells, and Roza aquifer wells continued with no observable response[1] during the individual MPE well testing (Figure 6). The subsections below summarize observations from each of these well tests. Section 6 presents an analysis of these test results for vapor specific capacity, ROI, conductivity, and intrinsic permeability.

4.4.3.1 Individual SVE Testing of MW-34p1

The MPE system was operated at 12.5 inches-Hg vacuum solely through MW-34p1 between September 21 and September 26. The MW-65p1 and MW-68p1 pumps remained on and available for liquid extraction, but only MW-34p1 was used for SVE.

The following observations were made during individual SVE testing of MW-34p1:

- The vacuum in MW-34p1 ranged from about 11.5 to 12 inches-Hg during the test, while vacuums in MW-65p1 and MW-68p1 were about 1 inch-Hg and 0.6 inch-Hg, respectively (Figure 10). Vacuums in the P1 observation wells ranged from < 0.1 inch-Hg farthest from MW-34p1 to about 0.2 inch-Hg closest to MW-34p1.
- Vapor VOC concentrations increased slightly when transitioning to the single-well test. Vapor VOC concentrations are discussed in detail in Section 5.1.2.
- Total vapor flow was stable and ranged between about 45 and 50 scfm (Figure 11).

---

[1] The instantaneous water level drop of 5 ft in MW-38p1 followed by recovery was a result of bi-annual purging and sampling of that well.

- Liquid discharge increased briefly to 0.9 gpm, then quickly dropped below 0.1 gpm during the test (Figure 8).
- Water level responses were relatively slow, with little change after 2 days with two exceptions. The MW-69p1 water level increased by about 0.6 ft during the first 2 days then continued to gradually increase. The MW-65p1 water level dropped below the transducer with the VAE valve fully closed (Figure 5).
- Water levels in MW-34p1, MW-68p1, and MW-65p1 remained below the transducer (Figure 5). The MW-64p1 water level began to stabilize toward the end of the individual well testing of MW-34p1, having previously been slowly decreasing. The increasing trend in MW-67p1 continued. Water levels in MW-36p1 remained constant near the bottom of the well.
- Water levels in P1 observations wells remained below the bottom of the P1 during this test, except in MW-64p1 and MW-70p1, where water levels remained between the bottom and top of the P1.

4.4.3.2 Individual SVE Testing of MW-68p1

The MPE system was operated at 12.5 inches-Hg vacuum solely through MW-68p1 between September 26 and October 3. MW-34p1 and MW-65p1 pumps remained on and available for liquid extraction, but only MW-68p1 was open to SVE.

The following observations were made during SVE well testing of MW-68p1:

- The vacuum in MW-68p1 was 12 to 13 inches-Hg, which is slightly higher than the vacuum observed during single-well testing of MW-34p1 and similar to observations during the Step 3 high-vacuum test with two wells (Figure 10). The vacuums observed in nearby observation wells MW-34p1 and MW-65p1 were both about 0.4 inch-Hg.
- Liquid discharge essentially ceased (Figure 8).
- Total vapor flow was constant (ranging from 25 to 30 scfm), which is about 60 percent lower than the vapor flow observed during single-well testing of MW-34p1 (Figure 11).
- Water levels in MW-34p1, MW-65p1, and MW-68p1 remained below the transducer throughout the test (Figure 5).
- The water levels in MW-69p1 decreased by 0.5 ft, while water levels increased by about 0.5 ft in MW-66p1 and by about 1 ft in MW-70p1 (Figure 5).
- Water levels in MW-64p1 and MW-36p1 did not respond and were relatively stable during the individual test of MW-68p1, and the increasing trend in MW-67p1 continued (Figure 5).
- Water levels in most P1 observation wells remained below the bottom of the P1, except for MW-64p1 and MW-67p1, where water levels were between the bottom and top of the P1, and MW-70p1, where water levels rose above the top of the P1.
- The vacuum response in other P1 observation wells ranged from < 0.1 inch-Hg farthest from MW-68p1 to 0.25 inch-Hg at MW-69p1 located 25 ft from MW-68p1. At MW-66p1, located only 15 ft from MW-68p1, the vacuum was lower at 0.1 inch-Hg (Figure 10). This suggests greater vacuum connection between MW-68p1 and MW-69p1.
- Vacuum responses were relatively quick (within minutes) and then fairly stable in all wells (Figure 10).

4.4.3.3 Individual SVE Testing of MW-65p1

The MPE system was operated at 12.5 inches-Hg vacuum solely through MW-65p1 with the SVE line fully open. The individual SVE well testing of MW-65p1 started October 3 and continued until October 10. MW-34p1 and MW-68p1 were closed to SVE, but pumps remained on and available for liquid extraction. The pump to MW-65p1 was also on, but did not function properly, as discussed in Section 4.5. The MW-65p1 data were therefore not analyzed quantitatively.

The following observations were made during SVE well testing of MW-65p1:

- The vacuum in MW-65p1 was 12 to 12.5 inches-Hg. The vacuums in P1 observation wells were initially as high as 0.5 inch-Hg in MW-34p1, but then decreased during the first few days of the test and stabilized to values ranging from < 0.1 inch-Hg farthest from MW-65p1 to 0.15 inch-Hg closest to MW-65p1 (Figure 10).
- The water level in MW-65p1 instantly increased by 10 ft with the application of vacuum, resulting in groundwater above the well screen. The water level continued to gradually increase by an additional 2 ft during the test (Figure 5). Despite the rise in water level, the pump in MW-65p1 did not operate, as discussed in Section 4.5.
- Although the water level in MW-65p1 was above the top of the well screen, there was some P1 vapor movement through the pump during this testing period; therefore, the P1 formation (i.e., below the water column in the well) might have been subject to vacuum to some degree (Section 4.5). The balance of the 12-scfm gas flow measured at the VTT comprised pneumatic air from the high pump cycle counts (Section 5.1.2.4).
- There was no liquid discharge from MW-65p1 during the test (Figure 8).
- The water level in MW-66p1 initially declined by less than 0.25 ft, indicating that the application of vacuum to MW-65p1 resulted in some drawdown remote from the vacuum well (Figure 5). However, water levels in other observation wells rose or were unaffected, suggesting that the influence was small and likely commensurate with the fact that total extraction from MW-65p1 consisted of less than 12 scfm vapor and no water.
- Water levels in most P1 observation wells remained below the bottom of the P1, except for MW-64p1 and MW-67p1, where water levels were between the bottom and top of the P1, and MW-70p1, where water levels were above the top of the P1.

4.5 MW-65p1 Observations

Starting in Step 3, when vacuum was first applied to the extraction wells, an unusual set of responses were observed at MW-65p1: fast and erratic pump cycle counts, rising water levels in the well casing, and little or no water discharge. Increasing the vacuum applied to the well seemed to exacerbate the situation. The pump was initially suspected; however, after evaluation in the field, removal and cleaning, and later inspection by the manufacturer, the pump was determined to be functioning properly. This was confirmed following completion of the MPE pilot test by switching the MW-65p1 and MW-34p1 pumps. The original MW-65p1 pump functioned properly in MW-34p1, and the previously observed phenomenon in MW-65p1 continued with the original MW-34p1 pump.

Although the causes for the observed behavior at MW-65p1 are not fully understood, the working hypothesis (vacuum draw effects, described further below) suggested design changes for new extraction wells. Namely, future P1 extraction well casings should be at least 6 inches in diameter. This will likely prevent possible vacuum draw effects and accommodate water level transducer placement alongside the pump intake so submersion of the intake can be confirmed.

At MW-65p1, the P1 is about 18 inches thick and has relatively high transmissivity. The well is drilled about 18 inches deeper than the bottom of the P1, and the pump intake is near the bottom of the well. The water level transducer is placed just above the pump, about 19 inches above the bottom of the well, or about 2.9 inches above the bottom of the P1 zone. As shown in Figure 7, the MW-65p1 water level dropped quickly and discharge fell steadily from about 1.3 to 0.9 gpm during the first week of Step 2 pumping, when only MW-65p1 was pumping. By the end of Step 2, water levels were low and stable at all three extraction wells and falling in the P1 observation wells, suggesting that a still expanding vadose zone had been created around the extraction wells. Groundwater discharge jumped briefly when system vacuum of 3.5 inches-Hg was applied in Step 3. Water levels in MW-65p1 increased by about 1 ft with application of 3.5 inches-Hg, and groundwater discharge became inconsistent.

During single-well testing of MW-65p1, the valve to the vacuum line was fully opened and the water level in the well increased by about 10 ft with application of 12.5 inches-Hg, which is above the well screen. The pneumatic pump also began to cycle at a fast rate but did not move any water. The vapor flow rate was about 12 scfm with a photoionization detector (PID) total VOC reading of about 8 parts per million (ppm). There was also a slight decrease in water levels at nearby observation well MW-66p1 in response to the applied vacuum. These observations suggest very little water draining from the P1 to MW-65p1 during the test; however, with the application of 12.5 inches-Hg, the extraction could pull in enough water from the formation to hold a column of water and create a vapor pathway to the pump intake, causing high cycle counts with no liquid movement, as described further below. Gas being drawn through the system during this time comprised vapor from the P1 and air from the pneumatic system (Section 5.1.2.4).

As mentioned in Section 2.1.2, the extraction well pumps are pneumatic. The pumps ordinarily cycle automatically as groundwater lifts a float in the pump, which opens the compressed air inlet valve. Compressed air pushes groundwater out of the pump chamber and the float drops, closing the air inlet valve and opening the air exhaust valve. In normal operation, exhaust air is pushed out of the pump by rising liquid, and the pump cycle repeats. These pumps are capable of cycling about once per second; however, cycling is far less frequent if drainage to the well is low. Pump air exhausts into the upper well casing, which is subject to system vacuum, at a range of 3.5 to 12.5 inches-Hg, unless the isolation valve is closed. Pump cycle counts indicate air pulses to the pump (i.e., when the pump air inlet valve opens), but do not directly indicate water movement. In the case of MW-65p1, exposure of the pump intake to vapor under vacuum would explain the observations, although how such exposure might occur with a water column above is not fully understood.

These conditions were not observed in MW-34p1 and MW-68p1, but should be anticipated as a potential P1 well condition when and if expanding the MPE well network.

4.6 Shutdown

Step 4 ended October 10, completing the MPE pilot test. Once complete, the MW-65p1 pump evaluation continued, as discussed in Section 4.5, until October 12. On October 13, the MPE system was turned off, and the pneumatic submersible pumps were retrieved from each well, cleaned, and stored in the operations building, including all ancillary equipment. Field piping and the condensate sump were drained or blown out with compressed air. The LTT and VTT were drained and equipment was winterized.

By November 21, water levels in most P1 wells had recovered by about 1 ft (Figure 5). As of this writing, P1 zone water levels continue to be recorded to observe P1 water level recovery.

5. CONTAMINANT MONITORING AND MASS REMOVAL DURING THE MPE PILOT TEST

Throughout the MPE pilot test, extracted liquids and vapors were sampled and analyzed for contaminant concentrations at distinct points within the extraction and treatment system. Points upstream of the treatment trains were sampled to evaluate untreated groundwater and vapor concentrations extracted from the P1 (Section 5.1 below). Points within and downstream of the treatment trains were sampled to evaluate the effectiveness of the treatment trains to reduce VOC concentrations (Section 5.2 below).

Parameters analyzed in liquid were:

- Iron and manganese (dissolved and total)
- Arsenic (dissolved)
- Chloride, nitrate, and total dissolved solids (TDS)
- Total petroleum hydrocarbons (TPH)
- VOCs
- Three semi-volatile organic compounds (SVOCs): 2-methylphenol, 4-methylphenol, and bis(2-ethylhexyl)phthalate.
- pH, dissolved oxygen, specific conductance, temperature, and turbidity (field parameters)

Parameters analyzed in vapor were:

- VOCs (summa canister EPA Method TO-15)
- Methane (CH_4), oxygen (O_2), and PID total VOC readings (field parameters)

Table 3 provides a complete list of the MPE pilot test monitoring points, the parameters measured at each point, and the frequency of measurements. Pre- and post-treatment samples for laboratory analysis were collected weekly and following certain system adjustments during the pilot test. Field parameters were collected at various frequencies ranging from four times daily to weekly.

As liquid extraction rates decreased over time, the reduced volumes limited the number of parameters that could be tested in liquid. In these cases, preferences were given to VOCs and TPH. Vapor samples were collected at the GAC1 influent, which is the first sample location where extracted vapor is at atmospheric or slightly positive pressure.

Liquid samples were analyzed by Analytical Resources, Inc. in Tukwila, Washington. The first three vapor samples were analyzed by Test America in West Sacramento, California, and the rest by Friedman and Bruya in Seattle, Washington. The analytical laboratory change was made to reduce shipping time and to achieve lower reporting limits. It should be noted that the earlier samples required more dilution, and Test America may also have been able to achieve the same reporting limits as Friedman and Bruya in the later samples.

Laboratory dilutions were required to quantify concentrations for many samples, limiting the quantification of comparatively low-concentration compounds in those samples. All analytical data were reviewed following standard Level III data-validation guidelines. Results are flagged in the data tables where inconsistencies were identified by the laboratory.

Contaminant monitoring results and mass removal calculations are discussed below in Sections 5.1 and 5.2.

5.1 Contaminant Results from P1 Zone Monitoring

Groundwater and vapor samples from individual extraction wells MW-34p1, MW-65p1, and MW-68p1, and total combined vapor samples from all three wells (GAC1 influent) were analyzed during the pilot test. In addition, O_2, CH_4, and total VOCs in the GAC1 influent were monitored with field instruments.

The following subsections summarize groundwater and vapor sample results.

5.1.1 Groundwater Contaminant Results

This section summarizes VOC results for each MPE well, followed by general observations about other parameters. Groundwater results from the P1 are provided in Tables 5, 6, and 7 and Figure 14.

MW-34p1

Total detected VOCs in MW-34p1 ranged from 2,357 to 12,047 µg/L, excluding two outlier measurements of 181 and 697,855 µg/L (Table 5). The high outlier occurred on July 5, a couple days after first initiating SVE, and may represent LNAPL entrainment. The low outlier occurred toward the end of the test, when there was very low liquid discharge rates, and the sample may have been stagnant water from the discharge line rather than freshly pumped water from the P1. Except for outliers, the overall trend in total VOCs in MW-34p1 was decreasing concentrations over time (Figure 14).

MW-68p1

Total detected VOCs in MW-68p1 ranged from 11,590 to 49,383 µg/L (Table 6). With a few exceptions, MW-68p1 generally had the highest concentrations of total VOCs compared to the other two extraction wells. Total VOC concentrations in MW-68p1 decreased (with some variability) during Steps 2 and 3, then increased slightly when transitioning to Step 4 (Figure 14). MW-68p1 is close to the drum area, which may explain the higher VOCs. RI Addendum 2 (PGG 2017) shows a total VOC concentration gradient in the P1, with highest concentrations near the drum area.

MW-65p1

Total detected VOCs in MW-65p1 ranged from 1,049 to 9,963 µg/L (Table 7). Due to the erratic pumping when MW-65p1 was under vacuum, insufficient samples were obtained to define a trend in VOCs. Only five groundwater samples were collected from MW-65p1 during the test, compared to 11 and 15 samples collected from MW-68p1 and MW-34p1, respectively.

All Three Wells

Toluene, xylene, and ethylbenzene were the predominant VOCs detected in all three wells. Collectively, these three VOCs accounted for approximately 50 to 90 percent of the total detected VOCs. All three wells also had elevated concentrations of TPH-G (gasoline range TPH; toluene is one), chlorinated ethanes, chlorinated ethenes, and trimethylbenzenes. TPH-G concentrations ranged from 3,530 to 170,000 µg/L, excluding an outlier of 2,800,000 µg/L from MW-34p1 on July 5. Like VOCs, MW-68p1 (i.e., closest to the drum area) generally had the highest concentrations of TPH-G.

For the three wells, the SVOCs 2-methylphenol and 4-methylphenol were detected in all samples, and there were a number of detections of bis(2-ethylhexyl)phthalate. Concentrations of 2-methylphenol ranged from 4 to 475 µg/L, 4-methylphenol concentrations ranged from 6.5 to 247 µg/L, and bis(2-ethylhexyl)phthalate concentrations ranged from non-detected to 34.1 µg/L. The highest SVOC concentrations were usually measured in samples collected from MW-68p1, except for the maximum concentration of 2-methylphenol, which was measured in a sample collected from MW-34p1 on July 5.

Inorganic parameters detected in P1 groundwater were:

- Iron: about 10,000 to 40,000 µg/L (total and dissolved)
- Manganese: about 2,000 to 10,000 µg/L (total and dissolved)
- Arsenic: 9 to 19 µg/L (except one low outlier at 2 µg/L)
- Chloride: 106 to 620 mg/L
- Sulfate: 7 to 450 mg/L
- TDS: 1,020 to 2,120 mg/L
- Nitrate+Nitrite as N: mostly non-detect (with a couple of detections ranging from about 0.03 to 0.3 mg/L).

Except for sulfate, there were no apparent trends in inorganic parameters. Sulfate concentrations showed an increasing trend over time in all three wells, which may suggest changes in redox conditions over time.

5.1.2 Vapor Contaminant Results

This section summarizes the vapor contaminant results. Laboratory summa canister results are presented first, followed by field-measured vapor concentrations (PID total VOC readings). Vapor results are provided in Tables 8, 9, 10, and 11 and Figure 15.

Differences between PID measurements and laboratory analytical data are also discussed, followed by an evaluation of vapor contribution from LFG and atmospheric air. The last subsection discusses future implications for SVE.

5.1.2.1 Vapor Analytical Results

VOC detections at each MPE well are discussed below.

Since the MPE wells were under vacuum, vapor samples had to be collected with evacuated canisters. This method is subject to sample dilution with atmospheric air if connections leak, which is a possible explanation of the low outliers noted in Figure 15.

MW-34p1

Thirteen vapor samples were collected from MW-34p1 during the pilot test. Total detected VOCs ranged from 34,190 to 450,190 µg/m^3, not including one outlier of 9,738 µg/m^3 on September 19 (Table 8). The general trend in MW-34p1 was exponential decrease in concentrations over time during the VAE portion of the test (Step 3), then stable concentrations in the range of 40,000 to 45,000 µg/m^3 leading into the step-down portion of the SVE test (Step 4). This was followed by an increase to about 100,000 µg/m^3 during the single-well test of MW-34p1 (Figure 15).

MW-68p1

Twelve vapor samples were collected from MW-68p1 during the pilot test. Total detected VOCs ranged from 118,935 to 3,057,000 µg/m^3, excluding two outlier measurements of 22,060 µg/m^3 on September 7 and no detections on September 12 (Table 9). With a few exceptions, MW-68p1 generally had the highest vapor concentrations of the three wells. The general trend in MW-68p1 was similar to MW-34p1, with concentrations decreasing exponentially over time during the VAE portion of the test (Step 3), then becoming stable at about 120,000 µg/m^3 during the SVE portion of the test (Step 4), except for an increase to about 170,000 µg/m^3 right after transitioning to the single-well test of MW-68p1 (Figure 15).

MW-65p1

Five vapor samples were collected from MW-65p1 during the pilot test when the well was open to SVE. Total detected VOCs ranged from 34,900 to 68,927 µg/m^3, excluding one outlier measurement at 87 µg/m^3 (Table 10). There was no discernable trend in total VOC measurements in the four samples collected during Step 3. However, there was an increase from 34,900 to 68,927 µg/m^3 while transitioning the test to the SVE phase (Step 4) (Figure 15).

GAC1 Influent

Fifteen vapor samples were collected from the GAC1 influent during the SVE portion of the pilot test. Total VOCs ranged from 80,530 to 3,362,000 µg/m^3, not including one outlier measurement of 15,040,000 µg/m^3, which occurred on July 10, shortly after initiating the first low-vacuum test, and may be related to LNAPL entrainment (Table 11). The general trend in GAC1 influent was similar to the trend observed in VOC measurements from the three extraction wells (described above), with concentrations decreasing over time during the VAE portion of the test (Step 3) (Figure 15). VOC measurements were then stable during the SVE portion of the test (Step 4). There was, however, a slight increase from 81,950 to 105,313 µg/m^3 when first transitioning the test to the SVE phase (Step 4).

Similar to P1 groundwater analytical results, toluene, xylene, and ethylbenzene had the highest concentrations in P1 vapor and collectively accounted for 20 to 90 percent of the total detected VOCs in vapor. Other VOCs detected in P1 vapor were typically similar to those found in groundwater, including chlorinated ethanes, chlorinated ethenes, and trimethylbenzenes. Notably, P1 vapor also had detected concentrations of chlorofluorocarbons (CFCs), common in LFG, including chlorodifluoromethane (CFC-22), 1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113), and Dichlorodifluoromethane (CFC-12).

5.1.2.2 Vapor Field Measurement Results

Field measurements of total VOCs (PID readings), O_2, and CH_4 were collected up to four times daily at the GAC1 influent (total combined vapor from P1 extraction wells). Results are plotted in Figure 16.

Similar to the trends in total detected VOCs discussed above, PID total VOC readings from the GAC1 influent generally decreased over time (with some variability) during the VAE test period (Step 3). The rate of decline was greatest during the initial low- and medium-vacuum phases of Step 3, decreasing (with some variability) from about 120 to 25 ppm. The rate of decline then decreased during the later high-vacuum phase and eventually stabilized toward the end of Step 3 at about 5 ppm. PID readings then increased to varying degrees during each phase of the SVE test period (Step 4), except the last phase (individual well testing of MW-65p1). PID readings increased to about 8 ppm during the step-down phase, 12 ppm during the step-up phase, 15 ppm during individual well testing of MW-34p1, and then up to 35 ppm during individual well testing of MW-68p1. Although PID results are as much as an order of magnitude lower, they follow a trend similar to the VOC analytical results discussed above. Summa canister samples were not collected during the single-well testing of MW-65p1; however, PID readings decreased to about 8 ppm during this last phase. As discussed further in the following subsection, PID results can be subject to order of magnitude error.

O_2 concentrations declined from about 5.5 to 4 percent in the first 10 days of low-vacuum test at 3.5 inches-Hg in Step 3, then stabilized. The O_2 concentrations then increased slowly throughout the medium-vacuum test (7.0 inches-Hg) and were steady at an average concentration of 6 percent during the high-vacuum test (12.5 inches-Hg). Upon stepping down from 12.5 to 3.5 inches-Hg, O_2 concentrations declined significantly to approximately 2 percent, followed by an increase to approximately 3 percent, with the step up to 12.5 inches-Hg. O_2 concentrations were higher during the MW-34p1 individual SVE test (about 3.5%) than during the MW-68p1 individual SVE test (< 2%). During the MW-65p1 individual SVE test, O_2 concentrations rose to approximate 7 percent. The higher O_2 in MW-65p1 is likely related to compressed air from the pneumatic pump (Section 5.1.2.4). Despite the increase in pump cycle counts during the individual well test, the MW-65p1 pump did not move water (Section 4.5).

Measured CH_4 concentrations exhibited a slow decreasing trend from 150 to 130 percent of the lower explosive limit (%LEL, or 6.5 to 7.5% volume) during the pilot test.

O_2 and CH_4 measured in the GAC1 influent likely resulted from atmospheric air infiltration and LFG infiltration, respectively, except during the MW-65p1 individual test, as further discussed in Section 5.1.2.4.

5.1.2.3 Differences in PID and Analytical VOC Data

During the vapor extraction steps of the pilot test, gas was monitored four times daily at the GAC1 influent (i.e., untreated vapor from the P1 extraction wells) using a MiniRAE 3000™ PID, and 18 confirmatory grab samples[2] were analyzed for VOCs using EPA Method TO-15 (gas chromatography/mass spectrometry [GC/MS] following gas sample collection with a specially prepared, evacuated summa canister). Although PID field measurements and the TO-15 laboratory analyses both measure VOCs, the methods are vastly different, and results are not typically comparable. Aspects of this are discussed below since both methods were used in the pilot test.

PIDs operate by bombarding the sample (i.e., the mixture being drawn through the instrument) with ultraviolet (UV) light of known photon energy (10.6 electron volts in this case). This causes ionization of VOCs, resulting in electrical current, which is sensed by the instrument. PIDs do not distinguish individual VOCs and are generally considered to provide only a rough estimate of total VOC concentration for the purposes of field screening. For the pilot test, PID total VOC results were used to evaluate vapor concentration trends and guide decisions about when to transition from step to step. PIDs are well suited to this type of comparative measurement; however, numerous factors tend to limit the accuracy of PID readings compared to analytical results. These include:

- Differences between calibrant and sample ionization response to photons of a given energy
- Sample concentrations significantly different than the calibration range
- Ion absorption by CH_4 (i.e., greater than 1% by volume) and water vapor in the sample
- Ionic reaction with O_2 in the sample
- Ion fragmentation and recombination
- Differences between calibrant and sample temperature and pressure
- Sensitivity to the sample collection method (i.e., time to stabilize, reactions with sample train components)

During the pilot test, CH_4 concentrations averaged over 6 percent volume, and the sample gas certainly contained water vapor, although it was not measured. O_2 averaged 4.3 percent volume. Vapor at the GAC1 influent typically included a mixture of 25 VOCs or more, comprising mainly toluene, xylenes, and ethylbenzene (72% volume of total detected VOCs on average). The PID was calibrated in the field with a mixture of 100 ppm isobutylene in air. In consideration of all the above, PID results should be

---

[2] Fifteen grab samples were collected from the GAC1 Influent. Three additional grab samples collected at the active SVE well during individual SVE well testing were also used to characterize total untreated vapor from P1 wells.

considered representative within about an order of magnitude at higher VOC concentrations, and perhaps a bit more accurate at lower concentrations, in the 10 to 1,000 ppm range. PID results are reasonably comparable for evaluating time trends and scaling purposes from sample to sample.

In contrast, EPA Method TO-15 is a laboratory procedure, typically producing quantified results below 1 part per billion (ppb) for individual VOCs. Reporting limits for the pilot test were typically in the 50 to 10,000 $\mu g/m^3$ range, depending on the analyte (i.e., roughly 10 to 2500 ppb). Vapor phase analytical results are thus considered reliable for mass removal calculations associated with the pilot test.

Figure 17 shows the comparison of PID total VOC readings and analytical results for the GAC1 influent[3]. For comparison, analytical results were converted from $\mu g/m^3$ to ppm based on the molecular weight of each individual VOC analyzed. Despite consistent and significant differences in results throughout much of the vapor extraction test (PID results being lower), and some variability of data, there are similarities in the trends of the respective sets of PID and analytical results. For instance, both PID and analytical results exhibit a general downward trend prior to the step tests, with an uptick when the vacuum was increased to 7.0 inches-Hg. Both groups then increase to some degree until the start of the MW-65p1 individual well test. Analytical results from July 3, when 3.5 inches-Hg vacuum was first applied, are an order of magnitude higher than the PID results. The PID was calibrated with 100 ppm isobutylene, whereas the total vapor VOCs were closer to 1,000 ppm early in the vapor extraction test. Matrix interference (i.e., water vapor and CH_4) was also likely.

Later during vapor testing, PID total VOC readings and analytical results converge. This may result from generally decreased analytical VOC results falling within the PID calibration range (i.e., 100 ppm isobutylene).

5.1.2.4 P1 Vapor Concentrations Relative to Air and LFG

GAC1 influent CH_4 and O_2 percent volume was monitored daily during MPE pilot test Steps 3 and 4 using a hand-held combustible gas meter. CH_4 averaged 6.6 percent volume, with a range of 6.3 to 6.9 percent. O_2 averaged 4.3 percent volume, with a range of 1.2 to 7.2 percent. These observations led to an evaluation of LFG and air entrainment as part of vapor extracted from the P1.

LFG is monitored quarterly and reported annually at Ephrata Landfill. At original landfill LFG wells GE-5, GE-6, and GE-7, which are those closest to the pilot test area, CH_4 averages 60 percent volume, with a range of 58 to 61 percent, and there is no measured O_2 (Parametrix 2017c). The total LFG flow from these wells was reported as 15 cubic feet per minute (cfm) for each of the last three quarterly monitoring events, which is among the higher LFG flows observed throughout the original landfill. The original landfill LFG collection system is passive (i.e., no blower), so LFG flow is directly related to natural LFG production near the wells. Although some CH_4 was likely present in the P1 prior to the pilot test, the relatively stable CH_4 concentrations in GAC1 influent during the pilot test suggest the original landfill was the primary source of CH_4 during the pilot test.

Conversely, there is no measured O_2 in LFG wells near the pilot test area. In addition, P1 chemistry is consistent with anaerobic conditions, so it is unlikely that O_2 was significant before the pilot test. Atmospheric air is therefore considered to be the primary source of O_2 in the GAC1 influent. Air introduced by the pneumatic system was generally negligible, except during the MW-65p1 individual well test at 12.5 inches-Hg, as further discussed below.

---

[3] Includes analytical results from some individual wells when only one well was contributing vapor.

CH_4 concentrations do not appear to be correlated with the system vacuum or the combination of wells under vacuum, other than during the MW-65p1 individual test. O_2 concentrations vary more depending on which wells are active and the vacuum setting, within a limited range (Section 5.1.2.2). This suggests that the P1 vapor flow path, atmospheric air flow path, and LFG flow path are constant once the vadose zone is formed.

Based on the above observations, the GAC1 influent comprises P1 vapor, LFG, and air. The following volume and concentration equation is solved for the volumetric proportions of each as if they were entirely separate sources. However, note that until dewatering occurred, the P1 contained little to no gas, and that gas that entered the pores during dewatering would have come from above (LFG, atmosphere, or nearby vadose zone). Therefore, P1 vapor is not truly separate from those ultimate gas sources. Once a vadose zone is present, vapor phase contaminants can partition from the liquid and soil phase into the gases that fill the pore spaces; however, those flow contributions are negligible compared to the advection of P1 vapor, air, and LFG. Calculations are provided in Appendix C.

$$Q_{GAC1}*VOL\%_{GAC1} = Q_{LFG}*VOL\%_{LFG} + Q_{P1}*VOL\%_{P1} + Q_{AIR}*VOL\%_{AIR}$$

Where: Q = Volumetric flow rate for either CH_4 of O_2
VOL% = Percent volume for either P1 vapor, CH_4, or O_2

If P1 vapor and air contain no CH_4, the LFG flow contribution can be calculated as follows:

$$Q_{GAC1}*CH_4\%_{GAC1} = Q_{LFG}*CH_4\%_{LFG}$$

and,

$$CH_4\%_{GAC1}/CH_4\%_{LFG} = Q_{LFG}/Q_{GAC1}$$

Based on the average CH_4 concentration in the GAC1 influent (6.6% volume) and LFG (60% volume), LFG accounted for 11 percent of the total vapor flow on average during the pilot test.

If P1 vapor and LFG contain no O_2 and since air is 21 percent O_2, the air flow contribution during normal system operation can be calculated as follows:

$$Q_{GAC1}*O_2\%_{GAC1} = Q_{AIR}*O_2\%_{AIR}$$

and,

$$O_2\%_{GAC1}/O_2\%_{AIR} = Q_{AIR}/Q_{GAC1}$$

On average, during normal operation, atmospheric air accounted for 20 percent of the total vapor flow during the pilot test. This was not true during the MW-65p1 individual well test at 12.5 inches-Hg, as discussed further below.

In normal operation, the well pumps discharge about 0.05 to 0.07 scf of air into the well casing each cycle, or about 0.4 to 0.45 scf per gallon pumped, according to manufacturer's data. This data was used to calculate pneumatic air contribution to the air portion of the total vapor flow at GAC1 influent. On average, the air portion of the GAC1 influent vapor comprised about 2.2 percent pneumatic and 97.8 percent atmospheric air. For purposes of evaluating air entrainment in the total vapor, the pneumatic air contribution is negligible during normal operation.

During the MW-65p1 individual well test at 12.5 inches-Hg, the air portion of the GAC1 influent vapor comprised only pneumatic air and no atmospheric air on average. P1 vapor was also being drawn through the pump and into the VAE system. This is consistent with observations of high pump cycle counts, negligible liquid discharge, and well water levels above the screened interval (see Section 4.5).

5.1.2.5 Vapor VOC Results with Implications for SVE System Operation

This section describes how trends in vapor concentrations over the course of the pilot test were used to inform SVE system operations.

The rapid decrease in vapor VOCs during the initial application of vacuum in Step 3, followed by a slowing of that trend, and possible stabilization toward the end of Step 3, is expected as a result of flushing of equilibrium vapor VOCs in the P1 with non-equilibrium air, and through depletion of source contamination.

When stepping the vacuum down to 3.5 inches-Hg after a month of operation at 12.5 inches-Hg, PID total VOC readings increased slightly (Figure 16), as did the analytical vapor VOC concentrations in MW-65p1 (Table 10) and GAC1 influent (Table 11). This suggests operation at a lower vacuum may enhance contaminant removal efficiency, although total mass removal rates also depend on vapor flow rates. Section 5.1.3 discusses removal rates in more detail.

PID total VOC readings and analytical vapor VOCs were slightly higher in MW-68p1 compared to MW-34p1 during the single-well testing phase (Figure 15), suggesting extraction from wells closer to the drum area (such as MW-68p1) may increase mass removal rates. However, mass removal rates also depend on well vapor flow rates, which were higher at MW-34p1 (45 to 50 scfm) compared to MW-68p1 (25 to 30 scfm) (Section 4.4.3).

5.1.3 Mass Removal from the P1 Zone

The subsections below summarize MPE pilot test total VOC extraction rates and cumulative mass removal for liquid and vapor from the P1. VOCs are the main driver for cleanup at the site and are therefore the focus of the mass removal calculations.

5.1.3.1 Liquid Extraction Rates and VOC Mass Removal

Total liquid extraction rates from the P1 were monitored by a flow meter in the LTT and declined from a high of about 3.5 gpm after application of first vacuum at 3.5 inches-Hg to < 0.1 gpm as the P1 was dewatered in the well field (Figure 8). The total volume of liquid extracted during the MPE pilot test was approximately 87,000 gallons (Figure 8). Liquid extraction rates, along with the contribution provided by each of the extraction wells, are shown in Figure 7.

Along with the general effect of dewatering, changes in liquid extraction rates were observed in response to system changes (i.e., pumping initiated from different wells or application of different vacuums), with the largest changes occurring during the first part of the test when more groundwater was available. Sections 4.1 through 4.4 describe the system responses through the progression of the pilot test.

Approximately 90 percent of the total liquid extracted from the P1 occurred from June 12 to July 29, with most of the liquid pumped from MW-34p1 and MW-68p1 (Figures 7 and 8). Individual wells did not have flow meters; however, the percentage of total liquid extracted from each well was estimated using field-measured pump stroke rates for each well, which was recorded four times daily during the pilot test. MW-34p1 supplied 50 to 90 percent of the total flow for much of the test, except during SVE individual well testing in Step 4.

Liquid extraction rates were used with analytical data to estimate total detected VOC mass removal rates using the following equation.

$M_R = C_L * Q_L * (3.79E\text{-}6)$

where

M_R = Mass removal rate of total detected VOCs (grams per minute)

C_L = Total detected VOC concentrations in liquid (µg/L)

Q_L = Liquid extraction rate at time of sampling (gpm)

3.79E-6 = Unit conversion factor

Results are shown in Figure 18 and indicate that mass removal rates in liquid decreased over the course of the pilot test from about 0.1 gram per minute to less than 0.005 gram per minute as liquid extraction rates decreased. As discussed in Section 5.1.1, one high outlier of total detected VOCs occurred in well MW-34p1 on July 5, shortly after application of the first vacuum, with a mass removal rate of about 5 grams per minute due to significantly higher VOC concentrations, possibly due to temporary LNAPL entrainment.

Total VOC mass removal in liquid during the pilot test was estimated by interpolating VOC concentrations between sampling events and multiplying interpolated concentrations by monitored liquid extraction rates (Q_L) for each monitoring time step (1 minute). The total mass removed in liquid was then calculated as:

$M_T = \Sigma\ (M_R * t * 0.001)$

where

M_T = Total mass removed (kilograms)

Σ = Sum

M_R = Mass removal rate at each time step (grams per minute)

t = Time interval (minutes)

0.001 = Unit conversion factor

Including the July 5 outlier, the total detected VOC mass removed in liquid during the pilot test was 47 kilograms (Figure 18). Excluding the outlier, 3.6 kilograms of total detected VOC mass were removed in liquid (Figure 18). The three dominant VOCs removed in liquid were toluene, xylene, and ethylbenzene (generally 50 to 90% of total detected VOCs). These calculations are based on detected

VOCs only, as non-detected VOCs below laboratory reporting limits are not considered; therefore, these calculations represent minimum liquid VOC mass removal rates.

5.1.3.2 Vapor Extraction Rates and VOC Mass Removal

Figure 11 shows total vapor extraction rates and cumulative total extracted volume from the P1. Vapor flow rates ranged from about 12 to 87 scfm throughout the Step 3 and 4 portions of the MPE pilot test, depending on applied vacuum and which MPE wells were active. Vapor flow responded quickly to vacuum changes during each transition of the pilot test, and the total vapor extracted over the duration of the test was about 7,100,000 scf.

Most of the Step 3 and 4 portions of the test were run with wells MW-34p1 and MW-68p1 open to applied vacuums. Occasionally, MW-65p1 was also open to vacuum; however, as discussed in Section 4.5, the pump in this well did not operate effectively under vacuum, and the well was often shut to applied vacuums.

Vapor extraction rates were used with vapor analytical data to estimate total detected VOC mass removal rates using the following equation:

$$M_R = C_V * Q_V * (2.83E\text{-}8)$$

where

M_R = Mass removal rate of total detected VOCs (grams per minute)

C_V = Total detected VOCs in vapor ($\mu g/m^3$)

Q_V = Vapor extraction rate at time of sampling (scfm)

2.83E-8 = Unit conversion factor

Total detected VOCs in vapor (C_V) were calculated using GAC1 influent vapor samples, except for three samples from September 22, 26, and 27, 2017, which were collected at wellheads during individual SVE well testing and are therefore representative of total vapor in the system.

Results are shown in Figure 19 and indicate that mass removal rates in vapor generally decreased during the pilot test from about 3 grams per minute to about 0.1 gram per minute as VOC concentrations in vapor decreased. One outlier occurred on July 10, with a mass removal rate of about 18 grams per minute due to significantly higher concentrations of total VOCs in vapor. The vapor outlier occurred 5 days after a similar outlier was observed in groundwater, possibly due to temporary LNAPL entrainment (Sections 5.1.1 and 5.1.2). Also, toward the end of the test, the vapor extraction rate increased briefly from 0.1 to 0.2 gram per minute on September 27 when initiating the single-well vacuum test of MW-68p1. Mass removal rates in vapor were much higher than those in liquid.

Total VOC mass removal in vapor during the MPE pilot test was estimated using the same approach that was used for the liquid VOC mass removal (Section 5.1.3.1). VOC concentrations between sampling events were interpolated, and these interpolated concentrations were multiplied by the monitored vapor extraction rate (Q_v) for each time interval (1 minute).

Including the July 10 outlier, the total detected VOC mass removed in vapor over the duration of the test was approximately 270 kilograms (Figure 19). Excluding the outlier, approximately 130 kilograms of total detected VOC mass were removed in vapor (Figure 19). The total VOC mass removed in vapor was one to two orders of magnitude higher than the mass removed in liquid. The dominant VOCs removed in vapor were toluene, xylene, and ethylbenzene. Cumulatively, these three VOCs accounted for 15 to 75 percent of the total detected VOCs removed in vapor. As with liquid, the vapor calculations are based on detected VOCs only, as non-detected VOCs below laboratory reporting limits are not considered; therefore, these calculations represent minimum vapor VOC mass removal rates.

5.2 Contaminant Results from Treatment Performance Monitoring

Extracted liquid and vapor were conveyed to the LTT and VTT treatment facilities for treatment prior to discharge or disposal. This section discusses the effectiveness of the LTT and VTT processes to remove VOCs during the MPE pilot test based on contaminant concentrations monitored at discrete sample locations before and after primary treatment equipment. Mass removal from the treatment facilities was calculated for total detected VOCs and TPH in groundwater and total detected VOCs in vapor. Minor liquid contributions, such as the occasional liquid discharge from the VTT knockout to the OWS, were negligible compared to the P1 liquid flow rates and excluded from the calculations.

Analytical data were used together with monitored flow rates to calculate mass flow rates and total cumulative mass of the contaminants entering the systems, removed during treatment, and discharged to the evaporation pond (liquid) or released to atmosphere (vapor) during the pilot test. The method for calculating mass flow rates and cumulative total mass uses the same equations and interpolation methodology presented in Section 5.1.3.

5.2.1 Contaminant Results from LTT Monitoring

LTT performance was monitored at three liquid sampling points and two vapor sampling points:

- OWS influent (liquid): untreated liquid from combined P1 extraction wells and condensate from the vapor stream
- OWS effluent (liquid): treated liquid discharging from the OWS before entering the AS
- AS effluent (liquid): treated liquid discharging from the AS before entering the evaporation pond
- GAC3 influent (vapor): untreated vapor primarily generated from the AS
- GAC3 effluent (vapor): treated vapor from GAC3 before entering the atmosphere

Liquid samples from the OWS effluent and AS effluent were taken approximately weekly. Two samples were collected at the OWS influent toward the end of the pilot test.

Tables 12, 13, and 14 summarize analytical results from the LTT sampling points. VOC concentrations were similar in the OWS influent and effluent. In addition, no oil phase separation was observed in the waste collection tank. LNAPL was presumably emulsified during the pumping process, which inhibited phase separation and removal in the OWS.

In contrast, VOC and TPH concentrations were notably reduced in the AS tank.

Weekly field PID total VOC readings were used to evaluate performance of GAC3, as summarized in Figure 20. VOCs in GAC3 effluent were undetected or significantly lower than GAC3 influent, indicating effective treatment of AS vapor. The GAC3 carbon did not need to be replaced during the test.

5.2.2 Contaminant Results from VTT Monitoring

VTT performance was monitored at three sampling points:

- GAC1 influent: untreated vapor from combined P1 extraction wells
- GAC1 effluent: treated vapor discharging from GAC1 before entering GAC2
- GAC2 effluent: treated vapor from GAC2 before entering the atmosphere

Analytical results are presented in Tables 11, 15, and 16 for the VTT sampling points. GAC1 influent samples for laboratory analysis were collected about once per week and after transitioning to different steps during the pilot test. Analytical results from individual well testing of MW-34p1 (sampling dates 9/22/17 and 9/26/17 in Table 8) and MW-68p1 (sampling date 9/27/17 in Table 9) were also used in the GAC1 influent calculations, since each of these wells was the only contribution at the time of sampling. Vapor samples for laboratory analysis were also collected from the GAC1 and GAC2 effluents if PID readings indicated VOC breakthrough.

PID total VOC readings are presented in Figure 21. PID readings were collected four times daily from the GAC1 influent starting on July 3, when SVE was first initiated, and daily from the GAC1 and GAC2 effluents starting July 13. The PID data show GAC1 and GAC2 performed well up to saturation when breakthrough occurred. GAC1 breakthrough occurred three times during the pilot test, and GAC2 breakthrough occurred twice (Figure 21). GAC was replaced in both units twice during the pilot test (July 26 and August 23), which required system shutdown for a few hours each time.

5.2.3 Mass Removal in the LTT

Mass removal in the LTT was calculated for total detected VOCs and TPH in the liquid phase based on analytical data from three locations sampled during the pilot test: OWS influent, OWS effluent, and AS effluent. As discussed in Section 5.2.1, there were few analytical samples collected from OWS influent (untreated groundwater). Therefore, OWS influent liquid contaminant concentrations were estimated from samples collected from individual wells that were then weighted by individual well pumping rates[4]. The estimated contaminant concentrations were used to calculate OWS influent mass flow rates when analytical data were not available.

VOC mass removal from the AS vapor that passed through GAC3 was qualitatively evaluated from field PID data. Concentration data from Tables 12, 13, and 14 and total liquid extraction rates, shown in Figure 8, were used to calculate the mass flow rates and cumulative total mass at each of the three liquid sample locations.

Results are discussed below for VOCs and TPH.

5.2.3.1 VOC Contaminant Removal in the LTT

Figure 22 shows the total detected VOC mass flow rates and cumulative mass conveyed through each liquid sample point in the LTT (OWS influent, OWS effluent, and AS effluent). Two sets of cumulative mass data are included for the OWS influent: one that includes a July 5 outlier data point for the OWS influent, and one that excludes that data point.

---

[4] Pumping rates at individual wells were not measured directly. Instead, pumping rates were estimated based on monitored pump cycle rates at each well and the total liquid flow measured at the LTT.

The July 5 sample event occurred shortly after initiating SVE, which included a sample from MW-34p1 with detected VOC concentrations an order of magnitude higher than any other sampling event, and may represent brief entrainment of LNAPL in that well, as discussed in Section 5.1.1 and shown in Table 5. Brief periods of significantly higher-than-normal concentrations in liquid extracted from the wells during early extraction are expected to be of limited duration and frequency and not representative of the mixture that occurs once the liquid enters the OWS. Exclusion of the outlier in this evaluation is expected to be most representative of the treatment process.

Omitting the outlier, Figure 22 shows OWS influent VOC mass flow rates generally ranged from about 0.1 gram per minute at the start of the test (with two wells operating) to less than 0.005 gram per minute as liquid extraction rates decreased, becoming too low to measure toward the end of the test. The peak VOC mass flow rate resulting from the outlier on July 5 was about 6.1 grams per minute.

VOC mass flow rates at the OWS effluent were similar to those at the OWS influent during the early part of the test (omitting the OWS influent outlier), indicating minimal removal of VOCs by the OWS. The cumulative total mass of VOCs at the OWS influent and effluent during the pilot test were similar (3.6 and 3.3 kilograms, respectively) and indicated only 8.3 percent removal of VOCs by the OWS.

In contrast, the VOC mass flow rates and cumulative mass (0.7 kilogram) in the liquid AS effluent were lower than in the OWS effluent, indicating an approximate 78.8 percent reduction of VOC mass by the AS during the pilot test. Most of the reduction occurred during the early part of the pilot test when extraction rates were highest.

During the pilot test, the OWS and AS reduced the total VOC influent mass of 3.6 kilograms by 0.3 kilogram and 2.6 kilograms, respectively (omitting the July 5 outlier) for an 80.6 percent reduction of total VOCs. The remaining 0.7 kilogram of VOCs in liquid was discharged to the evaporation pond, as discussed in Section 5.3.

Figure 20 shows field-measured PID total VOC readings of vapor generated from the AS discharge as sampled at the GAC3 influent and GAC3 effluent. P1 liquid extraction began on June 12; however, PID readings of the GAC3 influent and GAC3 effluent began on July 25 (43 days after P1 liquid extraction began). Thus, the data are only representative of treatment performance of lower contaminant concentrations and flow rates in the liquid. VOCs were not detected in the GAC3 effluent on July 25. Low-level VOC readings from the GAC3 effluent (< 1 ppm) were intermittently detected starting on August 29, indicating some breakthrough. Overall, the difference in PID readings between the influent and effluent indicates GAC3 reduced VOCs before discharge to the atmosphere. As discussed in Section 5.1.2.3, PID data are best suited to identify concentration trends rather than determine quantitative mass. However, based on a comparison of the VTT analytical verses PID VOC data, concentrations < 1 ppm measured at the GAC3 effluent should correlate to a very small mass. LTT vapor emissions are discussed further in Section 5.3.

5.2.3.2 TPH Contaminant Removal in the LTT

Figure 23 shows the TPH mass flow rates and cumulative mass conveyed through the OWS influent and OWS effluent. The intent of the OWS is to reduce TPH and it is the focus of this section. Two sets of cumulative mass were calculated for the OWS influent: one that includes the July 5 high outlier data point for the OWS influent, and one that excludes that data point. As discussed in 5.2.3.1, exclusion of the outlier in this evaluation is expected to be most representative of the treatment process.

Figure 23 shows the OWS influent with the July 5 mass flow rate outlier; however, if omitting the outlier, TPH mass flow rates generally ranged from approximately 0.7 gram per minute at the start of the MPE pilot test (with two wells operating), then decreased to less than 0.01 gram per minute as liquid extraction rates decreased, approaching zero toward the end of the pilot test. The peak TPH mass flow rate resulting from the outlier on July 5 was 24.6 grams per minute.

The TPH mass flow rates at the OWS effluent were similar to those at the OWS influent during the early part of the test (omitting the OWS influent outlier), indicating minimal removal of TPH by the OWS. The total cumulative mass of TPH at the OWS influent and effluent during the pilot test were similar (15.6 and 15.3 kilograms, respectively), indicating only 1.9 percent removal of TPH by the OWS.

5.2.4 Mass Removal in the VTT

Figure 24 shows the total detected VOC mass flow rates and cumulative mass conveyed through each vapor sample point in the VTT. Two sets of cumulative mass data are included: one including the July 10 outlier VOC data point and one excluding it. Brief periods of significantly higher-than-normal concentrations in vapor extracted from the wells during early extraction were of limited duration and frequency. Although the outlier is a valid data point and was identified in both the GAC1 influent and effluent samples, exclusion of the outlier in this evaluation is expected to be most representative of the treatment process.

Omitting the outlier VOC data and abnormal vapor flow rates, untreated P1 vapor entering GAC1 has a VOC mass flow rate that generally declined from approximately 3 grams per minute at the start of the pilot test to approximately 0.1 gram per minute toward the end of the pilot test. The peak incoming VOC mass flow rate resulting from the outlier VOC data on July 10, but excluding the irregular vapor flow rates, was about 18 grams per minute.

The VOC mass flow rates at the GAC1 effluent typically remained below that of the GAC1 influent. Similarly, GAC2 effluent VOC mass flow rates typically remained below the GAC1 effluent. However, when there was breakthrough, PID total VOC readings for the GAC1 and GAC2 effluents were sometimes higher than influent results. This could simply be erroneous PID results (Section 5.1.2.3), or it could indicate desorption once the carbon in the GAC was saturated.

During the pilot test, and excluding the July 10 outlier, GAC1 reduced the influent VOC mass of 125 kilograms by 58 kilograms, and GAC2 reduced the remaining 68 kilograms of VOC mass by 18 kilograms. The remaining breakthrough mass of 50 kilograms was released to atmosphere, as discussed in Section 5.3. Future VOC emissions during MPE operation can be reduced through GAC management practices.

5.3 MPE Treatment Facility Emissions

Treatment facility emissions are focused on VOC emissions comprising:

- VOCs in vapor released to atmosphere from GAC2 of the VTT
- VOCs in vapor released to atmosphere from GAC3 of the LTT
- VOCs in liquid released to the evaporation pond from the AS of the LTT and assumed to volatize during evaporation

Table 17 shows VOC emissions from the three locations described above. VOC emissions are specific to each contaminant tested during laboratory analysis and are compared to the small quantity emission rate (SQER) and de minimis regulatory limits prescribed by WAC 173-460-150.

Total VOC emissions from the VTT GAC2 and LTT evaporation pond were 48.86 and 0.67 kilograms, respectively, for a total of 49.53 kilograms. LTT GAC3 emissions were assumed to be zero since there was no breakthrough based on the PID field measurements. Note that emissions were calculated based on 1-minute flowrate increments and are slightly different than values presented in Section 5.2 that were based on 30-minute flowrate increments. The results indicate that the treatment facility had no exceedances during the pilot test.

6. IMPLICATIONS FOR REMEDIAL DESIGN

The subsections below summarize MPE pilot test performance data to facilitate feasibility assessment and remedial design. The final subsection presents specific considerations for design.

6.1 Groundwater Radius of Influence

The MPE pilot test indicates that the P1 can be dewatered by the pumps used in the pilot test and that after dewatering, mass removal will be dominated by contaminants carried in vapor. The objective of pumping groundwater is therefore primarily to dewater the P1 and develop a vadose zone for vapor extraction. The analysis is limited to selection of a well spacing that should result in effective dewatering.

Distance drawdown analysis of the MW-65p1 long-term aquifer pumping test (no vacuum) conducted in 2016 indicates that the ROI varied from about 30 to 300 ft, depending on the radial direction from the pumping well and which wells are selected for analysis (PGG 2017). The median ROI was about 100 ft[5]. These are large values for the small pumping rate (1.5 gpm) and drawdown stresses imposed by pumping MW-65p1 for 5 hours. They are substantially larger than the ROI observed for vapor responses, as discuss in Section 6.2. The MPE expansion system design should be based on vacuum well performance (ROI or similar basis), since any well to be used for vapor extraction needs to have a groundwater pump to prevent the vacuum system from drawing up groundwater into the well as vacuum is applied. A system designed on that basis should have more than enough groundwater pumps to develop and maintain a dewatered state in the P1.

6.2 Soil Vapor Radius of Influence

As discussed in Sections 4.4.3.1 and 4.4.3.2, the MPE pilot test included SVE at MW-34p1 and MW-68p1 separately, each at a nominal vacuum of 12.5 inches-Hg. Vacuum drawdown will be radially symmetric in a homogeneous vadose zone; however, distance drawdown analysis of vacuum data from the P1 single-well tests indicates that vacuum drawdown in wells at similar distances from the vacuum centers were very different. This indicates very heterogeneous conditions in the P1 air permeability and a vapor leakage layer above the P1. Appendices C and D provide estimated aquifer parameters from steady-state gas flow data for the two extraction wells. Adding to analysis uncertainty is the fact that vacuum response at P1 observation wells, spaced 15 to 90 ft away from the extraction wells, were a small fraction of the 12.5 inches-Hg applied at the extraction wells. Best-fit lines through distance drawdown data in Appendices C and D were nonetheless used to represent average P1 response, recognizing that this analysis does not represent system heterogeneity.

Projection of best-fit lines to distance drawdown data during the MW-34p1 and MW-68p1 tests suggests average vapor ROIs of 50 and 33 ft, respectively. Qualitative interpretation of multiple-well portions of the pilot test suggest these values are reasonable and that the ROI demonstrates little sensitivity to applied vacuum (quantitative distance drawdown interpretation of the multi-well test was not performed because there is no single “distance” when multiple wells are pumping). The low sensitivity

---

[5] The highest ROI value of 300 ft was not considered representative for the P1, and was not included in the calculation of median ROI.

of vapor ROI to applied vacuum may be explained by the leaky aquitard above the P1 and lateral bounding of the induced vadose zone.

6.3 Specific Capacity in SVE Wells

Selected vacuum and vapor flow data were extracted from periods of relatively steady system performance to calculate extraction well specific capacity (ratio of vapor flow divided by vacuum).

One synchronous flow and vacuum data set was extracted from the initial periods of operation at the nominal 3.5 and 7.0 inches-Hg vacuums with wells MW-34p1 and MW-68p1 under vacuum as shown in Figure 10. Two synchronous data sets were extracted from the two-well period of operation at the nominal 12.5 inches-Hg vacuum. Also, single data sets were extracted when wells MW-34p1 and MW-68p1 were operating separately, both at a nominal 12.5 inches-Hg vacuum. Periods when MW-65p1 was operating were not evaluated because of the uncertainty surrounding the performance of MW-65p1 (Section 4.5). Table 18 presents the extracted data.

Well MW-34p1 operated separately on September 22 at 11.5 inches-Hg and produced a vapor flow rate of 45.4 scfm[6]. Well MW-68p1 operated separately on September 30 at 12.3 inches-Hg and produced a vapor flow rate of 26.3 scfm. From those flow and vacuum ratios with only one well pumping, specific capacities of 3.9 and 2.1 scfm/inch-Hg were calculated for the two wells, respectively. Similar calculations were performed using actual cubic feet per minute (acfm) flow data[7].

The MPE system was designed with a single vapor flow meter that measured total flow from all operating wells. Individual well flow rates are known only when one well was pumping. Individual flow rates were estimated for periods of joint operation by apportioning the single measured flow rate by the specific capacity of the multiple wells with applied vacuum.

As shown in Table 18, the apportioned flows were divided by the vacuums measured within each well to calculate specific capacities at various vacuums. Separate calculations were performed using scfm and acfm flow data:

- The specific capacity of MW-34p1 declined from 7.3 scfm/inch-Hg at 3.4 inches-Hg to 3.9 scfm/inch-Hg at 11.5 inches-Hg. The specific capacity of MW-68p1 declined from 3.8 scfm/inch-Hg at 3.5 inches-Hg to 2.1 scfm/inch-Hg at 12.3 inches-Hg. The specific capacity trend in both wells using scfm was approximately linearly downward as a function of vacuum.
- The specific capacity of MW-34p1 declined from 9.0 acfm/inch-Hg at 3.4 inches-Hg to 7.4 acfm/inch-Hg at 11.5 inches-Hg. The specific capacity of MW-68p1 declined from 4.7 acfm/inch-Hg at 3.5 inches-Hg to 4.0 acfm/inch-Hg at 12.3 inches-Hg. In contrast to the scfm trend, the specific capacities using acfm flow data were nearly constant from 3.5 to 10.3 inches-Hg, then declined modestly at higher vacuums.

The specific capacity of an individual well, as shown in Table 18, can be used to predict the vapor yield of that well at various vacuums. For MPE expansion system design, an average or range of vapor yield for

---

[6] Small short-term variations in pressure are ignored.

[7] acfm is a measure of vapor flow at the actual pressure and temperature in the system, whereas scfm is a measure of vapor flow corrected to standardized pressure and temperature.

the expansion area is required. The data from the pilot test are probably biased high with respect to vapor flow because the P1 wells with the expected highest vapor flow[8] were selected as SVE centers. Given the limited understanding of the total range of vapor well yield, the specific capacity trend from the least productive pilot test well (MW-68p1) is probably the best basis for expansion design.

The range of well performance characteristics that should be expected in an MPE expanded system is as large, or larger, than the range of performance characteristics observed in the pilot test wells. Of the eight P1 wells drilled in the pilot test area, two were proven to be viable vacuum wells and one failed as a vacuum well, as discussed in Section 4.5. The other five had lower aquifer transmissivities to water and may not have been viable vapor wells after dewatering (although correlation between aquifer transmissivity and vapor productivity has not been established).

6.4 Soil-air Conductivity

The soil-air conductivity of the dewatered P1 and an assumed overlying aquitard was estimated using data from periods when MW-34p1 and MW-68p1 were operated separately at a nominal 12.5 inches-Hg vacuum. Based on the following concept and data, the P1 was assumed to be a semi-confined geologic layer overlain by a leaky aquitard and sources of gas at constant pressure:

- The P1 vadose zone is laterally bounded by groundwater saturation, except to the north where the P1 abuts the coarse backfill in the drum area.
- Vapor drawdowns quickly stabilized to changes in vacuum and were thereafter constant (steady-state).
- Vacuum ROIs were modest (e.g., 33 and 50 ft) and not sensitive to vacuum within the range tested.
- Vapor extracted from extraction wells contained CH_4 and O_2, indicating LFG and atmospheric contributions.

A distance-drawdown analysis permitted the estimation of the soil-air conductivity and a leakage factor. Parameters were estimated via the steady-state distance-drawdown method of Hantush and Jacob using procedure 4.2 in the Analysis and Evaluation of Pumping Test Data[9] (Kruseman and DeRidder, 1990). Briefly, the Hantush-Jacob method involves fitting a line to the change in pressure (i.e., drawdown) versus the $\log_{10}$-transformed distance of each observation well from the source of the vacuum. The application of groundwater flow models to estimate parameters in vapor extraction systems is an approach shown to yield good estimates when pressure differences in a system are less than about 15 inches-Hg and slip flow is negligible compared to viscous flow.

Parameter estimation relied on data collected on September 26 and October 3. Transducer data from September 26 recorded the vacuum in five observation wells screened within the P1, while MW-34p1 operated at a vacuum of approximately 12.5 inches-Hg. At that time, a relatively steady flow rate of 45.7 scfm was observed. Similarly, transducer data from October 3 recorded the vacuum in five

---

[8] Groundwater well yields were used as a predictor of vapor yields.

[9] As modified for soil-air testing, the Hantush-Jacob Solution assumes (1) the P1 is effectively infinite, homogeneous, and bound on the top by an aquitard; (2) the aquitard is overlain by a source of soil-air at a uniform pressure that does not change, known as the source bed; (3) soil-air flow in the aquitard is vertical; and (4) the aquitard is incompressible and does not experience a change in soil-air storage during pumping.

observation wells while MW-68p1 operated at a vacuum of approximately 12.5 inches-Hg, achieving a steady flow rate of 27.9 scfm. The different flow rates observed at the two extraction points when the same vacuum pressure was applied during single-well vacuum tests indicate the geologic material surrounding the MW-34p1 well screen is more conductive to vapor flow compared to that near the MW-68p1 well screen. Using the Hantush-Jacob method and data from September 26 (MW-34p1 only) and October 3 (MW-68p1 only), the following characteristics were interpreted (see Appendices C and D for details).

Extraction Well	P1 Soil-air Transmissivity (cm^2 per second)	P1 Intrinsic Permeability (cm^2)	Aquitard Hydraulic Resistance (minutes)	Soil-air Leakage Factor (cm)
MW-34p1	44	$4x10^{-5}$	500	1145
MW-68p1	24	$2.2x10^{-5}$	375	738

cm = centimeters.
cm^2 = square centimeters.

The intrinsic permeabilities are higher than expected based on prior pump testing. The intrinsic permeability of the P1 was estimated previously at $3x10^{-8}$ square centimeters (cm^2) based on P1 aquifer pumping test data and borehole logs (Parametrix 2015). The intrinsic permeabilities interpreted from the pilot test, above, are more than 100 times higher than the intrinsic permeability estimated from the P1 aquifer pumping tests if a similar thickness of the aquifer is assumed. The large difference in intrinsic permeability under these assumptions indicates that, following dewatering of the P1, the pores and fractures conducting soil-air flow are not entirely the same as the pores and fractures conducting water during aquifer pumping tests. Higher-permeability soil and rock is involved in moving soil-air toward extraction wells.

Aquitard hydraulic resistance is the aquitard thickness divided by the aquitard air conductivity, as shown in Appendices C and D. This interpretation suggests that if the aquitard is 100 centimeters (cm) thick, its intrinsic permeability is about 10^{-6} cm^2, or 3 to 13 times less permeable than the P1.

The average P1 soil-air transmissivity (T) and leakage (L) parameters estimated from the single-well tests (T = 34 cm^2 per second and L = 900 cm) were used to parameterize a multi-well, constant pumping rate, forward simulation in AQTESOLV 4.0 Pro[10]. The model assumes a homogeneous aquifer; thus, the model overestimates and underestimates vacuums at various locations in the zone of influence. Also, AQTESOLV uses the transient Hantush method, which requires a storage coefficient, whereas analyses in Appendices C and D use the steady-state version. The later-time drawdown from transient solutions for leaky aquifers approximate steady-state drawdown. Although vapor storage coefficients for the P1 are not well known, once steady conditions are reached, the storage coefficient no longer influences the results.

As shown in Figure 25, the results of the forward simulation were compared to observed pressures in six wells on September 6, when both MW-34p1 and MW-68p1 were operated at a vacuum of

---

[10] HydroSOLVE, Inc., hydrosolve@aqtesolv.com

approximately 12.5 inches-Hg. Those simulated and observed drawdowns are plotted in map view in Figure 26. Figures 25 and 26 indicate that the two-well simulation using parameters derived from single-well test data over-predicts vacuum drawdown by 2.3 to 9.5 inches-Hg in the extraction wells and 0.28 to 2.2 inches-Hg in the observation wells.

Further work with alternative conceptual models, alternative analytical methods, and calibration within a multi-well model would likely result in better matches between observed and simulated drawdowns. Therefore, additional work is warranted if AQTESOLV, or a similar model package, is used for design. Only very limited additional work was performed for this report. For example, doubling the inverse leakage factor (1/L) results in improved match to the pumping well vacuum drawdowns and retains reasonable fit in observation wells (Figure 27).

6.5 MPE Expansion Design Considerations

The following bullets present factors that should be considered during feasibility analysis and design of an MPE expansion system:

- SVE Effectiveness:
    - The MPE pilot test results suggest vapor movement through the P1 and overlying rock and soil. VOCs from past releases are present in all those bodies and are subject to removal by vapor flow during SVE.
    - The P1 remedial time frame may be limited by diffusion from the P1 into air moving in a limited number of higher-permeability pathways, both within and above the P1. Therefore, the remedial time frame of the entire P1 may be slower than the remedial time frame for higher-permeability zones.
    - Cyclical operation of the MPE system may enhance mass removal once vapor phase mass removal rates decrease to some threshold. Allowing the P1 to re-saturate may mobilize contaminants from low-permeability areas not effectively treated by vapor extraction.
- Above-ground design:
    - A different blower with a wider capacity range at intermediate vacuums compared to the VAE pump may be necessary to support an MPE expansion system.
    - Provide fittings and valves near wellheads to allow isolation and removal of pumps for servicing.
    - Consider single-well testing of expansion wells prior to final design of (fixed) conveyance, since those wells that will be viable extraction wells will not be known.
    - Design for conveyance flexibility (allow various wells to be used as extraction wells).
    - All extraction wells need a groundwater pump.

- Well layout process:
    - Outline the expansion area based on contaminant distribution in P1 groundwater.
    - Select from among current wells to start the expansion system layout (i.e., use wells MW-34p1 and MW-68p1).
    - Set expansion wells at key locations based on concentrations and boundaries (e.g., along the edge of the drum area).
    - Expand the network in a grid pattern using a relatively small well spacing of 30 to 40 ft.
    - Provide vent wells on expansion-area margins. The effect of vent wells was not pilot-tested. However, the expected effect is increased horizontal flow within the P1, decreased vertical leakage, a smaller ROI (assuming vent wells are placed within the unvented ROI), and possibly increased vapor yields. Vent wells will also introduce O_2 into the P1.
    - Consider refining the design by simulating vapor flow in AQTESOLV or a similar model.
    - Construct 6-inch-diameter extraction wells to avoid potential issues as described in Section 4.5 and to allow installation of transducers below the pumps.
- Factors for selection of target vacuum for long-term operation:
    - Dewatering was effective at all tested vacuums (3.5, 7.0, and 12.5 inches-Hg).
    - VOC concentrations in vapor were slightly higher at lower applied vacuum.
    - Vapor-well ROI was not very sensitive to applied vacuum within the range tested in the pilot test.
    - Vapor-well specific capacities decline with increasing vacuum; therefore, electrical cost per kilogram of contaminant removed will increase with increased vacuum.
- Liquid and vapor treatment trains:
    - Install dissolved air floatation (DAF) treatment in line after OWS to remove emulsified LNAPL.
    - Install larger GAC systems in the VTT and/or be prepared to change out GACs more frequently when vapor concentrations are high. Have spare GACs on site for frequent change-out.

7. MPE PILOT TEST IRA COST SUMMARY

This section provides a breakdown of MPE pilot test IRA costs for installing wells, constructing the MPE system, performing and recording the pilot test, and professional services. Costs incurred from July 1, 2015, through the completion of the pilot test and delivery of this IRA report are included. The total cost was $4,584,565, as further described below:

- New P1 well installation, initial testing, and reporting costs were $419,691.
- Pilot system planning, permitting, engineering design, and bidding services came to $677,202. Services during construction added $705,610.
- The pilot test facility fabrication and construction cost was $1,793,353.
- The pilot test, including the Phase 2 work plan and this IRA report, cost $763,301.

Table 19 provides further breakout of the above costs.

Other related costs not addressed in this section include landfill staff costs, Grant County and City of Ephrata administrative costs and attorney fees, Ecology’s administrative costs, and the cost of support from the Washington State Attorney General’s Office.

8. REFERENCES

Kruseman, G. P. and DeRidder, N. A. 1990. Analysis and evaluation of pumping test data. International Institute for Land Reclamation and Improvement. Publication 47. Wageningen, The Netherlands.

Parametrix. 2015. Interim Remedial Action Plan Supplement, Ephrata Landfill Corrective Action, Pilot Test of Multi-Phase Extraction (MPE) and Additional Monitoring Wells. Prepared by Parametrix, Seattle, Washington. September 2015.

Parametrix. 2017a. Pilot Test of Multi-Phase Extraction (MPE), Phase 2 Work Plan, Ephrata Landfill. Prepared by Parametrix, Seattle, Washington. July 2017.

Parametrix. 2017b. Construction Quality Assurance (CQA) Report, Ephrata Landfill – MPE Pilot Study Interim Action Evaporation Pond. Prepared by Parametrix, Seattle, Washington. December 2017.

Parametrix. 2017c. Ephrata Landfill 2016 NOC Permit Annual Report. January 30, 2017 letter report from Steve Emge, Parametrix to John Cleary, Ecology.

PGG. 2010. Draft Remedial Investigation Report, Ephrata Landfill. Prepared for Grant County Public Works and City of Ephrata. September 3.

PGG. 2017. Remedial Investigation Addendum 2. Ephrata Landfill (Agency Draft). Prepared for Grant County Public Works and City of Ephrata. December 22, 2017.

Tables

Table 1: Summary of Wells, Pumps, and Transducters

	Depth (feet) Below Measuring Point (MP) Used during Pilot Test								Elevation (feet)						
Well	**Pilot Test MP**	**Bottom of Well**	**Bottom of P1**	**Top of P1**	**Top of Screen**	**Screen Length**	**Intake of Liquid Pump**	**Liquid Level Transducer Sensor**	**Top of PVC Casing**	**Top of MP**	**Bottom of Well**	**Bottom of P1**	**Top of P1**	**Intake of Liquid Pump**	**Liquid Level Transducer Sensor**
MULTIPHASE EXTRACTION WELLS															
MW-65p1	QED Plate	39.55	36.78	35.28	34.55	5	38.39	36.81	1287.54	1288.74	1249.19	1251.96	1253.46	1250.35	1251.93
MW-34p1	QED Plate	40.72	40.81	35.81	34.72	6	39.88	38.30	1285.93	1287.11	1246.39	1246.30	1251.30	1247.23	1248.81
MW-68p1	QED Plate	39.03	36.61	30.11	31.03	8	38.04	36.46	1284.36	1285.54	1246.51	1248.93	1255.43	1247.50	1249.08
P1 OBSERVATION WELLS															
MW-36p1	Well Cap	42.24	39.85	38.35	37.24	5	na	na	1288.99	1289.15	1246.91	1249.30	1250.80	na	na
MW-64p1	QED Plate	44.50	42.97	40.97	39.50	5	na	44.33	1289.67	1289.77	1245.27	1246.80	1248.80	na	1245.44
MW-66p1	QED Plate	40.11	36.84	35.84	36.11	4	na	40.10	1286.83	1286.93	1246.82	1250.09	1251.09	na	1246.83
MW-67p1	PVC Case	43.25	38.94	34.94	34.25	9	na	na	1287.15	1287.15	1243.90	1248.21	1252.21	na	na
MW-69p1	QED Plate	36.74	33.87	28.87	31.74	5	na	36.70	1283.95	1284.05	1247.31	1250.18	1255.18	na	1247.35
MW-70p1	QED Plate	37.13	34.61	33.11	31.13	6	na	36.98	1283.01	1283.11	1245.98	1248.50	1250.00	na	1246.13
OTHER OBSERVATION WELLS															
MW-32a	PVC Case	25.14	na	na	20.44	5	na	na	1276.47	1276.47	1251.33	na	na	na	na
MW-33p2	PVC Case	58.43	na	na	48.43	10	na	na	1291.67	1291.67	1233.24	na	na	na	na
MW-35p2	PVC Case	54.66	na	na	48.66	6	na	na	1286.97	1286.97	1232.31	na	na	na	na
MW-38p2	PVC Case	48.11	na	na	38.11	10	na	na	1277.97	1277.97	1229.86	na	na	na	na
MW-29b	PVC Case	72.99	na	na	67.99	5	na	na	1285.18	1285.18	1212.19	na	na	na	na
MW-30b	PVC Case	78.79	na	na	68.79	10	na	na	1288.12	1288.12	1209.33	na	na	na	na
MW-31b	PVC Case	75.34	na	na	65.34	10	na	na	1274.89	1274.89	1199.55	na	na	na	na

na = not applicable.

This Page Intentionally Left Blank

Table 2: Distance from MPE Wells to Observation Wells

	Distance from MPE Well (feet)		
Observation Well	**MW-34p1**	**MW-65p1**	**MW-68p1**
MW-29b	120.82	149.63	149.81
MW-30b	93.31	65.70	67.57
MW-31b	183.87	182.43	157.17
MW-32a	102.78	133.39	116.04
MW-33p2	54.35	29.88	58.35
MW-34p1	0.00	31.95	31.31
MW-35p2	153.28	132.07	122.55
MW-36p1	91.44	65.03	64.60
MW-38p2	116.83	117.66	91.09
MW-64p1	58.82	27.57	51.93
MW-65p1	31.95	0.00	28.52
MW-66p1	34.23	15.52	15.43
MW-67p1	48.75	24.06	25.91
MW-68p1	31.31	28.52	0.00
MW-69p1	56.58	46.79	25.32
MW-70p1	52.36	83.91	78.48

Table 3: Monitoring Stations and Parameters

MANUAL TESTING AND SAMPLING

	Parameter																
Location	**Methane (%LEL)**	**Oxygen (%LEL)**	**VOCs PID**	**TDS (Liquid)**	**TPH (Liquid)**	**VOCs (Liquid)**	**VOCs (Vapor)**	**SVOCs (Liquid)**	**Depth To Water**	**Well Water Level**	**Vapor Pressure**	**Pump Cycle Counts**	**VAE Blower Speed**	**Temperature**	**Vapor Flow Rate**	**Liquid Flow Rate**	**Cumulative Liquid Volume**
MW-34p1				Weekly[1]	Weekly[1]	Weekly[1]	Weekly[1]	Weekly[1]				4x per Day					
MW-65p1				Weekly[2]	Weekly[2]	Weekly[2]	Weekly[2]	Weekly[2]				4x per Day					
MW-68p1				Weekly[1]	Weekly[1]	Weekly[1]	Weekly[1]	Weekly[1]				4x per Day					
MW-32a									Daily	Daily							
MW-36p1									Daily	Daily	Daily						
MW-67p1									Daily	Daily							
MW-33p2									Daily	Daily							
MW-35p2									Daily	Daily							
MW-38p2									Daily	Daily							
MW-29b									Daily	Daily							
MW-30b									Daily	Daily							
MW-31b									Daily	Daily							
OWS Influent				Weekly	Weekly	Weekly		Weekly								4x per Day	4x per Day
OWS Effluent				Weekly	Weekly	Weekly		Weekly									
AS Effluent				Weekly	Weekly	Weekly		Weekly									
GAC 3 Influent	Weekly	Weekly	Weekly														
GAC 3 Effluent	Weekly	Weekly	Weekly														
GAC 1 Influent	4x per Day	4x per Day	4x per Day				Weekly										
GAC 1 Effluent	Daily	Daily	Daily				Weekly[3]										
GAC 2 Effluent	Daily	Daily	Daily				Weekly[3]										
VTT Vapor Flow Meter											4x per Day		4x per Day		4x per Day		
VTT Knockout Tank Effluent											4x per Day			4x per Day			

Notes:

[1] MW-34p1 and MW-68p1 were occasionally sampled more frequently than weekly when transitioning between steps.

[2] MW-65p1 was only sampled weekly when the well was operating (see text).

[3] GAC1 and GAC2 effluent were only sampled weekly once breakthrough was observed with field VOC PID readings

Liquid samples were collected less often toward the end of the test as liquid flow rates decreased to near zero (see text)

INSTALLED INSTRUMENTS

	Parameter										
Location	**Temperature**	**Vapor Pressure**	**Liquid Pressure**	**Vapor Flow Rate**	**Liquid Flow Rate**	**Total Liquid Volume**	**Well Water Level**	**Tank Vapor Pressure**	**Methane (%LEL)**	**Oxygen (%LEL)**	**Tank Water Level**
MW-64p1		Minute					Minute				
MW-66p1		Minute					Minute				
MW-69p1		Minute					Minute				
MW-70p1		Minute					Minute				
Condensate Sump											Minute
MW-34p1		Minute					Minute				
MW-65p1		Minute					Minute				
MW-68p1		Minute					Minute				
OWS Influent					Minute	Minute					
Air Receiver Tank								Minute			
LTT Knockout Tank	Minute	Minute						Minute			
AS Effluent			Minute					Minute			
LTT Container									Minute	Minute	
VTT Vapor Flow Meter		Minute		Minute							
GAC 1 Influent	Minute										
VTT Knockout Tank Influent		Minute									
VTT Knockout Tank Effluent		Minute									
VTT Container									Minute	Minute	

Table 4: Summary of MPE Pilot Test Steps

Date	Event Description
STEP 1 EVENTS	
5/18/17	Pre-commission Monitoring Initiated.
5/22/17	Commission Phase Initiated.
5/23/17	Post-commission Monitoring Initiated.
STEP 2 EVENTS	
6/12/17	MW-65p1 Begins Pumping.
6/19/17	MW-34p1 Begins Pumping.
6/19/17	MPE Well Pumps Off.
6/19/17	MPE Well Pumps On.
6/26/17	MW-68p1 Begins Pumping.
STEP 3 EVENTS	
7/3/17	VAE Blower Initiated at All 3 MPE Wells at 3.5" Hg (MW-65p1 Starts Pumping Erratically).
7/7/17	Adjusted VAE Ball Valve to 20% Open at MW-65p1 to Limit Vacuum While Troubleshooting Erratic Pumping Issue.
7/8/17	Turned VAE Ball Valve Slightly Open at MW-65p1 While Troubleshooting Erratic Pumping Issue.
7/8/17	Turned VAE Ball Valve Slightly Open at MW-65p1 While Troubleshooting Erratic Pumping Issue.
7/11/17	VAE Blower Off.
7/11/17	VAE Blower On.
7/12/17	Turned Off Vacuum to MW-65p1 and Removed Plug in Wellcap.
7/13/17	Placed Plug with a Small Hole into Opening in MW-65p1 Wellcap.
7/15/17	Added Plug with No hole into MW-65p1 Wellcap.
7/24/17	VAE Blower and MPE Well Pumps Off to Troubleshoot MW-65p1 Erratic Pumping and Install Isolation Valves.
7/24/17	MPE Well Pumps On.
7/24/17	VAE Blower On.
7/26/17	VAE Blower Off for VTT GAC Media Changeout.
7/26/17	VAE Blower On.
7/31/17	Vacuum and Pump Air Supply in MW-65p1 Shut Down While Performing Pump Maintenance.
7/31/17	Vaccum and Pump Air Supply Reintroduced to MW-65p1 (MW-65p1 Still Pumping Erratically).
8/3/17	Vaccum and Pump Air Supply in MW-65p1 Shut Down to Remove Pump and Return It to QED.
8/6/17	VAE Blower Initiated at MPE Wells MW-34p1 and MW-68p1 at 7" Hg (MW-65p1 Closed to VAE Blower).
8/14/17	VAE Blower Initiated at MPE Wells MW-34p1 and MW-68p1 at 12 to 12.5" Hg (MW-65p1 Closed to VAE Blower). Set System to 14" Hg, but System Running at 12" Hg.
8/16/17	Vacuum Temporarily Reduced in MPE Wells While Pressure Relief Valves Installed.
8/16/17	VAE Blower Off During Overnight Power Loss.
8/17/17	VAE Blower On.
8/18/17	MW-65p1 Pump Reinstalled and Reconnected to VAE Blower.
8/18/17	MW-65p1 Closed to VAE Blower Due to the Reccurrence of Erratic Pumping After Troubleshooting.
8/19/17	Troubleshooting the Erratic Pumping in MW-65p1.
8/23/17	VAE Blower Off for VTT GAC Media Changeout.
8/23/17	VAE Blower Initiated at Wells MW-34p1 and MW-68p1 at 12 to 12.5" Hg (MW-65p1 Closed to Blower).
8/24/17	VAE Blower Off for VTT GAC Media Changeout.
8/24/17	VAE Blower Initiated at Wells MW-34p1 and MW-68p1 at 12 to 12.5" Hg (MW-65p1 Closed to Blower).
8/30/17	VAE Blower Off for an Hour.
8/30/17	VAE Blower On.
9/11/17	Turned VAE Ball Valve Slightly Open at MW-65p1 While Troubleshooting Erratic Pumping Issue.
STEP 4 EVENTS	
9/12/17	VAE Blower Initiated at All MPE Wells (with MW-65p1 Partially Open) at 3.5" Hg. All P1 Wells Closed to the Atmosphere.
9/19/17	VAE Blower Initiated at All MPE Wells (with MW-65p1 Partially Open) at 12.5" Hg. All P1 Wells Closed to the Atmosphere.
9/21/17	MW-34p1 Individual Well Test at 12.5" Hg.
9/26/17	MW-68p1 Individual Well Test at 12.5" Hg.
10/3/17	MW-65p1 Individual Well Test at 12.5" Hg.
10/10/17	End of MW-65p1 Individual Well Test at 12.5" Hg (All MPE Wells Closed to VAE Blower).
ADDITIONAL EVENTS	
10/11/17	Switched Pumps Between Wells MW-65p1 and MW-34p1. VAE Blower Initiated and Only Connected to MW-34p1. Pump from MW-65p1 Functioned Normally in Well MW-34p1.
10/12/17	VAE Blower Connected to MW-65p1.
10/12/17	MW-65p1 Closed to VAE Blower.
10/13/17	VAE Blower and MPE Well Pumps Turned Off. Treatment System Shut Down.
10/13/17	MPE Well Pumps Removed and Stored in Operations Building.

This Page Intentionally Left Blank

Table 5: Groundwater Analytical Results for MW-34p1

		Analysis	Sample Date													
Parameter	**Units**	**Method**	**6/19/17**	**6/27/17**	**7/5/17**	**7/12/17**	**7/19/17**	**7/28/17**	**8/3/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**
Inorganics																	
Arsenic, Dissolved	ug/L	E200.8	**10D**	**10.8**	**14.5D**	**13.8D**	**14.4D**	**11**	**9.81**	**9.98D**	**10.8D**	**10.5D**	**11.7D**	**10.2**	**9.34**	NA	**15.9D**
Iron, Dissolved	ug/L	E200.8	**26400D**	**21000**	**38000D**	**40800D**	**39000D**	**35200D**	**35500D**	**32500D**	**30700D**	**28000D**	**20600**	**19700**	**15900**	NA	**40100D**
Iron, Total	ug/L	E200.8	**25000D**	**28800D**	**38400D**	**38300D**	**29300D**	**34800D**	**33000D**	**32600D**	**13400D**	**29600D**	**20700**	**19400**	**12000**	NA	**44200D**
Manganese, Dissolved	ug/L	E200.8	**3720D**	**3720D**	**9440D**	**5260D**	**4900D**	**4710D**	**4740D**	**4610D**	**5070D**	**6130D**	**5920D**	**5620D**	**6000D**	NA	**5910D**
Manganese, Total	ug/L	E200.8	**3660D**	**3690D**	**7710D**	**4970D**	**3640D**	**4550D**	**4740D**	**4770D**	**2320D**	**5210D**	**5790D**	**5710D**	**5390D**	NA	**6730D**
Total Dissolved Solids	mg/L	EPA 160.1	**1030**	**1100**	**1570**	**1530**	**1590**	**1480**	**1510**	**1580**	**1750**	**1820**	**1790**	**2120**	**1870**	NA	NA
Chloride	mg/L	EPA 325.2	**109D**	**158D**	**226D**	**309D**	**303D**	NA	**246D**	**606D**	**256D**	NA	**288D**	**295D**	**303D**	NA	NA
Nitrate + Nitrite	mg-N/L	EPA 353.2	0.01U	0.05U	**0.026D**	0.05U	0.1U	NA	0.02U	0.4U	0.2U	NA	0.01U	0.05U	0.2U	NA	NA
N-Nitrate	mg/L	EPA 353.2	0.02U	0.1U	0.04U	0.1U	0.2U	NA	0.07U	0.8U	0.4U	NA	0.02U	0.1U	0.4U	NA	NA
N-Nitrite	mg-N/L	EPA 353.2	**0.011**	0.05U	**0.066D**	0.05U	0.1U	NA	0.05U	0.4U	0.2U	NA	**0.035**	0.05U	0.2U	NA	NA
Sulfate	mg/L	EPA 375.2	**13.5**	**19.3**	**31.4D**	**16.6D**	**24.6D**	NA	**106D**	**165D**	**265D**	NA	**450D**	**435D**	**428D**	NA	NA
Total Petroleum Hydrocarbons																	
Diesel Range Hydrocarbons	mg/L	NWTPHD	**3.22**	**1.99**	**7.17D**	**4.17**	**7.96D**	**10.4D**	**5.81D**	**6.84D**	**9.85D**	**9.59D**	**8.81D**	**7.14D**	**7.38D**	NA	NA
Motor Oil	mg/L	NWTPHD	**0.799**	**0.889**	**2.91D**	**1.33**	**5.18D**	**4.38D**	**1.11D**	**2.34**	**3.93D**	**2.72D**	**2.58D**	**1.73D**	**2.24D**	NA	NA
Gasoline Range Hydrocarbons	ug/L	NWTPHG	**40500**	**41500**	**2800000**	**43700**	**34300**	**33900**	**36300**	**21000**	**23700**	**20700**	**14100**	**13600**	**13600**	**8450**	**3530**
Volatile Organic Compounds																	
1,1,1,2-Tetrachloroethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
1,1,1-Trichloroethane	ug/L	SW8260C	**19**	**13**	**7040**	**87.6**	**34.8**	**30.5**	**40.6**	**14.5**	**21.2**	**25.8**	**20.4**	**20.8**	**15**	**15.1**	**1.01**
1,1,2,2-Tetrachloroethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	SW8260C	**1.15**	**1.21**	**18.1**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	**1.04**	1U
1,1,2-Trichloroethane	ug/L	SW8260C	0.2U	0.2U	**7.53**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
1,1-Dichloroethane	ug/L	SW8260C	**38.9**	**19.7**	**148E**	**32**	**28.9**	**35.8**	**49.5**	**19.7**	**44.5**	**47**	**39.5**	**43.7**	**48**	**63.4**	**7.87**
1,1-Dichloroethene	ug/L	SW8260C	**1.92**	**1.25**	**23.8**	20U	10U	10U	20U	4U	10U	4U	5U	**4.06**	**3.16**	**4.13**	1U
1,1-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
1,2,3-Trichlorobenzene	ug/L	SW8260C	**0.52**	0.5U	**0.72**	50U	25U	25U	50U	10U	25U	10U	12.5U	10U	5U	2.5U	2.5U
1,2,3-Trichloropropane	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	25U	25U	50U	10U	25U	10U	12.5U	10U	5U	2.5U	2.5U
1,2,4-Trichlorobenzene	ug/L	SW8260C	**2.8**	**2.97**	**2.63**	50U	25U	25U	50U	10U	25U	10U	12.5U	10U	5U	2.5U	2.5U
1,2,4-Trimethylbenzene	ug/L	SW8260C	**582**	**684**	**11200**	**799Q**	**611**	**433**	**498**	**329**	**293**	**236**	**191**	**190**	**164**	**178**	**16.9**
1,2-Dibromo-3-chloropropane	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	25U	25U	50U	10U	25U	10U	12.5U	10U	5U	2.5U	2.5U
1,2-Dibromoethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
1,2-Dichlorobenzene	ug/L	SW8260C	**61.4**	**52.4**	**88.7E**	**71.4**	**72.1**	**65**	20U	**55.9**	**52.6**	**49.9**	**41**	**36**	**28.5**	**33.7**	**3.93**
1,2-Dichloroethane	ug/L	SW8260C	**2.48**	**1.28**	**26.5**	20U	10U	10U	20U	**5.76H**	**11.1**	**15.5**	**14.8**	**16.6**	**16.1**	**20.3**	**1.86**
1,2-Dichloropropane	ug/L	SW8260C	**12.3**	**6.62**	**81.2E**	20U	**15.1**	**21.4**	**27.3**	**12.3**	**27.6**	**33.8**	**28.6**	**29.2**	**28.1**	**36.3**	**3.76**
1,3,5-Trimethylbenzene	ug/L	SW8260C	**265**	**314**	**4890**	**349**	**296**	**215**	**236**	**184**	**157**	**126**	**102**	**82.7**	**70.3**	**79**	**6.43**
1,3-Dichlorobenzene	ug/L	SW8260C	**4.89**	**3.56**	**9.37**	20U	10U	10U	20U	4U	10U	4U	5U	4U	**2.07**	**2.23**	1U
1,3-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
1,4-Dichlorobenzene	ug/L	SW8260C	**29.3**	**26.6**	**39.2**	**32.8**	**30.6**	**26.1**	**30.2**	**23.6**	**24.8**	**20.1**	**18.1**	**17.5**	**14.8**	**17.3**	**2.24**
2,2-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
2-Butanone	ug/L	SW8260C	5U	5U	**809E**	500U	250U	250U	500U	100U	250U	**493**	**284**	**143**	**214**	25U	25U
2-Chloroethylvinylether	ug/L	SW8260C	1U	1U	1U	100U	50U	50U	100U	20U	50U	20U	25U	20U	10U	5U	5U
2-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U

Table 5: Groundwater Analytical Results for MW-34p1

		Analysis	Sample Date														
Parameter	**Units**	**Method**	**6/19/17**	**6/27/17**	**7/5/17**	**7/12/17**	**7/19/17**	**7/28/17**	**8/3/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**
2-Hexanone	ug/L	SW8260C	5U	5U	**93.8**	500U	250U	250U	500U	100U	250U	100U	125U	100U	50U	**32.6**	25U
4-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
4-Isopropyltoluene	ug/L	SW8260C	**13.9**	**18.9**	**13.3**	20U	10U	**10**	20U	**11.1**	10U	**6.97**	5U	**4.06**	**3.58**	**5.09**	1U
4-Methyl-2-Pentanone (MIBK)	ug/L	SW8260C	**24.4**	**11.1**	**672E**	500U	250U	250U	500U	100U	250U	**378**	**393**	**336**	**384**	**426**	**31.6**
Acetone	ug/L	SW8260C	**15.5**	5U	**54600Q**	500U	**622**	250U	500U	**329**	250U	**807**	**1190**	**504**	**854**	**62.8**	25U
Acrolein	ug/L	SW8260C	5U	5U	5U	500U	250U	250U	500U	100U	250U	100U	125U	100U	50U	25U	25U
Acrylonitrile	ug/L	SW8260C	1U	1U	1U	100U	50U	50U	100U	20U	50U	20U	25U	20U	10U	5U	5U
Benzene	ug/L	SW8260C	**3.23**	**2.7**	**26.2**	20U	10U	10U	20U	4U	10U	**8.87**	**7.7**	**8.62**	**7.64**	**4.65**	1U
Bromobenzene	ug/L	SW8260C	0.2U	**1.16**	**4.78**	20U	10U	10U	20U	4U	10U	4U	5U	**4.31**	**3.58**	**2.04**	1U
Bromochloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Bromodichloromethane	ug/L	SW8260C	**0.34**	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Bromoethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Bromoform	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Bromomethane	ug/L	SW8260C	1U	1U	1U	100U	50U	50U	100U	20U	50U	20U	25U	20U	10U	5U	5U
Carbon Disulfide	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Carbon Tetrachloride	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Chlorobenzene	ug/L	SW8260C	**1.25**	**1.65**	**5.82**	20U	10U	10U	20U	**5.03H**	10U	**5.72**	**6.95**	**8.18**	**9.45**	**13**	**2.27**
Chloroethane	ug/L	SW8260C	**14**	**21.9Q**	**4.05**	20U	10U	10U	20U	4U	10U	**16.1Q**	**15.4**	**15.1**	**16.4**	1U	1U
Chloroform	ug/L	SW8260C	0.2U	0.2U	**11.8**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Chloromethane	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	25U	25U	50U	10U	25U	10U	12.5U	10U	5U	2.5U	2.5U
cis-1,2-Dichloroethene	ug/L	SW8260C	**13.9**	**9.58**	**10100**	**42.8**	**28.9**	**40**	**59.3**	**23.2**	**58.7**	**75.4**	**63.4**	**60.1**	**57.2**	**63.8Q**	**5.91**
cis-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Dibromochloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Dibromomethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Dichlorodifluoromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Ethylbenzene	ug/L	SW8260C	**1440**	**1120**	**40000**	**1440**	**772**	**593**	**707**	**393**	**505**	**453**	**333**	**383**	**316**	**292**	**30.6**
Hexachlorobutadiene	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	25U	25U	50U	10U	25U	10U	12.5U	10U	5U	2.5U	2.5U
Iodomethane	ug/L	SW8260C	1U	1U	1U	100U	50U	50U	100U	20U	50U	20U	25U	20U	10U	5U	5U
Isopropylbenzene	ug/L	SW8260C	**78.1**	**77.7**	**64.8**	**68.7**	**40.4**	**40.1**	**45.8**	**30**	**32**	**23**	**18.1**	**19.6**	**16.3**	**18**	**1.52**
m,p-Xylene	ug/L	SW8260C	**3190**	**2490**	**111000**	**3570**	**2280**	**1680**	**1850**	**961**	**1090**	**946**	**640**	**610**	**487**	**293**	**17.3**
Methylene Chloride	ug/L	SW8260C	1U	1U	**13.7**	100U	50U	50U	100U	20U	50U	20U	25U	20U	10U	5U	5U
Naphthalene	ug/L	SW8260C	**159**	**221**	**7250**	**99.5**	**175**	**157Q**	**135**	**184**	**102**	**105**	**86.4**	**53.1**	**42**	**54.4**	**7.82**
n-Butylbenzene	ug/L	SW8260C	**15.3**	**27.8**	**14.5**	**21.4**	**15.1**	10U	20U	**13.2**	10U	**5.33**	**5.26**	4U	**3.06**	**4.37**	1U
n-Propylbenzene	ug/L	SW8260C	**165**	**191**	**2530**	**183**	**107**	**82.9**	**99.3**	**65.6**	**65.2**	**47.6**	**35.6**	**35.9**	**31.1**	**36.6**	**3.43**
o-Xylene	ug/L	SW8260C	**1080**	**816**	**39400**	**1340**	**864**	**710**	**794**	**438**	**489**	**475**	**325**	**315**	**239**	**195**	**13.1**
sec-Butylbenzene	ug/L	SW8260C	**10.6**	**13.3**	**8.46**	20U	10U	10U	20U	**4.48H**	10U	4U	5U	4U	2U	**2.62**	1U
Styrene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	**1.48**	1U
tert-Butylbenzene	ug/L	SW8260C	**1.39**	**1.26**	**1.31**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Tetrachloroethene	ug/L	SW8260C	**0.87**	**0.64**	**16.9**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	**1.11**	1U
Toluene	ug/L	SW8260C	**4710**	**2430**	**407000**	**3910**	**2470**	**2210**	**2590**	**1240**	**1890**	**1480**	**1150**	**1150**	**741**	**370**	**20**
Total Xylenes	ug/L	SW8260C	**4260**	**3300**	**151000**	**4910**	**3140**	**2390**	**2640**	**1400**	**1580**	**1420**	**965**	**925**	**727**	**488**	**30.4**
trans-1,2-Dichloroethene	ug/L	SW8260C	0.2U	0.2U	**2.56**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U

Table 5: Groundwater Analytical Results for MW-34p1

		Analysis	Sample Date														
Parameter	**Units**	**Method**	**6/19/17**	**6/27/17**	**7/5/17**	**7/12/17**	**7/19/17**	**7/28/17**	**8/3/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**
trans-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
trans-1,4-Dichloro-2-butene	ug/L	SW8260C	1U	1U	1U	100U	50U	50U	100U	20U	50U	20U	25U	20U	10U	5U	5U
Trichloroethene	ug/L	SW8260C	**0.45**	**0.27**	**16.9**	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	**2.15**	1U
Trichlorofluoromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Vinyl Acetate	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	10U	10U	20U	4U	10U	4U	5U	4U	2U	1U	1U
Vinyl Chloride	ug/L	SW8260C	**5.68**	**3.85**	**19.1**	20U	10U	**13.7**	20U	**8.13H**	10U	**10.2**	**6.91**	**9.33**	**10.5**	**25.8**	**3.83**
Total Detected VOCs	***ug/L***		***11,955***	***8,580***	***697,855***	***12,047***	***8,459***	***6,364***	***7,158***	***4,352***	***4,865***	***5,889***	***5,016***	***4,100***	***3,827***	***2,357***	***181***
Semi-Volatile Organic Compounds																	
2-Methylphenol	ug/L	SW8270D	**115D**	**44.4**	**475D**	**53.6**	**35.6**	**23.9**	**27.1**	**13.1**	**26.4**	**37.6**	**37.1**	**37.6**	**39.3**	NA	NA
4-Methylphenol	ug/L	SW8270D	**44**	**18.3**	**174D**	**42.6**	**21.1**	**24**	**31.9**	**9.9**	**21.5**	**29.7**	**36.4**	**62.2**	**45.6**	NA	NA
bis(2-Ethylhexyl)phthalate	ug/L	SW8270D	**5.6**	3U	**16.1D**	**6.6**	3.4U	3U	3U	**9.1**	**10.9**	**5.1**	**13.1**	**4.6**	**6.5**	NA	NA

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#D: The reported value is from a dilution.

#Q: The reported value is out of control with continuing calibration.

#E: The reported value is out of range and estimated.

#M: The reported value was confirmed but with low spectral match and value is estimated.

#H: The reported value was analyzed outside the holding time.

NA: Parameter not analyzed.

Table 6: Groundwater Analytical Results for MW-68p1

		Analysis	**Sample Date**										
Parameter	**Units**	**Method**	**6/27/17**	**7/5/17**	**7/28/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**
Inorganics													
Arsenic, Dissolved	ug/L	E200.8	**11**	**13.3D**	**11.6**	**12.6D**	**2.11**	**12.4D**	**13.4D**	NA	NA	NA	**14.5D**
Iron, Dissolved	ug/L	E200.8	**21500D**	**37800D**	**39200D**	**40500D**	**30700D**	**33000D**	**23600**	NA	NA	NA	**37400D**
Iron, Total	ug/L	E200.8	**19400D**	**38400D**	**37700D**	**39300D**	**33900D**	**34000D**	**25500**	NA	NA	NA	**39900D**
Manganese, Dissolved	ug/L	E200.8	**6810D**	**5240D**	**8050D**	**8930D**	**5630D**	**9340D**	**8830D**	NA	NA	NA	**7230D**
Manganese, Total	ug/L	E200.8	**6360D**	**4450D**	**8820D**	**8160D**	**7100D**	**8370D**	**9150D**	NA	NA	NA	**8290D**
Total Dissolved Solids	mg/L	EPA 160.1	**1360**	**1390**	**1650**	**1630**	**1780**	**1760**	**1760**	NA	NA	NA	NA
Chloride	mg/L	EPA 325.2	**153D**	**263D**	NA	**620D**	**252D**	NA	**336D**	NA	NA	NA	NA
Nitrate + Nitrite	mg-N/L	EPA 353.2	0.01U	0.05U	NA	0.4U	0.2U	NA	0.05U	NA	NA	NA	NA
N-Nitrate	mg/L	EPA 353.2	0.02U	0.1U	NA	0.8U	0.4U	NA	0.06U	NA	NA	NA	NA
N-Nitrite	mg-N/L	EPA 353.2	0.01U	0.05U	NA	0.4U	0.2U	NA	0.01U	NA	NA	NA	NA
Sulfate	mg/L	EPA 375.2	**15.7**	**29.9D**	NA	**36.7D**	**10.7D**	NA	**74.5D**	NA	NA	NA	NA
Total Petroleum Hydrocarbons													
Diesel Range Hydrocarbons	mg/L	NWTPHD	**5.48D**	**2.82**	**15.3D**	**11.6D**	**15.4D**	**15.4D**	**18.6D**	NA	NA	NA	NA
Motor Oil	mg/L	NWTPHD	**1.47**	**1.45**	**4.53D**	**3.68**	**6.09D**	**2.77**	**3.36D**	NA	NA	NA	NA
Gasoline Range Hydrocarbons	ug/L	NWTPHG	**170000**	**39000**	**104000**	**77200**	**82600**	**61200**	**60700**	**43700**	**51600**	**86600**	**125000**
Volatile Organic Compounds													
1,1,1,2-Tetrachloroethane	ug/L	SW8260C	**10.4**	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,1,1-Trichloroethane	ug/L	SW8260C	**270**	**30**	**167**	**170**	**288**	**178**	**181**	**173**	**207**	**553**	**681**
1,1,2,2-Tetrachloroethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	SW8260C	**10.6**	**1.57**	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,1,2-Trichloroethane	ug/L	SW8260C	**3.35**	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,1-Dichloroethane	ug/L	SW8260C	**232**	**17.4**	**106**	**120**	**153**	**128**	**172**	**115**	**87.6**	**245**	**233**
1,1-Dichloroethene	ug/L	SW8260C	**28.9**	**1.94**	100U	40U	40U	40U	20U	**22.8**	20U	**58.3**	**65.5**
1,1-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,2,3-Trichlorobenzene	ug/L	SW8260C	0.5U	0.5U	250U	100U	100U	100U	50U	50U	50U	50U	125U
1,2,3-Trichloropropane	ug/L	SW8260C	0.5U	0.5U	250U	100U	100U	100U	50U	50U	50U	50U	125U
1,2,4-Trichlorobenzene	ug/L	SW8260C	**1.51**	**3.04**	250U	100U	100U	100U	50U	50U	50U	50U	125U
1,2,4-Trimethylbenzene	ug/L	SW8260C	**914**	**598**	**730**	**651**	**513**	**361**	**388**	**264**	**256**	**598**	**684**
1,2-Dibromo-3-chloropropane	ug/L	SW8260C	0.5U	0.5U	250U	100U	100U	100U	50U	50U	50U	50U	125U
1,2-Dibromoethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,2-Dichlorobenzene	ug/L	SW8260C	**159**	**48.5**	**131**	**99.7**	**75.5**	**73.9**	**74.8**	**47.1**	**41.2**	**86.4**	**94.5**
1,2-Dichloroethane	ug/L	SW8260C	**15.9**	**2.43**	100U	40U	40U	40U	**37**	**30.2**	20U	**27.8Q**	50U
1,2-Dichloropropane	ug/L	SW8260C	**74.7**	**10.3**	100U	**96.2**	**190**	**115**	**170**	**152**	**187**	**531**	**575**
1,3,5-Trimethylbenzene	ug/L	SW8260C	**387**	**274**	**397**	**385**	**315**	**248**	**256**	**151**	**152**	**319**	**353**
1,3-Dichlorobenzene	ug/L	SW8260C	**7.76**	**3.73**	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,3-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
1,4-Dichlorobenzene	ug/L	SW8260C	**65.5**	**24.3**	100U	40U	40U	40U	**34.3**	**23.1**	20U	**20.9**	50U
2,2-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
2-Butanone	ug/L	SW8260C	**216Q**	**19.2**	2500U	**1230**	**1070**	**1250**	**1460**	**787**	500U	500U	1250U
2-Chloroethylvinylether	ug/L	SW8260C	1U	1U	500U	200U	200U	200U	100U	100U	100U	100U	250U
2-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U

Table 6: Groundwater Analytical Results for MW-68p1

		Analysis	Sample Date										
Parameter	**Units**	**Method**	**6/27/17**	**7/5/17**	**7/28/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**
2-Hexanone	ug/L	SW8260C	**25.1**	5U	2500U	1000U	1000U	1000U	500U	500U	500U	500U	1250U
4-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
4-Isopropyltoluene	ug/L	SW8260C	**7.09**	**15.5**	100U	40U	40U	40U	20U	20U	20U	20U	50U
4-Methyl-2-Pentanone (MIBK)	ug/L	SW8260C	**303**	**19.5**	2500U	1000U	1000U	**1000**	**1220**	**745**	500U	**617**	1250U
Acetone	ug/L	SW8260C	**1180**	**47.4**	**7700**	**5850**	**5290**	**5580**	**6210**	**2870**	**853**	**2260**	**1700**
Acrolein	ug/L	SW8260C	5U	5U	2500U	1000U	1000U	1000U	500U	500U	500U	500U	1250U
Acrylonitrile	ug/L	SW8260C	1U	1U	500U	200U	200U	200U	100U	100U	100U	100U	250U
Benzene	ug/L	SW8260C	**16.1**	**4.11**	100U	40U	40U	40U	20U	20U	20U	**21.9**	50U
Bromobenzene	ug/L	SW8260C	**7.07**	**1.33M**	100U	40U	40U	40U	20U	20U	20U	**26.3**	50U
Bromochloromethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Bromodichloromethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Bromoethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Bromoform	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Bromomethane	ug/L	SW8260C	1U	1U	500U	200U	200U	200U	100U	100U	100U	100U	250U
Carbon Disulfide	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Carbon Tetrachloride	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Chlorobenzene	ug/L	SW8260C	**3.78**	**2.48**	100U	40U	40U	40U	20U	20U	20U	20U	50U
Chloroethane	ug/L	SW8260C	**4.71**	**7.55**	100U	40U	40U	40U	20U	20U	20U	20U	50U
Chloroform	ug/L	SW8260C	**5.09**	**0.38**	100U	40U	40U	40U	20U	20U	20U	20U	50U
Chloromethane	ug/L	SW8260C	0.5U	0.5U	250U	100U	100U	100U	50U	50U	50U	50U	125U
cis-1,2-Dichloroethene	ug/L	SW8260C	**696**	**24.1**	**433**	**473**	**666**	**498**	**637**	**429**	**469**	**1420Q**	**1990**
cis-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Dibromochloromethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Dibromomethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Dichlorodifluoromethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Ethylbenzene	ug/L	SW8260C	**3960**	**1460**	**895**	**662**	**768**	**764**	**812**	**590**	**542**	**1580**	**1700**
Hexachlorobutadiene	ug/L	SW8260C	0.5U	0.5U	250U	100U	100U	100U	50U	50U	50U	50U	125U
Iodomethane	ug/L	SW8260C	1U	1U	500U	200U	200U	200U	100U	100U	100U	100U	250U
Isopropylbenzene	ug/L	SW8260C	**112**	**62.7**	100U	40U	40U	40U	**34.1**	**26.6**	**25.2**	**72.9**	**80.1**
m,p-Xylene	ug/L	SW8260C	**9360**	**3260**	**5760**	**4220**	**3490**	**2840**	**2980**	**2110**	**1890**	**4920**	**5320**
Methylene Chloride	ug/L	SW8260C	**2.22**	**2.44**	500U	200U	200U	200U	100U	100U	100U	100U	250U
Naphthalene	ug/L	SW8260C	**294**	**95**	**293Q**	**271**	**310**	**144**	**189**	**95.6**	**105**	**330**	**314**
n-Butylbenzene	ug/L	SW8260C	**6.78**	**20.8**	100U	40U	40U	40U	20U	20U	20U	20U	50U
n-Propylbenzene	ug/L	SW8260C	**212**	**157**	100U	**48.3**	**53.9**	**57.4**	**56.5**	**43.6**	**39.4**	**102**	**119**
o-Xylene	ug/L	SW8260C	**3510**	**1090**	**2720**	**2020**	**1740**	**1480**	**1420**	**997**	**907**	**2300**	**2310**
sec-Butylbenzene	ug/L	SW8260C	**4.99**	**10.3**	100U	40U	40U	40U	20U	20U	20U	20U	50U
Styrene	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
tert-Butylbenzene	ug/L	SW8260C	**1**	**1.37**	100U	40U	40U	40U	20U	20U	20U	20U	50U
Tetrachloroethene	ug/L	SW8260C	**3.51**	**0.86**	100U	40U	40U	40U	20U	20U	20U	20U	50U
Toluene	ug/L	SW8260C	**27400**	**4270**	**9780**	**7630**	**9810**	**7560**	**8520**	**6890**	**5970**	**18900**	**19400**
Total Xylenes	ug/L	SW8260C	**12700**	**4350**	**8480**	**6240**	**5230**	**4320**	**4400**	**3110**	**2800**	**7220**	**7600**
trans-1,2-Dichloroethene	ug/L	SW8260C	**0.91**	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U

Table 6: Groundwater Analytical Results for MW-68p1

		Analysis	Sample Date										
Parameter	**Units**	**Method**	**6/27/17**	**7/5/17**	**7/28/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**
trans-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
trans-1,4-Dichloro-2-butene	ug/L	SW8260C	1U	1U	500U	200U	200U	200U	100U	100U	100U	100U	250U
Trichloroethene	ug/L	SW8260C	**6.03**	**0.4**	100U	40U	**62.4**	40U	20U	**35.5**	20U	20U	50U
Trichlorofluoromethane	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Vinyl Acetate	ug/L	SW8260C	0.2U	0.2U	100U	40U	40U	40U	20U	20U	20U	20U	50U
Vinyl Chloride	ug/L	SW8260C	**34.9**	**2.59**	100U	40U	40U	40U	**39.1**	**29.5**	**39**	**83.8**	**123**
Total Detected VOCs	***ug/L***		***49,383***	***11,590***	***29,112***	***23,926***	***24,795***	***22,277***	***24,891***	***16,630***	***11,773***	***35,073***	***35,712***
Semi-Volatile Organic Compounds													
2-Methylphenol	ug/L	SW8270D	**108D**	**41.7**	**168D**	**134D**	**134D**	**156D**	**166D**	NA	NA	NA	NA
4-Methylphenol	ug/L	SW8270D	**107D**	**22.6**	**162D**	**178D**	**185D**	**210D**	**247D**	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	ug/L	SW8270D	3U	**6.5**	**8.3**	**34.1D**	**33D**	**5.1H**	**11.1**	NA	NA	NA	NA

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#D: The reported value is from a dilution.

#Q: The reported value is out of control with continuing calibration.

#E: The reported value is out of range and estimated.

#M: The reported value was confirmed but with low spectral match and value is estimated.

#H: The reported value was analyzed outside the holding time.

NA: Parameter not analyzed.

This Page Intentionally Left Blank

Table 7: Groundwater Analytical Results for MW-65p1

Parameter	Units	Analysis Method	Sample Date				
			6/12/17	6/19/17	7/5/17	9/12/17	9/13/17
Inorganics							
Arsenic, Dissolved	ug/L	E200.8	**16.4**	**17.9D**	**18.6D**	NA	**14.7D**
Iron, Dissolved	ug/L	E200.8	**29700D**	**31900D**	**26800D**	NA	**34600D**
Iron, Total	ug/L	E200.8	**24800**	**30800D**	**27900D**	NA	**40300D**
Manganese, Dissolved	ug/L	E200.8	**3610D**	**3880D**	**4670D**	NA	**6270D**
Manganese, Total	ug/L	E200.8	**3720D**	**3930D**	**4370D**	NA	**6910D**
Total Dissolved Solids	mg/L	EPA 160.1	**1020**	**1110**	**1550**	NA	**1920**
Chloride	mg/L	EPA 325.2	**106D**	**130D**	**328D**	NA	**320D**
Nitrate + Nitrite	mg-N/L	EPA 353.2	0.01U	**0.071D**	0.01U	NA	**0.324D**
N-Nitrate	mg/L	EPA 353.2	0.02U	**0.0411**	0.02U	NA	**0.215**
N-Nitrite	mg-N/L	EPA 353.2	0.01U	**0.03**	0.01U	NA	**0.109D**
Sulfate	mg/L	EPA 375.2	**6.77D**	**11.8**	**28.1D**	NA	**319D**
Total Petroleum Hydrocarbons							
Diesel Range Hydrocarbons	mg/L	NWTPHD	**2.75**	**2.51**	**2.51**	NA	**8.46D**
Motor Oil	mg/L	NWTPHD	**0.518**	**0.502**	**1.53**	NA	**1.57D**
Gasoline Range Hydrocarbons	ug/L	NWTPHG	**34300**	**25200**	**4670**	**12500**	**16400**
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
1,1,1-Trichloroethane	ug/L	SW8260C	**6.27**	**12.3**	**2.16**	**24.7**	**57.2**
1,1,2,2-Tetrachloroethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	SW8260C	**0.64**	**1.9**	0.2U	1U	**3.01**
1,1,2-Trichloroethane	ug/L	SW8260C	**0.39**	0.2U	0.2U	1U	2U
1,1-Dichloroethane	ug/L	SW8260C	**52.3**	**36.1**	**6.39**	**37.2**	**53.7**
1,1-Dichloroethene	ug/L	SW8260C	**0.38**	**1.23**	0.2U	**2.29**	**6.17**
1,1-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
1,2,3-Trichlorobenzene	ug/L	SW8260C	0.5U	0.5U	0.5U	2.5U	5U
1,2,3-Trichloropropane	ug/L	SW8260C	0.5U	0.5U	0.5U	2.5U	5U
1,2,4-Trichlorobenzene	ug/L	SW8260C	**2.71**	**2.09**	**1.2**	2.5U	5U
1,2,4-Trimethylbenzene	ug/L	SW8260C	**537**	**320**	**88.9**	**108**	**147**
1,2-Dibromo-3-chloropropane	ug/L	SW8260C	0.5U	0.5U	0.5U	2.5U	5U
1,2-Dibromoethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
1,2-Dichlorobenzene	ug/L	SW8260C	**65.9**	**45.2**	**15.9**	**22.5**	**30.6**
1,2-Dichloroethane	ug/L	SW8260C	**2**	**1.66**	**0.28**	**10.4**	**18.1**
1,2-Dichloropropane	ug/L	SW8260C	**8.41**	**8.43**	**1.33**	**30.9**	**76.3**
1,3,5-Trimethylbenzene	ug/L	SW8260C	**217**	**140**	**34.4**	**50**	**68.7**
1,3-Dichlorobenzene	ug/L	SW8260C	**4.68**	**3.61**	**1.18**	**1.25**	2U
1,3-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
1,4-Dichlorobenzene	ug/L	SW8260C	**27**	**21.9**	**11.3**	**16.3**	**15.3**
2,2-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
2-Butanone	ug/L	SW8260C	**10.7**	5U	5U	**126**	**115Q**
2-Chloroethylvinylether	ug/L	SW8260C	1U	1U	1U	5U	10U
2-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
2-Hexanone	ug/L	SW8260C	**5.38**	5U	5U	25U	50U
4-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U

Table 7: Groundwater Analytical Results for MW-65p1

Parameter	Units	Analysis Method	Sample Date				
			6/12/17	6/19/17	7/5/17	9/12/17	9/13/17
4-Isopropyltoluene	ug/L	SW8260C	**9.59**	**8.7**	**3.81**	**2.21**	**3.2**
4-Methyl-2-Pentanone (MIBK)	ug/L	SW8260C	**16.2**	**10**	5U	**264**	**460**
Acetone	ug/L	SW8260C	**28.1**	5U	**44.7**	**661**	**291**
Acrolein	ug/L	SW8260C	5U	5U	5U	25U	50U
Acrylonitrile	ug/L	SW8260C	1U	1U	1U	5U	10U
Benzene	ug/L	SW8260C	**2.78**	**2.8**	**4.28**	**6.95**	**6.88**
Bromobenzene	ug/L	SW8260C	0.2U	0.2U	0.35M	**2.61**	**4.36**
Bromochloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Bromodichloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Bromoethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Bromoform	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Bromomethane	ug/L	SW8260C	1U	1U	1U	5U	10U
Carbon Disulfide	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Carbon Tetrachloride	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Chlorobenzene	ug/L	SW8260C	**1.03**	**1.23**	**5.99**	**10.1**	**8.4**
Chloroethane	ug/L	SW8260C	**22.1**	**18.2**	**12.3**	**7.15**	2U
Chloroform	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Chloromethane	ug/L	SW8260C	0.5U	0.5U	0.5U	2.5U	5U
cis-1,2-Dichloroethene	ug/L	SW8260C	**3.44**	**5.52**	**2.51**	**71.3**	**181Q**
cis-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Dibromochloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Dibromomethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Dichlorodifluoromethane	ug/L	SW8260C	0.2U	0.2U	**0.29**	1U	2U
Ethylbenzene	ug/L	SW8260C	**1350**	**836**	**75.7**	**202**	**288**
Hexachlorobutadiene	ug/L	SW8260C	0.5U	0.5U	0.5U	2.5U	5U
Iodomethane	ug/L	SW8260C	1U	1U	1U	5U	10U
Isopropylbenzene	ug/L	SW8260C	**62.5**	**48.7**	**2.84**	**10.8**	**13.6**
m,p-Xylene	ug/L	SW8260C	**2880**	**1760**	**300**	**435**	**665**
Methylene Chloride	ug/L	SW8260C	1U	1U	1U	5U	10U
Naphthalene	ug/L	SW8260C	**190**	**93.3**	**42.9**	**56.3**	**78.9**
n-Butylbenzene	ug/L	SW8260C	**10.9**	**10.6**	**0.63**	**1.79**	**2.32**
n-Propylbenzene	ug/L	SW8260C	**132**	**83**	**5.76**	**18.6**	**23.5**
o-Xylene	ug/L	SW8260C	**964**	**613**	**111**	**220**	**353**
sec-Butylbenzene	ug/L	SW8260C	**6.08**	**6.35**	**0.31**	1U	2U
Styrene	ug/L	SW8260C	0.2U	0.2U	0.2U	**1.06**	2U
tert-Butylbenzene	ug/L	SW8260C	**0.77**	**1**	**0.28**	1U	2U
Tetrachloroethene	ug/L	SW8260C	**0.35**	**0.4**	0.2U	1U	2U
Toluene	ug/L	SW8260C	**3330**	**2600**	**272**	**946**	**1070**
Total Xylenes	ug/L	SW8260C	**3850**	**2370**	**410**	**654**	**1020**
trans-1,2-Dichloroethene	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
trans-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
trans-1,4-Dichloro-2-butene	ug/L	SW8260C	1U	1U	1U	5U	10U
Trichloroethene	ug/L	SW8260C	**0.3**	**0.34**	0.2U	**1.47**	2U
Trichlorofluoromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U

Table 7: Groundwater Analytical Results for MW-65p1

Parameter	Units	Analysis Method	Sample Date 6/12/17	6/19/17	7/5/17	9/12/17	9/13/17
Vinyl Acetate	ug/L	SW8260C	0.2U	0.2U	0.2U	1U	2U
Vinyl Chloride	ug/L	SW8260C	NA	**7.17**	**1.27**	**7.52**	**15.4**
Vinyl Chloride	ug/L	SW8260CSIM	**6.11**	NA	NA	NA	NA
Total Detected VOCs	***ug/L***		***9,963***	***6,698***	***1,049***	***3,354***	***4,058***
Semi-Volatile Organic Compounds							
2-Methylphenol	ug/L	SW8270D	**20.4**	**33.7**	**4**	NA	**97.8D**
4-Methylphenol	ug/L	SW8270D	**31.7**	**38.3**	**6.5**	NA	**116D**
bis(2-Ethylhexyl)phthalate	ug/L	SW8270D	3U	3U	3U	NA	**3.8**

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#D: The reported value is from a dilution.

#Q: The reported value is out of control with continuing calibration.

#E: The reported value is out of range and estimated.

#M: The reported value was confirmed but with low spectral match and value is estimated.

#H: The reported value was analyzed outside the holding time.

NA: Parameter not analyzed.

Table 8: P1 Vapor Analytical Results for MW-34p1

Volatile Organic Compounds		**Sample Date**												
(EPA Method TO-15)	**Units**	**7/25/17**	**8/3/17**	**8/7/17**	**8/14/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**	**9/22/17**	**9/26/17**
1,1,1-Trichloroethane	ug/m3	**12000**	**10000**	**6500**	**4300**	**3300**	**3500**	**2400**	**2100**	**2800**	**3600**	**670**	**4800**	**3600**
1,1,2,2-Tetrachloroethane	ug/m3	440U	410U	570U	650U	690U	690U	690U	690U	690U	69U	34U	69U	69U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/m3	**1600**	**1200**	630U	730U	770U	770U	770U	770U	770U	**430**	**94**	**650**	**440**
1,1,2-Trichloroethane	ug/m3	350U	330U	450U	520U	550U	550U	550U	550U	550U	55U	27U	55U	55U
1,1-Dichloroethane	ug/m3	**1200**	**1000**	**640**	**480**	**430**	**410**	400U	400U	**410**	**570**	**89**	**980**	**580**
1,1-Dichloroethene	ug/m3	**380**	**330**	330U	380U	400U	400U	400U	400U	400U	**160**	**29**	**210**	**160**
1,2,3-Trimethylbenzene	ug/m3	**16000**	**6300**	**5900**	2300U	**3100**	**2700**	2500U	2500U	2500U	**820ca**	120U	**760ca**	**1000ca**
1,2,4-Trichlorobenzene	ug/m3	470U	450U	610U	710U	740U	740U	740U	740U	740U	74U	37U	74U	74U
1,2,4-Trimethylbenzene	ug/m3	**37000**	**10000**	**8100**	2300U	**2700**	2500U	2500U	2500U	2500U	**760**	120U	**1400**	**1900**
1,2-Dibromoethane (EDB)	ug/m3	490U	460U	630U	730U	770U	770U	770U	770U	770U	77U	38U	77U	77U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ug/m3	**530jl**	**660jl**	**630**	660U	700U	700U	700U	700U	700U	**240**	65	**350**	**300**
1,2-Dichlorobenzene	ug/m3	**4700**	**1700**	1700	1100U	1200U	1200U	1200U	1200U	1200U	**300**	60U	**240**	**310**
1,2-Dichloroethane	ug/m3	260U	240U	330U	380U	400U	400U	400U	400U	400U	**71**	20U	**120**	**76**
1,2-Dichloropropane	ug/m3	**310**	**290**	380U	440U	460U	460U	460U	460U	460U	**200**	**26**	**360**	**190**
1,3,5-Trimethylbenzene	ug/m3	**30000**	**12000**	**11000**	**4700**	**5300**	**4100**	2500U	2500U	2500U	**1800**	**160**	**2100**	**2700**
1,3-Butadiene	ug/m3	140U	130U	180U	210U	220U	220U	220U	220U	220U	22U	11U	22U	22U
1,3-Dichlorobenzene	ug/m3	770U	720U	990U	1100U	1200U	1200U	1200U	1200U	1200U	120U	60U	120U	120U
1,4-Dichlorobenzene	ug/m3	**1900**	**750**	**700**	570U	600U	600U	600U	600U	600U	**400**	**32**	**290**	**370**
1,4-Dioxane	ug/m3	230U	220U	300U	340U	360U	360U	360U	360U	360U	36U	18U	36U	36U
1-Butanol	ug/m3	3900U	3600U	5000U	5800U	6100U	6100U	6100U	6100U	6100U	610U	300U	610U	610U
2-Butanone (MEK)	ug/m3	1900U	1800U	2400U	2800U	2900U	2900U	2900U	2900U	2900U	290U	150U	290U	290U
2-Hexanone	ug/m3	2600U	2500U	3400U	3900U	4100U	4100U	4100U	4100U	4100U	410U	200U	410U	410U
2-Pentanone	ug/m3	2200U	2100U	2900U	3300U	3500U	3500U	3500U	3500U	3500U	350U	180U	350U	350U
2-Propanol	ug/m3	5500U	5200U	7100U	8200U	8600U	8600U	8600U	8600U	8600U	860U	**2600**	860U	860U
3-Hexanone	ug/m3	2600U	2500U	3400U	3900U	4100U	4100U	4100U	4100U	4100U	410U	200U	410U	410U
3-Pentanone	ug/m3	2200U	2100U	2900U	3300U	3500U	3500U	3500U	3500U	3500U	350U	180U	350U	350U
4-Methyl-2-Pentanone (MIBK)	ug/m3	2600U	2500U	3400U	3900U	4100U	4100U	4100U	4100U	4100U	410U	200U	410U	410U
Acetaldehyde	ug/m3	5700U	5400U	7400U	8600U	9000U	9000U	9000U	9000U	9000U	900U	450U	900U	900U
Acetone	ug/m3	**6700**	**6800**	3900U	4500U	4800U	4800U	4800U	4800U	4800U	480U	240U	**520**	480U
Acetonitrile	ug/m3	1100U	1000U	1400U	1600U	1700U	1700U	1700U	1700U	1700U	170U	84U	170U	170U
Acrolein	ug/m3	580U	550U	760U	870U	920U	920U	920U	920U	920U	92U	46U	92U	92U
Acrylonitrile	ug/m3	140U	130U	180U	210U	220U	220U	220U	220U	220U	22U	11U	22U	22U
Benzene	ug/m3	**570**	**520**	**440**	**340**	**350**	**400**	**340**	**340**	**460**	**360**	**93**	**450**	**420**
Benzyl chloride	ug/m3	330U	310U	430U	490U	520U	520U	520U	520U	520U	52U	26U	52U	52U
Bromodichloromethane	ug/m3	430U	400U	550U	640U	670U	670U	670U	670U	670U	67U	34U	67U	67U
Bromoform	ug/m3	1300U	1200U	1700U	2000U	2100U	2100U	2100U	2100U	2100U	210U	100U	210U	210U
Bromomethane	ug/m3	250U	230U	320U	370U	390U	390U	390U	390U	390U	39U	19U	39U	39U
Butanal	ug/m3	1900U	1800U	2400U	2800U	2900U	2900U	2900U	2900U	2900U	290U	150U	290U	290U
Carbon disulfide	ug/m3	4000U	3700U	5100U	5900U	6200U	6200U	6200U	6200U	6200U	620U	310U	620U	620U
Carbon tetrachloride	ug/m3	400U	380U	520U	600U	630U	630U	630U	630U	630U	63U	31U	63U	63U
Chlorobenzene	ug/m3	**720**	**520**	**490**	440U	460U	**800**	**780**	**910**	**1300**	**1300**	**200**	**1100**	**1200**
Chlorodifluoromethane	ug/m3	**2200jl**	**2200jl**	**2000**	**1700**	**1700**	**1700**	**1400**	**1600**	**1700**	**1500**	**340**	**2100**	**2000**
Chloroethane	ug/m3	**350jl**	**320jl**	220U	250U	260U	260U	260U	260U	260U	**140**	**29**	**210**	**200**
Chloroform	ug/m3	310U	290U	400U	460U	490U	490U	490U	490U	490U	**69**	24U	**59**	49U

Table 8: P1 Vapor Analytical Results for MW-34p1

Volatile Organic Compounds		**Sample Date**												
(EPA Method TO-15)	**Units**	**7/25/17**	**8/3/17**	**8/7/17**	**8/14/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/19/17**	**9/22/17**	**9/26/17**
Chloromethane	ug/m3	130U	120U	170U	200U	210U	210U	210U	210U	210U	21U	10U	21U	21U
cis-1,2-Dichloroethene	ug/m3	**1500**	**1500**	**1100**	**850**	**720**	**690**	**520**	**530**	**730**	**1100**	**180**	**2300**	**1500**
cis-1,3-Dichloropropene	ug/m3	290U	270U	370U	430U	450U	450U	450U	450U	450U	45U	23U	45U	45U
Cyclohexane	ug/m3	4400U	4100U	5700U	6500U	6900U	6900U	6900U	6900U	6900U	**1200**	340U	**2100**	**1500**
Cyclopentane	ug/m3	**330**	**360**	**290**	**300**	290U	290U	290U	290U	290U	**230**	**51**	**250**	**310**
Dibromochloromethane	ug/m3	540U	510U	700U	810U	850U	850U	850U	850U	850U	85U	43U	85U	85U
Dichlorodifluoromethane	ug/m3	**650**	**780**	**750**	**600**	**1000**	**1900**	**1100**	**1000**	**840**	**810**	**220**	**1200**	**1100**
Ethanol	ug/m3	4800U	4500U	6200U	7200U	7500U	7500U	7500U	7500U	7500U	750U	380U	750U	750U
Ethylbenzene	ug/m3	**12000**	**4200**	**2900**	**860**	**1300**	**880**	**590**	**710**	**1600**	**1500**	**340**	**1600**	**2200**
Hexachlorobutadiene	ug/m3	680U	640U	880U	1000U	1100U	1100U	1100U	1100U	1100U	110U	53U	110U	110U
Hexanal	ug/m3	2600U	2500U	3400U	3900U	4100U	4100U	4100U	4100U	4100U	410U	200U	410U	410U
Hexane	ug/m3	**3200**	**2700**	2900U	3300U	3500U	3500U	3500U	3500U	3500U	**1800**	**390**	**3100**	**2300**
Iodomethane	ug/m3	370U	350U	480U	550U	580U	580U	580U	580U	580U	58U	29U	58U	58U
Isobutene	ug/m3	**2500jl**	**2900jl**	**2100**	**1900**	**1900**	**1900**	**1600**	**1700**	**1800**	**1800**	**410**	**2100**	**2000**
Isoprene	ug/m3	180U	170U	230U	260U	280U	280U	280U	280U	280U	**67**	14U	**75**	**71**
m,p-Xylene	ug/m3	**130000**	**52000**	**41000**	**16000**	**18000**	**14000**	**8900**	**8200**	**11000**	**7400**	**1000**	**25000**	**23000**
Methacrolein	ug/m3	1800U	1700U	2400U	2700U	2900U	2900U	2900U	2900U	2900U	290U	140U	290U	290U
Methyl t-butyl ether	ug/m3	1100U	1100U	1500U	1700U	1800U	1800U	1800U	1800U	1800U	180U	90U	180U	180U
Methyl vinyl ketone	ug/m3	730U	690U	950U	1100U	1100U	1100U	1100U	1100U	1100U	110U	57U	110U	110U
Methylene chloride	ug/m3	55000U	52000U	72000U	82000U	87000U	87000U	87000U	87000U	87000U	8700U	4300U	8700U	8700U
Naphthalene	ug/m3	**4200**	**1300**	**1000**	500U	520U	520U	520U	520U	520U	**100**	26U	**70**	**100**
o-Xylene	ug/m3	**55000**	**28000**	**26000**	**13000**	**13000**	**10000**	**6100**	**5200**	**6300**	**6400**	**740**	**12000**	**11000**
Pentanal	ug/m3	2200U	2100U	2900U	3300U	3500U	3500U	3500U	3500U	3500U	350U	180U	350U	350U
Pentane	ug/m3	1900U	1800U	**3500**	2800U	3000U	3000U	3000U	3000U	3000U	**1300**	**300**	**1600**	**1500**
Propene	ug/m3	440U	410U	570U	650U	690U	690U	690U	690U	690U	69U	34U	69U	69U
Styrene	ug/m3	540U	510U	700U	810U	850U	850U	850U	850U	850U	85U	43U	85U	85U
Tetrachloroethene	ug/m3	**2200**	**2500**	**2300**	**1500**	**1300**	**1500**	**1200**	**1000**	**1400**	**1300**	**150**	**1300**	**1100**
Toluene	ug/m3	**120000**	**61000**	**47000**	**22000**	**28000**	**22000**	**13000**	**9500**	**12000**	**5500**	**1200**	**39000**	**35000**
trans-1,2-Dichloroethene	ug/m3	250U	240U	330U	380U	400U	400U	400U	400U	400U	40U	20U	40U	40U
trans-1,3-Dichloropropene	ug/m3	290U	270U	370U	430U	450U	450U	450U	450U	450U	45U	23U	45U	45U
Trichloroethene	ug/m3	**1500**	**1500**	**1000**	**740**	**620**	**730**	**580**	**580**	**710**	**820**	**150**	**860**	**800**
Trichlorofluoromethane	ug/m3	360U	340U	460U	530U	560U	560U	560U	560U	560U	56U	28U	**70**	**58**
Vinyl acetate	ug/m3	4500U	4200U	5800U	6700U	7000U	7000U	7000U	7000U	7000U	700U	350U	700U	700U
Vinyl chloride	ug/m3	**950jl**	**1000jl**	**890**	**800**	**800**	**920**	**740**	**820**	**940**	**830**	**180**	**1100**	**960**
Total Detected VOCs	***ug/m3***	***450,190***	***214,330***	***167,930***	***70,070***	***83,520***	***68,130***	***39,250***	***34,190***	***43,990***	***44,877***	***9,738***	***110,424***	***99,945***

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#jl: Lab control sample percent recove;ry and/or relative percent differences ouside accetance limits. Value reported is an estimate (#).

#ca: Calibration for parameter did not pass the acceptance criteria. Value reported is an estimate (#).

#ve: Parameter response exceeds instrument range. Value reported is an esimate (#).

NA: Parameter not analyzed.

Sample collected on 9/19/2017 may have sampling error that biasessample low (see main text in report).

Table 9: P1 Vapor Analytical Results for MW-68p1

Volatile Organic Compounds		Sample Date											
(EPA Method TO-15)	Units	7/25/17	8/3/17	8/7/17	8/14/17	8/15/17	8/22/17	8/30/17	9/7/17	9/12/17	9/13/17	9/27/17	10/3/17
1,1,1-Trichloroethane	ug/m3	**43000**	**29000**	**39000**	**24000**	**31000**	**19000**	**14000**	**2200**	5.2U	**11000**	**8500**	**5600**
1,1,2,2-Tetrachloroethane	ug/m3	1700U	840U	1400U	650U	1700U	690U	690U	690U	6.6U	69U	69U	69U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/m3	**4900**	**3300**	**5300**	**2700**	**4200**	**2000**	**1300**	770U	7.4U	**1400**	**1100**	**600**
1,1,2-Trichloroethane	ug/m3	1300U	670U	1100U	510U	1400U	550U	550U	550U	5.2U	55U	55U	55U
1,1-Dichloroethane	ug/m3	**4400**	**3300**	**3300**	**2300**	**2700**	**1700**	**1300**	400U	3.9U	**1200**	**1500**	**760**
1,1-Dichloroethene	ug/m3	**1000**	**750**	**1100**	**650**	990U	**470**	400U	400U	3.8U	**290**	**380**	**220**
1,2,3-Trimethylbenzene	ug/m3	**24000**	**13000**	**13000**	**8800**	**8700**	**7900**	**6900**	2500U	24U	**4800ca**	**3200ca**	**2500ca**
1,2,4-Trichlorobenzene	ug/m3	1800U	910U	1500U	700U	1900U	740U	740U	740U	7.1U	74U	74U	74U
1,2,4-Trimethylbenzene	ug/m3	**85000**	**40000**	**41000**	**20000**	**16000**	**8600**	**5200**	2500U	24U	**2800**	**2600**	**2500**
1,2-Dibromoethane (EDB)	ug/m3	1900U	950U	1600U	720U	1900U	770U	770U	770U	7.4U	77U	77U	77U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ug/m3	1700U	860U	1400U	660U	1700U	700U	700U	700U	6.7U	**360**	**340**	**310**
1,2-Dichlorobenzene	ug/m3	2900U	1500U	2500U	1100U	3000U	1200U	1200U	1200U	12U	**290**	**280**	**300**
1,2-Dichloroethane	ug/m3	990U	500U	830U	380U	1000U	400U	400U	400U	3.9U	**59**	**100**	**59**
1,2-Dichloropropane	ug/m3	1100U	**590**	950U	**450**	1200U	460U	460U	460U	4.4U	**210**	**360**	**200**
1,3,5-Trimethylbenzene	ug/m3	**64000**	**38000**	**38000**	**25000**	**25000**	**21000**	**16000**	2500U	24U	**11000**	**8100**	**5400**
1,3-Butadiene	ug/m3	540U	270U	450U	210U	550U	220U	220U	220U	2.1U	22U	22U	22U
1,3-Dichlorobenzene	ug/m3	2900U	1500U	2500U	1100U	3000U	1200U	1200U	1200U	12U	120U	120U	120U
1,4-Dichlorobenzene	ug/m3	1500U	740U	1200U	570U	1500U	**640**	600U	600U	5.8U	**740**	**450**	**450**
1,4-Dioxane	ug/m3	880U	440U	740U	340U	900U	360U	360U	360U	3.5U	36U	36U	36U
1-Butanol	ug/m3	15000U	7500U	12000U	5700U	15000U	6100U	6100U	6100U	58U	610U	610U	610U
2-Butanone (MEK)	ug/m3	7200U	3600U	6000U	2800U	7400U	2900U	2900U	2900U	28U	290U	290U	290U
2-Hexanone	ug/m3	10000U	5000U	8400U	3900U	10000U	4100U	4100U	4100U	39U	410U	410U	410U
2-Pentanone	ug/m3	8600U	4300U	7200U	3300U	8800U	3500U	3500U	3500U	34U	350U	350U	350U
2-Propanol	ug/m3	21000U	11000U	18000U	8100U	22000U	8600U	8600U	8600U	83U	860U	860U	860U
3-Hexanone	ug/m3	10000U	5000U	8400U	3900U	10000U	4100U	4100U	4100U	39U	410U	410U	410U
3-Pentanone	ug/m3	8600U	4300U	7200U	3300U	8800U	3500U	3500U	3500U	34U	350U	350U	350U
4-Methyl-2-Pentanone (MIBK)	ug/m3	10000U	5000U	8400U	3900U	10000U	4100U	4100U	4100U	39U	410U	410U	410U
Acetaldehyde	ug/m3	22000U	11000U	18000U	8500U	23000U	9000U	9000U	9000U	86U	900U	900U	900U
Acetone	ug/m3	12000U	5800U	9700U	4500U	12000U	4800U	4800U	4800U	46U	480U	480U	480U
Acetonitrile	ug/m3	4100U	2100U	3400U	1600U	4200U	1700U	1700U	1700U	16U	170U	170U	170U
Acrolein	ug/m3	2200U	1100U	1900U	860U	2300U	920U	920U	920U	8.8U	92U	92U	92U
Acrylonitrile	ug/m3	530U	270U	440U	200U	540U	220U	220U	220U	2.1U	22U	22U	22U
Benzene	ug/m3	**790**	**590**	**670**	**440**	800U	**360**	320U	320U	3.1U	**300**	**360**	**290**
Benzyl chloride	ug/m3	1300U	640U	1100U	490U	1300U	520U	520U	520U	5U	52U	52U	52U
Bromodichloromethane	ug/m3	1600U	820U	1400U	630U	1700U	670U	670U	670U	6.4U	67U	67U	67U
Bromoform	ug/m3	5100U	2500U	4200U	1900U	5200U	2100U	2100U	2100U	20U	210U	210U	210U
Bromomethane	ug/m3	950U	480U	800U	370U	970U	390U	390U	390U	3.7U	39U	39U	39U
Butanal	ug/m3	7200U	3600U	6000U	2800U	7400U	2900U	2900U	2900U	28U	290U	290U	290U
Carbon disulfide	ug/m3	15000U	7700U	13000U	5900U	16000U	6200U	6200U	6200U	60U	620U	620U	620U
Carbon tetrachloride	ug/m3	1500U	770U	1300U	590U	1600U	630U	630U	630U	6U	63U	63U	63U
Chlorobenzene	ug/m3	1100U	570U	940U	430U	1200U	460U	460U	460U	4.4U	**300**	**280**	**310**
Chlorodifluoromethane	ug/m3	**3300jl**	**3100jl**	**2800**	**2700**	**2800**	**2700**	**3200**	**860**	3.4U	**3500**	**2700**	**2000**
Chloroethane	ug/m3	**710jl**	**660jl**	540U	**450**	660U	**450**	**360**	260U	2.5U	**420**	**250**	**240ca, jl**
Chloroform	ug/m3	1200U	600U	1000U	460U	1200U	490U	490U	490U	4.7U	**67**	**71**	49U

Table 9: P1 Vapor Analytical Results for MW-68p1

Volatile Organic Compounds		**Sample Date**											
(EPA Method TO-15)	**Units**	**7/25/17**	**8/3/17**	**8/7/17**	**8/14/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/13/17**	**9/27/17**	**10/3/17**
Chloromethane	ug/m3	510U	250U	420U	190U	520U	210U	210U	210U	2U	21U	21U	21U
cis-1,2-Dichloroethene	ug/m3	**10000**	**8300**	**9500**	**6900**	**7100**	**4600**	**3500**	**600**	3.8U	**3000**	**4000**	**2300**
cis-1,3-Dichloropropene	ug/m3	1100U	560U	930U	430U	1100U	450U	450U	450U	4.4U	45U	45U	45U
Cyclohexane	ug/m3	17000U	8500U	14000U	6500U	17000U	6900U	6900U	6900U	66U	**2600**	**2500**	**1500**
Cyclopentane	ug/m3	700U	350U	590U	270U	720U	290U	290U	290U	2.8U	**210**	**270**	**200**
Dibromochloromethane	ug/m3	2100U	1000U	1700U	800U	2100U	850U	850U	850U	8.2U	85U	85U	85U
Dichlorodifluoromethane	ug/m3	1200U	**830**	1000U	**760**	1200U	**6500**	**11000**	**1400**	4.7U	**3300**	**1600**	**1000**
Ethanol	ug/m3	18000U	9300U	15000U	7100U	19000U	7500U	7500U	7500U	72U	750U	750U	750U
Ethylbenzene	ug/m3	**56000**	**18000**	**28000**	**5700**	**8700**	**3200**	**1600**	430U	4.2U	**1400**	**2100**	**1800**
Hexachlorobutadiene	ug/m3	2600U	1300U	2200U	1000U	2700U	1100U	1100U	1100U	10U	110U	110U	110U
Hexanal	ug/m3	10000U	5000U	8400U	3900U	10000U	4100U	4100U	4100U	39U	410U	410U	410U
Hexane	ug/m3	**9700**	**6800**	**10000**	**6300**	8800U	**4400**	3500U	3500U	34U	**3400**	**3700**	**2100**
Iodomethane	ug/m3	1400U	710U	1200U	550U	1500U	580U	580U	580U	5.6U	58U	58U	58U
Isobutene	ug/m3	**2600jl**	**2600jl**	**2100**	**2100**	**2300**	**1800**	**1600**	920U	8.8U	**2000**	**1900**	**1600**
Isoprene	ug/m3	680U	340U	570U	260U	700U	280U	280U	280U	2.7U	**48**	**42**	**31**
m,p-Xylene	ug/m3	**760000**	**360000**	**350000**	**180000**	**180000**	**100000**	**61000**	**4600**	8.3U	**23000**	**38000**	**27000**
Methacrolein	ug/m3	7000U	3500U	5900U	2700U	7200U	2900U	2900U	2900U	28U	290U	290U	290U
Methyl t-butyl ether	ug/m3	4400U	2200U	3700U	1700U	4500U	1800U	1800U	1800U	17U	180U	180U	180U
Methyl vinyl ketone	ug/m3	2800U	1400U	2400U	1100U	2900U	1100U	1100U	1100U	11U	110U	110U	110U
Methylene chloride	ug/m3	210000U	110000U	180000U	82000U	220000U	87000U	87000U	87000U	830U	8700U	8700U	8700U
Naphthalene	ug/m3	**1300**	**910**	1100U	**550**	1300U	520U	520U	520U	5U	**180**	**130**	**140**
o-Xylene	ug/m3	**270000**	**150000**	**140000**	**94000**	**100000**	**73000**	**48000**	**3600**	4.2U	**18000**	**21000**	**17000**
Pentanal	ug/m3	8600U	4300U	7200U	3300U	8800U	3500U	3500U	3500U	34U	350U	350U	350U
Pentane	ug/m3	7200U	3600U	6000U	2800U	7400U	3000U	3000U	3000U	28U	**1500**	**1400**	**1200**
Propene	ug/m3	1700U	850U	1400U	650U	1700U	690U	690U	690U	6.6U	69U	69U	69U
Styrene	ug/m3	2100U	1000U	1700U	800U	2100U	850U	850U	850U	8.2U	85U	85U	85U
Tetrachloroethene	ug/m3	**11000**	**6400**	**7700**	**6200**	**7400**	**6300**	**4700**	680U	6.5U	**3000**	**1600**	**1200**
Toluene	ug/m3	**1700000ve**	**910000**	**1300000**	**570000**	**550000**	**170000**	**92000**	**8800**	3.6U	**16000**	**58000**	**42000**
trans-1,2-Dichloroethene	ug/m3	970U	490U	810U	370U	990U	400U	400U	400U	3.8U	40U	40U	40U
trans-1,3-Dichloropropene	ug/m3	1100U	560U	930U	430U	1100U	450U	450U	450U	4.4U	45U	45U	45U
Trichloroethene	ug/m3	**4100**	**3000**	**3500**	**2900**	**3200**	**2400**	**2000**	540U	5.2U	**1500**	**1100**	**870**
Trichlorofluoromethane	ug/m3	1400U	690U	1200U	530U	1400U	560U	560U	560U	5.4U	**61**	56U	**57**
Vinyl acetate	ug/m3	17000U	8700U	14000U	6600U	18000U	7000U	7000U	7000U	68U	700U	700U	700U
Vinyl chloride	ug/m3	**1200jl**	**1100jl**	**930**	**970**	**1100**	**920**	**860**	260U	2.5U	**1000**	**930**	**700**
Total Detected VOCs	***ug/m3***	***3,057,000***	***1,600,230***	***1,995,900***	***963,870***	***950,200***	***437,940***	***274,520***	***22,060***	***0***	***118,935***	***168,843***	***122,437***

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#jl: Lab control sample percent recovery and/or relative percent differences outside acceptable limits. Value reported is an estimate (#).

#ca: Calibration for parameter did not pass the acceptance criteria. Value reported is an estimate (#).

#ve: Parameter response exceeds instrument range. Value reported is an estimate (#).

NA: Parameter not analyzed.

Samples collected on 9/7/2017 and 9/12/17 may have sampling errors that bias sample low (see main text in report).

Table 10: P1 Vapor Analytical Results for MW-65p1

Volatile Organic Compounds (EPA Method TO-15)	Units	Sample Date				
		7/25/17	8/3/17	9/12/17	9/13/17	9/19/17
1,1,1-Trichloroethane	ug/m3	330U	330U	550U	55U	2.2U
1,1,2,2-Tetrachloroethane	ug/m3	410U	410U	690U	69U	2.7U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/m3	460U	460U	770U	77U	3.1U
1,1,2-Trichloroethane	ug/m3	330U	330U	550U	55U	2.2U
1,1-Dichloroethane	ug/m3	240U	240U	400U	**140**	1.6U
1,1-Dichloroethene	ug/m3	240U	240U	400U	40U	1.6U
1,2,3-Trimethylbenzene	ug/m3	1500U	1500U	2500U	**840ca**	9.8U
1,2,4-Trichlorobenzene	ug/m3	450U	450U	740U	74U	3U
1,2,4-Trimethylbenzene	ug/m3	**3200**	**1900**	2500U	**2400**	9.8U
1,2-Dibromoethane (EDB)	ug/m3	460U	460U	770U	77U	3.1U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ug/m3	**700jl**	**690jl**	700U	**610**	2.8U
1,2-Dichlorobenzene	ug/m3	720U	720U	1200U	120U	4.8U
1,2-Dichloroethane	ug/m3	240U	240U	400U	**53**	1.6U
1,2-Dichloropropane	ug/m3	280U	280U	460U	**54**	1.8U
1,3,5-Trimethylbenzene	ug/m3	1500U	1500U	2500U	**1100**	9.8U
1,3-Butadiene	ug/m3	130U	130U	220U	22U	0.88U
1,3-Dichlorobenzene	ug/m3	720U	720U	1200U	120U	4.8U
1,4-Dichlorobenzene	ug/m3	**1300**	**700**	**710**	**1100**	2.4U
1,4-Dioxane	ug/m3	220U	220U	360U	36U	1.4U
1-Butanol	ug/m3	3600U	3600U	6100U	610U	24U
2-Butanone (MEK)	ug/m3	1800U	1800U	2900U	290U	12U
2-Hexanone	ug/m3	2500U	2500U	4100U	410U	16U
2-Pentanone	ug/m3	2100U	2100U	3500U	350U	14U
2-Propanol	ug/m3	5200U	5200U	8600U	860U	34U
3-Hexanone	ug/m3	2500U	2500U	4100U	410U	16U
3-Pentanone	ug/m3	2100U	2100U	3500U	350U	14U
4-Methyl-2-Pentanone (MIBK)	ug/m3	2500U	2500U	4100U	410U	16U
Acetaldehyde	ug/m3	5400U	5400U	9000U	900U	36U
Acetone	ug/m3	2900U	2900U	4800U	480U	19U
Acetonitrile	ug/m3	1000U	1000U	1700U	170U	6.7U
Acrolein	ug/m3	550U	550U	920U	92U	3.7U
Acrylonitrile	ug/m3	130U	130U	220U	22U	0.87U
Benzene	ug/m3	**1100**	**930**	**940**	**1500**	1.3U
Benzyl chloride	ug/m3	310U	310U	520U	52U	2.1U
Bromodichloromethane	ug/m3	400U	400U	670U	67U	2.7U
Bromoform	ug/m3	1200U	1200U	2100U	210U	8.3U
Bromomethane	ug/m3	230U	230U	390U	39U	1.6U
Butanal	ug/m3	1800U	1800U	2900U	290U	12U
Carbon disulfide	ug/m3	3700U	3700U	6200U	620U	25U
Carbon tetrachloride	ug/m3	380U	380U	630U	63U	2.5U
Chlorobenzene	ug/m3	**7800**	**6800**	**6700**	**8700**	1.8U
Chlorodifluoromethane	ug/m3	**3800jl**	**3300jl**	**4600**	**6500**	1.4U
Chloroethane	ug/m3	**550jl**	**390jl**	**270**	**290**	1.1U
Chloroform	ug/m3	290U	290U	490U	49U	2U
Chloromethane	ug/m3	120U	120U	210U	21U	**0.96**

Table 10: P1 Vapor Analytical Results for MW-65p1

Volatile Organic Compounds (EPA Method TO-15)	Units	Sample Date				
		7/25/17	8/3/17	9/12/17	9/13/17	9/19/17
cis-1,2-Dichloroethene	ug/m3	240U	240U	400U	**350**	1.6U
cis-1,3-Dichloropropene	ug/m3	270U	270U	450U	45U	1.8U
Cyclohexane	ug/m3	4100U	4100U	6900U	**2600**	28U
Cyclopentane	ug/m3	**340**	**350**	**380**	**680**	1.1U
Dibromochloromethane	ug/m3	510U	510U	850U	85U	3.4U
Dichlorodifluoromethane	ug/m3	**930**	**720**	**4100**	**5200**	**2.3**
Ethanol	ug/m3	4500U	4500U	7500U	750U	30U
Ethylbenzene	ug/m3	**10000**	**8000**	**5400**	**9100**	**10**
Hexachlorobutadiene	ug/m3	640U	640U	1100U	110U	4.3U
Hexanal	ug/m3	2500U	2500U	4100U	410U	16U
Hexane	ug/m3	**2300**	2100U	3500U	**4100**	14U
Iodomethane	ug/m3	350U	350U	580U	58U	2.3U
Isobutene	ug/m3	**3700jl**	**3300jl**	**2700**	**4200**	3.7U
Isoprene	ug/m3	170U	170U	280U	**46**	1.1U
m,p-Xylene	ug/m3	**11000**	**7700**	**5200**	**8300**	**42**
Methacrolein	ug/m3	1700U	1700U	2900U	290U	11U
Methyl t-butyl ether	ug/m3	1100U	1100U	1800U	180U	7.2U
Methyl vinyl ketone	ug/m3	690U	690U	1100U	110U	4.6U
Methylene chloride	ug/m3	52000U	52000U	87000U	8700U	350U
Naphthalene	ug/m3	**330**	310U	520U	**140**	2.1U
o-Xylene	ug/m3	**2700**	**1800**	**1400**	**2700**	**9.2**
Pentanal	ug/m3	2100U	2100U	3500U	350U	14U
Pentane	ug/m3	**2200**	**2000**	3000U	**3400**	12U
Propene	ug/m3	410U	410U	690U	69U	2.8U
Styrene	ug/m3	510U	510U	850U	85U	3.4U
Tetrachloroethene	ug/m3	410U	410U	680U	**210**	2.7U
Toluene	ug/m3	**1600**	**1200**	**1100**	**2100**	**23**
trans-1,2-Dichloroethene	ug/m3	240U	240U	400U	**71**	1.6U
trans-1,3-Dichloropropene	ug/m3	270U	270U	450U	45U	1.8U
Trichloroethene	ug/m3	320U	320U	540U	250	2.1U
Trichlorofluoromethane	ug/m3	340U	340U	560U	**93**	2.2U
Vinyl acetate	ug/m3	4200U	4200U	7000U	700U	28U
Vinyl chloride	ug/m3	**1400jl**	**1300jl**	**1400**	**2100**	1U
Total Detected VOCs	***ug/m3***	***54,950***	***41,080***	***34,900***	***68,927***	***87***

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#jl: Lab control sample percent recovery and/or relative percent differences outside acceptable limits. Value reported is an esti

#ca: Calibration for parameter did not pass the acceptance criteria. Value reported is an estimate (#).

#ve: Parameter response exceeds instrument range. Value reported is an estimate (#).

NA: Parameter not analyzed.

Sample collected on 9/19/2017 may have sampling error that biases sample low (see main text in report)

Table 11: P1 Vapor Analytical Results for GAC1 Influent

Volatile Organic Compounds		Sample Date														
(EPA Method TO-15)	**Units**	**7/3/17**	**7/10/17**	**7/18/17**	**7/25/17**	**8/3/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/9/17**	**9/12/17**	**9/13/17**	**9/19/17**	**10/3/17**
1,1,1-Trichloroethane	ug/m3	**600000**	**270000**	**35000**	**23000**	**16000**	**20000**	**13000**	**9100**	**6700**	**4600**	**4200**	**4100**	**6200**	**4300**	**3200**
1,1,2,2-Tetrachloroethane	ug/m3	69000U	150000U	18000U	820U	410U	570U	690U	690U	690U	690U	690U	690U	69U	69U	69U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/m3	**380000**	170000U	20000U	**2900**	**1800**	**2500**	**1600**	**900**	770U	770U	770U	770U	**740**	**540**	**340**
1,1,2-Trichloroethane	ug/m3	55000U	120000U	14000U	650U	330U	450U	550U	550U	550U	550U	550U	550U	55U	55U	55U
1,1-Dichloroethane	ug/m3	**81000**	69000U	7700U	**2400**	**1700**	**1800**	**1200**	**860**	**660**	**520**	**510**	**510**	**800**	**540**	**420**
1,1-Dichloroethene	ug/m3	79000U	180000U	20000U	**680**	**390**	**520**	400U	400U	400U	400U	400U	400U	**210**	**160**	**120**
1,2,3-Trimethylbenzene	ug/m3	NA	NA	NA	**20000**	**12000**	**14000**	2500U	**9300**	**6700**	**4400**	**3800**	**3600**	**3900ca**	**3700ca**	**3300ca**
1,2,4-Trichlorobenzene	ug/m3	380000U	820000U	96000U	890U	450U	610U	740U	740U	740U	740U	740U	740U	**140**	**120**	74U
1,2,4-Trimethylbenzene	ug/m3	98000U	**350000**	**69000**	**57000**	**28000**	**34000**	2500U	**8500**	**4600**	**2700**	2500U	**2700**	**3400**	**3500**	**3300**
1,2-Dibromoethane (EDB)	ug/m3	150000U	350000U	39000U	920U	460U	630U	770U	770U	770U	770U	770U	770U	77U	77U	77U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ug/m3	76000U	170000U	20000U	840U	**540jl**	580U	700U	700U	700U	700U	700U	700U	**390**	**330**	**170**
1,2-Dichlorobenzene	ug/m3	60000U	130000U	16000U	**4100**	**2200**	**2800**	1200U	**1300**	1200U	1200U	1200U	1200U	**620**	**630**	**440**
1,2-Dichloroethane	ug/m3	81000U	180000U	21000U	490U	240U	330U	400U	400U	400U	400U	400U	400U	**89**	**63**	40U
1,2-Dichloropropane	ug/m3	46000U	100000U	12000U	550U	**340**	**400**	460U	460U	460U	460U	460U	460U	**230**	**150**	**110**
1,3,5-Trimethylbenzene	ug/m3	49000U	**260000**	**59000**	**44000**	**27000**	**33000**	**10000**	**17000**	**12000**	**7300**	**6200**	**6000**	**7700**	**6600**	**6300**
1,3-Butadiene	ug/m3	NA	NA	NA	270U	130U	180U	220U	220U	220U	220U	220U	220U	22U	22U	22U
1,3-Dichlorobenzene	ug/m3	60000U	130000U	16000U	1400U	720U	990U	1200U	1200U	1200U	1200U	1200U	1200U	120U	120U	120U
1,4-Dichlorobenzene	ug/m3	60000U	130000U	16000U	**2000**	**1100**	**1300**	600U	**1000**	**910**	**850**	**790**	**1000**	**1600**	**1300**	**660**
1,4-Dioxane	ug/m3	NA	NA	NA	430U	220U	300U	360U	360U	360U	360U	360U	360U	36U	36U	36U
1-Butanol	ug/m3	NA	NA	NA	7300U	3600U	5000U	6100U	6100U	6100U	6100U	6100U	6100U	610U	610U	610U
2-Butanone (MEK)	ug/m3	59000U	130000U	15000U	3500U	1800U	2400U	2900U	2900U	2900U	2900U	2900U	2900U	290U	290U	290U
2-Hexanone	ug/m3	41000U	90000U	11000U	4900U	2500U	3400U	4100U	4100U	4100U	4100U	4100U	4100U	410U	410U	410U
4-EthylToluene	ug/m3	49000U	**360000**	**44000**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Pentanone	ug/m3	NA	NA	NA	4200U	2100U	2900U	3500U	3500U	3500U	3500U	3500U	3500U	350U	350U	350U
2-Propanol	ug/m3	NA	NA	NA	10000U	5200U	7100U	8600U	8600U	8600U	8600U	8600U	8600U	860U	**1800**	860U
3-Hexanone	ug/m3	NA	NA	NA	4900U	2500U	3400U	4100U	4100U	4100U	4100U	4100U	4100U	410U	410U	410U
3-Pentanone	ug/m3	NA	NA	NA	4200U	2100U	2900U	3500U	3500U	3500U	3500U	3500U	3500U	350U	350U	350U
4-Methyl-2-Pentanone (MIBK)	ug/m3	41000U	90000U	11000U	4900U	2500U	3400U	4100U	4100U	4100U	4100U	4100U	4100U	410U	410U	410U
Acetaldehyde	ug/m3	NA	NA	NA	11000U	5400U	7400U	9000U	9000U	9000U	9000U	9000U	9000U	900U	900U	900U
Acetone	ug/m3	120000U	260000U	31000U	5700U	2900U	3900U	4800U	4800U	4800U	4800U	4800U	4800U	480U	480U	480U
Acetonitrile	ug/m3	NA	NA	NA	2000U	1000U	1400U	1700U	1700U	1700U	1700U	1700U	1700U	170U	170U	170U
Acrolein	ug/m3	NA	NA	NA	1100U	550U	760U	920U	920U	920U	920U	920U	920U	92U	92U	92U
Acrylonitrile	ug/m3	NA	NA	NA	260U	130U	180U	220U	220U	220U	220U	220U	220U	22U	22U	22U
Benzene	ug/m3	32000U	70000U	8300U	**810**	**630**	**580**	**470**	**400**	**370**	**330**	320U	**460**	**710**	**600**	**160**
Benzyl chloride	ug/m3	100000U	230000U	26000U	620U	310U	430U	520U	520U	520U	520U	520U	520U	52U	52U	52U
Bromodichloromethane	ug/m3	52000U	110000U	13000U	800U	400U	550U	670U	670U	670U	670U	670U	670U	67U	67U	67U
Bromoform	ug/m3	100000U	230000U	27000U	2500U	1200U	1700U	2100U	2100U	2100U	2100U	2100U	2100U	210U	210U	210U
Bromomethane	ug/m3	78000U	170000U	20000U	470U	230U	320U	390U	390U	390U	390U	390U	390U	39U	39U	39U
Butanal	ug/m3	NA	NA	NA	3500U	1800U	2400U	2900U	2900U	2900U	2900U	2900U	2900U	290U	290U	290U
Carbon disulfide	ug/m3	62000U	140000U	16000U	7500U	3700U	5100U	6200U	6200U	6200U	6200U	6200U	6200U	620U	620U	620U
Carbon tetrachloride	ug/m3	130000U	280000U	32000U	750U	380U	520U	630U	630U	630U	630U	630U	630U	63U	63U	63U
Chlorobenzene	ug/m3	35000U	78000U	8700U	**2200**	**1700**	**460**	**500**	**650**	**850**	**870**	**870**	**2200**	**4000**	**3300**	**250**
Chlorodifluoromethane	ug/m3	NA	NA	NA	**3200jl**	**2500jl**	**2200**	**2600**	**2100**	**2200**	**2000**	**2000**	**2300**	**3200**	**2500**	**1100**
Chloroethane	ug/m3	53000U	120000U	13000U	**540jl**	**400jl**	**270**	260U	260U	260U	260U	260U	**270**	**300**	**230**	**140ca, jl**
Chloroform	ug/m3	38000U	83000U	9300U	590U	290U	400U	490U	490U	490U	490U	490U	490U	**70**	49U	49U

Table 11: P1 Vapor Analytical Results for GAC1 Influent

Volatile Organic Compounds (EPA Method TO-15)	Units	Sample Date														
		7/3/17	**7/10/17**	**7/18/17**	**7/25/17**	**8/3/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/9/17**	**9/12/17**	**9/13/17**	**9/19/17**	**10/3/17**
Chloromethane	ug/m3	41000U	93000U	11000U	250U	120U	170U	210U	210U	210U	210U	210U	210U	21U	21U	21U
cis-1,2-Dichloroethene	ug/m3	**140000**	87000U	10000U	**4700**	**3600**	**4600**	**3200**	**2100**	**1600**	**1200**	**1100**	**1100**	**1800**	**1400**	**1300**
cis-1,3-Dichloropropene	ug/m3	45000U	100000U	12000U	540U	270U	370U	450U	450U	450U	450U	450U	450U	45U	45U	45U
Cyclohexane	ug/m3	NA	NA	NA	8300U	4100U	5700U	6900U	6900U	6900U	6900U	6900U	6900U	**2300**	**1600**	**820**
Cyclopentane	ug/m3	NA	NA	NA	340U	**270**	240U	**320**	290U	290U	290U	290U	290U	**410**	**320**	**110**
Dibromochloromethane	ug/m3	85000U	190000U	22000U	1000U	510U	700U	850U	850U	850U	850U	850U	850U	85U	85U	85U
Dichlorodifluoromethane	ug/m3	49000U	110000U	13000U	**900**	**740**	**780**	**880**	**3500**	**4600**	**2400**	**2000**	**1700**	**2500**	**1700**	**570**
Ethanol	ug/m3	NA	NA	NA	9000U	4500U	6200U	7500U	7500U	7500U	7500U	7500U	7500U	750U	750U	750U
Ethylbenzene	ug/m3	**65000**	**1200000**	**74000**	**29000**	**11000**	**17000**	**5400**	**2000**	**1200**	**1000**	**920**	**2500**	**4400**	**5400**	**2100**
Hexachlorobutadiene	ug/m3	540000U	1200000U	140000U	1300U	640U	880U	1100U	1100U	1100U	1100U	1100U	1100U	110U	110U	110U
Hexanal	ug/m3	NA	NA	NA	4900U	2500U	3400U	4100U	4100U	4100U	4100U	4100U	4100U	410U	410U	410U
Hexane	ug/m3	NA	NA	NA	**5900**	**4100**	**5700**	**4500**	3500U	3500U	3500U	3500U	3500U	**3300**	**2500**	**1200**
Iodomethane	ug/m3	NA	NA	NA	700U	350U	480U	580U	580U	580U	580U	580U	580U	58U	58U	58U
Isobutene	ug/m3	NA	NA	NA	**3,200jl**	**2,600jl**	**2100**	**4400**	**1900**	**1700**	**1600**	**1600**	**1800**	**2700**	**2100**	**840**
Isoprene	ug/m3	NA	NA	NA	330U	170U	230U	280U	280U	280U	280U	280U	280U	**77**	**45**	28U
m,p-Xylene	ug/m3	**96000**	**4000000**	**690000**	**350000**	**180000**	**220000**	**100000**	**56000**	**37000**	**20000**	**18000**	**18000**	**18000**	**17000**	**24000**
Methacrolein	ug/m3	NA	NA	NA	3400U	1700U	2400U	2900U	2900U	2900U	2900U	2900U	2900U	290U	290U	290U
Methyl t-butyl ether	ug/m3	NA	NA	NA	2200U	1100U	1500U	1800U	1800U	1800U	1800U	1800U	1800U	180U	180U	180U
Methyl vinyl ketone	ug/m3	NA	NA	NA	1400U	690U	950U	1100U	1100U	1100U	1100U	1100U	1100U	110U	110U	110U
Methylene chloride	ug/m3	35000U	76000U	9000U	100000U	52000U	72000U	87000U	87000U	87000U	87000U	87000U	87000U	8700U	8700U	8700U
Naphthalene	ug/m3	NA	NA	NA	**3200**	**1900**	**2500**	520U	**1600**	**850**	520U	520U	520U	**510**	**640**	**290**
o-Xylene	ug/m3	43000U	**1100000**	**230000**	**130000**	**82000**	**95000**	**62000**	**42000**	**28000**	**17000**	**15000**	**14000**	**17000**	**15000**	**16000**
Pentanal	ug/m3	NA	NA	NA	4200U	2100U	2900U	3500U	3500U	3500U	3500U	3500U	3500U	350U	350U	350U
Pentane	ug/m3	NA	NA	NA	3500U	1800U	2400U	3000U	3000U	3000U	3000U	3000U	3000U	**2100**	**1600**	**640**
Propene	ug/m3	NA	NA	NA	830U	410U	570U	690U	690U	690U	690U	690U	690U	69U	69U	69U
Styrene	ug/m3	43000U	94000U	11000U	1000U	510U	700U	850U	850U	850U	850U	850U	850U	85U	85U	85U
Tetrachloroethene	ug/m3	68000U	150000U	18000U	**5400**	**3700**	**5100**	**4000**	**3600**	**3000**	**2100**	**1900**	**1900**	**2300**	**1400**	**770**
Toluene	ug/m3	**2000000**	**7500000**	**640000**	**830000**	**160000**	**240000**	**150000**	**82000**	**46000**	**22000**	**20000**	**16000**	**11000**	**18000**	**29000**
trans-1,2-Dichloroethene	ug/m3	40000U	87000U	10000U	480U	240U	330U	400U	400U	400U	400U	400U	400U	**48**	40U	40U
trans-1,3-Dichloropropene	ug/m3	45000U	100000U	12000U	540U	270U	370U	450U	450U	450U	450U	450U	450U	45U	45U	45U
Trichloroethene	ug/m3	54000U	120000U	14000U	**2400**	**1900**	**2100**	**1600**	**1400**	**1200**	**880**	**860**	**840**	**1200**	**880**	**540**
Trichlorofluoromethane	ug/m3	56000U	120000U	15000U	670U	340U	460U	560U	560U	560U	560U	560U	560U	**69**	56U	56U
Vinyl acetate	ug/m3	70000U	160000U	18000U	8500U	4200U	5800U	7000U	7000U	7000U	7000U	7000U	7000U	700U	700U	700U
Vinyl chloride	ug/m3	26000U	56000U	6600U	**1300jl**	**1000jl**	**890**	**910**	**920**	**870**	**800**	**780**	**970**	**1300**	**970**	**380**
Total Detected VOCs	***ug/m3***	***3,362,000***	***15,040,000***	***1,841,000***	***1,528,830***	***549,110***	***709,600***	***366,580***	***248,130***	***161,010***	***92,550***	***80,530***	***81,950***	***105,313***	***100,918***	***98,570***

Bold: Parameter detected above lab reporting limit.
#U: Parameter not detected at associated lab reporting limit (#).
#jl: Lab control sample percent recovery and/or relative percent differences outside acceptable limits. Value reported is an estimate (#).
#ca: Calibration for parameter did not pass the acceptance criteria. Value reported is an estimate (#).
#ve: Parameter response exceeds instrument range. Value reported is an estimate (#).
NA: Parameter not analyzed.

Table 12: LTT Liquid Analytical Results for OWS Influent

Parameter	Units	Analysis Method	Sample Date	
			9/27/2017	10/4/2017
Inorganics				
Arsenic, Dissolved	ug/L	E200.8	**11.7D**	**10.4D**
Iron, Dissolved	ug/L	E200.8	**5250D**	**283D**
Iron, Total	ug/L	E200.8	**6370D**	**2310D**
Manganese, Dissolved	ug/L	E200.8	**9470D**	**1040D**
Manganese, Total	ug/L	E200.8	**9400D**	**2200D**
Total Dissolved Solids	mg/L	EPA 160.1	NA	NA
Chloride	mg/L	EPA 325.2	NA	NA
Nitrate + Nitrite	mg-N/L	EPA 353.2	NA	NA
N-Nitrate	mg/L	EPA 353.2	NA	NA
N-Nitrite	mg-N/L	EPA 353.2	NA	NA
Sulfate	mg/L	EPA 375.2	NA	NA
Total Petroleum Hydrocarbons				
Diesel Range Hydrocarbons	mg/L	NWTPHD	NA	NA
Motor Oil	mg/L	NWTPHD	NA	NA
Gasoline Range Hydrocarbons	ug/L	NWTPHG	**20500**	100U
Volatile Organic Compounds				
1,1,1,2-Tetrachloroethane	ug/L	SW8260C	2U	0.2U
1,1,1-Trichloroethane	ug/L	SW8260C	**77**	0.2U
1,1,2,2-Tetrachloroethane	ug/L	SW8260C	2U	0.2U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	SW8260C	**4**	0.2U
1,1,2-Trichloroethane	ug/L	SW8260C	2U	0.2U
1,1-Dichloroethane	ug/L	SW8260C	**119**	0.2U
1,1-Dichloroethene	ug/L	SW8260C	**6.04**	0.2U
1,1-Dichloropropene	ug/L	SW8260C	2U	0.2U
1,2,3-Trichlorobenzene	ug/L	SW8260C	5U	0.5U
1,2,3-Trichloropropane	ug/L	SW8260C	5U	0.5U
1,2,4-Trichlorobenzene	ug/L	SW8260C	5U	0.5U
1,2,4-Trimethylbenzene	ug/L	SW8260C	**174**	0.2U
1,2-Dibromo-3-chloropropane	ug/L	SW8260C	5U	0.5U
1,2-Dibromoethane	ug/L	SW8260C	2U	0.2U
1,2-Dichlorobenzene	ug/L	SW8260C	**31.6**	0.2U
1,2-Dichloroethane	ug/L	SW8260C	**14.2**	0.2U
1,2-Dichloropropane	ug/L	SW8260C	**81**	0.2U
1,3,5-Trimethylbenzene	ug/L	SW8260C	**99.2**	0.2U
1,3-Dichlorobenzene	ug/L	SW8260C	**2**	0.2U
1,3-Dichloropropane	ug/L	SW8260C	2U	0.2U
1,4-Dichlorobenzene	ug/L	SW8260C	**15**	0.2U
2,2-Dichloropropane	ug/L	SW8260C	2U	0.2U
2-Butanone	ug/L	SW8260C	**244**	5U
2-Chloroethylvinylether	ug/L	SW8260C	10U	1U
2-Chlorotoluene	ug/L	SW8260C	2U	0.2U
2-Hexanone	ug/L	SW8260C	**59.2**	5U
4-Chlorotoluene	ug/L	SW8260C	2U	0.2U
4-Isopropyltoluene	ug/L	SW8260C	**3.26**	0.2U
4-Methyl-2-Pentanone (MIBK)	ug/L	SW8260C	**746**	5U
Acetone	ug/L	SW8260C	**977**	**10.1**
Acrolein	ug/L	SW8260C	50U	5U
Acrylonitrile	ug/L	SW8260C	10U	1U
Benzene	ug/L	SW8260C	**9.94**	0.2U
Bromobenzene	ug/L	SW8260C	**6.88**	0.2U
Bromochloromethane	ug/L	SW8260C	2U	0.2U
Bromodichloromethane	ug/L	SW8260C	2U	0.2U

Table 12: LTT Liquid Analytical Results for OWS Influent

		Analysis	Sample Date	
Parameter	**Units**	**Method**	**9/27/2017**	**10/4/2017**
Bromoethane	ug/L	SW8260C	2U	0.2U
Bromoform	ug/L	SW8260C	2U	0.2U
Bromomethane	ug/L	SW8260C	10U	1U
Carbon Disulfide	ug/L	SW8260C	2U	0.2U
Carbon Tetrachloride	ug/L	SW8260C	2U	0.2U
Chlorobenzene	ug/L	SW8260C	**3.97**	0.2U
Chloroethane	ug/L	SW8260C	2U	0.2U
Chloroform	ug/L	SW8260C	2U	0.2U
Chloromethane	ug/L	SW8260C	5U	0.5U
cis-1,2-Dichloroethene	ug/L	SW8260C	**358**	0.2U
cis-1,3-Dichloropropene	ug/L	SW8260C	2U	0.2U
Dibromochloromethane	ug/L	SW8260C	2U	0.2U
Dibromomethane	ug/L	SW8260C	2U	0.2U
Dichlorodifluoromethane	ug/L	SW8260C	2U	0.2U
Ethylbenzene	ug/L	SW8260C	**250**	0.2U
Hexachlorobutadiene	ug/L	SW8260C	5U	0.5U
Iodomethane	ug/L	SW8260C	10U	1U
Isopropylbenzene	ug/L	SW8260C	**14.3**	0.2U
m,p-Xylene	ug/L	SW8260C	**943**	0.4U
Methylene Chloride	ug/L	SW8260C	10U	1U
Naphthalene	ug/L	SW8260C	70.7	0.5U
n-Butylbenzene	ug/L	SW8260C	2U	0.2U
n-Propylbenzene	ug/L	SW8260C	**15.7**	0.2U
o-Xylene	ug/L	SW8260C	**549**	0.2U
sec-Butylbenzene	ug/L	SW8260C	2U	0.2U
Styrene	ug/L	SW8260C	**2.79**	0.2U
tert-Butylbenzene	ug/L	SW8260C	2U	0.2U
Tetrachloroethene	ug/L	SW8260C	2U	0.2U
Toluene	ug/L	SW8260C	**2650**	**0.31**
Total Xylenes	ug/L	SW8260C	**1490**	0.6U
trans-1,2-Dichloroethene	ug/L	SW8260C	2U	0.2U
trans-1,3-Dichloropropene	ug/L	SW8260C	2U	0.2U
trans-1,4-Dichloro-2-butene	ug/L	SW8260C	10U	1U
Trichloroethene	ug/L	SW8260C	**8.14**	0.2U
Trichlorofluoromethane	ug/L	SW8260C	2U	0.2U
Vinyl Acetate	ug/L	SW8260C	2U	0.2U
Vinyl Chloride	ug/L	SW8260C	**32**	0.2U
Total Detected VOCs	***ug/L***		***7,565***	***10***
Semi-Volatile Organic Compounds				
2-Methylphenol	ug/L	SW8270D	NA	NA
4-Methylphenol	ug/L	SW8270D	NA	NA
bis(2-Ethylhexyl)phthalate	ug/L	SW8270D	NA	NA

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#D: The reported value is from a dilution.

#Q: The reported value is out of control with continuing calibration.

#E: The reported value is out of range and estimated.

#M: The reported value was confirmed but with low spectral match and value is estimated.

#H: The reported value was analyzed outside the holding time.

NA: Parameter not analyzed.

Table 13: LTT Liquid Analytical Results for OWS Effluent

		Analysis	**Sample Date**											
Parameter	**Units**	**Method**	**6/19/17**	**6/27/17**	**7/5/17**	**7/12/17**	**7/28/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/19/17**
Inorganics														
Arsenic, Dissolved	ug/L	E200.8	**11.3D**	**11.5**	**12.4D**	**13.3D**	**9.16**	**7D**	**1.3**	**7.77D**	**8.42D**	**4.08**	**8.27**	**6.63**
Iron, Dissolved	ug/L	E200.8	**27700D**	**31500D**	**37700D**	**41400D**	**20500**	**15900D**	**5970D**	**580D**	**342**	**166**	**611**	**260D**
Iron, Total	ug/L	E200.8	**28300D**	**29100D**	**37500D**	**40400D**	**26100D**	**19800D**	**9870D**	**2730D**	**1510**	**3010**	**1330**	**532**
Manganese, Dissolved	ug/L	E200.8	**3830D**	**4140D**	**5700D**	**5630D**	**5810D**	**6150D**	**6480D**	**7690D**	**7130D**	**7330D**	**7110D**	**8210D**
Manganese, Total	ug/L	E200.8	**3970D**	**4020D**	**4530D**	**5430D**	**5150D**	**6320D**	**6560D**	**6760D**	**6920D**	**6500D**	**6920D**	**6350D**
Total Dissolved Solids	mg/L	EPA 160.1	**1050**	**1090**	**1400**	**1520**	**1500**	**1530**	**1630**	**1610**	**1710**	**1780**	**1730**	NA
Chloride	mg/L	EPA 325.2	**104D**	**156D**	**258D**	**304D**	NA	**563D**	**256D**	NA	**272D**	**295D**	**300D**	NA
Nitrate + Nitrite	mg-N/L	EPA 353.2	0.01U	0.05U	0.01U	0.05U	NA	0.2U	0.05U	NA	0.01U	0.05U	0.01U	NA
N-Nitrate	mg/L	EPA 353.2	0.02U	0.06U	0.02U	0.06U	NA	0.4U	0.1U	NA	0.02U	0.1U	0.02U	NA
N-Nitrite	mg-N/L	EPA 353.2	0.01U	0.01U	**0.022**	0.01U	NA	0.2U	0.05U	NA	0.01U	0.05U	0.01U	NA
Sulfate	mg/L	EPA 375.2	**12.7**	**19**	**29D**	**16.6D**	NA	**81.9D**	**117D**	NA	**225D**	**233D**	**260D**	NA
Total Petroleum Hydrocarbons														
Diesel Range Hydrocarbons	mg/L	NWTPHD	**2.76**	**2.71**	**2.84**	**3.34**	**11D**	**8.54D**	**9.3D**	**10.6D**	**10.9D**	**9.51D**	**8.41D**	NA
Motor Oil	mg/L	NWTPHD	**0.542**	**1.02**	**1.4**	**0.451**	**3.25D**	**2.22**	**3.71D**	**2.18**	**2D**	**1.71D**	**1.51**	NA
Gasoline Range Hydrocarbons	ug/L	NWTPHG	**36300**	**48100**	**42900**	**44800**	**37900**	**26200**	**22700**	**20400**	**15900**	**12600**	**14500**	**5710**
Volatile Organic Compounds														
1,1,1,2-Tetrachloroethane	ug/L	SW8260C	0.2U	0.2U	**1.68**	20U	20U	2U	10U	4U	5U	**3.39**	2U	1U
1,1,1-Trichloroethane	ug/L	SW8260C	**16.3**	**33.7**	**53.1**	**97.9**	**48.6**	**53**	**52.6**	**45.2**	**32.9**	**38.9**	**37.9**	1U
1,1,2,2-Tetrachloroethane	ug/L	SW8260C	**0.46**	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	SW8260C	**1.31**	**8.57**	**2.4**	20U	20U	2U	10U	4U	5U	**2.45**	**2.59**	1U
1,1,2-Trichloroethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
1,1-Dichloroethane	ug/L	SW8260C	**37**	**32.1**	**27.5**	**39.9**	**43.1**	**42.9**	**44.3**	**54**	**59.3**	**72.3**	**75.1**	**4.96**
1,1-Dichloroethene	ug/L	SW8260C	**1.5**	**6.18**	**2.92**	20U	20U	**2.3H**	10U	4U	5U	**6.35**	**5.49**	1U
1,1-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
1,2,3-Trichlorobenzene	ug/L	SW8260C	0.5U	**0.52**	**0.51**	50U	50U	5U	25U	10U	12.5U	5U	5U	2.5U
1,2,3-Trichloropropane	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	50U	5U	25U	10U	12.5U	5U	5U	2.5U
1,2,4-Trichlorobenzene	ug/L	SW8260C	**2.52**	**2.89**	**3.23**	50U	50U	5U	25U	10U	12.5U	5U	5U	2.5U
1,2,4-Trimethylbenzene	ug/L	SW8260C	**465**	**678**	**333**	**641Q**	**354**	**314**	**204**	**204**	**178**	**164**	**173**	**10.3**
1,2-Dibromo-3-chloropropane	ug/L	SW8260C	0.5U	15.4	0.5U	50U	50U	5U	25U	10U	12.5U	5U	5U	2.5U
1,2-Dibromoethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
1,2-Dichlorobenzene	ug/L	SW8260C	**54.3**	**61.1**	**45.3**	**62.6**	**62.3**	**60**	**43.5**	**41.8**	**34.2**	**33.9**	**32.4**	**2.2**
1,2-Dichloroethane	ug/L	SW8260C	**2.12**	**2.68**	**3.75**	20U	20U	**9.72H**	**11.3**	**15.1**	**14**	**18.1**	**15.5**	1U
1,2-Dichloropropane	ug/L	SW8260C	**10.1**	**11.9**	**14.3**	20U	**26.9**	**31.3**	**34.5**	**41**	**45.6**	**60.6**	**70.5**	**4.87**
1,3,5-Trimethylbenzene	ug/L	SW8260C	**212**	**318**	**160**	**268**	**187**	**195**	**132**	**128**	**111**	**95.6**	**97.6**	**6.3**
1,3-Dichlorobenzene	ug/L	SW8260C	**4.31**	**3.89**	**4.3**	20U	20U	**2.58H**	10U	4U	5U	**2.13**	**2.02**	1U
1,3-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
1,4-Dichlorobenzene	ug/L	SW8260C	**26.1**	**27.9**	**21.1**	**28.6**	**24.3**	**24.1**	**15.1**	**16.5**	**14.6**	**15.2**	**14.1**	1U
2,2-Dichloropropane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
2-Butanone	ug/L	SW8260C	5U	**47.2Q**	**91.5**	500U	500U	**204H**	250U	100U	125U	50U	50U	25U
2-Chloroethylvinylether	ug/L	SW8260C	1U	1U	1U	100U	100U	10U	50U	20U	25U	10U	10U	5U
2-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U

Table 13: LTT Liquid Analytical Results for OWS Effluent

		Analysis	Sample Date											
Parameter	**Units**	**Method**	**6/19/17**	**6/27/17**	**7/5/17**	**7/12/17**	**7/28/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/19/17**
2-Hexanone	ug/L	SW8260C	5U	5U	**7.56**	500U	500U	50U	250U	100U	125U	50U	50U	25U
4-Chlorotoluene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
4-Isopropyltoluene	ug/L	SW8260C	**11.7**	**17.5**	**16**	20U	20U	**4.87H**	10U	**4.35**	5U	**3.88**	**3.76**	1U
4-Methyl-2-Pentanone (MIBK)	ug/L	SW8260C	**18.8**	**60.6**	**79.4**	500U	500U	**362H**	**287**	**639**	**586**	**488**	**418**	**30.9**
Acetone	ug/L	SW8260C	**7.78**	**372**	**286**	**1050**	**813**	**616H**	**258**	**369**	125U	50U	50U	25U
Acrolein	ug/L	SW8260C	5U	5U	5U	500U	500U	50U	250U	100U	125U	50U	50U	25U
Acrylonitrile	ug/L	SW8260C	1U	1U	1U	100U	100U	10U	50U	20U	25U	10U	10U	5U
Benzene	ug/L	SW8260C	**2.98**	**3.21**	**5.43**	20U	20U	**4.06H**	10U	**6.13**	**6.39**	**7.85**	**7.63**	1U
Bromobenzene	ug/L	SW8260C	0.2U	0.2U	**1.63**	20U	20U	2U	10U	4U	5U	**3.19**	**3.68**	1U
Bromochloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Bromodichloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Bromoethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Bromoform	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Bromomethane	ug/L	SW8260C	1U	1U	1U	100U	100U	10U	50U	20U	25U	10U	10U	5U
Carbon Disulfide	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Carbon Tetrachloride	ug/L	SW8260C	0.2U	**4.6**	0.2U	20U	20U	2U	10U	**7.18**	5U	2U	2U	1U
Chlorobenzene	ug/L	SW8260C	**1.11**	**1.78**	**2.77**	20U	20U	**2.86H**	10U	4U	5U	**4.21**	**4.36**	1U
Chloroethane	ug/L	SW8260C	**14.4**	**26.4**	**7.08**	20U	20U	2U	10U	**6.18**	**7.41**	**7.24**	**7.69**	1U
Chloroform	ug/L	SW8260C	0.2U	**0.55**	**0.95**	20U	20U	2U	10U	4U	5U	2U	2U	1U
Chloromethane	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	50U	5U	25U	10U	12.5U	5U	5U	2.5U
cis-1,2-Dichloroethene	ug/L	SW8260C	**11.1**	**51.1**	**68.7**	**84.6**	**103**	**128**	**129**	**141**	**140**	**155**	**158**	**12.3**
cis-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Dibromochloromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Dibromomethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Dichlorodifluoromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Ethylbenzene	ug/L	SW8260C	**1160**	**1230**	**920**	**1080**	**248**	**176**	**104**	**137**	**159**	**174**	**203**	**10.2**
Hexachlorobutadiene	ug/L	SW8260C	0.5U	0.5U	0.5U	50U	50U	5U	25U	10U	12.5U	5U	5U	2.5U
Iodomethane	ug/L	SW8260C	1U	1U	1U	100U	100U	10U	50U	20U	25U	10U	10U	5U
Isopropylbenzene	ug/L	SW8260C	**68.5**	**76.1**	**55.9**	**52**	**23.1**	**11.9H**	**10.4**	**10.8**	**10.7**	**10.7**	**11.1**	1U
m,p-Xylene	ug/L	SW8260C	**2550**	**2780**	**2060**	**3630**	**2040**	**1690**	**1050**	**1060**	**849**	**790**	**723**	**26.6**
Methylene Chloride	ug/L	SW8260C	1U	1U	2.77	100U	100U	10U	50U	20U	25U	10U	10U	5U
Naphthalene	ug/L	SW8260C	**126**	**240**	**85.2**	**96.3**	**158Q**	**150**	**106**	**121**	**100**	**71.5**	**64.3**	**6.16**
n-Butylbenzene	ug/L	SW8260C	**12.7**	**24.7**	**20**	20U	20U	**2.69H**	10U	4U	5U	2U	2U	1U
n-Propylbenzene	ug/L	SW8260C	**120**	**178**	**90.1**	**102**	**22.5**	**11.4H**	10U	**9.93**	**10.9**	**10.3**	**10.4**	1U
o-Xylene	ug/L	SW8260C	**868**	**962**	**711**	**1390**	**962**	869	**570**	**596**	**445**	**430**	**418**	**19.6**
sec-Butylbenzene	ug/L	SW8260C	**8.87**	**11.3**	**10.3**	20U	20U	2U	10U	4U	5U	2U	2U	**8.27**
Styrene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
tert-Butylbenzene	ug/L	SW8260C	**1.3**	**1.23**	**1.4**	20U	20U	2U	10U	4U	5U	2U	2U	1U
Tetrachloroethene	ug/L	SW8260C	**0.67**	**0.83**	**1.86**	20U	20U	**2.28H**	10U	4U	5U	2U	**2.16**	1U
Toluene	ug/L	SW8260C	**3720**	**3520**	**3820**	**4990**	**2980**	**2640**	**2100**	**1680**	**1080**	**535**	**307**	**2.36**
Total Xylenes	ug/L	SW8260C	**3420**	**3740**	**2780**	**5020**	**3000**	**2560**	**1620**	**1650**	**1290**	**1220**	**1140**	**46.2**
trans-1,2-Dichloroethene	ug/L	SW8260C	0.2U	**0.23**	**0.25**	20U	20U	2U	10U	4U	5U	2U	2U	1U

Table 13: LTT Liquid Analytical Results for OWS Effluent

Parameter	Units	Analysis Method	Sample Date											
			6/19/17	6/27/17	7/5/17	7/12/17	7/28/17	8/7/17	8/15/17	8/22/17	8/30/17	9/7/17	9/12/17	9/19/17
trans-1,3-Dichloropropene	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	**11.3**	2U	1U
trans-1,4-Dichloro-2-butene	ug/L	SW8260C	1U	1U	1U	100U	100U	10U	50U	20U	25U	10U	10U	5U
Trichloroethene	ug/L	SW8260C	**0.37**	**0.69**	**1.37**	20U	20U	**6.71H**	**13.8**	**6.16**	5U	**9.95**	**6.99**	1U
Trichlorofluoromethane	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Vinyl Acetate	ug/L	SW8260C	0.2U	0.2U	0.2U	20U	20U	2U	10U	4U	5U	2U	2U	1U
Vinyl Chloride	ug/L	SW8260C	**5.72**	**17.6**	**3.61**	20U	20U	**7.85H**	**10.2**	**10.7**	**10.5**	**12.7**	**15.8**	1U
Total Detected VOCs	***ug/L***		***9,545***	***10,828***	***9,033***	***13,613***	***8,094***	***7,626***	***5,176***	***5,344***	***3,891***	***3,238***	***2,890***	***145***
Semi-Volatile Organic Compounds														
2-Methylphenol	ug/L	SW8270D	**156D**	**205D**	**115D**	**153D**	**60.4**	**43.7**	**24.9**	48.1	**41.7**	**58D**	**61.1**	NA
4-Methylphenol	ug/L	SW8270D	**28.8**	**57.4D**	**57.9D**	**56D**	**61.7**	**41.1**	**17.4**	42.2	**41.6**	**84.4D**	**79.4**	NA
bis(2-Ethylhexyl)phthalate	ug/L	SW8270D	3U	3U	3U	9U	**5.4**	**6**	**8.2**	3U	**5.1**	3U	3.4U	NA

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#D: The reported value is from a dilution.

#Q: The reported value is out of control with continuing calibration.

#E: The reported value is out of range and estimated.

#M: The reported value was confirmed but with low spectral match and value is estimated.

#H: The reported value was analyzed outside the holding time.

NA: Parameter not analyzed.

Table 14: LTT Liquid Analytical Results for AS Effluent

Parameter	Units	Analysis Method	Sample Date											
			6/19/17	6/27/17	7/5/17	7/12/17	7/28/17	8/7/17	8/15/17	8/22/17	8/30/17	9/7/17	9/12/17	9/19/17
Inorganics														
Arsenic, Dissolved	ug/L	E200.8	**7.64D**	**6.29**	**6.81D**	**5.77D**	**4.08**	**5.24**	**6.55D**	**8.83D**	**9.86D**	**8.84**	**9.2**	**11.5D**
Iron, Dissolved	ug/L	E200.8	**5130D**	**841D**	**974**	**168**	**239**	**437**	**432D**	**242D**	**142**	**174**	**252**	**131D**
Iron, Total	ug/L	E200.8	**32600D**	**29400D**	**38500D**	**39400D**	**16900D**	**10300D**	**5210D**	**2520D**	**1230**	**727**	**462**	**394D**
Manganese, Dissolved	ug/L	E200.8	**3600D**	**3310D**	**4480D**	**2620D**	**4020D**	**1800D**	**1980D**	**3010D**	**2760D**	**2200D**	**2760D**	**866D**
Manganese, Total	ug/L	E200.8	**4430D**	**4010D**	**4870D**	**4130D**	**4440D**	**2190D**	**2730D**	**3210D**	**2890D**	**2340D**	**2900D**	**1190D**
Total Dissolved Solids	mg/L	EPA 160.1	**1030**	**1100**	**1390**	**1330**	**1440**	**1330**	**1390**	**1480**	**1510**	**1470**	**1610**	NA
Chloride	mg/L	EPA 325.2	**112D**	**153D**	**271D**	**294D**	NA	**612D**	**257D**	NA	**286D**	**294D**	**306D**	NA
Nitrate + Nitrite	mg-N/L	EPA 353.2	0.01U	0.01U	0.01U	0.05U	NA	0.01U	0.02U	NA	0.01U	0.01U	0.05U	NA
N-Nitrate	mg/L	EPA 353.2	0.02U	0.02U	0.02U	0.07U	NA	0.03U	0.04U	NA	0.02U	0.02U	0.1U	NA
N-Nitrite	mg-N/L	EPA 353.2	0.01U	0.01U	0.01U	0.02U	NA	0.02U	0.02U	NA	0.01U	0.01U	0.05U	NA
Sulfate	mg/L	EPA 375.2	**12**	**18.4**	**26.7D**	**14.8D**	NA	**72.1D**	**104D**	NA	**218D**	**229D**	**243D**	NA
Total Petroleum Hydrocarbons														
Diesel Range Hydrocarbons	mg/L	NWTPHD	**3.55**	**2.08**	**2.51**	**2.28**	**4.81**	**4.15**	**3.12**	**3.65**	**2.49**	**2.58**	**2.63**	NA
Motor Oil	mg/L	NWTPHD	**1**	**0.77**	**1.28**	**0.499**	**2.22**	**1.18**	**0.874**	**1.79**	**0.981**	**1.1**	**1.17**	NA
Gasoline Range Hydrocarbons	ug/L	NWTPHG	**10800**	**7710**	**9260**	**2080**	**2330**	**448**	**528**	**183**	100U	**118**	**142**	100U
Volatile Organic Compounds														
1,1,1,2-Tetrachloroethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,1,1-Trichloroethane	ug/L	SW8260C	**3.53**	**3.56**	**7.58**	**2.86**	**6.02**	**0.68**	**1.18**	**0.46**	**0.22**	**0.29**	**0.37**	0.2U
1,1,2,2-Tetrachloroethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,1,2-Trichloroethane	ug/L	SW8260C	0.2U	2U	**0.32**	1U	**0.51**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,1-Dichloroethane	ug/L	SW8260C	**10.8**	**5.56**	**5.31**	**1.83**	**6.54**	**0.88**	**1.48**	**0.97**	**0.57**	**0.96**	**1.26**	0.2U
1,1-Dichloroethene	ug/L	SW8260C	**0.29**	2U	**0.32**	1U	**0.29**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,1-Dichloropropene	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,2,3-Trichlorobenzene	ug/L	SW8260C	0.5U	5U	0.5U	2.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
1,2,3-Trichloropropane	ug/L	SW8260C	0.5U	5U	0.5U	2.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
1,2,4-Trichlorobenzene	ug/L	SW8260C	**1.33**	5U	**1.1**	2.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
1,2,4-Trimethylbenzene	ug/L	SW8260C	**150**	**94.8**	**79**	**26.7**	**2.16**	**0.42**	**0.29**	**0.24**	**0.39**	**0.35**	**0.25**	0.2U
1,2-Dibromo-3-chloropropane	ug/L	SW8260C	0.5U	5U	0.5U	2.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
1,2-Dibromoethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,2-Dichlorobenzene	ug/L	SW8260C	**25.4**	**14.4**	**16.2**	**5.69**	**7.39**	**1.55**	**2**	**0.69**	**0.36**	**0.65**	**0.56**	0.2U
1,2-Dichloroethane	ug/L	SW8260C	**1.09**	2U	**1.58**	**1.01**	**3.36**	**0.62**	**1.03**	**0.74**	**0.42**	**0.76**	**0.79**	0.2U
1,2-Dichloropropane	ug/L	SW8260C	**3.82**	**2.8**	**4.01**	**1.55**	**6.09**	**1**	**1.93**	**1.17**	**0.77**	**1.49**	**1.94**	0.2U
1,3,5-Trimethylbenzene	ug/L	SW8260C	**72.2**	**38.7**	**41.8**	**12.3**	**20.7**	**3.15**	**3.13**	**0.58**	**0.39**	**0.56**	0.2U	0.2U
1,3-Dichlorobenzene	ug/L	SW8260C	**1.69**	2U	**1.12**	1U	**0.6**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,3-Dichloropropane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
1,4-Dichlorobenzene	ug/L	SW8260C	**10.3**	**5.57**	**6.41**	**1.72**	**2.18**	**0.55**	**0.6**	**0.44**	**0.24**	**0.35**	**0.43**	0.2U
2,2-Dichloropropane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
2-Butanone	ug/L	SW8260C	**9.71**	50U	**59.7**	**68.4**	5U	5U	**8.19**	5U	5U	5U	5U	5U
2-Chloroethylvinylether	ug/L	SW8260C	1U	10U	1U	5U	1U	1U	1U	1U	1U	1U	1U	1U
2-Chlorotoluene	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
2-Hexanone	ug/L	SW8260C	5U	50U	5U	25U	5U	5U	5U	5U	5U	5U	5U	5U
4-Chlorotoluene	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
4-Isopropyltoluene	ug/L	SW8260C	**3.24**	2U	**2.48**	1U	**0.64**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
4-Methyl-2-Pentanone (MIBK)	ug/L	SW8260C	**16**	50U	**62.7**	**42.5**	**20.7**	**7.52**	**25.6**	5U	5U	5U	5U	5U
Acetone	ug/L	SW8260C	**62.6**	**233**	**219**	**503**	**120**	**71.6**	**78.4**	**9.16B**	**9.21**	**9.18**	**8.01**	5U
Acrolein	ug/L	SW8260C	5U	50U	5U	25U	5U	5U	5U	5U	5U	5U	5U	5U
Acrylonitrile	ug/L	SW8260C	1U	10U	1U	5U	1U	1U	1U	1U	1U	1U	1U	1U
Benzene	ug/L	SW8260C	**0.81**	2U	**1**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Bromobenzene	ug/L	SW8260C	0.2U	2U	**0.5**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Bromochloromethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Bromodichloromethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U

Table 14: LTT Liquid Analytical Results for AS Effluent

		Analysis	**Sample Date**											
Parameter	**Units**	**Method**	**6/19/17**	**6/27/17**	**7/5/17**	**7/12/17**	**7/28/17**	**8/7/17**	**8/15/17**	**8/22/17**	**8/30/17**	**9/7/17**	**9/12/17**	**9/19/17**
Bromoethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Bromoform	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Bromomethane	ug/L	SW8260C	1U	10U	1U	5U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Disulfide	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Carbon Tetrachloride	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Chlorobenzene	ug/L	SW8260C	**0.37**	2U	**0.68**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Chloroethane	ug/L	SW8260C	**3.19**	**3.04Q**	**0.92**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Chloroform	ug/L	SW8260C	0.2U	2U	**0.23**	1U	**0.32**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Chloromethane	ug/L	SW8260C	0.5U	5U	0.5U	2.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
cis-1,2-Dichloroethene	ug/L	SW8260C	**3.58**	**11.5**	**16.3**	**4.34**	**9.48**	**1.87**	**4.26**	**2.15**	**1.28**	**2.2**	**2.7**	0.2U
cis-1,3-Dichloropropene	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Dibromochloromethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Dibromomethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Dichlorodifluoromethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Ethylbenzene	ug/L	SW8260C	**324**	**158**	**173**	**10.6**	**2.04**	**0.73**	**0.69**	**0.69**	**0.58**	**0.77**	**0.41**	0.2U
Hexachlorobutadiene	ug/L	SW8260C	0.5U	5U	0.5U	2.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Iodomethane	ug/L	SW8260C	1U	10U	1U	5U	1U	1U	1U	1U	1U	1U	1U	1U
Isopropylbenzene	ug/L	SW8260C	**17.8**	**7.4**	**10.8**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
m,p-Xylene	ug/L	SW8260C	**758**	**391**	**431**	**139**	**19.7**	**3.25**	**2.11**	**1.89**	**2.25**	**2.03**	**1.03**	0.4U
Methylene Chloride	ug/L	SW8260C	1U	10U	1U	5U	1U	1U	1U	1U	1U	1U	1U	1U
Naphthalene	ug/L	SW8260C	**92.2**	**93.4**	**71.1**	**24**	**10.1**	**1.73**	**3.23**	**0.65**	0.5U	**0.94**	**0.83**	0.5U
n-Butylbenzene	ug/L	SW8260C	**2.77**	2U	**2.96**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
n-Propylbenzene	ug/L	SW8260C	**34**	**16.2**	**20.1**	1U	**0.22**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
o-Xylene	ug/L	SW8260C	**303**	**164**	**177**	**74.2**	**79.1**	**12.3**	**16.9**	**4.61**	**2.19**	**3.32**	**1.29**	0.2U
sec-Butylbenzene	ug/L	SW8260C	**1.85**	2U	**1.2**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Styrene	ug/L	SW8260C	**0.72**	2U	**0.62**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
tert-Butylbenzene	ug/L	SW8260C	**0.33**	2U	**0.21**	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Tetrachloroethene	ug/L	SW8260C	0.2U	2U	**0.25**	1U	**0.67**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Toluene	ug/L	SW8260C	**1080**	**606**	**841**	**136**	**29.5**	**5.04**	**15.2**	**4.56**	**2.15**	**2.14**	**0.84**	0.2U
Total Xylenes	ug/L	SW8260C	**1060**	**555**	**608**	**213**	**110**	**15.6**	**19**	**6.5**	**4.44**	**5.35**	**2.33**	0.6U
trans-1,2-Dichloroethene	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
trans-1,3-Dichloropropene	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
trans-1,4-Dichloro-2-butene	ug/L	SW8260C	1U	10U	1U	5U	1U	1U	1U	1U	1U	1U	1U	1U
Trichloroethene	ug/L	SW8260C	0.2U	2U	**0.22**	1U	**0.72**	0.2U	**0.33**	0.2U	0.2U	0.2U	0.2U	0.2U
Trichlorofluoromethane	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Vinyl Acetate	ug/L	SW8260C	0.2U	2U	0.2U	1U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Vinyl Chloride	ug/L	SW8260C	**1.1**	2U	**0.35**	1U	**0.83**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
Total Detected VOCs	***ug/L***		***2,994.72***	***1,848.93***	***2,258.07***	***1,055.50***	***361.06***	***112.94***	***166.54***	***29***	***21.02***	***25.99***	***20.72***	***0***
Semi-Volatile Organic Compounds														
2-Methylphenol	ug/L	SW8270D	**75.3**	**28.8D**	**44.5**	**3.9**	**2.1**	1U	1U	1U	1U	1U	1.1U	NA
4-Methylphenol	ug/L	SW8270D	**5.2**	10U	**22.1**	**5.7**	2.1U	**2.8**	2U	2U	2U	2U	2.2U	NA
bis(2-Ethylhexyl)phthalate	ug/L	SW8270D	3U	15U	3U	3U	3.2U	3U	3U	3U	3U	3U	3.4U	NA

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#D: The reported value is from a dilution.

#Q: The reported value is out of control with continuing calibration.

#E: The reported value is out of range and estimated.

#M: The reported value was confirmed but with low spectral match and value is estimated.

#H: The reported value was analyzed outside the holding time.

NA: Parameter not analyzed.

Table 15: P1 Vapor Analytical Results for GAC1 Effluent

Volatile Organic Compounds (EPA Method TO-15)	Units	Sample Date							
		7/10/2017	7/18/2017	7/25/2017	8/3/2017	8/7/2017	8/15/2017	8/22/2017	10/3/2017
1,1,1-Trichloroethane	ug/m3	**490,000**	**14**	**28,000**	**15,000**	**36,000**	**12,000**	**8,400**	**8,500**
1,1,2,2-Tetrachloroethane	ug/m3	260000U	14U	840U	410U	770U	690U	690U	69U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/m3	290000U	15U	**2,800**	**1,600**	**3,200**	**1,500**	**840**	**660**
1,1,2-Trichloroethane	ug/m3	210000U	11U	670U	330U	610U	550U	550U	55U
1,1-Dichloroethane	ug/m3	110000U	**7.7**	**2,500**	**1,700**	**3,200**	**1,200**	**800**	**1,100**
1,1-Dichloroethene	ug/m3	300000U	16U	**680**	**450**	**1,000**	400U	400U	**300**
1,2,3-Trimethylbenzene	ug/m3	NA	NA	3000U	1500U	2800U	2500U	**3,600**	250U
1,2,4-Trichlorobenzene	ug/m3	1400000U	74U	910U	450U	830U	740U	740U	74U
1,2,4-Trimethylbenzene	ug/m3	370000U	20U	3000U	1500U	2800U	**6,100**	**12,000**	250U
1,2-Dibromoethane (EDB)	ug/m3	580000U	31U	940U	460U	860U	770U	770U	77U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ug/m3	290000U	15U	860U	**550jl**	790U	700U	700U	**340**
1,2-Dichlorobenzene	ug/m3	230000U	12U	1500U	720U	1400U	1200U	1200U	120U
1,2-Dichloroethane	ug/m3	300000U	16U	500U	240U	460U	400U	400U	**81**
1,2-Dichloropropane	ug/m3	180000U	9.2U	**630**	**350**	**1,000**	460U	460U	**230**
1,3,5-Trimethylbenzene	ug/m3	190000U	9.8U	**27,000**	1500U	**4,700**	**24,000**	**24,000**	250U
1,3-Butadiene	ug/m3	NA	NA	270U	130U	250U	220U	220U	22U
1,3-Dichlorobenzene	ug/m3	230000U	12U	1500U	720U	1400U	1200U	1200U	120U
1,4-Dichlorobenzene	ug/m3	230000U	12U	740U	360U	680U	600U	600U	60U
1,4-Dioxane	ug/m3	NA	NA	440U	220U	410U	360U	360U	36U
1-Butanol	ug/m3	NA	NA	7400U	3600U	6800U	6100U	6100U	610U
2-Butanone (MEK)	ug/m3	220000U	12U	3600U	1800U	3300U	2900U	2900U	290U
2-Hexanone	ug/m3	160000U	8.2U	5000U	2500U	4600U	4100U	4100U	410U
4-EthylToluene	ug/m3	190000U	9.8U	NA	NA	NA	NA	NA	NA
2-Pentanone	ug/m3	NA	NA	4300U	2100U	4000U	3500U	3500U	350U
2-Propanol	ug/m3	NA	NA	11000U	5200U	9700U	8600U	8600U	860U
3-Hexanone	ug/m3	NA	NA	5000U	2500U	4600U	4100U	4100U	410U
3-Pentanone	ug/m3	NA	NA	4300U	2100U	4000U	3500U	3500U	350U
4-Methyl-2-pentanone (MIBK)	ug/m3	160000U	8.2U	5000U	2500U	4600U	4100U	4100U	410U
Acetaldehyde	ug/m3	NA	NA	11000U	5400U	10000U	9000U	9000U	900U
Acetone	ug/m3	450000U	24U	5800U	2900U	5300U	4800U	4800U	480U
Acetonitrile	ug/m3	NA	NA	2100U	1000U	1900U	1700U	1700U	170U
Acrolein	ug/m3	NA	NA	1100U	550U	1000U	920U	920U	92U
Acrylonitrile	ug/m3	NA	NA	270U	130U	240U	220U	220U	22U
Benzene	ug/m3	120000U	6.4U	**1,100**	**590**	**1,600**	**570**	**410**	**570**
Benzyl chloride	ug/m3	390000U	21U	630U	310U	580U	520U	520U	52U
Bromodichloromethane	ug/m3	190000U	10U	820U	400U	750U	670U	670U	67U
Bromoform	ug/m3	390000U	21U	2500U	1200U	2300U	2100U	2100U	210U
Bromomethane	ug/m3	NA	NA	480U	230U	440U	390U	390U	39U
Butanal	ug/m3	290000U	16U	3600U	1800U	3300U	2900U	2900U	290U
Carbon disulfide	ug/m3	230000U	12U	7600U	3700U	7000U	6200U	6200U	620U
Carbon tetrachloride	ug/m3	470000U	25U	770U	380U	710U	630U	630U	63U
Chlorobenzene	ug/m3	NA	NA	**610**	280U	**1,300**	**700**	**640**	**530**
Chlorodifluoromethane	ug/m3	130000U	6.9U	**3,000jl**	**2,700jl**	**2,400**	**1,900**	**2,100**	**2,300**
Chloroethane	ug/m3	200000U	**25**	**560jl**	**400jl**	**380**	**290**	**270**	**290ca, jl**
Chloroform	ug/m3	140000U	7.3U	600U	290U	550U	490U	490U	**55**

Table 15: P1 Vapor Analytical Results for GAC1 Effluent

Volatile Organic Compounds		**Sample Date**							
(EPA Method TO-15)	**Units**	**7/10/2017**	**7/18/2017**	**7/25/2017**	**8/3/2017**	**8/7/2017**	**8/15/2017**	**8/22/2017**	**10/3/2017**
Chloromethane	ug/m3	150000U	8.3U	250U	120U	230U	210U	210U	21U
cis-1,2-Dichloroethene	ug/m3	150000U	**13**	**6,300**	**2,500**	**8,500**	**4,100**	**2,300**	**2,500**
cis-1,3-Dichloropropene	ug/m3	170000U	9.1U	560U	270U	510U	450U	450U	45U
Cyclohexane	ug/m3	NA	NA	8400U	4100U	7700U	6900U	6900U	**2,600**
Cyclopentane	ug/m3	NA	NA	350U	**360**	**380**	**300**	290U	**300**
Dibromochloromethane	ug/m3	320000U	17U	1000U	510U	960U	850U	850U	85U
Dichlorodifluoromethane	ug/m3	190000U	**150**	**810**	**790**	**830**	**830**	**3,500**	**1,200**
Ethanol	ug/m3	NA	NA	9200U	4500U	8500U	7500U	7500U	750U
Ethylbenzene	ug/m3	160000U	8.7U	**46,000**	**2,700**	**21,000**	**12,000**	**3,100**	**1,400**
Hexachlorobutadiene	ug/m3	2000000U	NA	1300U	640U	1200U	1100U	1100U	110U
Hexanal	ug/m3	NA	NA	5000U	2500U	4600U	4100U	4100U	410U
Hexane	ug/m3	NA	NA	**7,400**	**4,100**	**14,000**	**4,000**	3500U	**3,600**
Iodomethane	ug/m3	NA	NA	710U	350U	650U	580U	580U	58U
Isobutene	ug/m3	NA	NA	**3,000jl**	**3,100jl**	**2,600**	**1,900**	**1,900**	**1,800**
Isoprene	ug/m3	NA	110U	340U	170U	310U	280U	280U	**59**
m,p-Xylene	ug/m3	330000U	NA	**1,100,000**	**16,000**	**210,000**	**220,000**	**85,000**	**3,200**
Methacrolein	ug/m3	NA	NA	3500U	1700U	3200U	2900U	2900U	290U
Methyl t-butyl ether	ug/m3	NA	NA	2200U	1100U	2000U	1800U	1800U	180U
Methyl vinyl ketone	ug/m3	NA	17U	1400U	690U	1300U	1100U	1100U	110U
Methylene chloride	ug/m3	130000U	**20**	110000U	52000U	98000U	87000U	87000U	8700U
Naphthalene	ug/m3	NA	NA	640U	310U	590U	520U	520U	52U
o-Xylene	ug/m3	170000U	8.7U	**220,000**	**3,500**	**69,000**	**100,000**	**56,000**	**590**
Pentanal	ug/m3	NA	NA	4300U	2100U	4000U	3500U	3500U	350U
Pentane	ug/m3	NA	NA	3600U	1800U	3300U	3000U	3000U	**1,500**
Propene	ug/m3	NA	NA	840U	410U	770U	690U	690U	69U
Styrene	ug/m3	160000U	8.5U	1000U	510U	960U	850U	850U	85U
Tetrachloroethene	ug/m3	260000U	14U	**4,700**	**2,000**	**10,000**	**5,700**	**4,100**	**3,400**
Toluene	ug/m3	**12,000,000**	**7.9**	**600,000**	**100,000**	**1,000,000**	**410,000**	**110,000**	**55,000**
trans-1,2-Dichloroethene	ug/m3	150000U	7.9U	490U	240U	450U	400U	400U	40U
trans-1,3-Dichloropropene	ug/m3	170000U	9.1U	560U	270U	510U	450U	450U	45U
Trichloroethene	ug/m3	200000U	11U	**2,600**	**1,600**	**5,200**	**2,100**	**1,500**	**1,300**
Trichlorofluoromethane	ug/m3	210000U	11U	690U	340U	630U	560U	560U	**58**
Vinyl acetate	ug/m3	260000U	14U	8600U	4200U	7900U	7000U	7000U	700U
Vinyl chloride	ug/m3	97000U	**180***	**1,200jl**	**1000jl**	**980**	**840**	**920**	**860**
Total Detected VOCs	***ug/m3***	***12,490,000***	***418***	***2,058,890***	***160,990***	***1,397,270***	***810,030***	***321,380***	***94,323***

Bold: Parameter detected above lab reporting limit.
#U: Parameter not detected at associated lab reporting limit (#).
#jl: Lab control sample percent recovery and/or relative percent differences outside acceptable limits. Value reported is an estimate (#).
#ca: Calibration for parameter did not pass the acceptance criteria. Value reported is an estimate (#).
#ve: Parameter response exceeds instrument range. Value reported is an estimate (#).
NA: Parameter not analyzed.
*: Lab control sample is outside laboratory acceptance limits.

Table 16: P1 Vapor Analytical Results for GAC2 Effluent

Volatile Organic Compounds (EPA Method TO-15)	Units	Sample Date			
		7/18/2017	7/25/2017	8/15/2017	8/22/2017
1,1,1-Trichloroethane	ug/m3	**200,000**	**54,000**	**29,000**	**10,000**
1,1,2,2-Tetrachloroethane	ug/m3	37000U	4100U	3400U	690U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/m3	41000U	**7,300**	3800U	**940**
1,1,2-Trichloroethane	ug/m3	29000U	3300U	2700U	550U
1,1-Dichloroethane	ug/m3	16000U	**6,200**	**2,700**	**980**
1,1-Dichloroethene	ug/m3	44000U	2400U	2000U	400U
1,2,3-Trimethylbenzene	ug/m3	NA	15000U	12000U	2500U
1,2,4-Trichlorobenzene	ug/m3	200000U	4500U	3700U	740U
1,2,4-Trimethylbenzene	ug/m3	54000U	15000U	12000U	2500U
1,2-Dibromoethane (EDB)	ug/m3	85000U	4600U	3800U	770U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ug/m3	41000U	4200U	3500U	700U
1,2-Dichlorobenzene	ug/m3	32000U	7200U	6000U	1200U
1,2-Dichloroethane	ug/m3	45000U	2400U	2000U	400U
1,2-Dichloropropane	ug/m3	25000U	2800U	2300U	460U
1,3,5-Trimethylbenzene	ug/m3	27000U	15000U	12000U	2500U
1,3-Butadiene	ug/m3	NA	1300U	1100U	220U
1,3-Dichlorobenzene	ug/m3	32000U	7200U	6000U	1200U
1,4-Dichlorobenzene	ug/m3	32000U	3600U	3000U	600U
1,4-Dioxane	ug/m3	NA	2200U	1800U	360U
1-Butanol	ug/m3	NA	36000U	30000U	6100U
2-Butanone (MEK)	ug/m3	32000U	18000U	15000U	2900U
2-Hexanone	ug/m3	22000U	25000U	20000U	4100U
2-Pentanone	ug/m3	NA	21000U	18000U	3500U
2-Propanol	ug/m3	NA	52000U	43000U	8600U
3-Hexanone	ug/m3	NA	25000U	20000U	4100U
3-Pentanone	ug/m3	NA	21000U	18000U	3500U
4-Ethyltoluene	ug/m3	27000U	NA	NA	NA
4-Methyl-2-Pentanone (MIBK)	ug/m3	22000U	25000U	20000U	4100U
Acetaldehyde	ug/m3	NA	54000U	45000U	9000U
Acetone	ug/m3	64000U	29000U	24000U	4800U
Acetonitrile	ug/m3	NA	10000U	8400U	1700U
Acrolein	ug/m3	NA	5500U	4600U	920U
Acrylonitrile	ug/m3	NA	1300U	1100U	220U
Benzene	ug/m3	17000U	1900U	1600U	**610**
Benzyl chloride	ug/m3	57000U	3100U	2600U	520U
Bromodichloromethane	ug/m3	27000U	4000U	3400U	670U
Bromoform	ug/m3	56000U	12000U	10000U	2100U
Bromomethane	ug/m3	43000U	2300U	1900U	390U
Butanal	ug/m3	NA	18000U	15000U	2900U
Carbon disulfide	ug/m3	34000U	37000U	31000U	6200U
Carbon tetrachloride	ug/m3	69000U	3800U	3100U	630U
Chlorobenzene	ug/m3	18000U	2800U	2300U	**870**
Chlorodifluoromethane	ug/m3	NA	**7,400jl**	**2,000**	**2,200**
Chloroethane	ug/m3	29000U	1600U	1300U	260U
Chloroform	ug/m3	20000U	2900U	2400U	490U

Table 16: P1 Vapor Analytical Results for GAC2 Effluent

Volatile Organic Compounds (EPA Method TO-15)	Units	Sample Date			
		7/18/2017	7/25/2017	8/15/2017	8/22/2017
Chloromethane	ug/m3	23000U	1200U	1000U	210U
cis-1,2-Dichloroethene	ug/m3	**27,000**	**13,000**	**5,900**	**3,600**
cis-1,3-Dichloropropene	ug/m3	25000U	2700U	2300U	450U
Cyclohexane	ug/m3	NA	41000U	34000U	6900U
Cyclopentane	ug/m3	NA	1700U	1400U	290U
Dibromochloromethane	ug/m3	46000U	5100U	4300U	850U
Dichlorodifluoromethane	ug/m3	27000U	3000U	2500U	**3,800**
Ethanol	ug/m3	NA	45000U	38000U	7500U
Ethylbenzene	ug/m3	23000U	**110,000**	**9,400**	**14,000**
Hexachlorobutadiene	ug/m3	290000U	6400U	5300U	1100U
Hexanal	ug/m3	NA	25000U	20000U	4100U
Hexane	ug/m3	NA	21000U	18000U	3500U
Iodomethane	ug/m3	NA	3500U	2900U	580U
Isobutene	ug/m3	NA	**7200jl**	4600U	**2,000**
Isoprene	ug/m3	NA	1700U	1400U	280U
m,p-Xylene	ug/m3	48000U	**23,000**	**47,000**	**180,000**
Methacrolein	ug/m3	NA	17000U	14000U	2900U
Methyl t-butyl ether	ug/m3	NA	11000U	9000U	1800U
Methyl vinyl ketone	ug/m3	NA	6900U	5700U	1100U
Methylene chloride	ug/m3	19000U	520000U	430000U	87000U
Naphthalene	ug/m3	NA	3100U	2600U	520U
o-Xylene	ug/m3	23000U	2600U	**6,900**	**63,000**
Pentanal	ug/m3	NA	21000U	18000U	3500U
Pentane	ug/m3	NA	18000U	15000U	3000U
Propene	ug/m3	NA	4100U	3400U	690U
Styrene	ug/m3	23000U	5100U	4300U	850U
Tetrachloroethene	ug/m3	37000U	**25,000**	**5,400**	**7,500**
Toluene	ug/m3	**1,500,000**	**2,800,000**	**230,000**	**240,000**
trans-1,2-Dichloroethene	ug/m3	21000U	2400U	2000U	400U
trans-1,3-Dichloropropene	ug/m3	25000U	2700U	2300U	450U
Trichloroethene	ug/m3	29000U	**5,800**	2700U	**2,300**
Trichlorofluoromethane	ug/m3	30000U	3400U	2800U	560U
Vinyl acetate	ug/m3	39000U	42000U	35000U	7000U
Vinyl chloride	ug/m3	14000U	**2,900jl**	1300U	**980**
Total VOCs	***ug/m3***	***1,727,000***	***3,061,800***	***338,300***	***532,780***

Bold: Parameter detected above lab reporting limit.

#U: Parameter not detected at associated lab reporting limit (#).

#jl: Lab control sample percent recovery and/or relative percent differences outside acceptable limits. Value reported is an estima

#ca: Calibration for parameter did not pass the acceptance criteria. Value reported is an estimate (#).

#ve: Parameter response exceeds instrument range. Value reported is an estimate (#).

NA: Parameter not analyzed.

Table 17: MPE Treatment Facility Emissions

Volatile Organic Compounds (EPA Method TO-15)	VTT Vapor VOCs Cumulative Mass (kg)	Evaporation Pond VOCs Cumulative Mass (kg)	Combined VOCs Cumulative Mass (kg)	Combined VOCs Cumulative Mass (lb)	Emissions (lb/yr)	SQER (lb/yr)	de Minimis (lb/yr)	Does Change Exceed de Minimis? (Yes, No)	Does Change Exceed SQER? (Yes, No)
1,1,1,2-Tetrachloroethane (water)		0	0	0	0	26	1	No	No
1,1,1-Trichloroethane (water and vapor)	2.597359801	0.001437309	2.59879711	5.729360084	0.000127617	47,815	2,398	No	No
1,1,2,2-Tetrachloroethane (water and vapor)	0	0	0	0	0	3	0	No	No
1,1,2-Trichloro-1,2,2-trifluoroethane (water and vapor)	0.065355318	0	0.065355318	0.144083641	3.20935E-06				
1,1,2-Trichloroethane (water and vapor)	0	3.19799E-05	3.19799E-05	7.05036E-05	1.57041E-09	12	1	No	No
1,1-Dichloroethane (water and vapor)	0.102894509	0.002129842	0.105024351	0.231538785	5.15734E-06	120	6	No	No
1,1-Dichloroethene (water and vapor)	0	5.7268E-05	5.7268E-05	0.000126254	2.81221E-09				
1,1-Dichloropropene (water)		0	0	0	0				
1,2,3-Trimethylbenzene (vapor)	0		0	0	0				
1,2,3-Trichlorobenzene (water)		0	0	0	0				
1,2,3-Trichloropropane (water)		0	0	0	0	88	4	No	No
1,2,4-Trichlorobenzene (water and vapor)	0	0.000215724	0.000215724	0.000475589	1.05934E-08				
1,2,4-Trimethylbenzene (water and vapor)	0	0.029965503	0.029965503	0.066062548	1.47149E-06				
1,2-Dibromo-3-chloropropane (water)		0	0	0	0	0	0	No	No
1,2-Dibromoethane (water and vapor)	0	0	0	0	0	3	0	No	No
1,2-Dichloro-1,1,2,2-Tetrafluoroethane (vapor)	0		0	0	0				
1,2-Dichlorobenzene (water and vapor)	0	0.005313805	0.005313805	0.01171492	2.6094E-07				
1,2-Dichloroethane (water and vapor)	0	0.000328185	0.000328185	0.000723522	1.61159E-08	7	0	No	No
1,2-Dichloropropane (water and vapor)	0	0.0010997	0.0010997	0.002424421	5.4002E-08	19	1	No	No
1,3,5-Trimethylbenzene (water and vapor)	0	0.014409338	0.014409338	0.031767115	7.07587E-07				
1,3-Butadiene (vapor)	0		0	0	0	1	0	No	No
1,3-Dichlorobenzene (water and vapor)	0	0.000260626	0.000260626	0.000574582	1.27984E-08				
1,3-Dichloropropane (water)		0	0	0	0				
1,4-Dichlorobenzene (water and vapor)	0	0.002089178	0.002089178	0.004605843	1.02591E-07	17	1	No	No
2,2-Dichloropropane (water)		0	0	0	0				
1,4-Dioxane (vapor)	0		0	0	0	25	1	No	No
1-Butanol (vapor)	0		0	0	0				
2-Butanone (water and vapor)	0	0.007820365	0.007820365	0.017240933	3.84028E-07				
2-Chloroethylvinylether (water)		0	0	0	0				
2-Chlorotoluene (water)		0	0	0	0				
2-Hexanone (water and vapor)	0	0	0	0	0				
2-Pentanone (vapor)	0		0	0	0				
2-Propanol (vapor)	0		0	0	0				
3-Hexanone (vapor)	0		0	0	0				
3-Pentanone (vapor)	0		0	0	0				
4-Chlorotoluene (water)		0	0	0	0				
4-Ethyltoluene (vapor)	0		0	0	0				
4-Isopropyltoluene (water)		0.000518679	0.000518679	0.00114349	2.54703E-08				
4-Methyl-2-Pentanone (MIBK) (water and vapor)	0	0.008297873	0.008297873	0.018293656	4.07476E-07				
Acetaldehyde (vapor)	0		0	0	0	71	4	No	No

Table 17: MPE Treatment Facility Emissions

Volatile Organic Compounds (EPA Method TO-15)	VTT Vapor VOCs Cumulative Mass (kg)	Evaporation Pond VOCs Cumulative Mass (kg)	Combined VOCs Cumulative Mass (kg)	Combined VOCs Cumulative Mass (lb)	Emissions (lb/yr)	SQER (lb/yr)	de Minimis (lb/yr)	Does Change Exceed de Minimis? (Yes, No)	Does Change Exceed SQER? (Yes, No)
Acetone (water and vapor)	0	0.0622017	0.0622017	0.137131111	3.05449E-06				
Acetonitrile (vapor)	0		0	0	0	11,500	576	No	No
Acrolein (water and vapor)	0	0	0	0	0	3	0	No	No
Acrylonitrile (water and vapor)	0	0	0	0	0	1	0	No	No
Benzene (water and vapor)	0.009931268	0.000157169	0.010088437	0.02224117	4.95404E-07	7	0	No	No
Benzyl Chloride (vapor)	0		0	0	0	4	0	No	No
Bromobenzene (water)		3.90638E-05	3.90638E-05	8.61209E-05	1.91827E-09				
Bromochloromethane (water)		0	0	0	0				
Bromodichloromethane (water and vapor)	0	0	0	0	0	5	0	No	No
Bromoethane (water)		0	0	0	0				
Bromoform (water and vapor)	0	0	0	0	0	174	9	No	No
Bromomethane (water and vapor)	0	0	0	0	0				
Butanal (vapor)	0		0	0	0				
Carbon Disulfide (water and vapor)	0	0	0	0	0	38,325	1,920	No	No
Carbon Tetrachloride (water and vapor)	0	0	0	0	0	5	0	No	No
Chlorobenzene (water and vapor)	0.014164268	8.9232E-05	0.0142535	0.03142355	6.99934E-07	47,815	2,398	No	No
Chlorodifluoromethane (vapor)	0.078254223		0.078254223	0.172520826	3.84276E-06	2,398,050	119,720	No	No
Chloroethane (water and vapor)	0	0.000648523	0.000648523	0.001429748	3.18465E-08				
Chloroform (water and vapor)	0	2.23484E-05	2.23484E-05	4.92697E-05	1.09744E-09	8	0	No	No
Chloromethane (water and vapor)	0	0	0	0	0				
cis-1,2-Dichloroethene (water and vapor)	0.459089333	0.002962293	0.462051626	1.018648256	2.26896E-05				
cis-1,3-Dichloropropene (water and vapor)	0	0	0	0	0				
Cyclohexane (vapor)	0		0	0	0	287985	14,381	No	No
Cyclopentane (vapor)	0		0	0	0				
Dibromochloromethane (water and vapor)	0	0	0	0	0	7	0	No	No
Dibromomethane (water)		0	0	0	0				
Dichlorodifluoromethane (water and vapor)	0.061866916	0	0.061866916	0.136393041	3.03805E-06				
Ethanol (vapor)	0		0	0	0				
Ethylbenzene (water and vapor)	1.136811926	0.05930563	1.196117556	2.636984685	5.87367E-05	76.8	4	No	No
Hexachlorobutadiene (water and vapor)	0	0	0	0	0	8.73	0	No	No
Hexanal (vapor)	0		0	0	0				
Hexane (vapor)	0		0	0	0				
Iodomethane (water and vapor)	0	0	0	0	0				
Isobutene (vapor)	0.04182955		0.04182955	0.092218262	2.05409E-06				
Isoprene (vapor)	0		0	0	0				
Isopropylbenzene (water)		0.003226674	0.003226674	0.00711359	1.5845E-07				
m,p-Xylene (water and vapor)	3.861644587	0.146489042	4.008133629	8.836411561	0.000196824	21170	1,059	No	No
Methacrolein (vapor)	0		0	0	0				
Methyl t-butyl ether (vapor)	0		0	0	0				
Methyl vinyl ketone (vapor)	0		0	0	0				

Table 17: MPE Treatment Facility Emissions

Volatile Organic Compounds (EPA Method TO-15)	VTT Vapor VOCs Cumulative Mass (kg)	Evaporation Pond VOCs Cumulative Mass (kg)	Combined VOCs Cumulative Mass (kg)	Combined VOCs Cumulative Mass (lb)	Emissions (lb/yr)	SQER (lb/yr)	de Minimis (lb/yr)	Does Change Exceed de Minimis? (Yes, No)	Does Change Exceed SQER? (Yes, No)
Methylene Chloride (water and vapor)	0	0	0	0	0				
Naphthalene (water and vapor)	0	0.023640314	0.023640314	0.05211791	1.16088E-06	5.64	0	No	No
n-Butylbenzene (water)		0.000501559	0.000501559	0.001105746	2.46296E-08				
n-Propylbenzene (water)		0.006305243	0.006305243	0.013900664	3.09626E-07				
o-Xylene (water and vapor)	1.139231558	0.061375787	1.200607345	2.646882965	5.89572E-05	10585	529	No	No
Pentanal (vapor)	0		0	0	0				
Pentane (vapor)	0		0	0	0				
Propene (vapor)	0		0	0	0				
sec-Butylbenzene (water)		0.000274279	0.000274279	0.000604681	1.34688E-08				
Styrene (water and vapor)	0	0.000118698	0.000118698	0.000261684	5.82879E-09	43070	2,157	No	No
tert-Butylbenzene (water)		4.86087E-05	4.86087E-05	0.000107164	2.38699E-09				
Tetrachloroethene (water and vapor)	0.382374552	2.87005E-05	0.382403252	0.843053858	1.87783E-05				
Toluene (water and vapor)	38.79319128	0.228858443	39.02204973	86.02879127	0.001916222	239,805	12,009	No	No
trans-1,2-Dichloroethene (water and vapor)	0	0	0	0	0	38,690	1,935	No	No
trans-1,3-Dichloropropene (water and vapor)	0	0	0	0	0				
trans-1,4-Dichloro-2-butene (water)		0	0	0	0				
Trichloroethene (water and vapor)	0.077212628	2.91106E-05	0.077241739	0.170288682	3.79304E-06				
Trichlorofluoromethane (water and vapor)	0	0	0	0	0				
Vinyl Acetate (water and vapor)	0	0	0	0	0	9,600	478	No	No
Vinyl Chloride (water and vapor)	0.035838584	0.000146042	0.035984626	0.079332426	1.76707E-06	2	0	No	No
Total VOCs	***48.86***	***0.67***	***49.53***	***109.19***	***0.002432***				

Notes:

1. Toxic air pollutant regulatory information based on WAC 173-460-150.
2. Regulatory values for m,p-Xylene are based on the combined WAC 173-460-150 values for m-Xylene and p-Xylene.
3. VOCs with toxic air pollutant regulatory information not listed in WAC 173-460-150 are identified with grey shading. ▨
4. Emission period was a 123-day treatment accumulation period (time for evaporation not included). Emissions (lb/yr) is an extrapolation of the data over 1 year.
5. LTT vapor emissions through GAC3 were intermittent and not considered full breakthrough during the pilot test. Therefore, no GAC3 effluent laboratory data were generated, and the emsissions are assumed to be zero.
6. Emissions, de Minimis, and SQER are shown in lb/yr for comparison. Some substances in the table have different emissions averaging periods.
7. Data are based on 1-minute flowrate increments.

This Page Intentionally Left Blank

Table 18: Specific Capacity during Vapor Extraction

Representative Date and Time	Effective Vacuum at MPE Wells (inches-Hg)	Observed Total Discharge from MPE Wells (scfm)	Calculated Discharge of Individual Wells			Specific Capacity of Individual Wells (scfm/inch-Hg)	Specific Capacity of Individual Wells (acfm/inch-Hg)
			MPE Well	Percent of Total Vacuum Going to Specified Well	Discharge from MPE Well (scfm)		
8/6/17 2:13 AM	3.4	38.4	MW-34p1	65%	24.9	7.3	9.0
8/6/17 2:13 AM	3.5		MW-68p1	35%	13.5	3.8	4.7
8/7/17 2:06 PM	6.9	61.4	MW-34p1	65%	39.9	5.8	8.7
8/7/17 2:06 PM	7.0		MW-68p1	35%	21.6	3.1	4.6
8/18/17 1:29 AM	10.3	75.9	MW-34p1	65%	49.3	4.8	8.8
8/18/17 1:29 AM	10.6		MW-68p1	35%	26.7	2.5	4.6
9/11/17 9:56 AM	11.3	69.4	MW-34p1	65%	45.0	4.0	7.7
9/11/17 9:56 AM	11.6		MW-68p1	35%	24.4	2.1	4.0
9/22/17 10:50 AM*	11.5	45.4	MW-34p1	100%	45.4	3.9	7.4
9/30/17 10:12 AM*	12.3	26.3	MW-68p1	100%	26.3	2.1	4.0

*: Individual well test period, used as a basis for allocating total flows.
inches-Hg: inches mercury.
scfm: standard cubic feet per minute.

This Page Intentionally Left Blank

Table 19. Pilot Test IRA Cost Summary

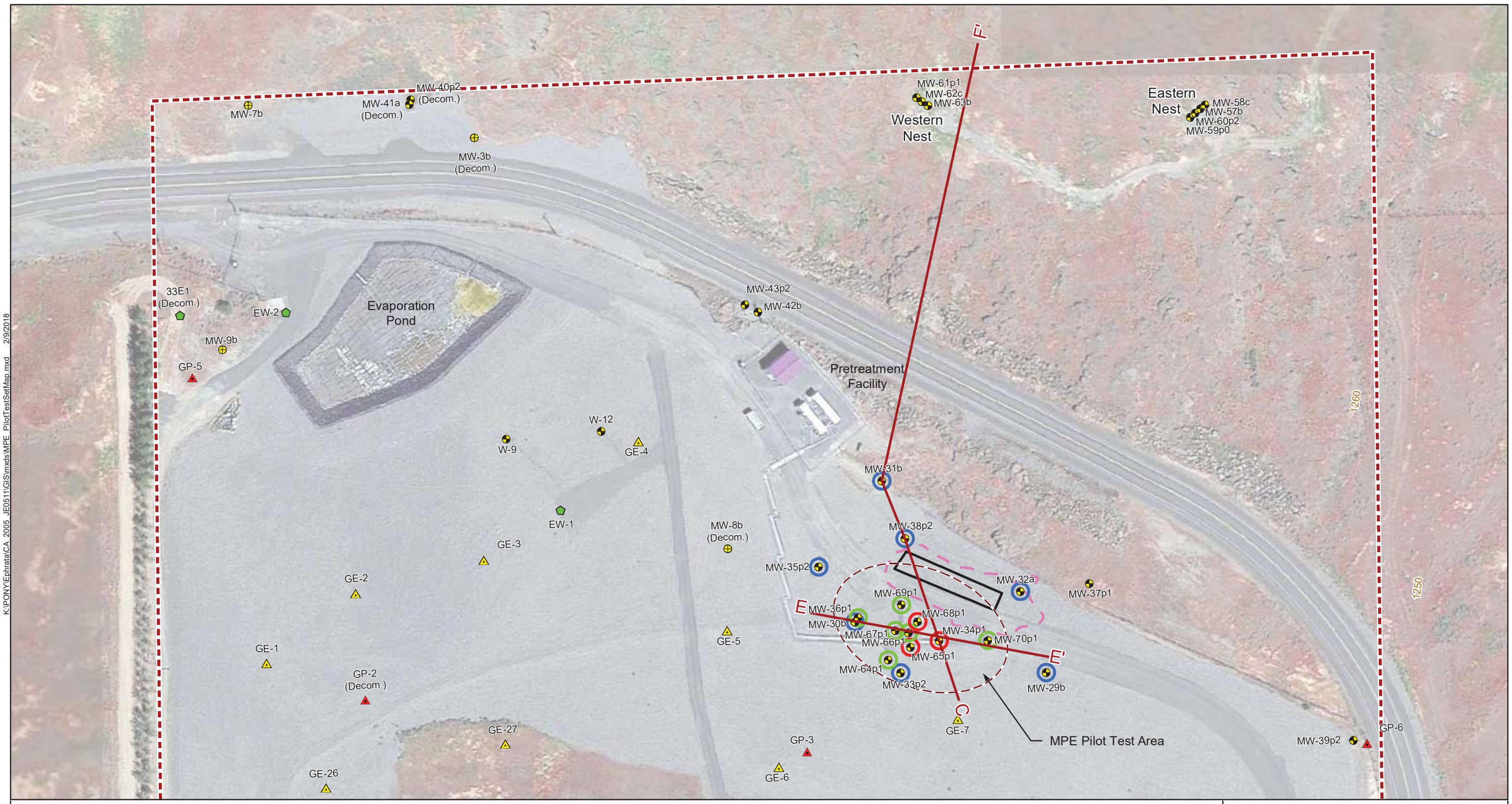
Phase	Cost Category	Budgeted Cost	Change	Final Cost
IRAP	Parametrix	$175,000	$0	$175,000
	PGG	$50,408	$0	$50,408
	Subtotal	**$225,408**	**$0**	**$225,408**
Well Drilling and Testing	Parametrix	$13,208	($12,953)	$255
	PGG	$108,811	$19,529	$128,340
	Well Drilling Contract	$299,474	($34,008)	$265,466
	Geology Laboratory	$17,361	($15,947)	$1,414
	Analytical Laboratory	$14,832	($4,979)	$9,853
	Other Direct Costs	$19,556	($5,192)	$14,364
	Subtotal	**$473,242**	**($53,551)**	**$419,691**
MPE System Planning, Design, and Permitting	Parametrix	$662,471	$4,731	$667,202
	PGG	$10,000	$0	$10,000
	Subtotal	**$672,471**	**$4,731**	**$677,202**
MPE System Construction	Parametrix	$330,975	$301,899	$632,874
	PGG	$5,000	$0	$5,000
	Grant County Regional Landfill	$0	$20,736	$20,736
	Construction Contract	$1,550,616	$242,737	$1,793,353
	Other Direct Costs	$21,000	$26,000	$47,000
	Subtotal	**$1,907,591**	**$591,372**	**$2,498,963**
Pilot Test, Including Phase 2 Work Plan	Parametrix	$175,957	$194,043	$370,000
	PGG	$171,615	$29,248	$200,863
	Analytical Laboratory	$31,500	$51,279	$82,779
	Other Direct Costs	$82,028	$27,631	$109,659
	Subtotal	**$461,100**	**$302,201**	**$763,301**
Grand Total		**$3,739,812**	**$844,753**	**$4,584,565**

Note: Costs include applicable Washington State Sales Tax (7.9%).

Figures

This Page Intentionally Left Blank

K:\PONY\Ephrata\CA_2005_JE0511\GIS\mxds\MPE_PilotTestSetMap.mxd 2/9/2018



Existing Wells

- ⊕ Quarterly Monitoring Well (MW)
- ● Remedial Investigation Monitoring Well (MW)
- ▲ Gas Extraction (GE)
- ▲ Gas Probe (GP)
- ⬟ Other Well

- ▭ Footprint of Drums Removed in 2008
- ⬚ Extent of Soil Removal to Bedrock in 2008
- ⬚ Groundwater Point of Compliance
- — Cross Section Alignment

Pilot Test Wells

- ○ P1 MPE
- ○ P1 Observation
- ○ Other Observation

0 Feet 100

N

Google Earth Aerial Photo 2017

Figure 1

MPE Pilot Test Site Map

Ephrata Landfill

PGG

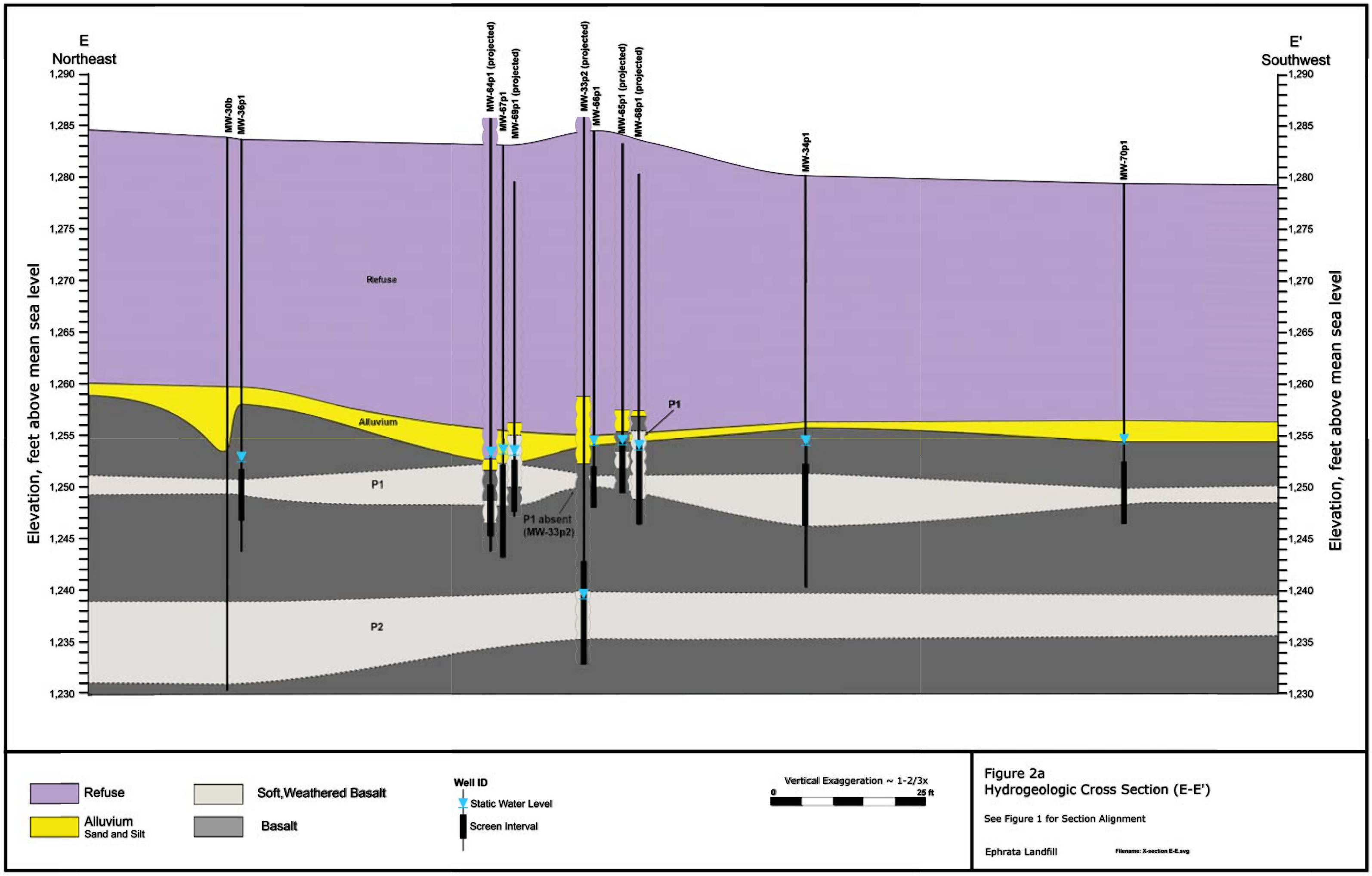
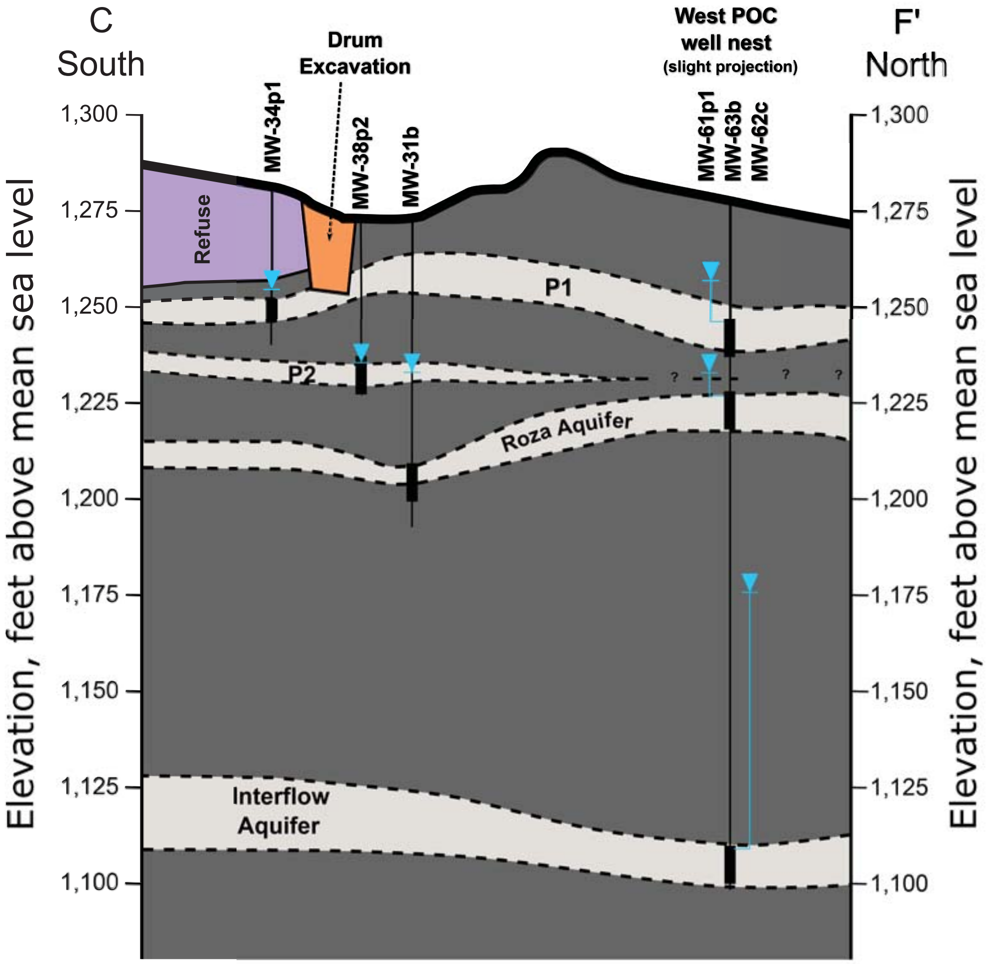


Figure 2a
Hydrogeologic Cross Section (E-E')

See Figure 1 for Section Alignment

Ephrata Landfill

Filename: X-section E-E.svg



Details of p1 and basalt top at former drum cache not shown.
See ranges of contacts disclosed in new p1 borings near former drum cache.

Vertical Exaggeration ~5x
0 Feet 250

▨ Refuse

▨ Soft,Weathered Basalt

▨ Basalt

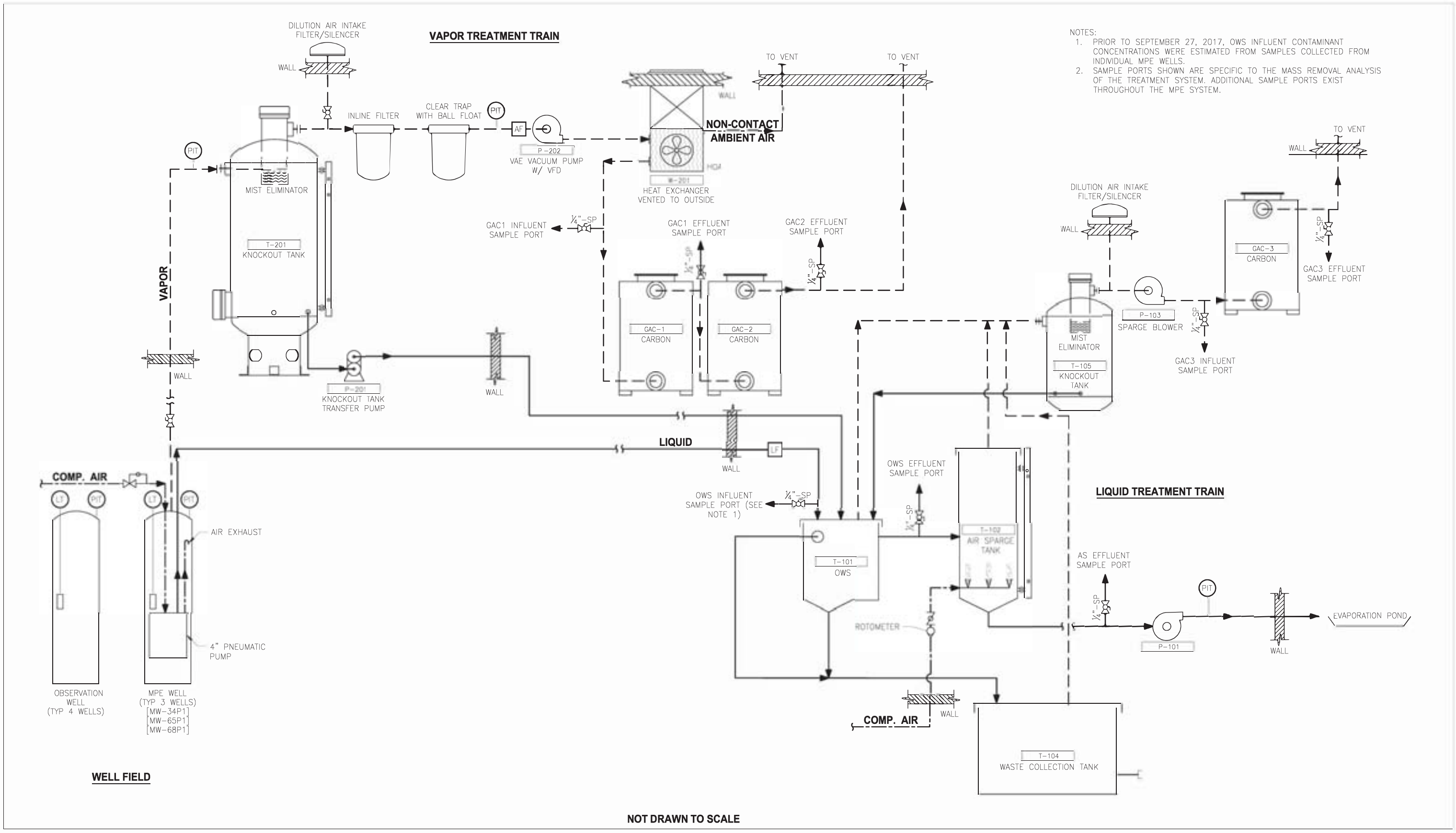
Well ID
▼ Static Water Level
Screen Interval

Figure 2b
Hydrogeologic Cross Section (C-F')

See Figure 1 for Section Alignment

Ephrata Landfill

Filename: X-section C-D.svg



NOTES:
1. PRIOR TO SEPTEMBER 27, 2017, OWS INFLUENT CONTAMINANT CONCENTRATIONS WERE ESTIMATED FROM SAMPLES COLLECTED FROM INDIVIDUAL MPE WELLS.
2. SAMPLE PORTS SHOWN ARE SPECIFIC TO THE MASS REMOVAL ANALYSIS OF THE TREATMENT SYSTEM. ADDITIONAL SAMPLE PORTS EXIST THROUGHOUT THE MPE SYSTEM.

LEGEND

PIT	PRESSURE INDICATING TRANSMITTER
LT	LIQUID LEVEL TRANSMITTER
LF	LIQUID FLOW METER
AF	AIR FLOW METER
————	LIQUID PIPING
— — — —	VAPOR PIPING
—·—·—	AIR PIPING

Figure 3
Treatment Trains Schematic

K:\PONY\Ephrata\CA 2005 JE0511\GIS\mxds\P1Drawdown.mxd 2/2/2018

● Observation Well

▭ Footprint of Drums Removed in 2008

▭ Extent of Soil Removal to Bedrock in 2008

— Vadose Zone Thickness Contour (in Feet)

1.88 - feet above top of P1 (Red)

1.04 - feet below top of P1 (Blue)

* Water levels in MW-34p1, MW-65p1, and MW-68p1 are below the transducer and may be below the actuation level of the well pump. Transducers in these wells are located at the top of the pump, and the actuation level of the pump (i.e., the level required to make the pump cycle) is about 0.3 foot below the transducer.

N

0 Feet 30

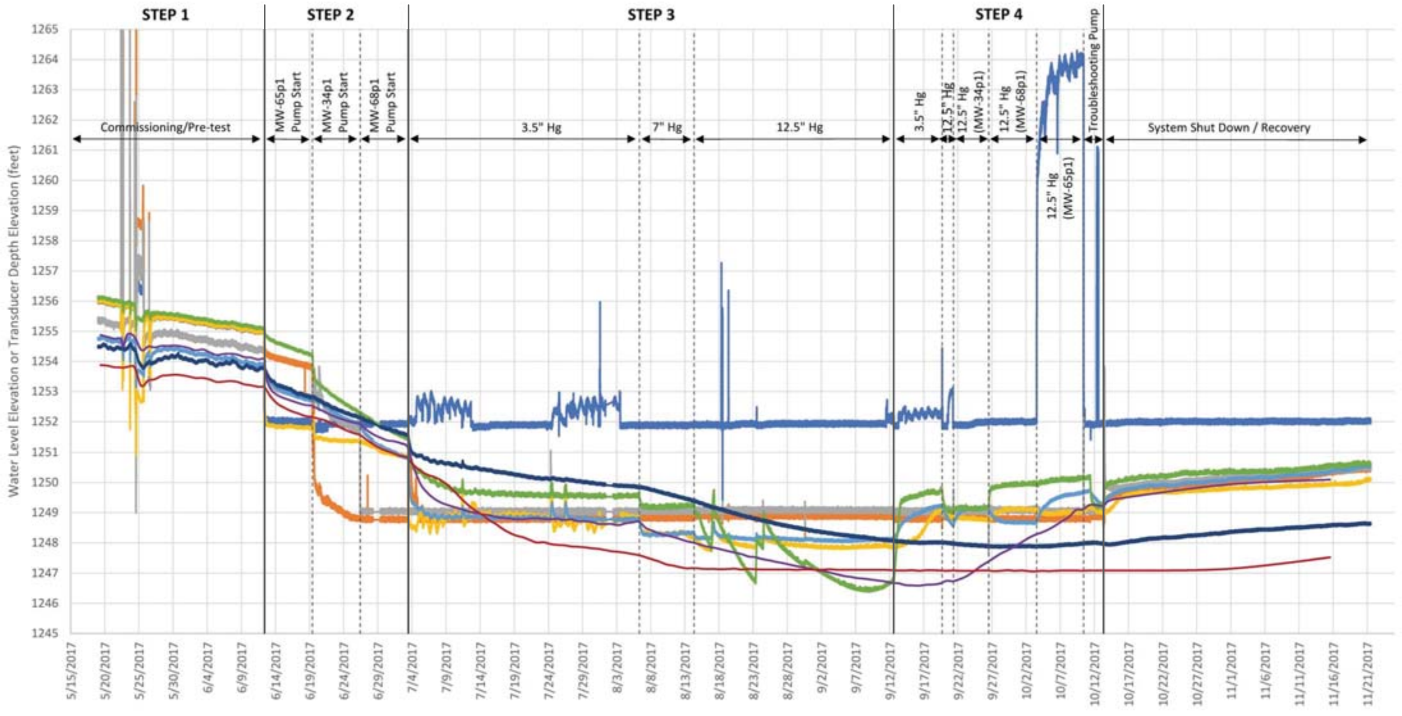
2017 Aerial photo from Google Earth

Figure 4
Thickness of P1 Vadose Zone on 6/12/17 (Pre-test)

Ephrata Landfill

PGG

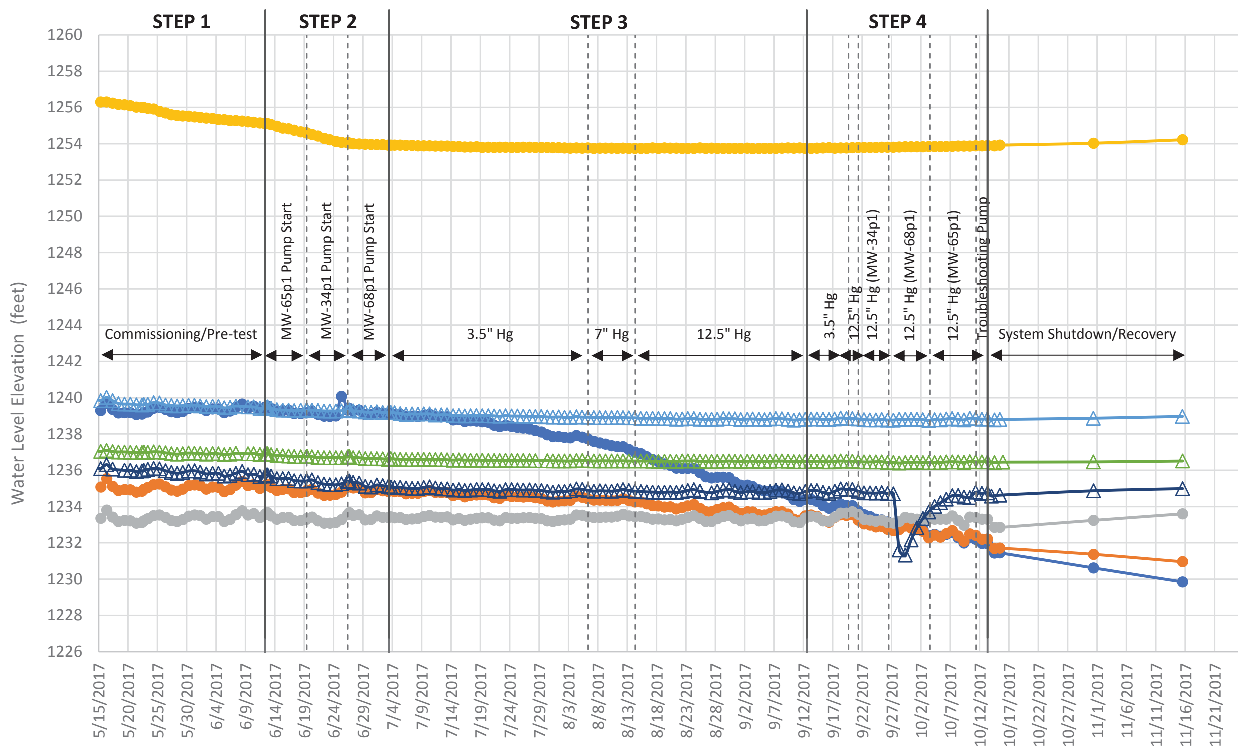
This Page Intentionally Left Blank



Note:
Water levels in MPE Wells MW-34p1, MW-68p1, and MW-65p1 dropped below level of transducer (at top of pump) by start of Step 3 and then plot as fairly straight lines at the level of the transducer. Water level in MW-36p1 dropped to bottom of well by start of the 12.5" Hg step and then plots as fairly straight line until recovery after test. Periodic fluctuations in MW-65p1 water levels are related to pump troubleshooting (see main text).

Figure 5
Water Level Time Series - P1

Ephrata Landfill MPE Pilot Test 2017



LEGEND

- ● MW-29b (Roza Aquifer)
- ● MW-30b (Roza Aquifer)
- ● MW-31b (Roza Aquifer)
- ● MW-32a (Drum Area Backfill)
- △ MW-33p2
- △ MW-35p2
- △ MW-38p2

Note:
Sudden drop and recovery of water level in MW-38p2 on 9/28 from bi-annual sampling of that well.

Figure 6
Water Level Time Series - Drum Area Backfill, P2, and Roza Aquifer

Ephrata Landfill MPE Pilot Test 2017

PGG

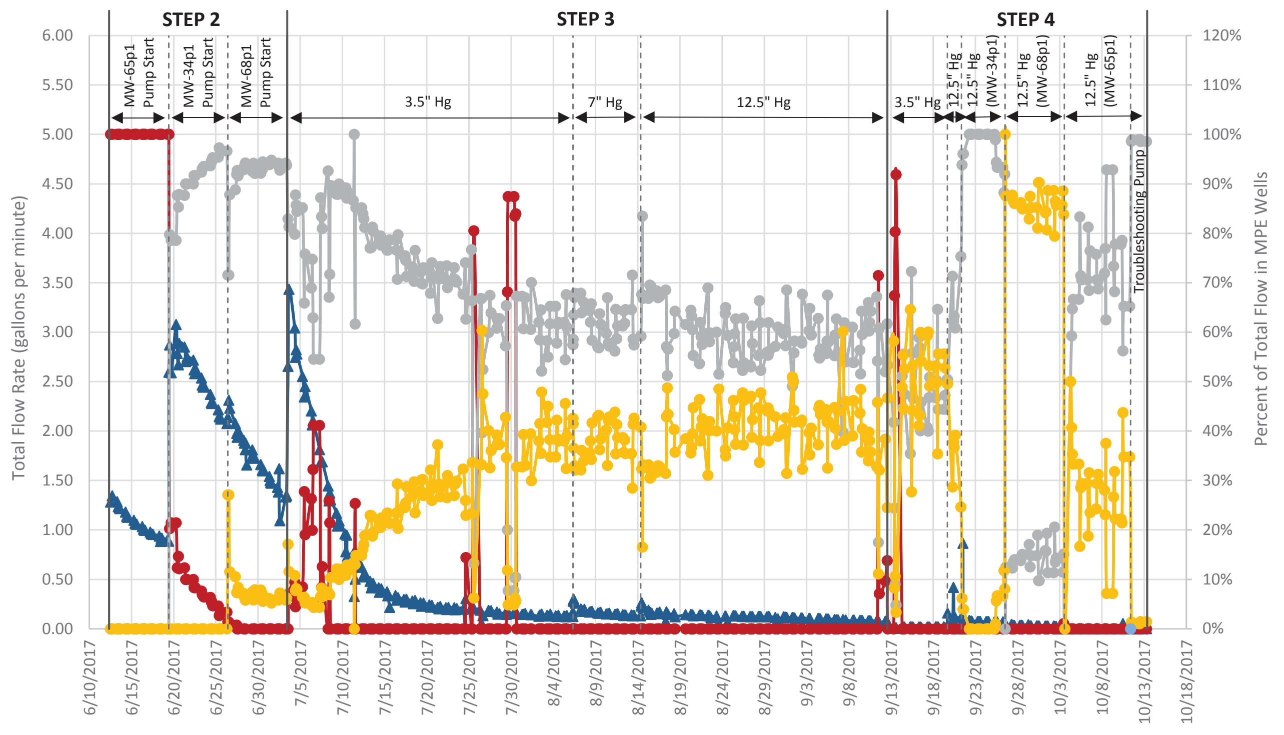
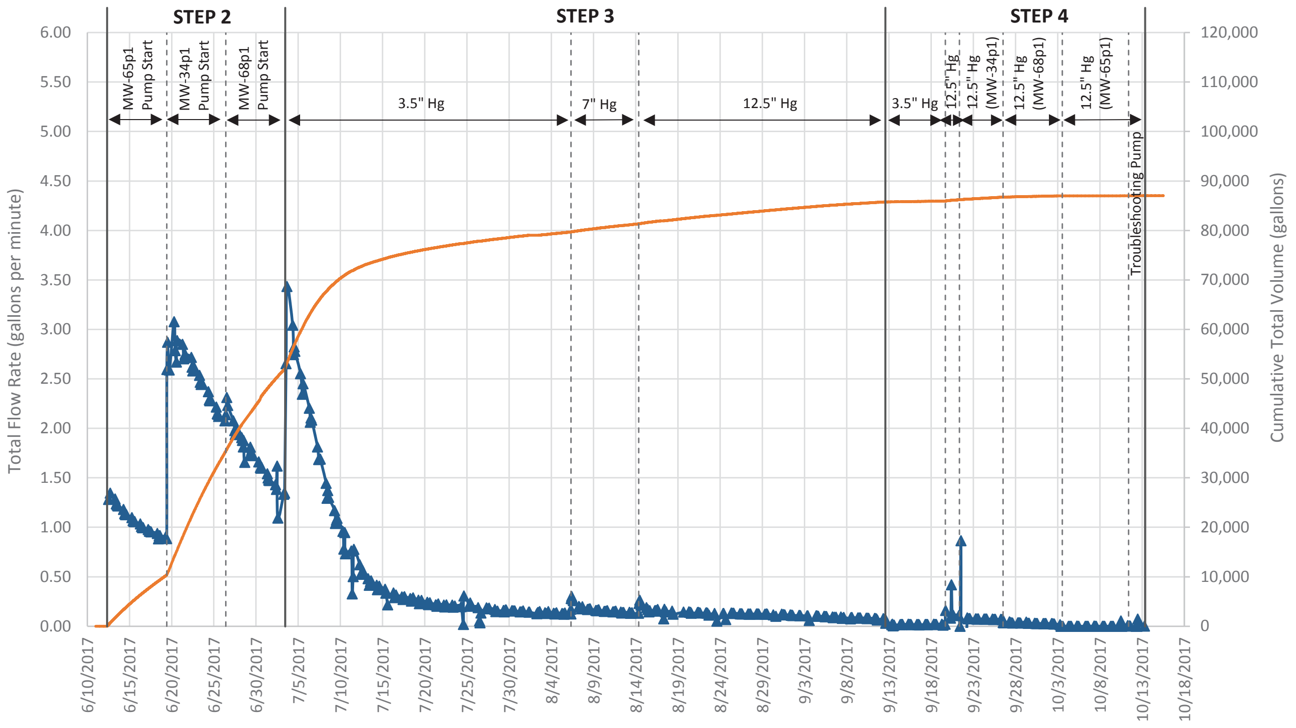


Figure 7
Total Liquid Flow Rate over Time and Percentage of Flow at Each MPE Well

Ephrata Landfill MPE Pilot Test 2017



LEGEND

▲ Total Flow Rate (gpm)

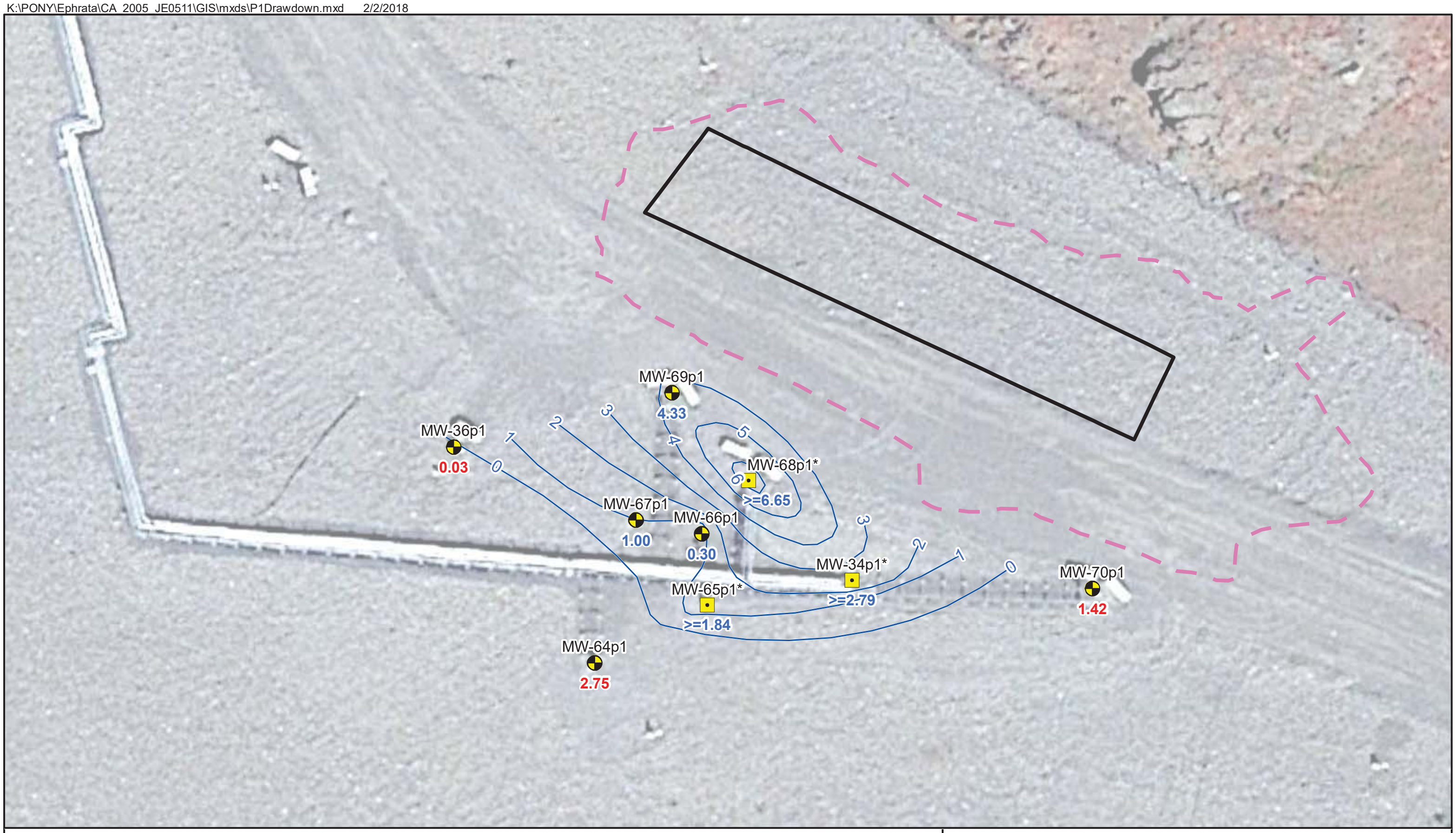
— Cumulative Total Volume (gallons)

Figure 8
Total Liquid Flow Rate and Cumulative Total Liquid Volume Extracted over Time

PgG

Ephrata Landfill MPE Pilot Test 2017

K:\PONY\Ephrata\CA_2005_JE0511\GIS\mxds\P1Drawdown.mxd 2/2/2018



▪ Active MPE Well

● Observation Well

1.88 - feet above top of P1 (Red)

1.04 - feet below top of P1 (Blue)

▭ Footprint of Drums Removed in 2008

Extent of Soil Removal to Bedrock in 2008

Vadose Zone Thickness Contour (in Feet)

* Water levels in MW-34p1, MW-65p1, and MW-68p1 are below the transducer and may be below the actuation level of the well pump. Transducers in these wells are located at the top of the pump, and the actuation level of the pump (i.e., the level required to make the pump cycle) is about 0.3 foot below the transducer.

N

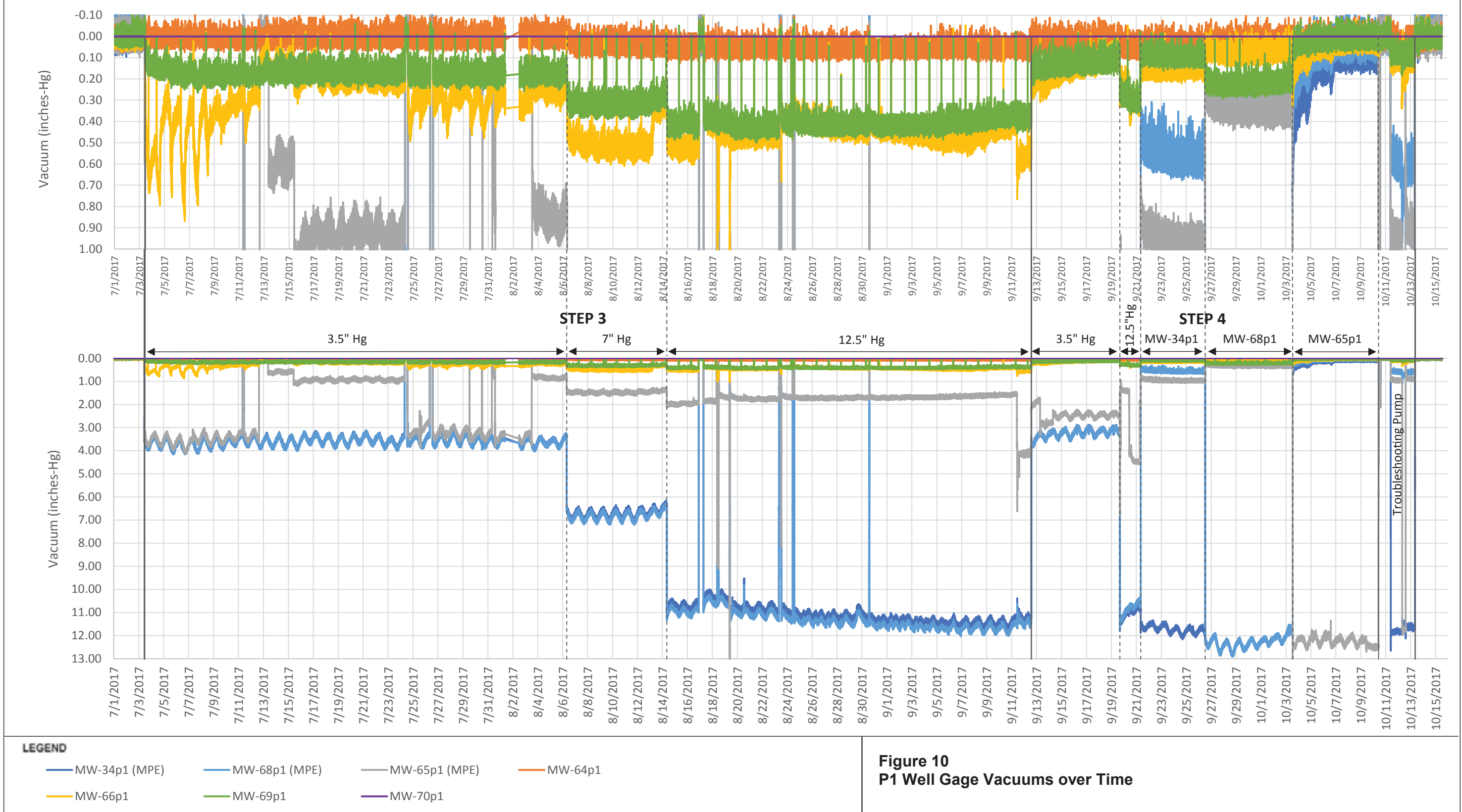
0 Feet 30

2017 Aerial photo from Google Earth

Figure 9
Thickness of P1 Vadose Zone on 7/3/17 (Pumping without Vacuum)

Ephrata Landfill

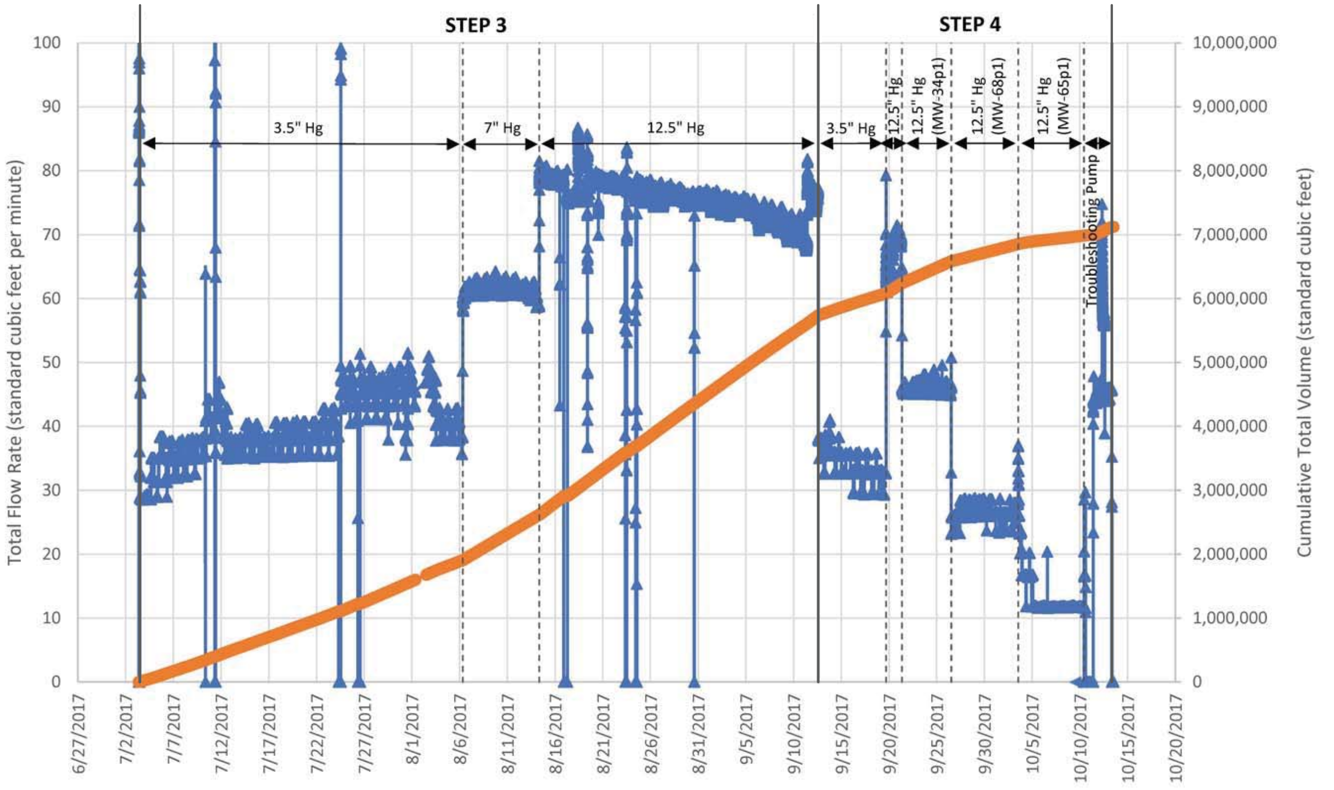
PGG



Notes:
Upper graph plots Y-axis from -0.1 to 1 inch-Hg to show details of lower vacuum observations.
The short-term daily change to 0 or less vacuum in MW-66p1 and MW-69p1 occured when manual water levels were collected and the well was open to atmospheric pressure.

Figure 10
P1 Well Gage Vacuums over Time

This Page Intentionally Left Blank



LEGEND

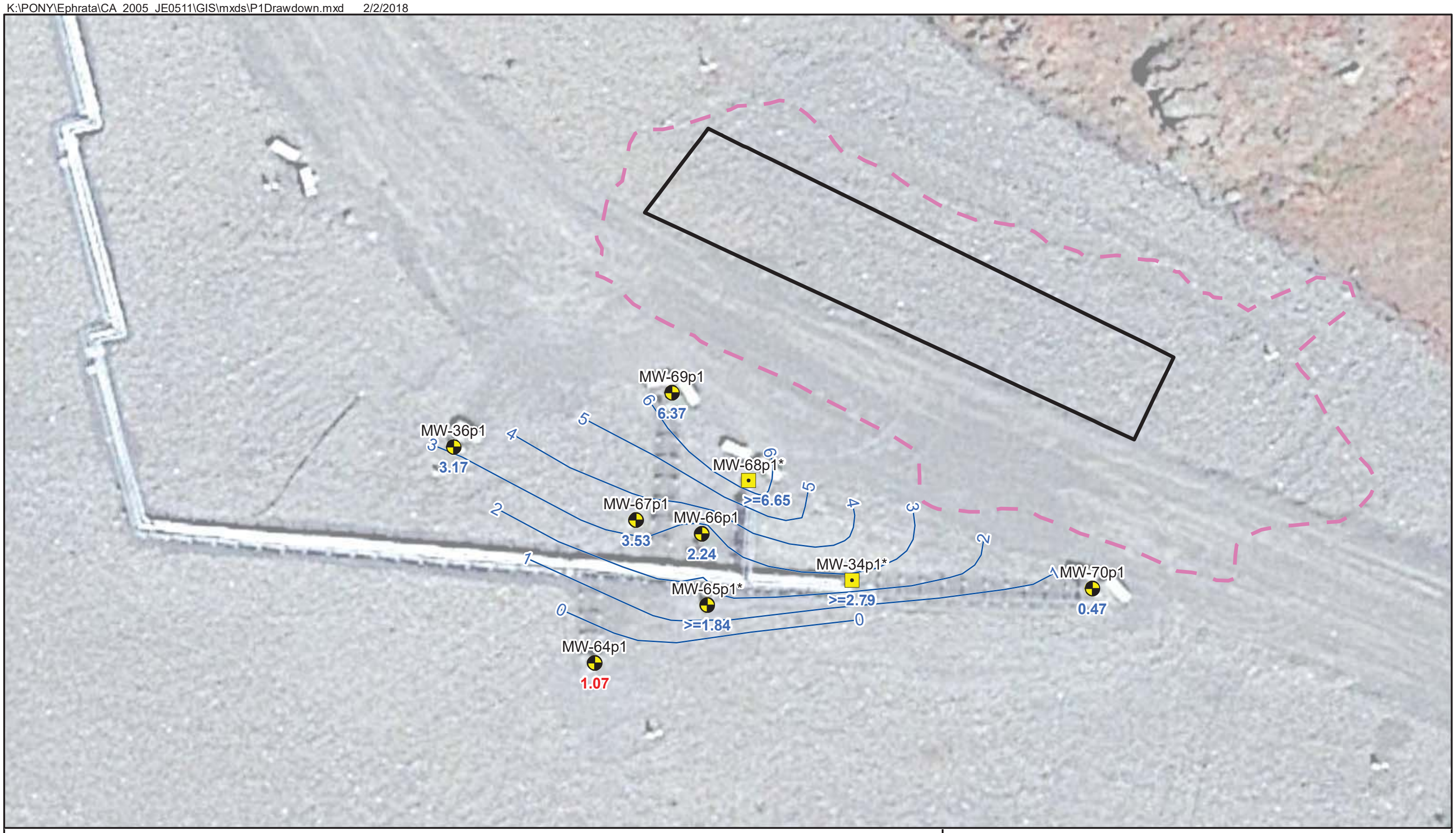
▲ Total Flow Rate (scfm) ● Cumulative Total Volume (scf)

Figure 11
Total Vapor Flow Rate and Cumulative Total Vapor Volume Extracted over Time

PGG

Ephrata Landfill MPE Pilot Test 2017

K:\PONY\Ephrata\CA_2005_JE0511\GIS\mxds\P1Drawdown.mxd 2/2/2018



▪ Active MPE Well

● Observation Well

1.88 - feet above top of P1 (Red)

1.04 - feet below top of P1 (Blue)

☐ Footprint of Drums Removed in 2008

Extent of Soil Removal to Bedrock in 2008

Vadose Zone Thickness Contour (in Feet)

* Water levels in MW-34p1, MW-65p1, and MW-68p1 are below the transducer and may be below the actuation level of the well pump. Transducers in these wells are located at the top of the pump, and the actuation level of the pump (i.e., the level required to make the pump cycle) is about 0.3 foot below the transducer.

N

0 Feet 30

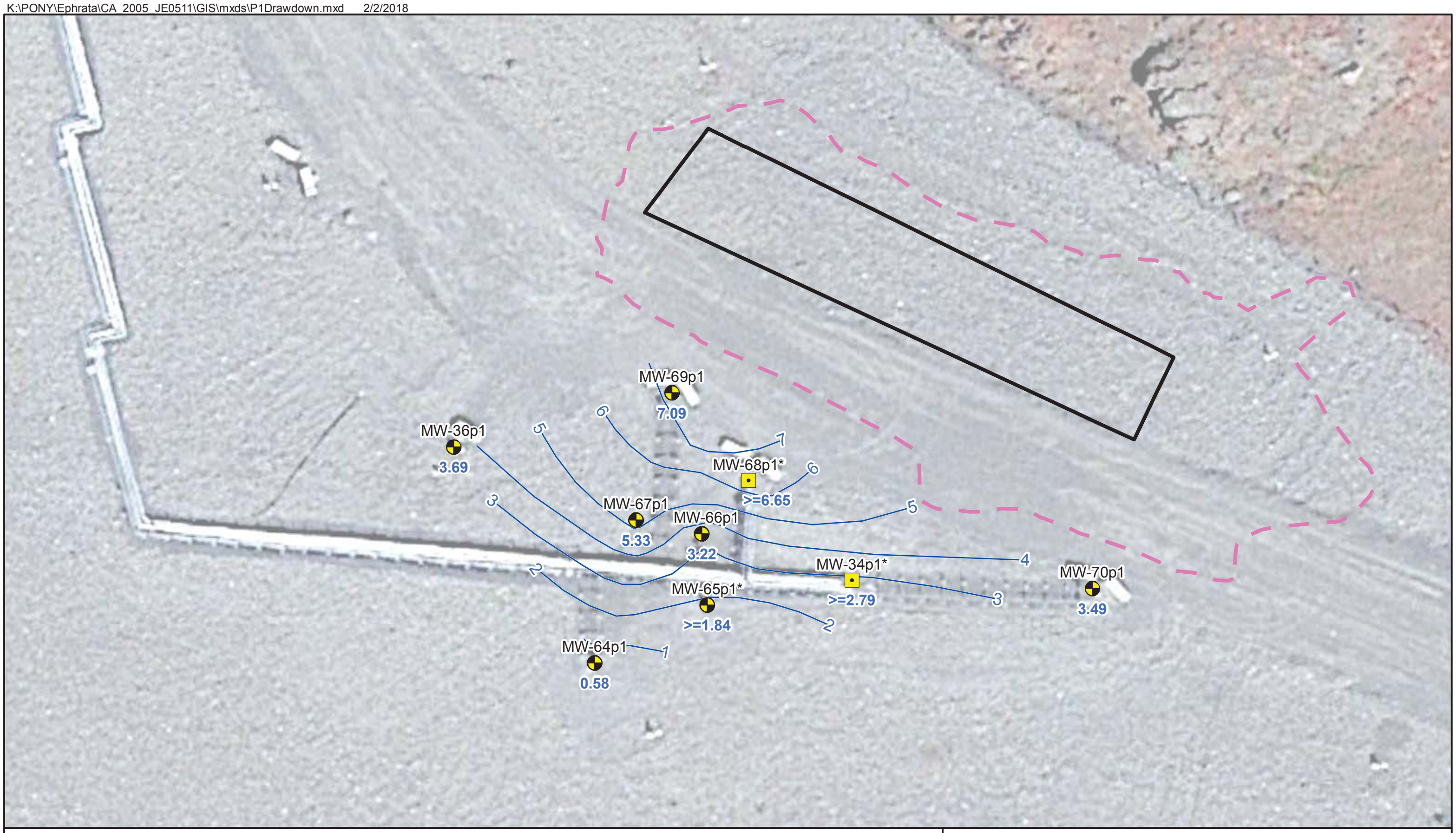
2017 Aerial photo from Google Earth

Figure 12
Thickness of P1 Vadose Zone
on 8/5/17 (3.5 inches-Hg,
Two Wells Pumping)

Ephrata Landfill

PGG

K:\PONY\Ephrata\CA_2005_JE0511\GIS\mxds\P1Drawdown.mxd 2/2/2018



- 🟨 Active MPE Well
- ● Observation Well
- **1.88** - feet above top of P1 (Red)
- **1.04** - feet below top of P1 (Blue)
- ▭ Footprint of Drums Removed in 2008
- ⌐ ¬ Extent of Soil Removal to Bedrock in 2008
- — Vadose Zone Thickness Contour (in Feet)

* Water levels in MW-34p1, MW-65p1, and MW-68p1 are below the transducer and may be below the actuation level of the well pump. Transducers in these wells are located at the top of the pump, and the actuation level of the pump (i.e., the level required to make the pump cycle) is about 0.3 foot below the transducer.

N

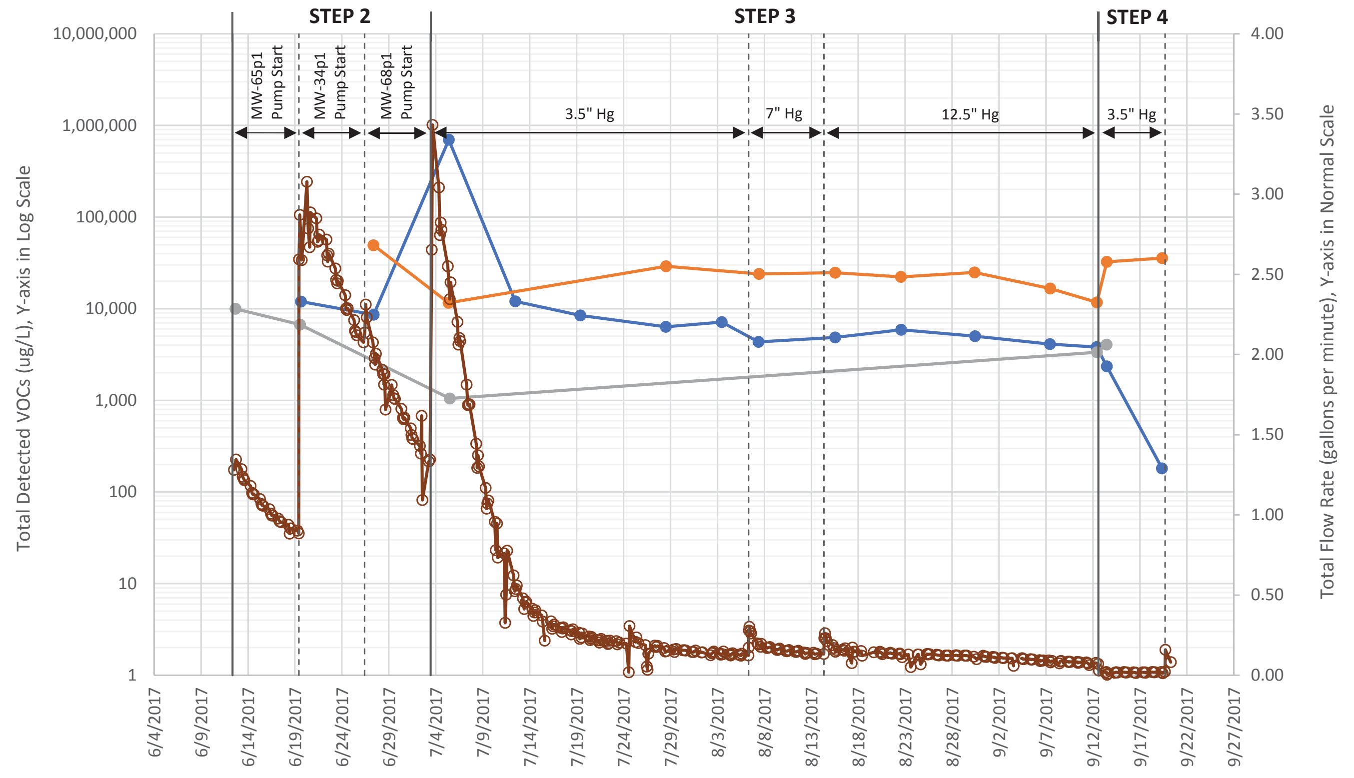
0 Feet 30

2017 Aerial photo from Google Earth

Figure 13
Thickness of P1 Vadose Zone on 9/26/17 (12.5 inches-Hg, Two Wells)

Ephrata Landfill

PgG



LEGEND

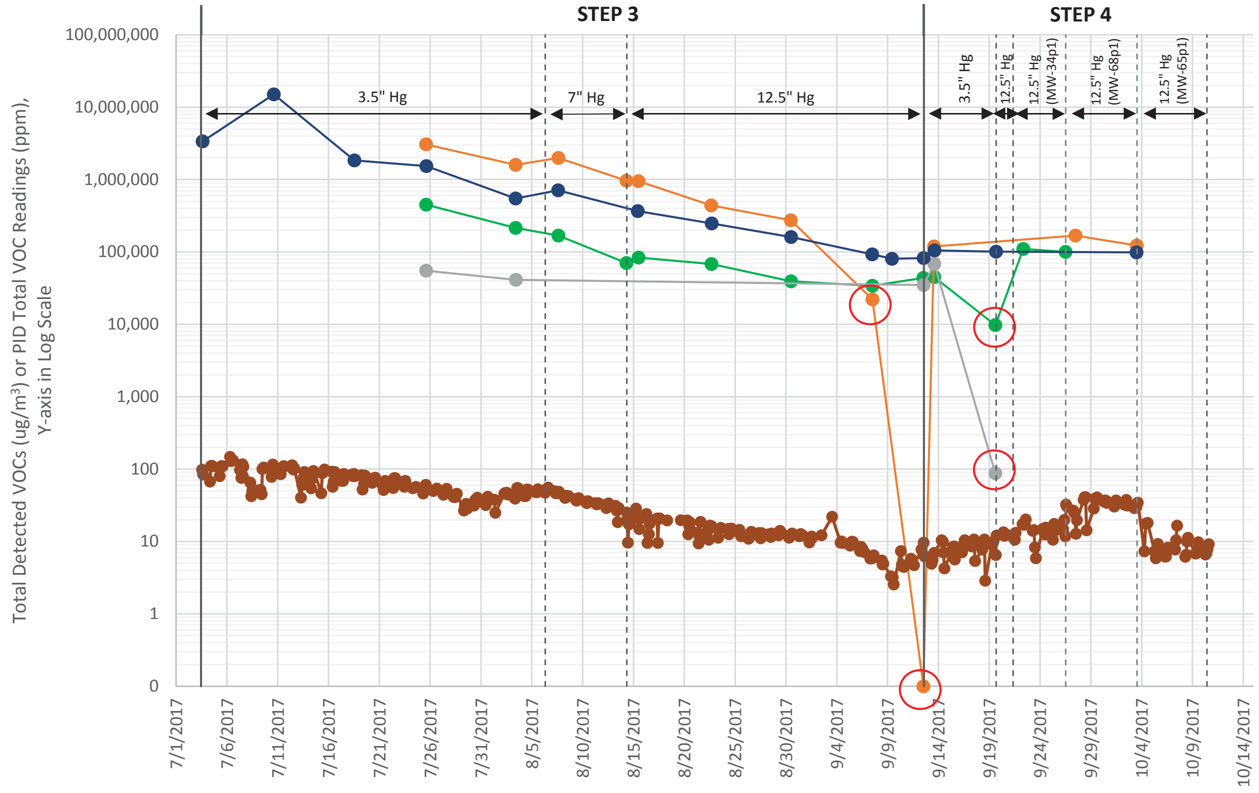
- ● MW-34p1 (Total Detected VOCs)
- ● MW-68p1 (Total Detected VOCs)
- ● MW-65p1 (Total Detected VOCs)
- ○ Total Liquid Flow Rate

Note: Not enough liquid flow for well sampling during later part of SVE test (Step 4).

Figure 14
Total Detected VOCs in Groundwater and Total Liquid Flow Rate over Time

Ephrata Landfill MPE Pilot Test 2017

PgG

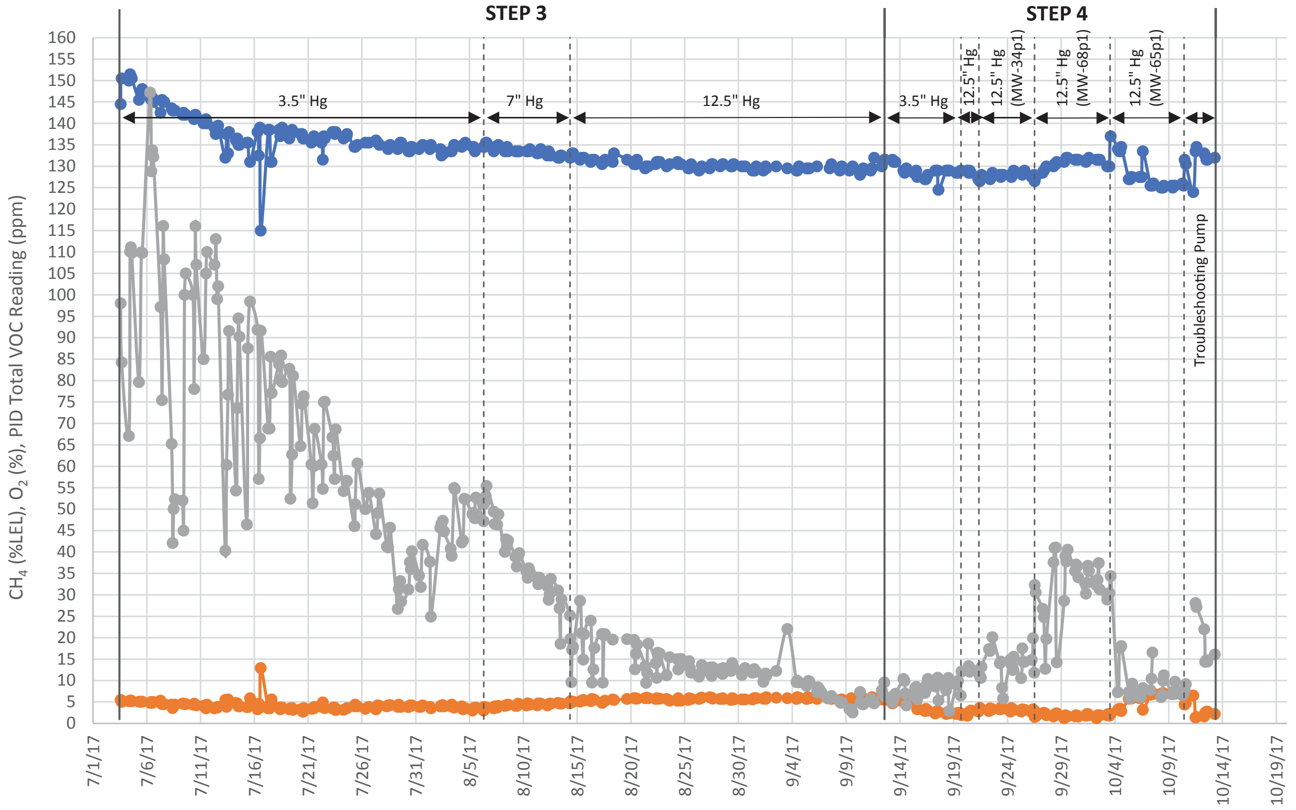


LEGEND

- MW-34p1 (Total Detected VOCs)
- MW-68p1 (Total Detected VOCs)
- MW-65p1 (Total Detected VOCs)
- GAC1 Influent (Total Detected VOCs)
- GAC1 Influent (PID Total VOC Readings)
- ○ Circled data points may have sampling error that biases samples low (see text)

Figure 15
Total Detected VOCs and PID Total VOC Readings in Vapor over Time

Ephrata Landfill MPE Pilot Test 2017

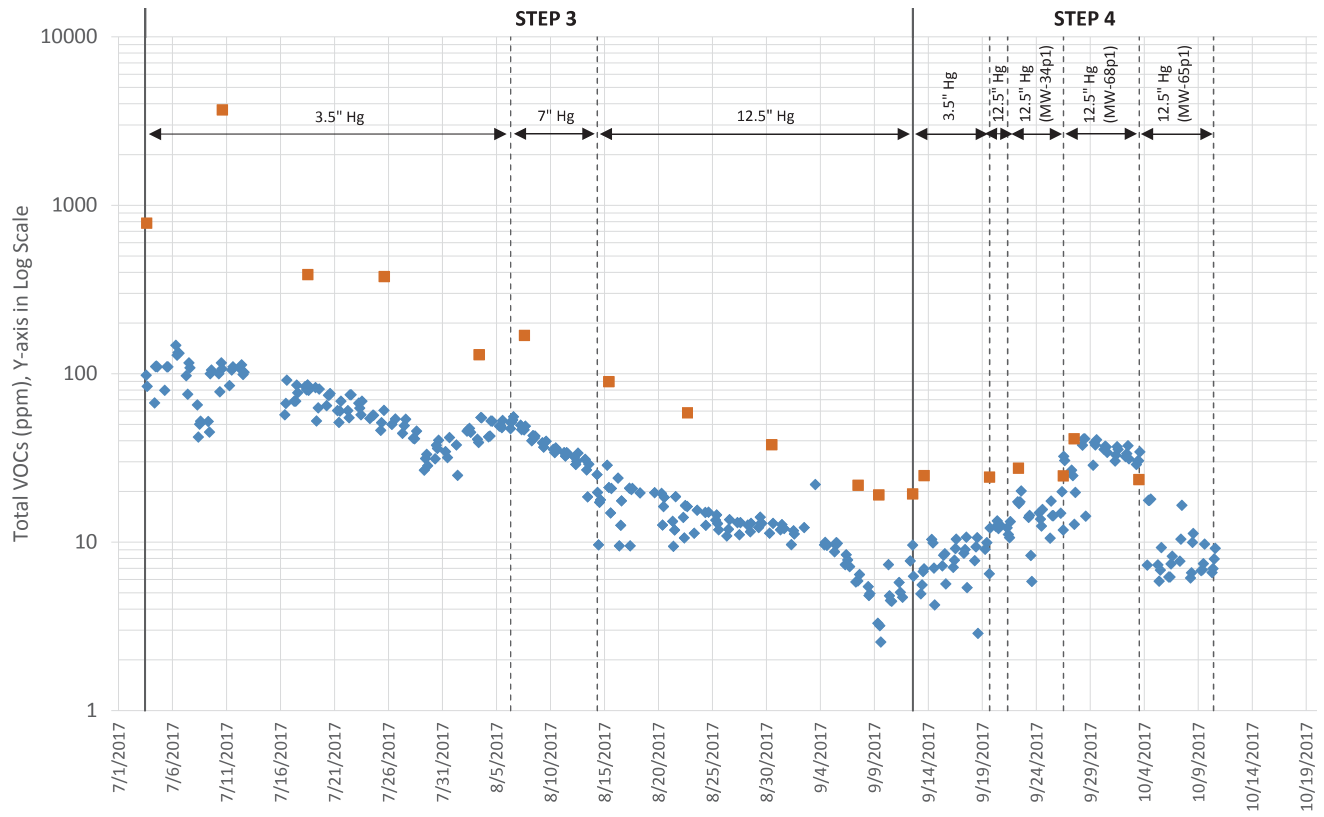


LEGEND

●CH4 ●O2 ●PID Total VOC Reading

Figure 16
Vapor CH$_4$, O$_2$, and PID Total VOC Readings over Time (GAC1 Influent)

Ephrata Landfill MPE Pilot Test 2017



LEGEND

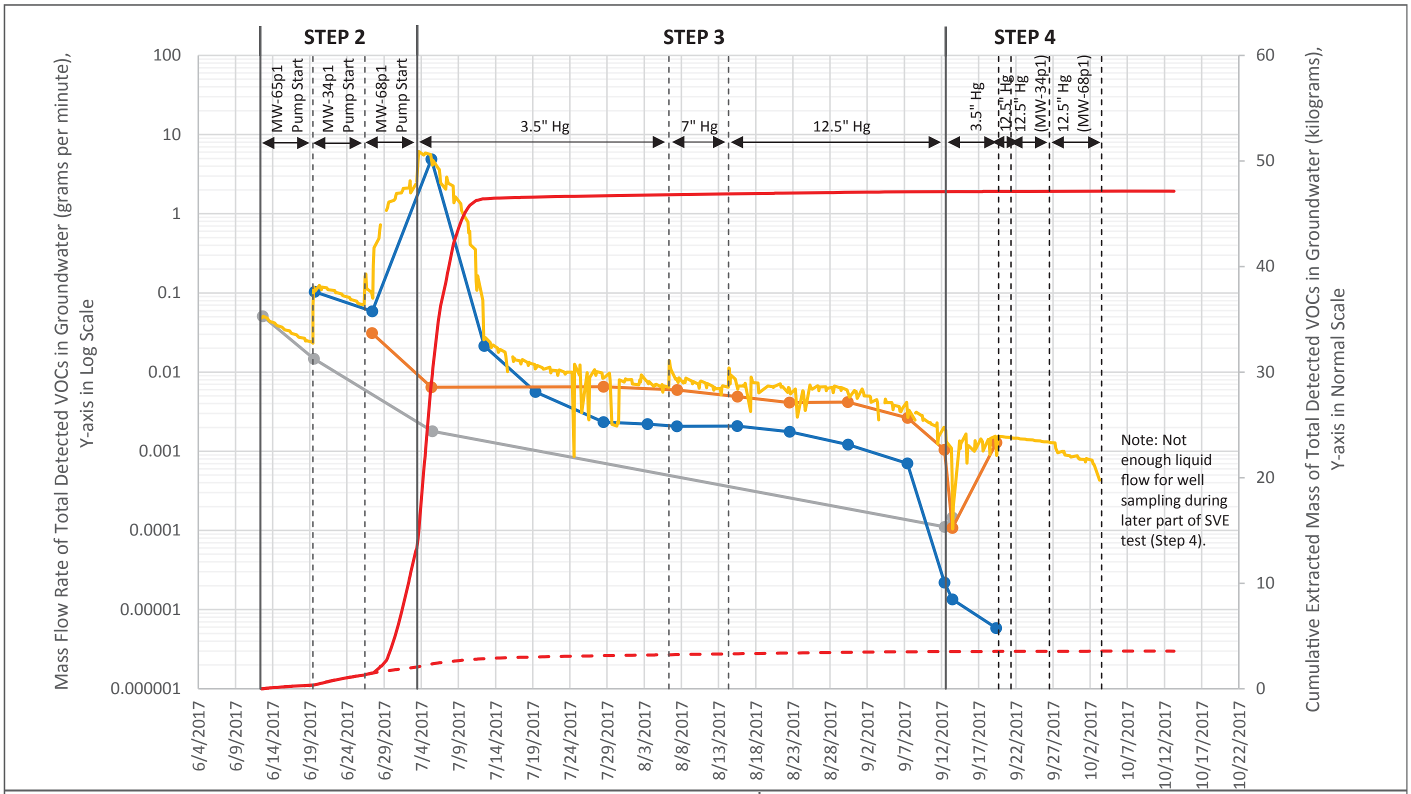
◆ Total VOCs (PID Readings)

■ Total Detected VOCs (Analytical Results)

Figure 17
Comparison of GAC1 Influent PID Readings and Analytical Results for Total VOCs

Ephrata Landfill MPE Pilot Test 2017

Parametrix

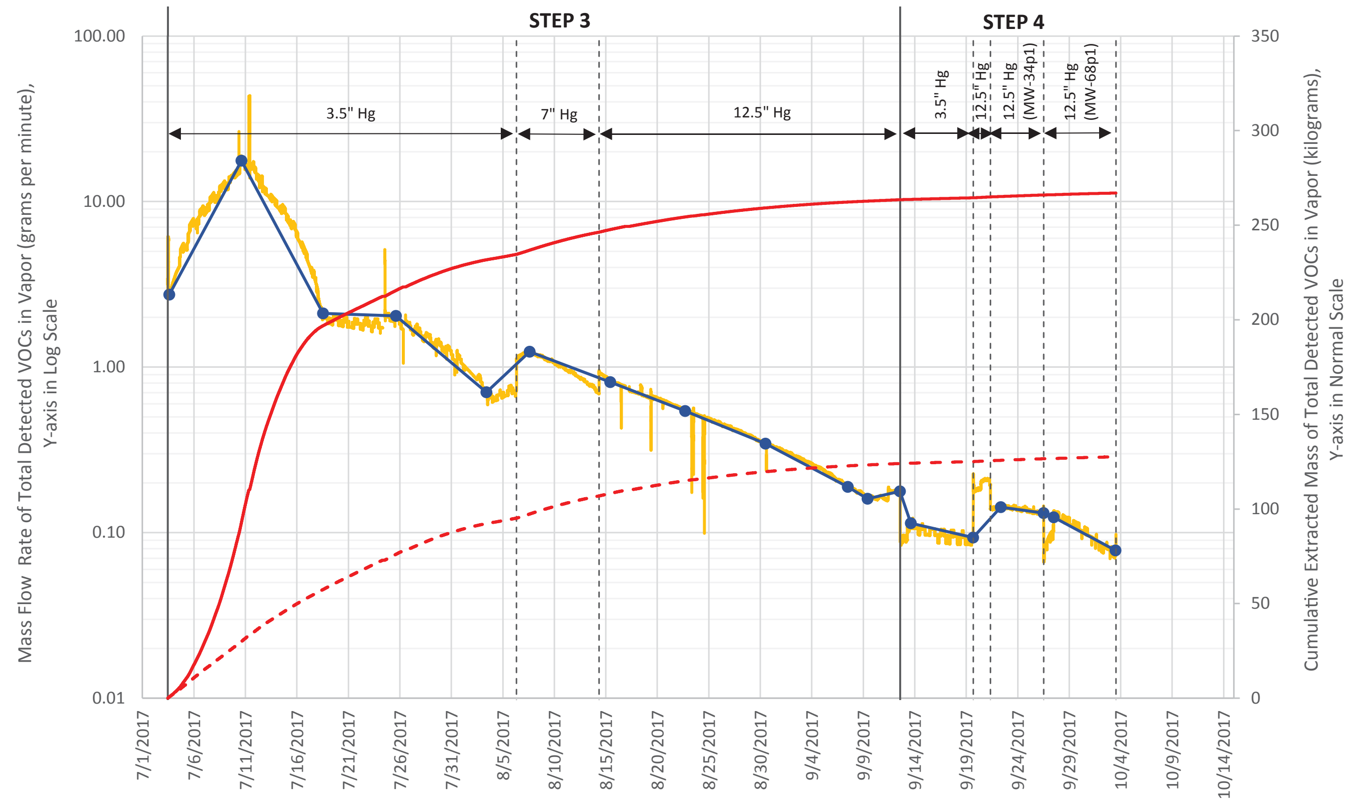


LEGEND

- MW-65p1 Measured Mass Flow Rate of Detected VOCs (grams per minute)
- MW-34p1 Measured Mass Flow Rate of Detected VOCs (grams per minute)
- MW-68p1 Measured Mass Flow Rate of Detected VOCs (grams per minute)
- Interpolated Total VOC Mass Flow Rate (grams per minute)
- Cumulative Extracted Mass of Detected VOCs (kilograms)
- Cumulative Extracted Mass of Detected VOCs (kilograms) - MW-34p1 Outlier Omitted

Figure 18
Total VOC Mass Flow Rates and Cumulative Extracted Mass in P1 Groundwater over Time

Ephrata Landfill MPE Pilot Test 2017



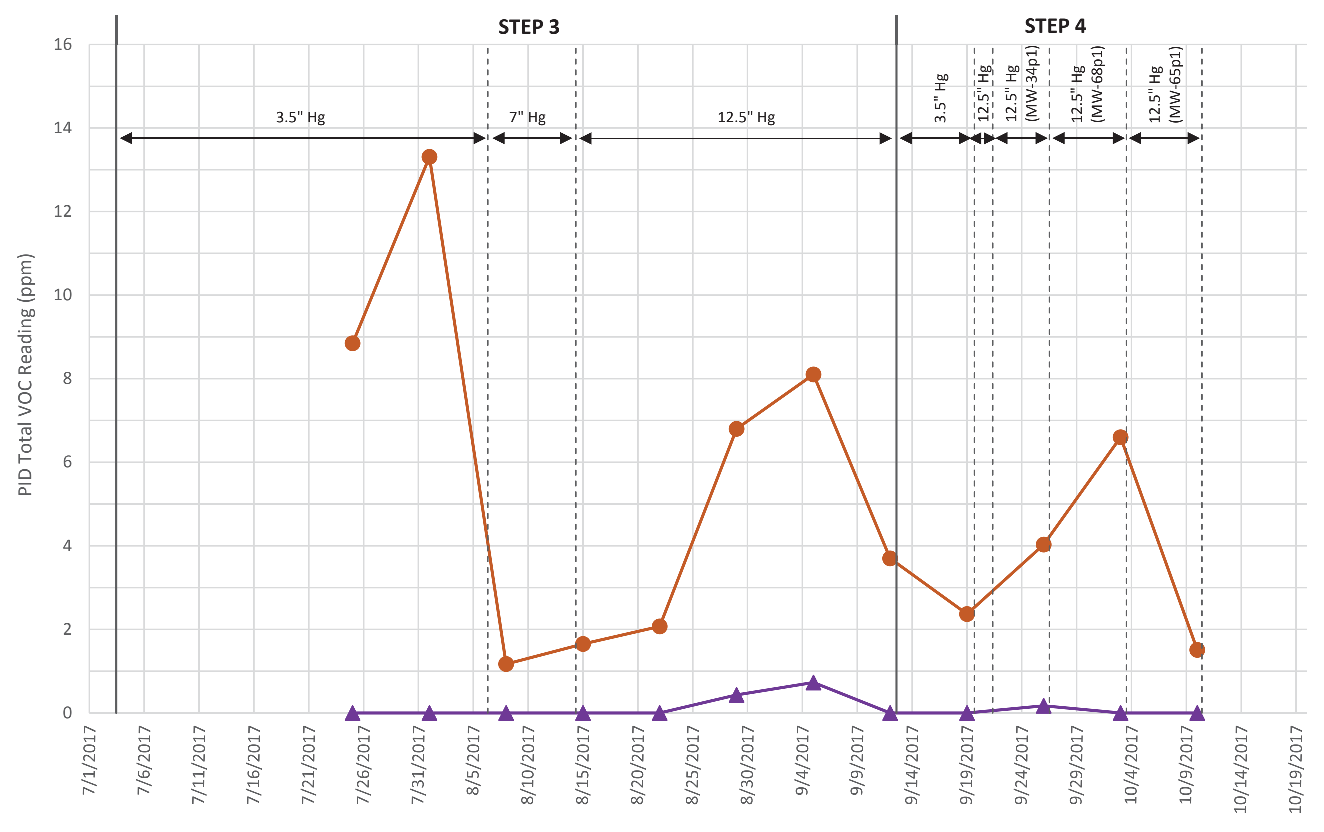
LEGEND

- Interpolated Total VOC Mass Flow Rate (grams per minute)
- ●— Measured Mass Flow Rate of Detected VOCs (grams per minute)
- Cumulative Extracted Mass of Detected VOCs (kilograms)
- - - Cumulative Extracted Mass of Detected VOCs (kilograms) - Outlier Omitted

Figure 19
Total VOC Mass Flow Rates and Cumulative Extracted Mass in P1 Vapor over Time

Ephrata Landfill MPE Pilot Test 2017

PgG



LEGEND

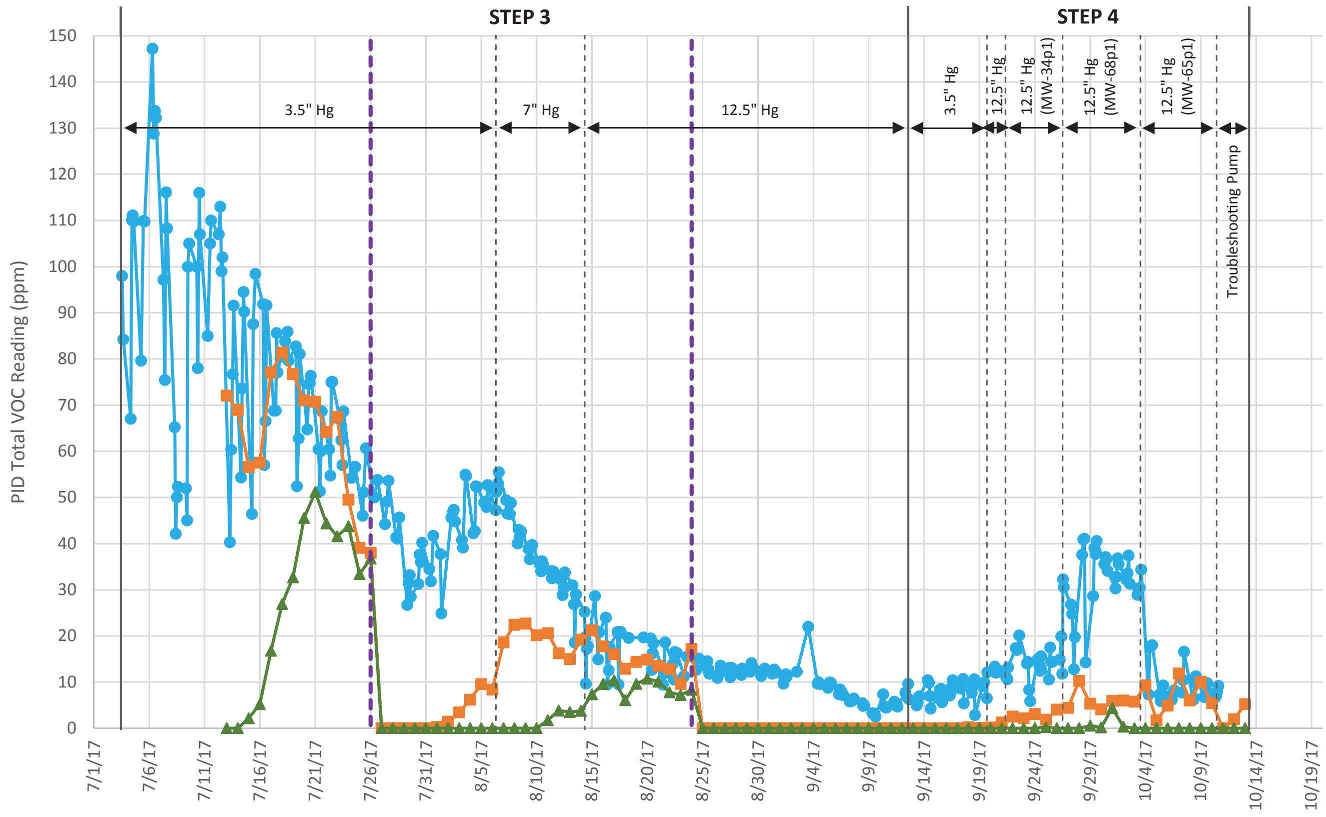
●— GAC3 Influent
▲— GAC3 Effluent

LTT = liquid treatment train.

Figure 20
LTT PID Total VOC Readings over Time (GAC3 Influent and GAC3 Effluent)

Ephrata Landfill MPE Pilot Test 2017

Parametrix

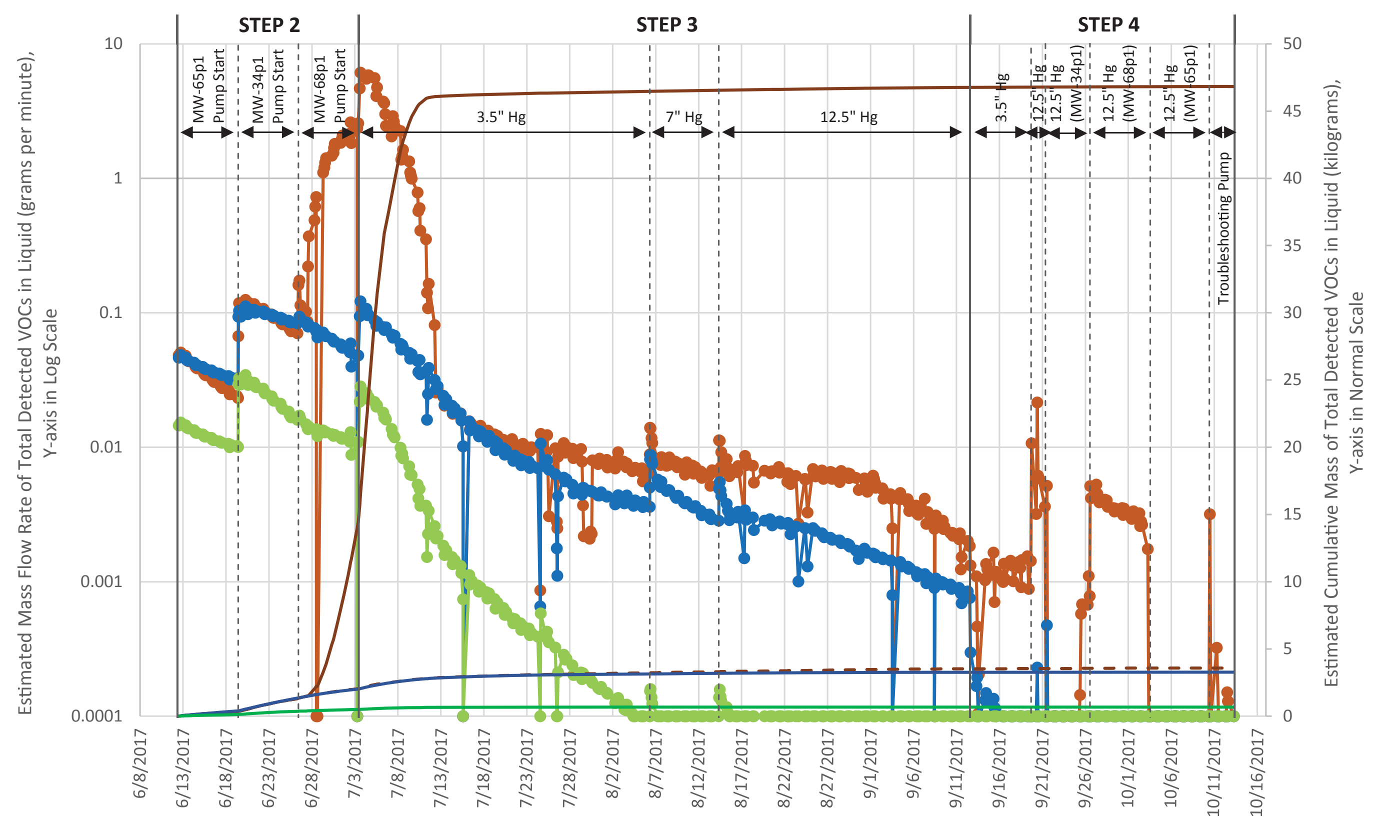


VTT = vapor treatment train.

Figure 21
VTT PID Total VOC Readings over Time (GAC1 Influent, GAC1 Effluent, and GAC2 Effluent)

Ephrata Landfill MPE Pilot Test 2017

Parametrix



LEGEND

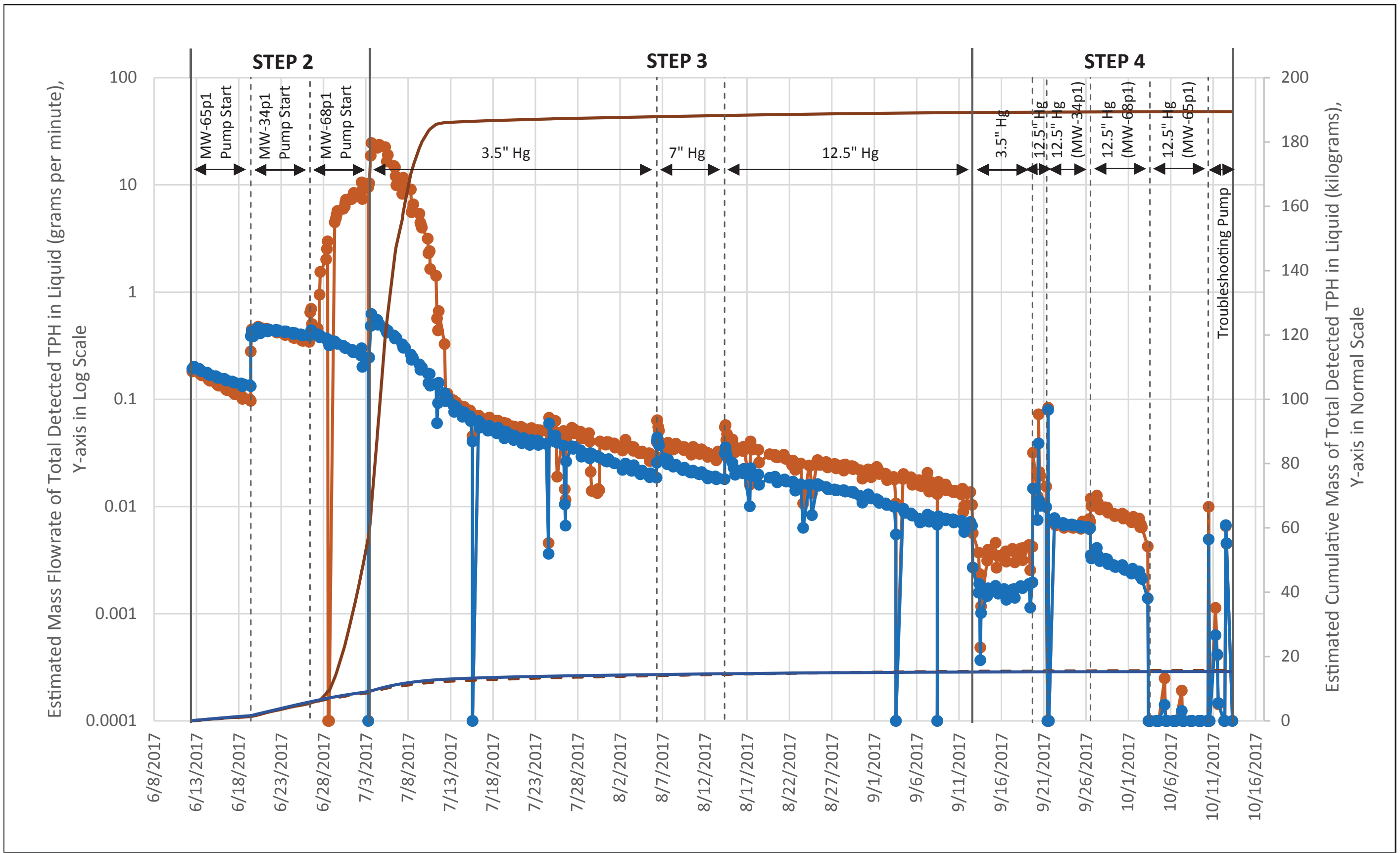
- OWS Influent VOC Mass Flow Rate
- OWS Effluent VOC Mass Flow Rate
- AS Effluent VOC Mass Flow Rate
- Cumulative VOC Mass Entering OWS
- Cumulative VOC Mass Entering OWS (Outlier Removed)
- Cumulative VOC Mass Exiting OWS
- Cumulative VOC Mass Exiting AS

LTT = liquid treatment train.

Figure 22
Total VOC Mass Flow Rates and Cumulative Mass in LTT over Time

Ephrata Landfill MPE Pilot Test 2017

Parametrix



LEGEND

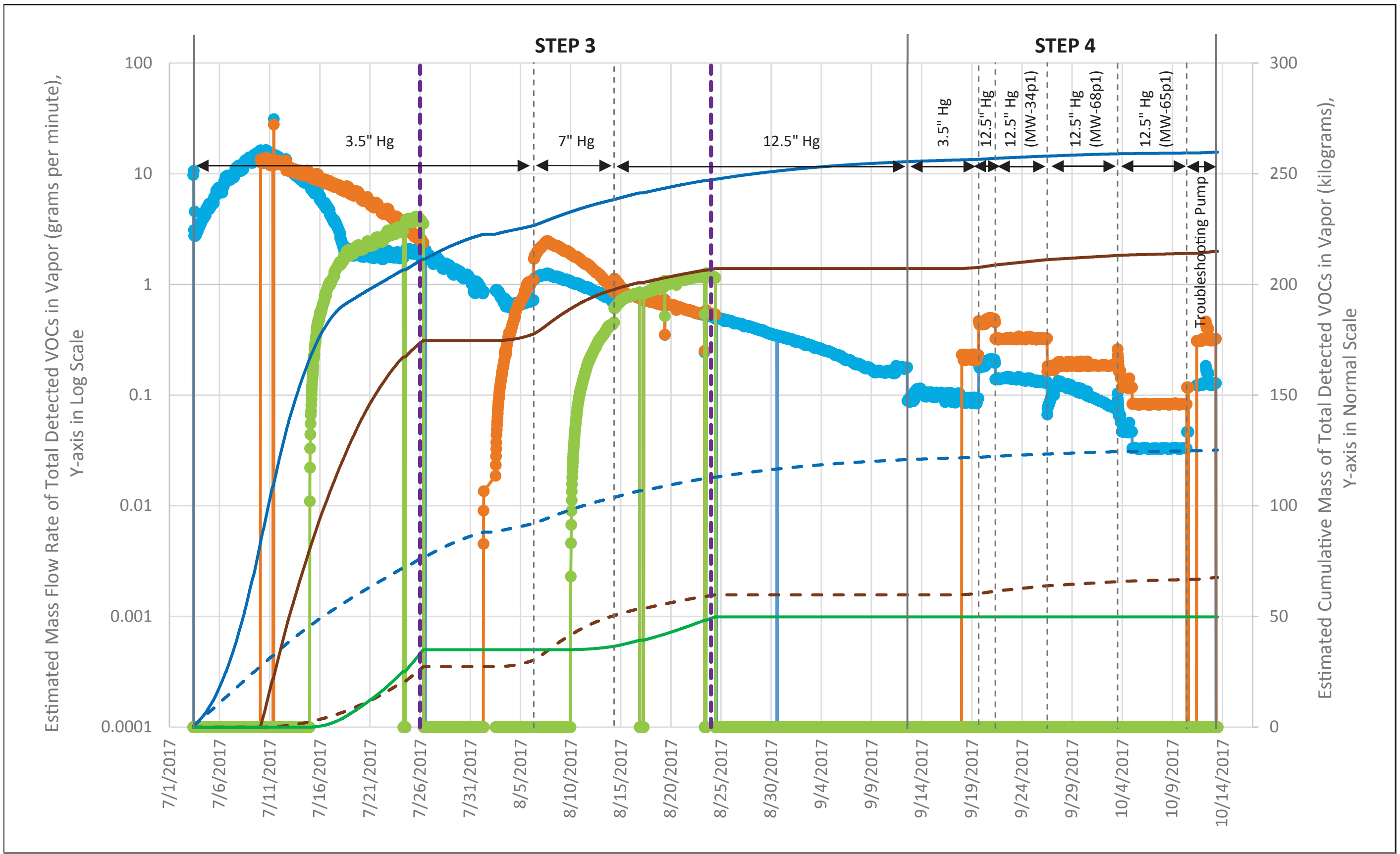
- OWS Influent TPH Mass Flow Rate
- OWS Effluent TPH Mass Flow Rate
- Cumulative TPH Mass Entering OWS
- Cumulative TPH Mass Entering OWS (Outlier Removed)
- Cumulative TPH Mass Exiting OWS

LTT = liquid treatment train.

Figure 23
Total TPH Mass Flow Rates and Cumulative Mass in LTT over Time

Ephrata Landfill MPE Pilot Test 2017

Parametrix



VTT = vapor treatment train.

Figure 24
Total VOC Mass Flow Rates and Cumulative Mass in VTT over Time

Ephrata Landfill MPE Pilot Test 2017

Parametrix

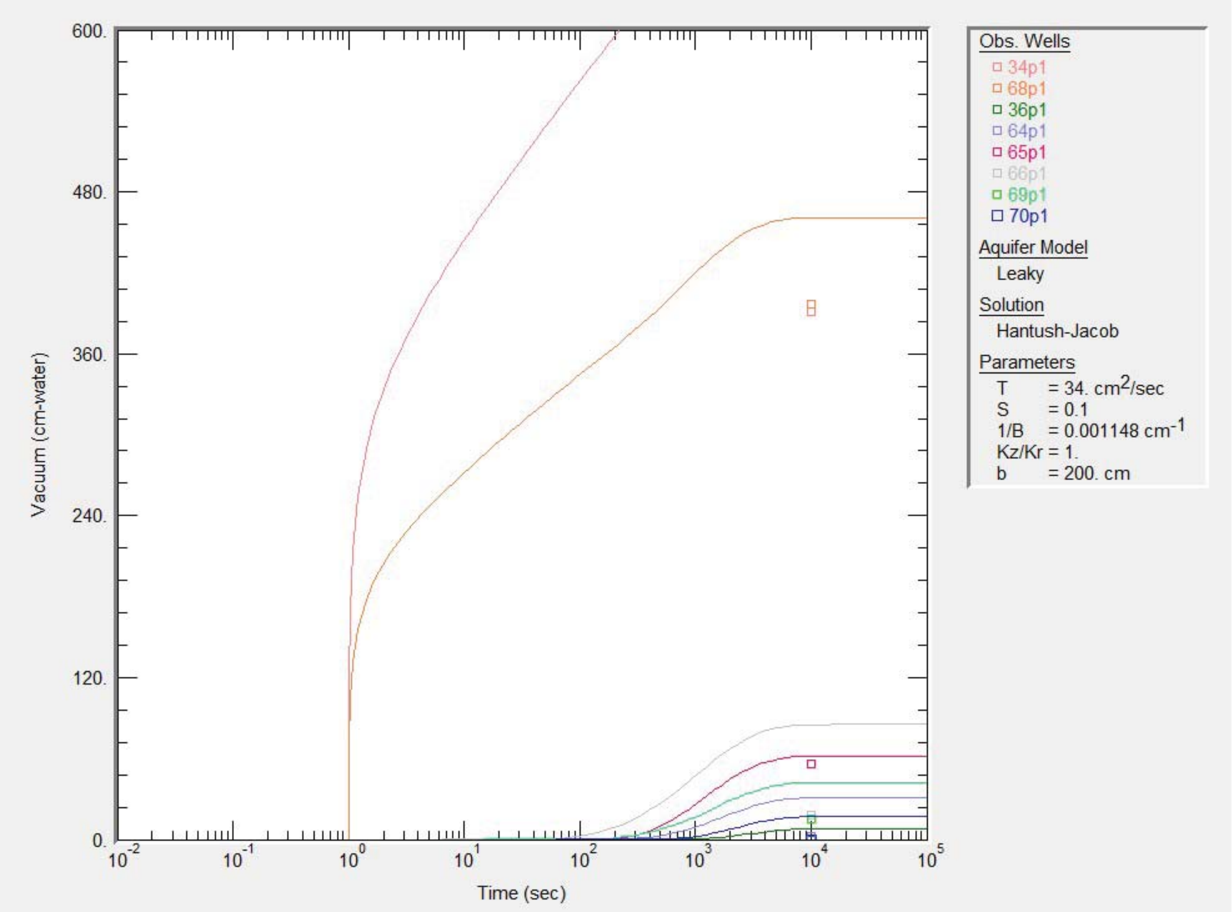
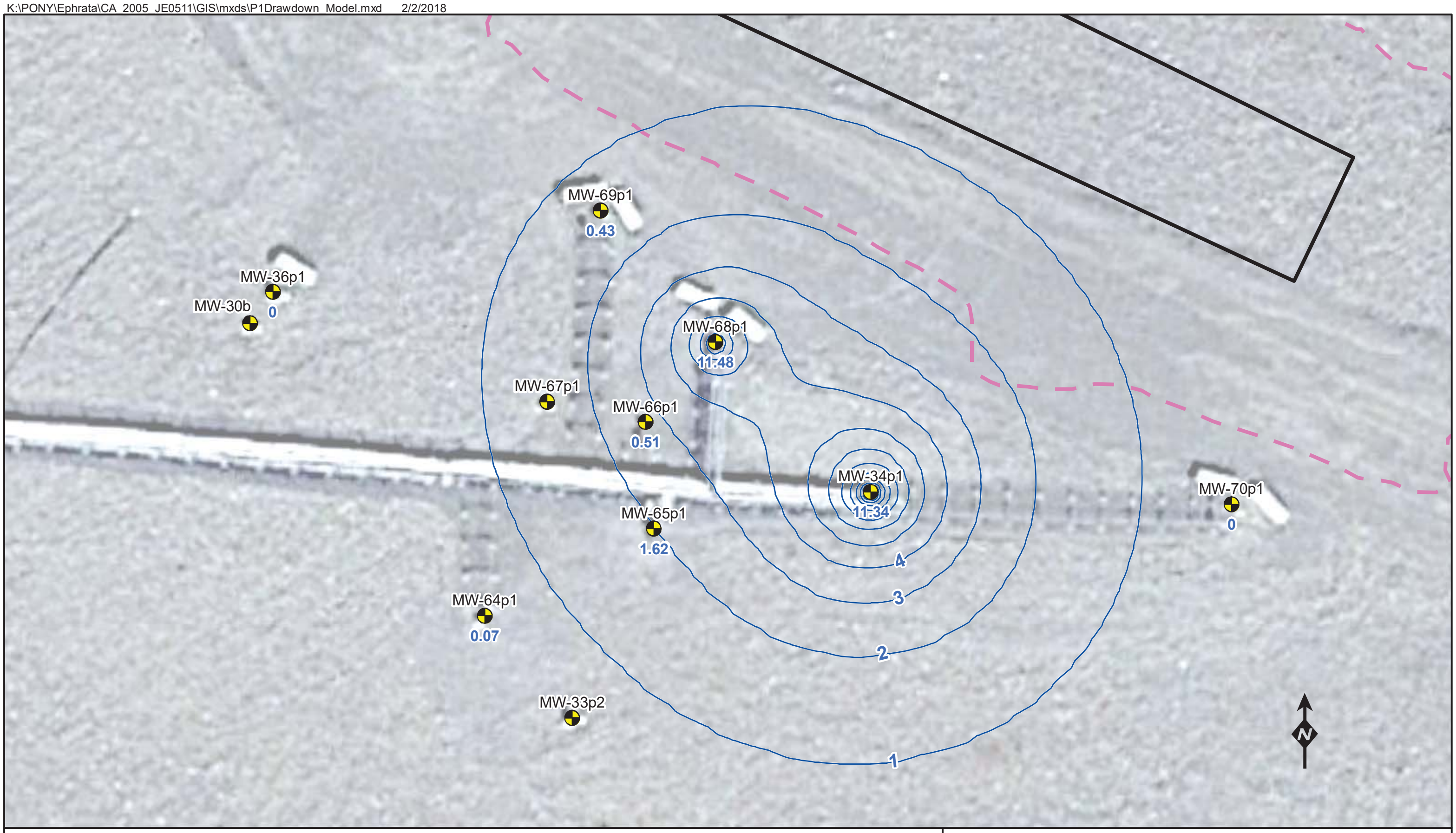


Figure 25
Simulation of Two Wells Pumping, No Calibration

Ephrata Landfill MPE Pilot Test 2017

K:\PONY\Ephrata\CA_2005_JE0511\GIS\mxds\P1Drawdown_Model.mxd 2/2/2018



▭ Footprint of Drums Removed in 2008

┌ ┐ Extent of Soil Removal to Bedrock in 2008

— Modeled Drawdown Contour (inches-Hg on 9/6/2017)

● Remedial Investigation Monitoring Well (MW)

1.04 observed drawdown on 9/6/2017 (inches-Hg)

0 Feet 20

2017 Aerial photo from Google Earth

$Q_{MW\text{-}34p1}$ **= 45.4 scfm**
$Q_{MW\text{-}68p1}$ **= 27.8 scfm**
T = 34 cm^2
1/B = 0.001 cm^{-2}
S = 0.1
t = 10^4 sec

Figure 26
Modeled Versus Observed Vacuums with Two Wells Pumping on 9/6/2017

Ephrata Landfill

PGG

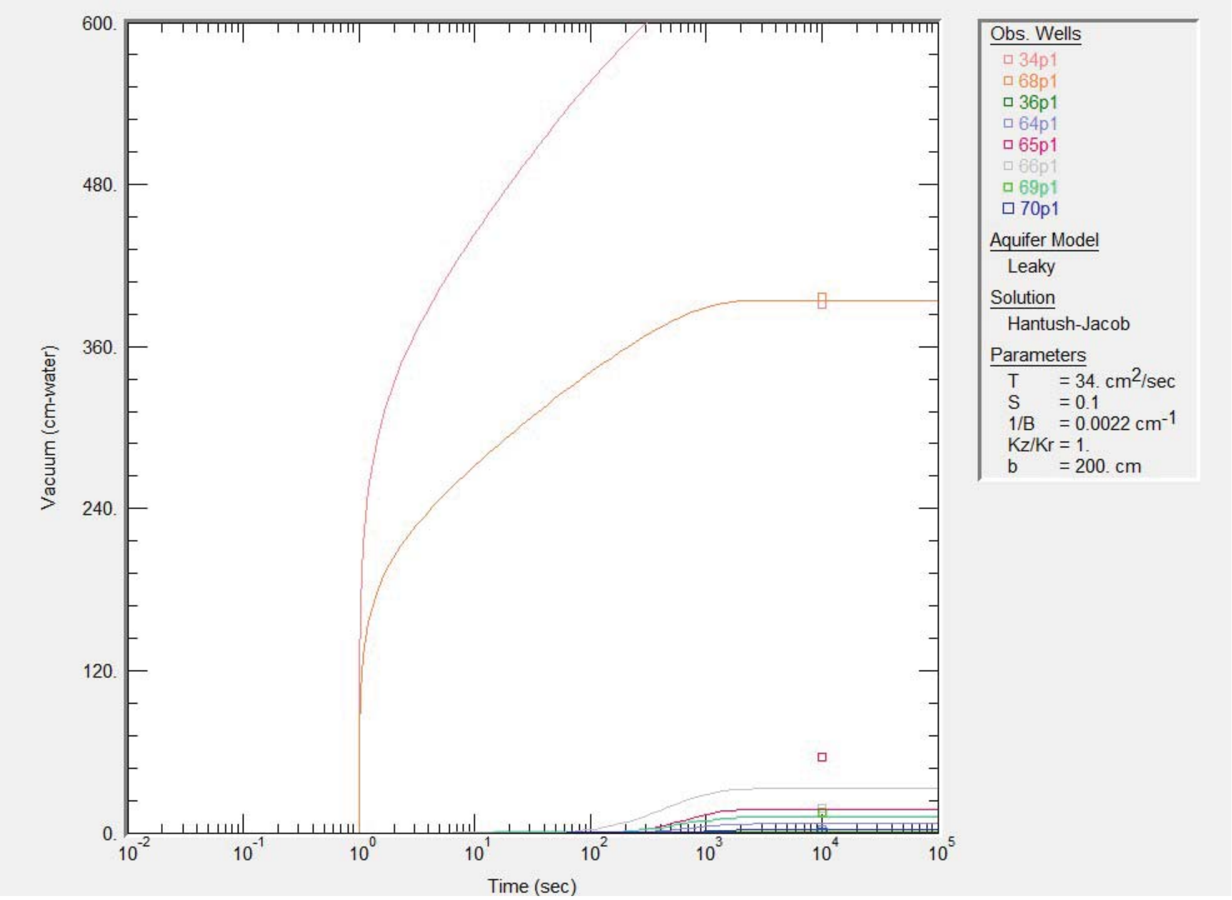


Figure 27
Simulation of Two Wells Pumping with Calibrated Leakage Parameter