Honeywell

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October 8, 2014

Mr. Tracy Smith
Division of Environmental Remediation
Remedial Bureau D
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-7013

Re: **Semet Residue Ponds Site**
**Order on Consent: Index #D7-0005-01-09**
**Expanded Remedy Selection Treatability Study Report**

Dear Mr. Smith:

Enclosed is the finalized Expanded Remedy Selection Treatability Study (ERSTS) Report associated with the Semet Residue Ponds Site located in the Town of Geddes, Onondaga County, New York. The ERSTS was performed under Administrative Consent Order (ACO) D7-0005-01-09 entered into by Honeywell International Inc. (Honeywell), and the New York State Department of Environmental Conservation (NYSDEC) dated January 22, 2004.

Please contact Paul Schultz of O'Brien & Gere at (315) 956-6686 or me if you have any questions regarding this matter.

Sincerely,

John P. McAuliffe by CLC

John P. McAuliffe, P.E.
Program Director

Enc. /2 copies, 1 CD

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FINAL REPORT

# Semet Residue Ponds
# Expanded Remedy SelectionTreatability Study

Honeywell

October 2014

O'BRIEN & GERE

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# Semet Residue Ponds Expanded Remedy SelectionTreatability Study

Prepared for:

Honeywell

CHRISTOPHER C. CALKINS, VICE PRESIDENT
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## ACRONYM LIST

| | |
|---|---|
| Accutest | Accutest Laboratories |
| ACO | Administrative Consent Order |
| AO | Advanced oxidation |
| AOP | Advance oxidation process |
| AQM | Air quality monitoring |
| BSA | Benzene sulfonic acid |
| BTU/lb | British thermal units per pound |
| CAMP | Community Air Monitoring Plan |
| °C | Degrees Celsius |
| CFR | Code of Federal Regulations |
| Clean Harbors | Clean Harbors Environmental Services, Inc. |
| COC | Chain-of-custody |
| cy | Cubic yard |
| DOT | Department of Transportation |
| EBM | Earth boring machine |
| EQ | EQ - The Environmental Quality Company |
| ERSTS | Expanded Remedy Selection Treatability Study |
| °F | Degrees Fahrenheit |
| g | Grams |
| gal/ton | Gallons per ton |
| GAR | Green America Recycling, LLC |
| GC/MS | Gas chromatography/mass spectrometry |
| gpm | Gallons per minute |
| GWTP | Groundwater treatment plant |
| $H_2S$ | Hydrogen sulfide |
| Hazen Research | Hazen Research Inc. |
| Heritage | Heritage Environmental Services, LLC |
| Honeywell | Honeywell International, Inc |
| HP | Horsepower |

| | |
|---|---|
| HPLC | High-performance liquid chromatography |
| ID | Identification |
| LDR | Land Disposal Restrictions |
| LEL | Lower explosive limit |
| µg/L | Microgram per liter |
| $\mu g/m^3$ | Microgram per cubic meter |
| Mo | Molybdenum |
| mph | Miles per hour |
| NMR | Nuclear magnetic resonance |
| NYSDEC | New York State Department of Environmental Conservation |
| OU1 | Operable Unit 1 |
| OUs | Odor units |
| PCB | Polychlorinated biphenyls |
| PID | Photoionization detector |
| $PM_{10}$ | Particulate matter up to 10 micron in size |
| ppm | Parts per million |
| psi | Pounds per square inch |
| RCRA | Resource Conservation and Recovery Act |
| rpm | Revolutions per minute |
| RSTS | Remedy Selection Treatability Study |
| RTA | Rotary thermal apparatus |
| SCA | Sediment Consolidation Area |
| Site | Semet Residue Ponds Site |
| SVOCs | Semi-volatile organic compounds |
| TAL | Target Analyte List |
| TCL | Target Compound List |
| TCLP | Toxicity Characteristic Leaching Procedure |
| tph | Ton per hour |
| TVOC | Total volatile organic compound |
| TWA | Time-weighted average |

| | |
|---|---|
| UN | United Nations |
| UTS | Universal Treatment Standards |
| VOCs | Volatile organic compounds |

## EXECUTIVE SUMMARY

### Introduction

This document serves as the Expanded Remedy Selection Treatability Study (ERSTS) Report for Operable Unit 1 (OU1) of the Semet Residue Ponds Site (the site) located in the Town of Geddes, Onondaga County, New York. This report documents ERSTS tasks completed in accordance with the ERSTS Work Plan submitted to the New York State Department of Environmental Conservation (NYSDEC) on May 22, 2012 (Work Plan; O'Brien & Gere 2012) and approved by the NYSDEC on June 15, 2012 (Smith 2012b). The ERSTS was performed under Administrative Consent Order (ACO) D7-0005-01-09 entered into by Honeywell International, Inc. (Honeywell), and NYSDEC dated January 22, 2004. The ERSTS was intended to provide additional information for off-site reuse and off-site and on-site thermal treatment, and address uncertainties identified during the previous RSTSs.

### Field Testing, Data, Observations, and Lessons Learned

#### *Removal/Dewatering Seasonal Trials*

Removal and dewatering of Semet Residue was performed and evaluated during three different seasonal conditions (*i.e.*, hot, below freezing, and thaw). Trial timeframes were as follows:

- Hot trial – July to October, 2012
- Below freezing trial – January  to February, 2013
- Thaw trial – March to July, 2013.

#### *Excavation*

Ponds 1, 2, 5, and Stringer Pond material were excavated and loaded directly to double lined shipping containers for off-site transport during the ERSTS hot trial and a portion of the thaw trial, when no free aqueous phase was observed. The excavation and direct-loading rates for Ponds 1, 2, 5, and Stringer Pond material were between approximately 10 and 90 tons per hour (tph), and averaged approximately 40 tph. Ponds 3 and 4 were excavated and placed in the hopper of a mobile dewatering screw to remove free liquid and render the material suitable for transport. For Ponds 3 and 4, the excavation rate was driven by the dewatering rate, which was between approximately 1 and 5 tph.

The excavation area was covered with a cement-based or fiber-based spray cover at the end of each work day to mitigate emissions/odors. Perimeter air monitoring was conducted during excavation operations in accordance with the Community Air Monitoring Plan (CAMP) referenced in the Work Plan. When a snow or water cover was present at the excavation area, the excavation area was not spray covered since the snow and/or water acted as an effective cover (during the ERSTS below freezing and thaw trials).

#### *Dewatering*

Efforts related to dewatering performed during the ERSTS included bench-scale dewatering tests, purchase/modification of a dewatering screw, evaluation of different excavator bucket configurations, and pilot-scale dewatering of material from Ponds 3 and 4 during the three seasonal trials. A used stainless steel screw conveyor was identified and purchased for dewatering efforts. Modifications of this screw conveyor were coordinated with a material handling expert (Thomas & Muller). Dewatering rates achieved in the field ranged from 1 to 5 tph. Collection sumps were located beneath the screw conveyor to capture aqueous phase from the dewatering process (process aqueous). Plastic and piping were used to direct the aqueous phase from the screens located along the screw and below the hopper to the sumps. Aqueous phase separated by the mobile dewatering unit was either collected for the aqueous phase evaluation or returned to the Semet Residue Ponds. Aqueous phase generation rates ranged from an estimated 32 to 54 gallons/ton (gal/ton) Semet Residue dewatered. The mobile dewatering screw was effective at material temperatures greater than 32°F with Pond 3 residue, and at material temperatures greater than 45°F with Pond 4 residue.

#### *Earth Boring Machine*

The custom fabricated earth boring machine (EBM) utilized during the 2011 Hot Weather RSTS was tested again during the ERSTS hot and thaw trials to demonstrate potential removal rate and dewatering efficiency.

During the ERSTS hot evaluation, it was observed that the hydraulic direct drive system was unable to be powered by the excavator. Larger diameter hydraulic hoses and fittings were used during the thaw trial to reduce pressure restrictions while powering the EBM off of an excavator. However, this still led to overheating of the excavator hydraulics. A standalone, fan-cooled hydraulic unit was used to power the EBM during the thaw trial, and the EBM was able to remove Semet Residue at a rate of approximately 1.4 tph. Material removed with the EBM appeared to be a shippable material.

### *Stability Testing*

A pilot scale evaluation of the Mabey Dura-Base® Mat system for support of construction equipment on the Semet Residue ponds was conducted. The Mabey Dura-Base® Mats did not support their own weight on top of Semet Residue Pond 4, or provide enough support for heavy equipment, and will not be suitable for use on the Semet Residue ponds. Based on experience at the Honeywell Sediment Consolidation Area (SCA) site, the Dura-Base® Mat system would likely be useful as a method to support equipment during construction on top of Solvay Waste adjacent to the Semet Residue ponds or below the Semet Residue ponds after the Semet Residue is removed.

### *Community Air Monitoring*

Community air monitoring was conducted during excavation/intrusive work and/or dewatering operations for the ERSTS field activities. Results of air monitoring in comparison to community air monitoring control levels and work perimeter limits are summarized as follows:

- No control level or work perimeter limit exceedances for total volatile organic compounds (TVOC) during excavation/intrusive work and/or dewatering operations.
- Control level and work perimeter limit exceedances were observed during the ERSTS thaw trial when no excavation/intrusive work was being performed. TVOC levels exceeded the control level on two days and the work perimeter limit on one day. In these instances, additional controls were applied.
- No observed odor readings greater than 4 odor units (OUs) at the perimeter (work perimeter limit is 7 OUs).
- One hydrogen sulfide ($H_2S$) work perimeter exceedance during the ERSTS hot trial. Elevated $H_2S$ was not observed in the work zone, but work in this area was halted and additional controls were applied.
- One control level and work perimeter limit exceedance for dust related to excavator movement during dry conditions (ERSTS hot trial). No additional dust exceedances were observed.

### *Off-Site Material Shipment for Vendor Testing*

During the ERSTS trials, dewatered Semet Residue was transported for off-site vendor testing at Green America Recycling, LLC (GAR) in Hannibal, Missouri, Systech in Fredonia, Kansas, and Clean Harbors Environmental Services, Inc. (Clean Harbors) in Sarnia, Ontario. Shipping containers used included double-lined 25-cubic yard (cy) and 30-cy roll-offs and dump trailers. Semet Residue loads were limited to approximately 15 tons for roll-offs and 22 tons for dump trailers.

Over the three seasonal trials, GAR received 34 containers totaling 532 tons of material direct-loaded from Ponds 1, 2, 5, and the Stringer Ponds, and dewatered material from Ponds 3 and 4. Systech received one roll-off during the below freezing trial and two roll-offs during the thaw trial. The thaw trial roll-offs were subsequently shipped to GAR for management following processing difficulties with the first thaw trial roll-off. One roll-off was shipped to Clean Harbors during the thaw trial.

### *Thermal Treatability Evaluation*

Thermal treatability testing was conducted at temperatures of 250, 350 and 450°C with a laboratory-scale rotary thermal apparatus (RTA) to:

- Identify the optimum treatment temperature to meet the Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) limits listed in 40 Code of Federal Regulations (CFR) Part 261.24(b),

- Identify the optimum treatment temperature to meet the RCRA Land Disposal Restriction (LDR) Universal Treatment Standards (UTS) listed in 40 CFR Part 268.48(a),
- Evaluate the mass distribution of residual streams, and
- Evaluate material handling properties of the treated materials.

Based on an evaluation of the factors considered, it appears that the optimum treatment temperature is between 350 and 450°C. The relative amounts of the residual organic condensate and treated solids streams produced during the tests were a function of solids treatment temperature, with more organic condensate and less treated solids produced as the treatment temperature was increased. The amount of aqueous condensate produced was about the same at all three treatment temperature conditions.

Blending other reagents with the Semet Residue could change the dynamics of contaminant removal. Based on a comparison of RTA test results for dewatered Semet material with the full-scale Clean Harbors tests conducted in 2011 with blends of Semet, soil, and lime, it appears that the addition of blending reagents may significantly improve treatment results for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs).

***Aqueous Treatability Evaluation***

Aqueous phase treatability testing was conducted during the ERSTS in 2012 in accordance with the Work Plan to validate and expand upon the 2011 results and further evaluate the feasibility of treating the high and low end of the range of estimates of aqueous phase at the Wills Ave Groundwater Treatment Plant (GWTP). Findings from the evaluation are summarized below:

- Treating Semet aqueous phase at the GWTP at the blends evaluated is technically feasible for regulated parameters.

Aqueous phase samples were shipped to three vendors: Clean Harbors, EQ – The Environmental Quality Company (EQ), and Heritage Environmental Services, LLC (Heritage) for treatability evaluations in 2012.

**Conclusions**

The following conclusions have been developed based on the results of the ERSTS:

- Excavation/Removal
  - In order to maintain perimeter air concentrations below perimeter limits, work locations will be selected based on wind direction and speed.
  - Working within the wind guidelines referenced in Section 2.2, excavation rates greater than 20 tph were documented not to cause perimeter air limit exceedances.
  - Spray covers are effective for emission/odor control.
  - Use of stability mats on top of Semet Residue is not a technically feasible option to allow access to the center of the Semet Residue ponds.
  - The earth boring machine was observed to remove and dewater material at a rate of 1 tph and was observed to have reduced emissions/odors compared to excavation.
- Dewatering
  - Large slots cut into the excavator bucket along with a thumb attachment improved the removal of free aqueous.
  - During dry weather conditions, direct loading of Ponds 1, 2, 5, and stringer pond material (~20,000 tons) to transport containers is feasible. Direct loading is anticipated to be most feasible between June and September, based on local historical precipitation data and field observations. Absorbents may be used on the surface of shipping containers to absorb small amount of free liquids. This practice will compensate for the effects of precipitation during the direct loading season.

   - Ponds 1, 2, 5 and stringer pond material were observed to have material properties that would likely not allow them to be dewatered with a screw during the cold and wet seasons.
   - Dewatering of Ponds 3 and 4 (~46,000 tons) is feasible only at material temperatures above 32°F and 45°F, respectively.  Ambient temperatures near or below freezing limit operations or make them technically infeasible without warming the residue.  Utilizing the ERSTS dewatering screw system and belt conveyors for Ponds 3 and 4 above these material temperatures produces a material that is suitable for transport as a solid (*i.e.,* no free liquids).
- Off-site transport
   - Material was successfully transported with roll-offs and dump trailers double-lined with plastic liners and covered with a cement-based or fiber-based spray cover and plastic tarp covers.  Plastic liner thicknesses included 3, 4, 6, and 8-mil. GAR reportedly did not observe any improvements in processing from utilizing different liner thicknesses.  However, the optimum liner thickness may be temperature dependent, based on the ability to separate the liner from the Semet material.
   - The fiber-based spray cover was observed to be a more effective container surface cover than the cement-based spray cover, likely due to the water content of the cement-based product.
   - The use of 25-cy and 30-cy roll-offs limits loads to approximately 15 tons, due to total weight restrictions for the truck and roll-off.
   - The use of dump trailers facilitates increased shipment loads to approximately 22 tons.
- On-site thermal treatment
   - Feed preparation would likely be required that includes transfer of Semet Residue  to a bunker or pit located in a material handling building, mixing of recycled solids and lime with Semet Residue using a pug mill, and loading of the mix to the thermal treatment system.
   - Pre-design investigations would be necessary to evaluate optimum temperature and feed mix, operability issues due to coking in the thermal desorber, and potential product marketability/pricing.
- Aqueous phase treatment
   - Treating Semet aqueous phase at the GWTP at the blends evaluated is technically feasible for currently regulated parameters.

# 1. INTRODUCTION

This document serves as the ERSTS Report for OU1 of the Semet Residue Ponds Site (the site) located in the Town of Geddes, Onondaga County, New York. This report documents ERSTS tasks completed in accordance with the ERSTS Work Plan submitted to the NYSDEC on May 22, 2012 (Work Plan; O'Brien & Gere 2012) and approved by NYSDEC on June 15, 2012 (Smith 2012b). The ERSTS was performed under ACO D7-0005-01-09 entered into by Honeywell and NYSDEC dated January 22, 2004.

Site background, objectives and approach are described in this introductory section. Section 2 summarizes the ERSTS testing, data, observations, and lessons learned from each of the hot, below freezing, and thaw trials. Treatability evaluations are discussed in Section 3, and additional remedy selection evaluation tasks are discussed in Section 4. Conclusions are summarized in Section 5.

## 1.1. BACKGROUND

The project background prior to the Cold and Hot Weather RSTSs was summarized in the Cold and Hot Weather RSTS Work Plan (O'Brien & Gere 2011a). Results of the Characterization for Thermal Treatment RSTS were summarized in a report (Labuz 2011a) approved by NYSDEC (Smith 2011). Results of the Cold and Hot Weather RSTSs were documented in the Cold and Hot Weather RSTS Report (O'Brien & Gere 2011b) approved by NYSDEC (Smith 2012a).

The ERSTS was intended to provide additional information for off-site reuse and off-site and on-site thermal treatment, and address uncertainties identified during the previous RSTSs. The following completed ERSTS Work Plan tasks are summarized in this report:

- Removal/dewatering/off-site shipment/thermal treatment/reuse of Semet Residue during different seasonal conditions (hot, below freezing, thaw)
- Equipment base stability evaluation
- Sampling and analyses of material from adjacent areas
- Thermal treatability evaluation
- Aqueous phase evaluation (bench-scale and off-site treatability testing).

The following additional tasks were performed to support remedy selection, but were not included in the ERSTS Work Plan:

- Transportation classification evaluation
- Benzene sulfonic acid (BSA) evaluation.

## 1.2. OBJECTIVES AND APPROACH

### 1.2.1. Objectives

The objectives for the ERSTS, as detailed in the Work Plan, are summarized in the following table:

**Table 1-1. ERSTS Objectives**

| ERSTS Objectives |
|---|
| **Evaluate alternative Semet Residue removal processes at multiple ponds and locations** |
| **Optimize on-site dewatering process** |
| **Evaluate ability of GAR to treat the dewatered Semet Residue from multiple ponds/locations and varying ambient temperatures (see GAR objectives below)** |
| **Evaluate ability of additional off-site vendors to treat dewatered Semet Residue** |
| **Collect additional characterization data at various depths/reaches of each pond** |
| **Evaluate need for pretreatment of the excavated Semet Residue (*e.g.*, shredding) prior to dewatering in below freezing conditions** |
| **Evaluate stability of the ponds to confirm what would be required if large excavation equipment were used in the middle of each pond** |
| **Evaluate optimum feed composition for thermal treatment with regard to feed blending, neutralization, and coking (applicable to on-site and off-site thermal treatment)** |
| **Evaluate ability of Willis Avenue GWTP to accept process aqueous phase from on-site dewatering operations.** |

GAR's objectives were to evaluate the following in order to identify potential issues associated with handling and management of dewatered Semet Residue for a multi-year project:

- Changes in benzene concentrations when processing Semet Residue at different ambient temperatures
- Changes in benzene concentrations from Semet Residue extracted at different levels within a pond as well as older vs. newer ponds
- Changes in Semet Residue handling requirements at different ambient temperatures
- Will shredding the Semet Residue improve handling/processing efficiency?
- Will sulfur levels in the Semet Residue vary within a Semet pond or from pond to pond?
- Sulfur impacts to the cement process over an extended feeding period
- Test for changes in Semet Residue constituents, i.e., chlorides, organics, metals, etc.
- Impacts on processing of the Semet Residue/Solvay Waste mix layer
- Will debris/soils be encountered when Semet Residue is extracted near pond bottoms?
- Can shipping by alternate types of roll-offs improve handling efficiencies?
- Will a top surface coating be required on the Semet Residue in the transport container to reduce emissions during transport?
- Document impacts to cement kiln stack emissions (no impact expected)
- Other changes that can be made to improve the economics of using the Semet Residue as an alternative fuel.

Additional objectives not detailed in the Work Plan included the following:

- Evaluate the Department of Transportation (DOT) regulatory classifications for the dewatered Semet Residue.
- Evaluate whether BSA is present in the Semet Residue and, if so, if the gas chromatography/mass spectrometry (GC/MS) analytical method for VOCs could be generating benzene from BSA.

### 1.2.2. Approach

To address objectives identified in Section 1.2.1, the ERSTS included the following tasks to generate information to reduce uncertainties associated with off-site and on-site treatment alternatives:

**Table 1-2. ERSTS Tasks**

| ERSTS Task | Off-Site Cement Kiln | Off-Site Thermal Desorption | On-Site Thermal Desorption | On-Site Distillation for Beneficial Reuse |
|---|---|---|---|---|
| Removal/dewatering in different seasonal conditions | √ | √ | √ | √ |
| Extended duration production-scale treatment/reuse trial with one off-site vendor | √ | | | |
| Smaller scale treatment/reuse trial with up to two off-site vendors | √ | √ | √ | |
| Equipment base stability evaluation | √ | √ | √ | √ |
| Thermal treatability evaluation | √ | √ | √ | √ |
| Aqueous phase evaluation | √ | √ | √ | √ |
| Thermal treatment engineering support | √ | √ | √ | √ |

To address the additional objectives not detailed in the Work Plan, the following tasks were performed:

- Solid flammability and corrosivity testing
- BSA evaluation.

## 2. FIELD TESTING, DATA, OBSERVATIONS, AND LESSONS LEARNED

ERSTS efforts are summarized in this section and include the following:

- Removal/dewatering during three different seasonal conditions (hot, below freezing, and thaw)
  - Excavation
  - Dewatering
  - Earth boring machine
  - Odor/emission control evaluation (odor management mist evaluation, wind block testing, excavation evaluation)
- Equipment base stability evaluation
- Sampling and analyses of adjacent areas
- Community air monitoring
- Health and safety
- Off-site material shipment for vendor testing.

### 2.1. REMOVAL/DEWATERING SEASONAL TRIALS

Removal and dewatering of Semet Residue was performed and evaluated during three different seasonal conditions (*i.e.*, hot, below freezing, and thaw). Trial timeframes were as follows:

- Hot trial – July 9, 2012 to October 5, 2012
- Below freezing trial – January 7, 2013 to February 4, 2013
- Thaw trial – March 27, 2013 to June 3, 2013. Demobilization was performed the week of July 8, 2013, and a final touchup of pond surfaces was performed July 16 and 17, 2013.

### 2.2. EXCAVATION

Raw Semet Residue from each of the ponds and Stringer Pond material was excavated during the hot trial in July, August, September, and October 2012, the below freezing trial in January 2013, and the thaw trial in April and May 2013. Material was excavated using a tracked long-reach excavator.

Ponds 1, 2, and 5 were considered for direct loading to double-lined shipping containers based on the absence of free aqueous during previous field work during summer months. Free aqueous has been defined as surface waters or aqueous phase from excavation activities which remains in the ponds. During the ERSTS hot trial and a portion of the thaw trial, when no free aqueous was observed, excavated material from Ponds 1, 2, 5, and the stringer ponds was placed in shipping containers that were double-lined with plastic liners. Off-site shipments are summarized in Section 2.10.

Test scoops were excavated from Pond 2 during the ERSTS below freezing and thaw trials when no surface water was present on the pond surface to evaluate the presence of free aqueous within the pond material. For the duration of the below freezing trial and the majority of the thaw trial, direct loading was not feasible as a result of free aqueous presence. Excavation of Ponds 1 and 5 during the below freezing and thaw trials was limited to sample collection.

Excavated material from Ponds 3 and 4 was placed in the hopper of a mobile dewatering screw. The discharge from the mobile dewatering screw was loaded to shipping containers utilizing a belt conveyor(s). The dewatering process is discussed in Section 2.3, and off-site shipments are summarized in Section 2.10.

The excavation area was covered with a cement-based or fiber-based spray cover at the end of each work day to mitigate emissions/odors. Perimeter air monitoring was conducted during excavation operations in accordance with the CAMP referenced in the Work Plan, as discussed in Section 2.8. When a snow or water cover was present at the excavation area, the excavation area was not spray covered since the snow and/or water acted as an effective cover (during the ERSTS below freezing and thaw trials). During snow cover presence, snow (instead of a spray cover) was replaced over the excavation area at the end of the day.

Excavation locations are noted on ***Figure 1***.

### 2.2.1 Testing – Excavation

Samples of raw excavated Semet Residue were collected from each of the ponds for laboratory analyses for each of the three ERSTS seasonal trials. Additionally, a sample of Stringer Pond material located on the southwest end of Pond 2, as indicated on ***Figure 1,*** was collected for laboratory analyses during the ERSTS hot trial. In accordance with the Work Plan, samples were analyzed by Accutest Laboratories (Accutest) for the following parameters:

- pH
- Target Compound List (TCL) VOCs and SVOCs
- Target Analyte List (TAL) metals.

Analyses for pH were eliminated for the below freezing and thaw trials because pH data were sufficient for solid characterization for off-site vendors.

In accordance with the Work Plan, the samples were analyzed by Hazen Research Inc. (Hazen Research) or Accutest for the following parameters:

- percent moisture
- density
- total sulfur
- calorific value.

Raw Semet Residue samples from Ponds 3 and 4 were only analyzed for percent moisture during the below freezing and thaw trials as the material required dewatering prior to shipment.

The Work Plan indicated that free aqueous samples would be collected from each pond during each seasonal trial. Free aqueous was not present during the excavation of Ponds 1, 2, 5, and Stringer Pond material during the hot trial, and therefore, free aqueous samples were not collected from these ponds and submitted for laboratory analyses. Due to the plan to direct load Ponds 1, 2, and 5 (pending weather conditions), it was determined that free aqueous samples from the below freezing and thaw trials would not be required.

Shaker tests were also not performed on material from Ponds 1, 2, 5, and Stringer Pond material as no free aqueous was visually observed. Shaker tests were not performed on excavated material from Ponds 3 and 4 as free aqueous was observed, and it was apparent that the material would require dewatering prior to off-site transport.

### 2.2.2 Data and Observations – Excavation

#### Excavation Observations

For Ponds 1, 2, 5, and Stringer Pond material, the excavation and direct-loading rates were between approximately 10 and 90 tph, and averaged approximately 40 tph. For Ponds 3 and 4, the excavation rate was driven by the dewatering rate discussed in Section 2.3, which was between approximately 1 and 5 tph. Refer to ***Table 1*** for additional information regarding the excavation and loading rates.

Excavation tests were performed at a rate of 20 tph to evaluate odor and emission generation and are discussed in Section 2.5. Pond specific observations and data are presented below.

#### Pond-Specific Data and Discussions

Consistent with observations documented in the Cold and Hot Weather RSTS Report (O'Brien & Gere, 2011b), ERSTS observations and data analyses indicate that each of the ponds have distinct characteristics. Brief summaries of data and observations for excavated raw Semet Residue from each of the ponds and Stringer Pond material are presented below. Summaries of detected compounds for the raw excavated solid phase samples collected during the ERSTS field activities are included in Tables A-1 through A-4 of ***Appendix A***. Perimeter air monitoring data are discussed in Section 2.8.

***Pond 1***

During the 2012 ERSTS hot trials, Pond 1 was observed to be dry (no free aqueous), and Semet Residue was observed to be a thin layer amongst soils. Excavation efforts targeted the western corner of Pond 1, which is one of the few areas where vegetation does not grow as a likely result of the thickness of Semet Residue. During excavation, work was halted (July 12, 2012) as a result of hydrogen sulfide ($H_2S$) levels at the perimeter. Further discussion of this is included in Section 2.8. $H_2S$ readings were below detection limits in the work zone.

Excavation of Pond 1 during the 2013 ERSTS below freezing and thaw trials was limited to sample collection. Surface water from precipitation/snow melt was present on Pond 1 during sample collection during the below freezing trial (January 31, 2013). No free aqueous was observed during excavation/sample collection during the thaw trial (May 23, 2013).

***Pond 2***

During the 2012 ERSTS hot trial, Pond 2 was observed to be a low viscosity solid, and free aqueous was not observed. A test scoop was excavated on January 9, 2013 during the below freezing trial, and free aqueous was observed. During the thaw trial, excavation and direct loading of material was performed when no free aqueous was observed.

***Pond 3***

The physical nature of the Pond 3 Semet Residue was a loosely consolidated tar during the 2012 ERSTS hot trial with a significant amount of free aqueous present. In the low ambient temperatures during the below freezing trial, excavated Pond 3 material was observed to behave as a high viscosity solid. During excavation of Pond 3 during the below freezing trial, the bottom of the Pond was reached based on visual observation of the material in the bucket. The excavation area was covered with free liquid and the bottom of the pond was not visible. However, the material in the bucket appeared to be a mixture of Semet Residue and Solvay Waste. During the thaw trial, Pond 3 material characteristics were observed to be temperature dependent, with viscosity increasing with lower temperature and decreasing with higher temperature. Discussions regarding dewatering and aqueous phase are presented in Section 2.3.

***Pond 4***

The physical nature of the Pond 4 Semet Residue was a loosely consolidated tar during the 2012 ERSTS hot trial with a significant amount of free aqueous present.

As a likely result of the low ambient temperatures during the below freezing trial, excavated Pond 4 material was observed to behave as a high viscosity solid. No shipments were loaded with excavated and dewatered Pond 4 material during the below freezing trial.

During the thaw trial, Pond 4 material characteristics were observed to be temperature dependent, and viscosity was observed to change based on the ambient temperature. Additional discussions regarding dewatering and aqueous phase are presented in Section 2.3.

***Pond 5***

Pond 5 material was observed to be a low viscosity solid during the 2012 ERSTS hot trial and free aqueous was not observed. Excavation of Pond 5 during the 2013 below freezing and thaw trials was limited to sample collection. Surface water from precipitation/snow melt was present on Pond 5 during sample collection during the below freezing trial on January 31, 2013. No free aqueous was observed during excavation/sample collection during the thaw trial on May 23, 2013.

***Stringer Ponds***

The material from the Stringer Ponds was observed to be similar to a dry soil, and no free aqueous was observed to be present during the 2012 ERSTS hot trial excavation. A sample was collected for laboratory analyses during the 2012 hot trial. Additional samples of Stringer Pond material were not collected during the below freezing and thaw trials.

### 2.2.3. Lessons Learned - Excavation

The lessons learned from excavating each of the ponds and the Stringer Ponds material are as follows:

- Raw Semet Residue from Ponds 1, 2, 5 and the Stringer Ponds material was able to be excavated and direct-loaded to shipping containers during dry conditions (ranging from May through August) because of the absence of free aqueous.
  - Direct loading is dependent on the weather and field conditions (*i.e,* presence of surface water)
  - Estimated months for direct loading these ponds are between June and September based on historical rain events (≤0.5" of rain over a 24 hour period). Precipitation data and field observations are included in ***Figure 2***.
- A minimal amount of absorbent may be applied to the surface in the shipping containers to minimize emissions and absorb any surface moisture from processing or precipitation.
- Working within the wind guidelines summarized in ***Figure 3***, excavation rates in Ponds 3 and 4 up to 20 tph were documented not to cause perimeter air limit exceedances.

## 2.3. DEWATERING (PONDS 3 AND 4)

Efforts related to dewatering performed during the ERSTS included bench-scale dewatering tests, purchase/modification of a dewatering screw, evaluation of different excavator bucket configurations, and pilot-scale dewatering of material from Ponds 3 and 4 during the three seasonal trials.

### 2.3.1. Bench-Scale Testing - Dewatering

Bench-scale testing was performed to identify improvements to the pilot dewatering process as specified in the Work Plan. The bench-scale dewatering testing, results, and observations are summarized in the Bench Scale Dewatering Memorandum included as ***Appendix B***. It was observed that increased pressure exerted on the material during dewatering may result in increased moisture content of the solid Semet Residue, indicating possible additional entrainment of liquid with increased pressure. It is hypothesized that improved removal of aqueous phase prior to the dewatering step (*i.e.,* removal from the excavator bucket) may improve moisture content reduction. Extrusion, shaking/vibrating, and dropping/mashing of the material were evaluated and did not improve moisture content reduction.

### 2.3.2. Equipment Purchase/Modification - Dewatering

A used stainless steel screw conveyor was identified and purchased for dewatering efforts. Modifications of this screw conveyor were coordinated with a material handling expert (Thomas & Muller). The modifications included the addition of a hopper and dewatering screens, and replacing the electric motor with a hydraulic motor (same one used on the EBM). A 10 horsepower (HP) electric hydraulic pump and manifold was procured from Ralph W. Earl to drive the hydraulic motor.

### 2.3.3. Excavator Bucket - Dewatering

For the ERSTS hot trial, slots were cut into the excavator bucket as specified in the Work Plan to improve removal of free aqueous from the excavator bucket being transferred to the dewatering screw hopper. Free aqueous from the excavator bucket was expected to more readily drain from the bucket with the increased number of dewatering slots. However, these slots also clogged during excavation. The slots were then made slightly larger to further improve dewatering from the bucket.

Prior to the start of the below freezing trial, rectangular openings were cut into the bucket to provide for more area for aqueous phase to drain. This bucket was used for the majority of the below freezing trial. However, a replacement excavator and bucket were delivered on January 29, 2013 to be used for the remainder of the below freezing trial and the duration of the thaw trial. O'Brien & Gere coordinated with the excavator vendor to cut openings in the bucket prior to delivery.

To further improve dewatering from the excavator bucket, a stationary thumb with plate was installed on the excavator arm prior to the start of the thaw trial. The excavator bucket was able to be curled in toward the plate to press material within the bucket. The combination of large slots and a thumb was observed to work best for removal of free aqueous from the bucket.

### 2.3.4. Pilot-Scale ERSTS Dewatering

Pilot-scale dewatering efforts for each of the three ERSTS seasonal trials are discussed in the following subsections.

**Hot ERSTS Trial - Dewatering**

Collection sumps were located beneath the screw conveyor to capture aqueous phase from the dewatering process (process aqueous). Plastic and piping were used to direct the aqueous phase from the screens located along the screw and below the hopper to the sumps. Aqueous phase separated by the mobile dewatering unit was either collected for the aqueous phase evaluation or returned to the Semet Residue Ponds.

On August 16, 2012, the dewatering efforts did not yield a Pond 3 material suitable for off-site shipment as aqueous phase was visually observed on the surface of the roll-off. This was a result of aqueous phase discharging from the dewatering screw along with dewatered material onto the belt conveyor and into the roll-off. Filling the roll-off was halted and the material in the roll-off was later dumped to Pond 4. A large quantity of aqueous phase exited at the screw conveyor discharge upon start up of the conveyor. In the process of optimizing the dewatering, on August 17, 2012 the initial material discharging the screw conveyor was captured on plastic and not sent to the roll-off to minimize aqueous phase going to the roll-off. Following the initial flow of aqueous phase, dewatered material was then sent to the roll-off and sampled (sample description August 20, 2012). This effort was also unsuccessful at producing a material suitable for off-site transport because of aqueous phase traveling up the belt conveyor into the roll-off.

Based on these results, the dewatering screw and process were modified as described below to improve dewatering of Pond 3:

- making the discharge smaller by welding a plate over approximately half of the discharge to increase pressure exerted on the material
- welding a metal plate above the screws at the discharge end to alleviate building up at the cover
- welding a plate shroud in the hopper to minimize overfilling of the screw conveyor trough
- utilizing two belt conveyors in series to minimize the amount of aqueous phase traveling along the belt conveyors and into the roll-off.

This work was considered additional optimization of the dewatering screw as indicated by the sample description for the September 27, 2012 dewatered Pond 3 sample. The modified dewatering process yielded material suitable for off-site shipment, and two roll-offs (approximately 23 tons total) were loaded for shipment to GAR.

**Below Freezing ERSTS Trial - Dewatering**

For the below freezing trial, minor changes were made in January 2013 to the mobile dewatering unit used during the ERSTS hot trial. Slots were cut into the dewatering screens located along the bottom of the screw conveyor and below the hopper as they were observed to clog during previous field work. Additional plastic and containment sumps were utilized to improve aqueous phase collection and handling. A 20 HP gas-fired hydraulic unit was rented to drive the hydraulic motor. The 20 HP unit was observed to overheat. Following this, the 10 HP electric-powered hydraulic unit (purchased for the hot trial) was used for the remainder of the field work.

Two roll-off containers (approximately 31 tons total) of dewatered Pond 3 material were loaded and shipped off-site.

There were several field trials to dewater Pond 4 material during the below freezing trial using the modified dewatering screw used at Pond 3. A dewatered material suitable for off-site shipment was not generated until ambient temperatures increased to approximately 45 °F. No Pond 4 material was shipped off-site during the below freezing trial.

Based on field observations during the below freezing trial, the material handling challenges are expected to be a function of temperature. During the attempts to dewater Semet Residue from Pond 4, material within the hopper was shaved off the bottom as the screw conveyor scraped the bottom and no improvement in dewatering efficacy was observed. Therefore, it was determined that shredding of the material would not improve dewatering.

**Thaw ERSTS Trial - Dewatering**

For the thaw trial, larger fittings and hydraulic hoses were used to connect the 10 HP electric-powered hydraulic unit to the screw conveyor in order to reduce hydraulic flow restrictions. During the thaw trial, scales were placed under two dump trailers and one roll-off while loading with dewatered material to provide hourly flow rate data.

Approximately 170 tons of dewatered Pond 3 material and 15 tons of dewatered Pond 4 material were loaded to containers and shipped off-site.

*Testing*

Samples of dewatered Pond 3 and Pond 4 Semet Residue were collected from the discharge of the dewatering screw for laboratory analyses for each of the three seasonal field trials. Dewatered residue samples were submitted to Accutest for analyses for the following parameters in accordance with the Work Plan:

- pH
- TCL VOCs and SVOCs
- TAL metals.

Analyses for pH were eliminated for the below freezing and thaw trials because pH data were sufficient for solid characterization for off-site vendors. In accordance with the Work Plan, dewatered residue samples were analyzed by Hazen Research or Accutest for the following parameters:

- percent moisture
- density
- total sulfur
- calorific value.

In accordance with the Work Plan, samples of free aqueous from the excavator bucket were collected from Ponds 3 and 4 for each of the three seasonal trials and analyzed by Accutest for the following parameters:

- TCL VOCs and SVOCs
- TAL metals
- polychlorinated biphenyls (PCBs)
- molybdenum (Mo)
- ammonia
- flash point.

In accordance with the Work Plan, samples of process aqueous phase generated during dewatering of Ponds 3 and 4 were collected and analyzed by Accutest for the following parameters:

- TCL VOCs and SVOCs
- TAL metals
- PCBs

- Mo
- ammonia
- flash point.

Shaker tests were performed on certain dewatered material samples from Ponds 3 and 4. The shaker test was performed by shaking approximately 1 gallon of material in a paint can for 1 hr in order to evaluate if aqueous separated from the material. The shaker test provided information regarding how the material may behave while being transported (the shaking that occurs during transportation). A minimal amount of visual free aqueous was allowed on the surface because previous field experience showed that a spray cover sprayed on the surface would absorb this liquid. It was observed that the fiber-based spray cover was more absorbent than the cement-based spray cover and may be a better spray cover for shipping containers.

In addition to shaker tests, paint filter tests were performed on certain dewatered material samples from Ponds 3 and 4 to evaluate if aqueous phase separated from the material. Paint filter tests were performed under guidance of Method SW-846 9056A, which consists of putting approximately 100g of material in a suspended paint filter and measuring the amount of free aqueous that passes through the filter. This test also provided information on whether dewatered Semet Residue was suitable for shipment as a solid.

### 2.3.5. Data and Observations - Dewatering

Summaries of detected compounds for the dewatered Pond 3 and 4 residue samples collected during the ERSTS field activities are included in Tables A-1 through A-4 of ***Appendix A***. Shaker test and paint filter test results are summarized in Tables A-5 and A-6 of ***Appendix A***. Aqueous phase data are included in Tables A-7 through A-11 of ***Appendix A***, and are discussed later in this section. Air monitoring data are discussed in Section 2.8.

Dewatering rates achieved in the field ranged between 1 and 5 tph as indicated in ***Table 1***. The material throughput was estimated based on start and stop times of the process and total load weights. The adjusted throughput accounts for lost time during start up and shutdown and adjusts the operating time by an hour for every startup.

Additional evaluations related to scale-up feasibility of the dewatering screw conveyor design have been included in a Supplemental Testing Work Plan Addendum letter submitted to the NYSDEC on July 15, 2014. Following approval and completion of the supplemental tests, additional field trials to confirm the larger screw conveyor design may be developed and summarized in a subsequent work plan to the NYSDEC.

A discussion of data and observations for dewatering during excavation and material processed through the dewatering pilot process is presented below.

**Hot ERSTS Trial - Dewatering**

The dewatering screw conveyor utilized during the hot ERSTS trial reduced the moisture content of Pond 4 material from 17.5% to 16.0%. The material discharged as intermittent chunks. The dewatered material was suitable for transport and was loaded to roll-offs by a belt conveyor for off-site shipment. There was some aqueous phase exiting the discharge with the solid material and the belt conveyor was operated at a slow speed to allow for aqueous phase to run off prior to loading the roll-off. The dewatering screens along the bottom of the screw trough were observed to clog and limited the dewatering efficacy of the screw, which likely led to aqueous phase traveling up the screw incline and to the discharge.

The modified dewatering screw conveyor reduced the moisture content of Pond 3 material from 16.2% to 14.4%. Two belt conveyors in series were utilized to minimize the amount of aqueous phase entering the roll-off along with the dewatered material. This arrangement also produced a material suitable for off-site shipment.

A dewatering rate of 1 to 2.5 tph was achieved. The hydraulic pump used to drive the dewatering screw supplied oil at 5 to 6 gallons per minute (gpm) at 3,500 pounds per square inch (psi). This dewatering flow rate was slower than stated in the Work Plan (4 to 6 tph), which has been attributed to the limited hydraulic oil flow rate from the 10 HP hydraulic unit. The 10 HP limit was recommended in order to stay below 31,500 inch-pounds of torque as recommended by Thomas & Muller based on its evaluation of the screw conveyor. The speed of the screw conveyor was adjusted manually by adjusting set screws on the hydraulic unit. A flow adjusting valve was added to the hydraulic system during the below freezing trial to optimize the speed adjustment.

**Below Freezing ERSTS Trial - Dewatering**

Minimal modifications were made to the dewatering screw conveyor prior to the start of field work for the below freezing trial. To increase the dewatering flow rate, a 20 HP gas-powered hydraulic unit was rented (set up to provide 10 gpm at 2,500 psi). This unit was expected to provide twice the hydraulic flow rate, and thus twice the material throughput (increase throughput from 2 tph to 4 tph). The dewatering operation was observed to be largely affected by the low ambient temperatures, which resulted in low material temperatures and high material viscosity. Dewatered material flow rates were generally <1 tph. Operating the hydraulic unit continuously at maximum capacity resulted in overheating the system because of inadequate system cooling. Following overheating of the 20 HP gas-powered unit, the 10 HP electric-powered hydraulic unit utilized during the hot trial was used.

It was observed that Pond 3 material was sufficiently dewatered at a speed <2 revolutions per minute (rpm) above 32°F (normally operated between 1 and 2 rpm). Greater than 2 rpm resulted in the presence of aqueous phase exiting at the discharge.

At the start of field work, Pond 4 material was excavated from the east location as indicated on ***Figure 1*** and was not sufficiently dewatered. The material was observed to be ground up rather than squeezed, which was attributed to the low material temperature. It was also observed that the material did not flow into the screws once in the hopper, and the screws effectively shaved the bottom of the solid mass.

**Thaw ERSTS Trial - Dewatering**

Similar to the below freezing trial, the dewatering operation was observed to be largely affected by the ambient temperature. Processing rates ranged between 1 and 5 tph (as high as 6 tph adjusting for startup/shutdown), with the low end occurring on colder days (ambient temperature below 50 °F). The 10 HP electric-powered hydraulic unit was utilized and typically operated at maximum parameters (5-6 gpm at ~3,500 psi).

During the thaw trial, scales were placed under shipping containers in order to provide for hourly tracking of processing rates. Hourly processing rates were recorded for approximately 20 hours over the span of three loads (two dump trailers and one roll-off). The average processing rates ranged between approximately 2 and 4 tph as indicated in ***Table 1***.

**Free Aqueous and Process Aqueous Phase**

The amount of free aqueous on the surface of the ponds is a function of weather conditions and precipitation, and ranges from no free aqueous (dry surface) to a layer of free aqueous across the pond surface (water cover). It has been observed during excavation field activities on Ponds 3 and 4, that even with a dry pond surface, a pool of free aqueous forms in the excavation hole. Therefore, the amount of free aqueous remaining in the excavator bucket is directly related to the bucket design. Based on moisture content data for raw and dewatered samples, there is a minimal change in moisture content through the dewatering process. It is assumed that the free aqueous excavated and collected in the excavator bucket along with raw Semet Residue and transferred to the screw hopper is similar in quantity and quality as process aqueous phase collected in sumps beneath the dewatering screw conveyor.

Process aqueous was estimated as a percent of bucket volume for the ERSTS hot trial, and has been converted to generation rates (gal/ton). For the freezing and thaw trials, estimates of process aqueous generation were based on dewatering sump collection volumes and dewatering rates. A summary of process aqueous phase generation rates is provided below:

**Table 2-1. Estimated Process Aqueous Phase Generation**

| PROCESS AQUEOUS GENERATION FROM THE DEWATERING PROCESS | | | |
|---|---|---|---|
| POND | HOT | BELOW FREEZING | THAW |
| POND 3 | 52 gal/ton ( 20% vol) | 32 gal/ton | 50 gal/ton |
| POND 4 | 54 gal/ton (20% vol) | No Information | 52 gal/ton |

-Dewatering process was unable to dewater Pond 4 material during Below Freezing trial.

As presented in Table 2-1 above, aqueous phase generation ranged from an estimated 32 to 54 gal/ton Semet Residue dewatered. Summaries of detected compounds for the free aqueous samples collected from the excavator bucket during excavation and for the process aqueous samples collected from the collection sumps beneath the dewatering screw conveyor from the dewatering of Ponds 3 and 4 during the ERSTS field activities are included as Tables A-7 through A-11 of ***Appendix A***.

### 2.3.6. Lessons Learned – Dewatering

The lessons learned from dewatering efforts related to Ponds 3 and 4 are summarized as:

- Pond 3 material can be dewatered at temperatures above 32°F using the mobile dewatering screw.
- Pond 4 material can be dewatered at temperatures above 45°F using the mobile dewatering screw.
- The speed (rpm) of the dewatering screw (1-2 rpm is ideal), the ambient temperature/residue temperature (warmer temperatures, better dewatering), and the amount of material in the hopper (avoid overloading) all affect the dewatering performance.
- Slots cut perpendicular to the screw shaft have been observed to be more effective than parallel as a result of self cleaning.
- Aqueous phase remaining in the excavator bucket is the main source of the aqueous phase processed from the dewatering screw.

## 2.4. EARTH BORING MACHINE

The custom fabricated EBM utilized during the 2011 Hot Weather RSTS was tested again during the ERSTS hot and thaw trials to demonstrate potential removal rate and dewatering efficiency. During the hot ERSTS evaluation, it was observed that the hydraulic direct drive system was unable to be powered by the excavator. Larger diameter hydraulic hoses and fittings were used during the thaw trial to reduce pressure restrictions while powering the EBM off of an excavator. However, this still led to overheating of the excavator hydraulics. A standalone, fan-cooled hydraulic unit was used to power the EBM during the thaw trial, and the EBM was able to remove Semet Residue at a rate of approximately 1.4 tph.

### 2.4.1. Testing - EBM

#### Hot ERSTS Trial

O'Brien & Gere contacted Thomas & Muller to provide recommendations to improve the 24-inch custom fabricated EBM utilized during the Hot Weather RSTS in 2011. Following review of historical data, Thomas & Muller recommended that an additional set of screw flights be added to the end of the custom fabricated EBM to improve operation (*i.e*., provide more balanced operation when turning). The screw flights were procured through Thomas & Muller and welded onto the EBM in the field by O'Brien & Gere technicians. More slots (with dimensions of approximately 5 inch long by 1/8 inch wide) were cut in the casing of the EBM to provide additional points for aqueous phase to drain from the machine.

The EBM was tested in Pond 3 on September 24, 2012. The EBM was driven by the auxiliary hydraulics of a long reach excavator. There were two attempts (trials 1 and 2) at using the EBM, each at different hydraulic parameters. The parameters were:

- Trial 1 - 60 to 65 gpm of hydraulic oil at 3,500 psi

- Trial 2 - 80 to 85 gpm of hydraulic oil at 4,900 psi

Run time was limited for both attempts because the excavator hydraulics would overheat. Visually, the rate observed prior to hydraulic overheating was approximately 2 tph.

**Thaw ERSTS Trial**

Minor changes were made to the 24 inch custom-fabricated EBM prior to evaluating it on Pond 4 in March 2013. Modifications included use of larger diameter hydraulic fittings and hoses to reduce pressure restrictions.

On March 27, 2013, the EBM was evaluated in Pond 4 using the 10 HP hydraulic unit and was observed to be ineffective. On March 28, 2013, the EBM was evaluated again in Pond 4 at the same location as the test on March 27, 2013, but about 1-2 feet deeper. During this trial it was determined that the mechanical seals on the 100 HP hydraulic drive motor had ruptured on the EBM. The hydraulic motor was removed and repaired.

Upon evaluation of the cause of the hydraulic motor failure, it was observed that the EBM did not have a thrust bearing and the screw was directly connected to the hydraulic motor. With this configuration, the horizontal force from boring was exerted on the hydraulic motor, effectively pulling apart the hydraulic motor. Prior to evaluating the EBM again in May 2013, a thrust bearing was installed on the screw to alleviate horizontal force on the hydraulic motor.

On May 21, 2013, the EBM (with thrust bearing) was evaluated in an alternate location of Pond 4 (northwest corner). Three trials were performed.

During the first trial on May 21, 2013, the EBM was powered by the 10 HP hydraulic unit. The rate achieved was <0.5 tph.

The second trial on May 21, 2013 utilized the excavator auxiliary hydraulics. The hydraulic flowrate and pressure parameters were adjusted during the trial. After approximately 40 minutes operation using the excavator auxiliary hydraulics, the test was stopped as a result of high temperature of the hydraulics. Approximately 100 lbs of material was collected in the front end loader, or <0.1 tph.

The EBM was evaluated again (third trial) on May 21, 2013, again utilizing the 10 HP hydraulic unit, with a goal of operating the EBM for 1 hour following the start of material discharge. Dewatered residue was collected in the front-end loader bucket. The weight of residue collected was estimated to be 1.41 tons (flow rate estimated to be 1.41 tph). The increased rate is attributed to the higher Semet Residue temperature (101 °F versus 85 °F) resulting in lower material viscosity and from the aqueous phase lubricating the inside of the EBM from use.

Samples were collected from the discharge of the EBM for laboratory analyses. In accordance with the Work Plan, the EBM hot trial discharge samples were analyzed by Accutest for the following parameters:

- pH
- TCL VOCs and SVOCs
- TAL metals.

In accordance with the Work Plan, EBM discharge hot trial samples were also analyzed by Hazen Research for the following parameters:

- percent moisture
- density
- total sulfur
- calorific value.

A shaker test was performed on the Pond 3 material discharged from the EBM during the hot trial to evaluate suitability for transport. EBM discharge thaw trial samples were submitted to Accutest for percent moisture analyses.

### 2.4.2. Data and Observations - EBM

Summaries of detected compounds for the Pond 3 solid phase sample collected from the discharge of the EBM during the 2012 hot trial are included in Tables A-1 through A-4 of ***Appendix A***. Shaker test and paint filter test results are summarized in Tables A-5 and A-6 of ***Appendix A***. Percent moisture data for the Pond 4 solid phase samples collected from the discharge of the EBM during the 2013 thaw trial are included in Table A-4 of ***Appendix A***. Air monitoring data are discussed in Section 2.8.

Utilizing auxiliary hydraulics to power the EBM is not recommended because of inadequate hydraulic cooling. A larger hydraulic unit (greater than the 10HP unit used on May 21, 2013) is expected to improve removal rates.

The sample collected of Pond 3 material discharged from the EBM from the hot trial failed shaker testing (free aqueous was removed from shaking). However, the moisture content of the material (12.8%) was similar to that of dewatered Pond 3 material. There was free aqueous exiting the discharge of the EBM along with solid material that was collected in the sample bucket and may have affected shaker test results. The Pond 4 material collected in the front end loader bucket during the third trial on May 21, 2013 appeared to be a shippable material.

### 2.4.3. Lessons Learned - EBM

The lessons learned from the EBM field operations are as summarized below:

- Hydraulic unit requires internal hydraulic oil cooling to operate for a sustained period of time without overheating.
- Reduction on EBM from 24” to 12” could be further explored to assess impacts on dewatering Semet Residue and overheating.

## 2.5.ODOR/EMISSION CONTROL EVALUATION

Odor/emission control evaluations conducted during the ERSTS included:

- Measuring the effectiveness of an odor management mist
- Measuring the effectiveness of a physical wind block
- Monitoring at near field distances downwind of an excavation test.

### Odor Management Mist Evaluation

During the hot trial, a misting agent, intended to break down a broad spectrum of organic and inorganic compounds, was tested for its effectiveness at reducing/controlling emissions. Misting fans (approximately 16 inches in diameter) were used to mist the agent into the air over Pond 2. The misting fans are recommended to be installed in a triangular configuration and operated to spray mist in the direction of the wind (with the wind).

### Physical Wind Block Evaluation

Based on RSTS observations, full-scale excavation will likely involve selection of the daily work area based on wind direction. The potential for a wind screen to reduce wind direction constraints by mitigating emissions/odors from traveling from the excavation area to the perimeter was tested during the thaw trial. A wind block was constructed from metal frame material with tarps secured to the frame and was suspended at the excavation area by a telescoping forklift. Testing was performed on May 9, 2013 at Pond 4. The wind block was suspended above Pond 4 with the wind direction coming from the south and the excavation was started approximately 10 feet behind the screen. Wind speeds were low (less than 5 mph) and shifted between SE, SW, and W. Excavation continued for 30 minutes, and peak TVOC levels were measured as high as 7 parts per million (ppm) at approximately 100 feet downwind. Due to variable wind directions, the excavation was not always sheltered by the wind block during the test. After 30 minutes of excavation, the winds shifted to the SW resulting in TVOC readings in the work zone above the permissible limit (>50 ppm). Excavation and testing were halted and personnel exited the area.

Based on the limited testing with the wind block, any such shielding of the wind may result in higher work zone TVOC levels. To continue work at TVOC levels above 50 ppm, personnel would require a higher level of respirator protection (supplied air). In addition, the wind block did not reliably mitigate emissions/odors due to wind direction variability.

### Excavation Evaluation

Evaluation of perimeter air impacts from excavating and dewatering was performed during the thaw ERSTS trial. An excavation rate of 20 tph was tested while dewatering material. The target of 20 tph equated to approximately 20 excavator scoops per hour, or a scoop every three minutes. TVOC emissions and odors have been shown to be highest during the excavation process. Therefore, it was anticipated that performing excavation at a rate of 20 tph while dewatering at a lower rate would provide additional information for evaluating full-scale emissions and odors. During the test, excavated material was either loaded to the dewatering screw hopper (if hopper was empty) or piled near the excavation area. The following high rate excavation tests (while dewatering) were performed:

- April 17, 2013 at both Ponds 3 and 4: Each test was approximately 1 hour in duration.
- April 23, 2013 at Pond 3: Test was for approximately 1 hour in duration.

Ponds 3 and 4 were selected for the excavation evaluation because they have the highest volatile organic contents. ***Table 2*** summarizes midfield air quality monitoring (AQM) data from the excavation evaluation. ***Figure 4*** shows the midfield monitoring locations as well as the distance from the midfield locations to the excavation areas.

Additional AQM testing was performed during the excavation evaluation on April 23. The testing included the collection of two whole air samples (1-Liter Summa canisters) for speciated VOC analysis. The canisters were collected approximately 20 feet downwind of the excavation of Pond 3, where instantaneous TVOC levels were approximately 8 ppm or greater. The canisters were filled with ambient air over a period of 30-seconds each. After the testing was complete, the canisters were shipped to Accutest under routine chain-of-custody (COC) for TO-15 analysis. The results of the analysis are included in Table A-12 of ***Appendix A***. As indicated in the results, benzene was the primary constituent of VOCs in both samples (76 to 78% of the total detected VOCs).

## 2.6. EQUIPMENT BASE STABILITY EVALUATION

### *Testing*

On August 1, 2012, a pilot scale evaluation of the Mabey Dura-Base® Mat system for support of construction equipment on the Semet Residue ponds was conducted. The details of the stability testing are presented in a memorandum included as ***Appendix C***.

### *Lessons Learned*

- Dura-Base® Mat system is not suitable for use to support construction equipment on the Semet Residue ponds.
- Based on experience at the Honeywell SCA site, the Dura-Base® Mat system would likely be useful as a method to support equipment during construction on top of Solvay Waste adjacent to the Semet Residue ponds or below the Semet Residue ponds after the Semet Residue is removed.

## 2.7.SAMPLING AND ANALYSES OF MATERIALS FROM ADJACENT AREAS

### *Testing*

Samples of the following site materials were collected from the following areas in August 2012, January/February 2013, and June 2013 for characterization.

- Overburden material overlying Ponds 1, 2, 3, 4, and 5
- Material adjacent to the Semet Residue Ponds
- Solvay Waste and material underlying the Semet Residue Ponds.

Samples were collected either by excavating a small hole with a stainless steel shovel and digging up material for transfer to a dedicated aluminum pan, or by utilizing a long reach excavator and transferring material from the bucket to sample jars using a stainless steel trowel. Approximate sample locations are indicated on ***Figure 1***.

In accordance with the Work Plan, samples were analyzed by Accutest for the following parameters:

- pH
- TCL VOCs and SVOCs
- TAL metals.

In accordance with the Work Plan, samples were also analyzed by Hazen Research or Accutest for the following parameters:

- percent moisture
- density
- total sulfur
- calorific value.

***Data and Observations***

Summaries of detected compounds are included in Tables A-13 through A-16 of ***Appendix A***.

## 2.8.COMMUNITY AIR MONITORING

Community air monitoring was conducted to evaluate potential airborne contaminant releases at the work site perimeter as a direct result of the ERSTS work activities.

***Method***

Community air monitoring was conducted during excavation/intrusive work and/or dewatering operations for the ERSTS field activities and is summarized below:

- Hot ERSTS Trial (22 days total)
  - 5 days between July 9 and July 13, 2012
  - 10 days between August 6 and September 6, 2012
  - 7 days between September 24 and October 2, 2012
- Below Freezing ERSTS Trial
  - 17 days between January 8 and February 4, 2013
- Thaw ERSTS Trial
  - 38 days between March 27 and July 9, 2013

As indicated in the ERSTS Work Plan (O'Brien & Gere 2012), the community air monitoring program was conducted following procedures specified in the CAMP included in the Cold & Hot Weather RSTS Work Plan (O'Brien & Gere 2011) and CAMP Addendum 1 included in the Hot Weather Work Plan Addendum (Labuz 2011b). Air monitoring was conducted at or within the site perimeter and consisted of real-time continuous monitoring for TVOC and dust (hot weather only), and routine periodic (grab) air monitoring for $H_2S$ and odors.

*Air Monitoring Locations*

Air monitoring was conducted along or within the site perimeter using portable air monitoring stations. The locations of the portable air monitoring stations were selected at the beginning of each work day based on the predicted wind direction for the day and the location of the anticipated work area. Air monitoring locations were moved during the day if the wind direction shifted into a new quadrant or if the work area location moved. The goal of moving the monitoring locations was to maintain air monitoring upwind and downwind of ground intrusive activities. Site wind (and other meteorological) conditions were monitored each day using the Honeywell 10-meter weather station located along the east edge of the Semet Residue Ponds.

*Continuous Air Monitoring*

Continuous air monitoring consisted of real-time air monitoring of TVOC and $PM_{10}$ (dust) at one upwind location and two downwind locations during daily excavation and dewatering activities in accordance with the CAMP and CAMP Addendum 1. Work perimeter limits and control levels were established in the CAMP and CAMP Addendum 1 for TVOC and dust. Work perimeter limits identify the air quality levels requiring work stoppage to protect the community. Control levels provided air quality levels requiring corrective responses to site activities prior to reaching work perimeter limits. Investigate levels provided air quality levels requiring the AQM operator to investigate the cause of the levels. Control and investigate levels and work perimeter limits are based on 15-minute time weighted averages for TVOC and dust. Please note that with the approval of NYSDEC, monitoring for dust was not performed during the below freezing and thaw trials (January through May, 2013).

Continuous air monitoring limits and levels were as follows:

- Work Perimeter Limits: TVOC: 1.2 ppm; Dust: 150 microgram/cubic meter ($\mu g/m^3$)
- Control Levels: TVOC: 0.7 ppm; Dust: 100 $\mu g/m^3$
- Investigate Levels: TVOC: 0.5 ppm

Continuous air monitoring at each location included an automatic alarm that would notify the site operator prior to a downwind level reaching the work perimeter limits or control levels. Evaluation of monitoring data with respect to work perimeter limits and control levels were determined from the 15-minute time weighted average concentrations from a downwind location after subtraction of the background level, as determined by the upwind location reading from the same time period.

*Periodic Air Sampling/Monitoring*

Routine periodic perimeter odor monitoring consisted of real-time spot checks of $H_2S$ and odors each day at the downwind perimeter monitoring locations in accordance with the CAMP and CAMP Addendum 1.

$H_2S$ concentrations were measured by the Jerome 631X that has a minimum detection limit of 3 ppb. Work perimeter limits for $H_2S$ were 10 ppb (1-hr average according to NYSDEC short-term guideline concentrations).

Perimeter odor monitoring consisted of routine qualitative and quantitative on-site odor observations downwind of daily work activities at the downwind TVOC/dust monitoring stations. Quantitative measurements were obtained with the St. Croix Sensory Nasal Ranger Olfactometer. The work perimeter limit for odors was 7 OUs based on a 15-minute time-weighted average.

***Data and Observations***

Air monitoring results for the ERSTS field activities are summarized in Tables D-1 through D-3 of ***Appendix D*** and discussed below.

*Hot ERSTS Trial*

Results of the 22 days of air monitoring performed for the hot trial in comparison to control levels and work perimeter limits are presented in Table D-1 of ***Appendix D*** and are summarized as follows:

- No control level or work perimeter limit exceedances for TVOC
- No observed odor readings greater than 4 OUs at the perimeter
- One $H_2S$ work perimeter limit exceedance (discussed below)
- One control level and work perimeter limit exceedance for dust (discussed below).

*Continuous Air Monitoring (Dust and TVOC)*

One dust exceedance of the work perimeter limit occurred during the 22 days of air monitoring. On July 13, 2012 a background-corrected dust exceedance of 298 $ug/m^3$ resulted from excavator movement along the Pond 1 access road. In order to access the excavation site at Pond 1, the excavator had to travel around the perimeter access road of Pond 1, where one of the downwind AQM stations was positioned. Due to dry site conditions, the excavator generated a large dust cloud as it passed immediately by the downwind station, causing a brief spike in dust concentrations. To control dust emissions, the excavator movement was immediately halted. The next highest 15-minute background-corrected downwind concentration was 93 ug/m$^3$ after background subtraction. No exceedances of TVOC above work perimeter limit or control level criteria occurred during the entire monitoring period.

*Periodic Air Sampling ($H_2S$ and Odors)*

One $H_2S$ exceedance of the work perimeter limit occurred during the 22 days of air monitoring. On July 12, 2012 one 1,300 ppb $H_2S$ measurement was observed near the downwind perimeter while excavation and direct loading was being conducted at Pond 1. $H_2S$ readings were below detection limits in the work zone. Based on the observed high perimeter $H_2S$ reading, excavator operation was halted and more $H_2S$ measurements were collected for a 1-hour period. A 1-hour average consisting of 15 $H_2S$ measurements was 96 ppb at the downwind perimeter location. As this average exceeded the 1-hour NYSDEC limit of 10 ppb, the excavation of Pond 1 was stopped for the remainder of the day, and O'Brien & Gere applied odor controls (Rusmar foam) to the excavation area. Subsequent $H_2S$ readings after controls were applied ranged from 6 to 8 ppb over a ten minute time frame.

*Below Freezing ERSTS Trial*

Results of the air monitoring performed for the below freezing trial in comparison to CAMP Control Levels and Work Perimeter Limits are presented in Table D-2 of ***Appendix D*** and are summarized as follows:

- No control level or work perimeter limit exceedances for TVOCs
- No observed odor readings greater than 2 OUs at the perimeter
- No $H_2S$ work perimeter limit exceedances

*Continuous Air Monitoring (TVOC)*

No exceedances of TVOCs above the work perimeter limit or control level criteria occurred during the entire monitoring period. Dust monitoring was not required during the below freezing trial.

*Periodic Air Sampling ($H_2S$ and Odors)*

No exceedances of $H_2S$ or odors of the work perimeter limit occurred during the entire monitoring period.

*Thaw ERSTS Trial*

Results of the air monitoring performed for the thaw trial in comparison to CAMP control levels and work perimeter limits are presented in Table D-3 of ***Appendix D*** and are summarized as follows:

- TVOC levels exceeded the control level on two days, and work perimeter limit on one day (discussed below)
- No observed odor readings greater than 4 OUs at the perimeter
- No $H_2S$ work perimeter limit exceedances.

*Continuous Air Monitoring (TVOC)*

There were two days out of the 38 days air monitoring was performed when TVOC exceedances occurred. On May 7, 2013 AQM equipment was set up prior to excavation of Pond 3, while wind directions were from the northeast. Approximately 45 minutes after set-up and prior to intrusive work, a TVOC investigate level (0.5 ppm) was observed from a downwind AQM location. The source of the elevated TVOCs was determined to be Pond 4. With a northeast wind, the AQM location was ~10 feet downwind of Pond 4.

No excavation activities were performed during the day of May 7, 2013, but air monitoring continued. Throughout the day, there were seven total control level exceedances, ranging from 0.7 to 0.9 ppm, after background correction. Four applications of cement-based spray cover were applied. However, the application device available that day was not able to reach the middle of the pond, thereby leaving a large area of the pond uncovered.

On May 8, 2013 no excavations took place. However, perimeter monitoring continued due to similar wind conditions as May 7, 2013. There were 25 total control level exceedances, five of which exceeded work perimeter limits ranging from 1.2 to 1.4 ppm. At approximately 13:45, heavy rain began and site TVOC levels were observed to fall below 0.5 ppm for the remainder of the monitoring period. Some days after these events, a larger application device applied a spray cover to more effective mitigate odors/emissions.

*Periodic Air Sampling ($H_2S$ and Odors)*

No exceedances of $H_2S$ or odors above the work perimeter limit occurred during the entire monitoring period.

## 2.9.HEALTH AND SAFETY

The health and safety program for the ERSTS field activities was implemented as outlined in the Work Plan.

***Testing***

The health and safety program for the ERSTS field activities was implemented as outlined in the Work Plan. Sampling for the purpose of evaluating worker exposure potentials was performed during the ERSTS field activities. Personal exposure samples for benzene, using passive badge techniques, were taken as follows:

- Hot Trial - four days, August 14, 15, 16, and 17, 2012, for two on-site personnel.
- Below Freezing Trial – four days, January 22, 23, 29, and 30, 2013, for three on-site personnel
- Thaw Trial – one day, May 16, 2013, for four on-site personnel. Also, one day, April 29, 2013 for two locations (one inside the excavator cabin and one just outside the excavator cabin), to evaluate the performance of the cabin filter installed on the excavator during the thaw trial.

Each badge was placed on the collar (breathing zone) of field personnel and worn for a full shift and was analyzed for benzene by Galson Laboratories using modified NIOSH Method 1501. Badge sampling results provide a measure of time-weighted average (TWA) benzene exposures. While badge samples were being collected, real-time benzene and TVOC measurements were taken in the operator cabs and work zone. Real-time measurements for benzene and TVOCs were taken with a RAE Systems UltraRAE 3000 photoionization detector (PID). A RAE Sep tube was placed on the UltraRAE 3000 inlet to remove many interfering organic compounds and obtain more benzene-specific readings.

***Data and Observations***

Laboratory data reports for badge samples are included in ***Exhibit A***. Badge data are summarized in ***Table 3***. In general, benzene exposure was observed to be below the OSHA PEL of 1 ppm. In addition, respirators were worn by personnel when TVOC PID readings were above 1ppm.

## 2.10. OFF-SITE MATERIAL SHIPMENT FOR VENDOR TESTING

### 2.10.1 Off-Site Shipment

**Shipping Containers**

In accordance with the Work Plan, 30-cy roll-offs were utilized at the start of the hot ERSTS trial. The target Semet Residue load weight was 20 tons. Following the first load, Waste Management advised the maximum allowable load was approximately 15 tons for roll-offs.

Following the hot ERSTS trial, options to increase shipment loads were discussed with Waste Management. It was determined that the use of dump trailers for shipment would be evaluated during the below freezing and thaw trial. The use of dump trailers was expected to increase the target load weight to 22 tons (vs. 15 tons for roll-offs). A dump trailer was used at the start of the below freezing trial, however, dewatering performance was affected by the low ambient temperatures and free aqueous was observed in the dump trailer. As a result of free aqueous in the dump trailer, the material in the trailer was returned to the pond. Based on the processing rates observed during the low ambient temperatures (<1 tph), a 30-yd roll-off was filled for shipment instead of a dump trailer.

During the thaw trial, dump trailers were utilized for off-site shipment. The average load weight was approximately 22 tons. 25-cy and 30-cy roll-offs were also used during the thaw trial.

Containers utilized during the ERSTS trials are summarized in ***Table 1***.

**Lining, Surface Spray, and Headspace**

Roll-offs utilized during the hot trial were double-lined. After several shipments, it was recommended by Page Trucking (roll-off supplier and transport company) that an additional layer of plastic be placed on the bottom of the roll-off and wrapped up and over the surface of the roll-off when filled. This technique was implemented and was expected to limit material movement when the roll-off was being loaded/unloaded onto the shipping truck. The implementation of an additional layer of plastic was continued during loading of two roll-offs during the below freezing trial. During the thaw trial, the additional layer of plastic was not used because the amount of plastic used during shipment was attempted to be minimized (for off-site vendor material handling evaluations). Plastic liner thicknesses evaluated included 3, 4, 6, and 8-mil.

Once a shipping container was filled to the desired level, the surface was sprayed with a cement-based or fiber-based spray cover, the additional plastic liner was wrapped over the surface (when applicable), the inner liners were folded down, and the weather cover (tarp or hard top) was secured for transport. The fiber-based spray cover was observed to be a more effective container surface cover than the cement-based spray cover, likely due to the water content of the cement-based product.

One headspace sample of a covered roll-off was collected during the hot trial using a SUMMA canister, and submitted to Accutest for speciated VOC/SVOC analyses. Data for the headspace sample is presented in Table A-12 of ***Appendix A***. The headspace sample was collected from roll-off SC-2541 on July 19, 2012 that was filled on July 13, 2012 with direct loaded Pond 2 material.

**Shipment**

The shipment log (***Table 1***) includes the following information relevant to transportation:

- Pond material
- Container type/size and identification (ID), liner material, and surface spray material
- Manifest number and date shipped
- Freeboard, estimated weight from the field and as-received weight
- Information regarding the receipt and processing at the off-site facility.

Copies of manifests for the off-site shipments are included as ***Exhibit B***.

In July - September 2012, Semet Residue was direct loaded from Ponds 1, 2, and 5 and the Stringer Ponds into 25-cy and 30-cy roll-offs for transport off-site, because no free aqueous was observed in the excavated material from these ponds. In August-September 2012, dewatered material from Pond 4 was conveyed into 30-cy roll-offs for off-site transport. In September-October 2012, dewatered material from Pond 3 was conveyed into 30-cy and 25-cy roll-offs for transport off-site.

During the thaw trial, six dump trailers were loaded (four with dewatered Pond 3 material, one with some dewatered Pond 3 and direct loaded Pond 2 material, and one with direct loaded Pond 2 material) and shipped to GAR. The GAR trial is discussed in Section 2.10.2 below. A dump trailer loading area was built to reduce the height difference between the mobile dewatering unit and the top edge of the dump trailer. This was performed because the belt conveyors being utilized were not able to effectively operate at the steeper angle. Freeboard for dump trailers ranged between approximately 25 inches and 34 inches.

Two 30-cy roll-offs that had been loaded and shipped to Systech in May 2013 were later shipped to GAR in May 2013 after Systech concluded the contents could not be accepted. The Systech trial is discussed in Section 2.10.3 below.

Additionally, one 25-cy roll-off was sent to Clean Harbors in Sarnia, Ontario in April 2013. The Clean Harbors trial is discussed in Section 2.10.4 below.

### 2.10.2 Green America Recycling

Semet Residue was transported for off-site vendor testing at GAR in Hannibal, Missouri during the hot ERSTS trial in July, August, September and October 2012, during the below freezing trial in January 2013, and during the thaw trial in April and May 2013. GAR received 34 containers totaling 532 tons of material direct-loaded from Ponds 1, 2, 5, and the Stringer Ponds, and dewatered material from Ponds 3 and 4. Refer to Section 2.10.1 and ***Table 1*** for additional shipment information.

GAR reported no specific impacts to their emissions during the trials conducted. However, based on the material processed to date, GAR may impose limitations on the sulfur content, moisture content, and calorific value of the Semet Residue received at their facility, which may impact removal and processing rates. On June 2, 2014, Honeywell submitted to the NYSDEC a Demonstration Program Work Plan Addendum to the Expanded Remedy Selection Treatability Study (ERSTS) Work Plan Addendum that was submitted to NYSDEC in May 2012 and approved by NYSDEC on June 15, 2012, which describes field work to further evaluate removal, shipment, and off-site thermal treatment of the Semet Residue. The Demonstration Program is intended to remove, direct load dump trailers, and ship approximately 3,000 tons of Semet Residue from Ponds 1, 2, and 5 during dry summer conditions (approximately July through September 2014).

### 2.10.3 Systech

Semet Residue was transported for off-site vendor testing at Systech in Fredonia, Kansas during the below freezing trial in January 2013 and during the thaw trial in May 2013.

In January 2013, one 30-cy roll-off was loaded with dewatered Pond 3 Semet Residue and transported off-site to Systech. The 30-cy roll-off loaded in January did not have a back end that fully opened because of the extension added to the sides (a 25-cy roll-off was modified to be a 30-cy roll-off). Unloading and processing of the roll-off shipped in January 2013 was slower than Systech's typical processing timeframe, which was partly a result of the crossbar at the back end of the roll-off. At Systech's request, two additional roll-offs were shipped in May 2013 and transported in fully opening roll-offs; one loaded with direct loaded Pond 2 material and one with dewatered Pond 4 material. Systech experienced processing difficulties with the Pond 2 material. The remaining Pond 2 material, as well as the other roll-off, loaded with dewatered Pond 4 material, were shipped to GAR for treatment. Refer to Section 2.10.1 and ***Table 1*** for additional shipment information.

### 2.10.4 Clean Harbors

One roll-off of dewatered Pond 3 Semet Residue was transported for off-site vendor testing at Clean Harbors Environmental Services (Clean Harbors) in Sarnia, Ontario during the thaw trial in April 2013.

# 3. TREATABILITY EVALUATIONS

## 3.1. THERMAL TREATABILITY EVALUATION

In accordance with the Work Plan, the first phase of bench-scale thermal treatability testing was conducted in 2012 on a Semet Residue sample from Pond 4. Subsequent phases of thermal treatability testing outlined in the Thermal Treatability Test Plan presented in the Work Plan were placed on hold, pending the outcome of off-site vendor evaluations.

### Testing

Phase 1 thermal treatability testing performed is described in the Thermal Treatability Test Report for Semet Residue prepared by Focus Environmental, Inc. and included as ***Exhibit C***. Phase 1 testing was conducted at temperatures of 250, 350 and 450°C with a laboratory-scale RTA to:

- Identify the optimum treatment temperature to meet the RCRA TCLP limits, listed in 40 CFR Part 261.24(b),
- Identify the optimum treatment temperature to meet the RCRA LDR UTS listed in 40 CFR Part 268.48(a),
- Evaluate the mass distribution of residual streams, and
- Evaluate material handling properties of the treated materials.

### Data and Observations

Data and observations from the Phase 1 thermal treatability testing are presented in ***Exhibit C***.

### Lessons Learned

- Based on an evaluation of all of the factors that were considered, it appears that the optimum treatment temperature is between 350 and 450°C.
- The relative amounts of the residual organic condensate and treated solids streams produced during the tests were a function of solids treatment temperature, with more organic condensate and less treated solids produced as the treatment temperature was increased. The amount of aqueous condensate produced was about the same at all three treatment temperature conditions.
- Treated solids at all temperature conditions formed a hard, glass-like material. The condensate stream separated into three phases: a milky-white aqueous phase, a dark brown organic phase with viscosity similar to motor oil, and a light yellow phase with very low viscosity and a gasoline-like odor.
- Blending other reagents with the Semet Residue could change the dynamics of contaminant removal. Based on a comparison of RTA test results for dewatered Semet material with the full-scale Clean Harbors tests conducted in 2011 with blends of Semet, soil, and lime, it appears that the addition of blending reagents may significantly improve treatment results for VOCs and SVOCs.

## 3.2. AQUEOUS TREATABILITY EVALUATION

### 3.2.1. Bench-Scale Testing

Bench-scale treatability testing was performed in 2011 to evaluate if the aqueous phase from Semet Residue may be managed at the Willis Ave GWTP. Additional aqueous phase treatability testing was conducted during the ERSTS in 2012 in accordance with the Work Plan to validate and expand upon the 2011 results and further evaluate the feasibility of treating the high and low end of the range of estimates of aqueous phase at the Wills Ave GWTP.

### Testing

Bench-scale aqueous phase treatability testing performed is described in the Bench-Scale Aqueous Phase Testing Report included as ***Appendix E***. The Work Plan indicated that aqueous phase collected from two of the three seasonal field programs in the ERSTS was to be used for this evaluation. It was subsequently decided that treatability testing would be performed on the aqueous phase from two ponds (Ponds 3 and 4) from hot weather dewatering operations, instead of aqueous phase generated from two different seasons.

**Data and Observations**

Data and observations from the bench-scale aqueous phase treatability testing are presented in ***Appendix E***.

**Lessons Learned**

- Treating Semet process aqueous phase at the GWTP at the blends evaluated is technically feasible for currently regulated parameters.
  - Pretreating for pH will be required at the 1:60 ratio, and not required for the 1:600 ratio.
  - Metals in the Semet process aqueous phase liquid can be removed to meet the discharge limits via the current GWTP metals removal approach. There may be a nominal increase in solids generated during treatment, but it is anticipated to be managed through existing equipment.
  - The concentrations of calcium, magnesium, manganese, and iron in the blends are similar to or slightly greater than the concentrations in the GWTP Influent. Hence, there may be a minimal increase in scaling potential compared to current GWTP operations.
  - For VOCs removal, no impact to air stripper operations is foreseen; however, it is likely that additional VOC load will be conveyed to the Regenerative Thermal Oxidizer (RTO).
  - GAC will be technically feasible to manage currently regulated parameters; life-cycle evaluations may result in additional organic treatment, such as advance oxidation process (AOP).

### 3.2.2. Off-Site Testing

Aqueous phase samples were shipped to three vendors for treatability evaluations in 2012. Samples of aqueous from Ponds 3 and 4were shipped to Clean Harbors, and samples of aqueous from Pond 4 were shipped to EQ and Heritage. Waste Management Model City received an aqueous phase sample for treatability evaluation in 2011.

## 4. ADDITIONAL REMEDY SELECTION EVALUATIONS

The following additional remedy selection evaluation efforts are summarized in this section:

- Transportation evaluation, and
- BSA evaluation.

### 4.1. TRANSPORTATION EVALUATION

The transportation task involved the evaluation of DOT classification of dewatered solid-phase Semet Residue. To support evaluation of DOT classification, laboratory testing of dewatered Semet Residue was performed to assess flammable solid and corrosive classifications. A sample of dewatered Semet Residue from Pond 4 was submitted to UTEC Corporation for United Nations' (UN) Readily Combustible Solid and Self-Heating Solid analyses by UN test methods N.1 and N.4. Pond 4 was selected because it represents approximately half of the total pond volume and it has the highest VOC/SVOC concentrations and lowest pH. A sample of dewatered Semet Residue from Pond 4 was submitted to MB Research Laboratories for corrosivity analysis by the Corrositex® test method.

Laboratory reports for flammable solid and corrosive classification testing are presented in ***Exhibits D*** and ***E***, respectively. The following conclusions were made based on the laboratory test results:

- The dewatered Semet Residue sample was not considered to be a Division 4.1 Flammable Solid.
- The dewatered Semet Residue sample was not considered to be a Division 4.2 Self-Heating Solid.
- The dewatered Semet Residue sample was not considered to be a Class 8 Corrosive.

### 4.2. BENZENE SULFONIC ACID EVALUATION

Testing was performed to evaluate whether BSA is present in the Semet Residue and if so, whether the GC/MS analytical method for VOCs could be generating benzene from BSA. A summary of the testing is presented in ***Appendix F***. The following conclusions were made based on the test results:

- Based on high-performance liquid chromatography (HPLC)/PID and nuclear magnetic resonance (NMR) analyses, BSA was not present in the Semet Residue material analyzed.
- The GC/MS and HPLC/PID procedures produced similar results, suggesting that benzene is not being generated in the GC/MS analytical procedure.

## 5. CONCLUSIONS

The following conclusions have been developed based on the results of the ERSTS:

- Excavation/Removal
  - In order to maintain perimeter air concentrations below perimeter limits, work locations will be selected based on wind direction and speed.
  - Working within the wind guidelines summarized in ***Figure 3***, excavation rates up to 20 tph in Ponds 3 and 4 were documented not to cause perimeter air limit exceedances.
  - Spray covers are effective for emission/odor control.
  - Use of stability mats on top of Semet Residue is not a technically feasible option to allow access to the center of the Semet Residue ponds.
  - The earth boring machine was observed to remove and dewater material at a rate of 1 tph and was observed to have reduced emissions/odors compared to excavation.
- Dewatering
  - Large slots cut into the excavator bucket along with a thumb attachment improved the removal of free aqueous.
  - During dry weather conditions, direct loading of Ponds 1, 2, 5, and stringer pond material (~20,000 tons) to transport containers is feasible. Direct loading is anticipated to be most feasible between June and September, based on local historical precipitation data and field observations. Absorbents may be used on the surface of shipping containers to absorb small amount of free liquids. This practice will compensate for the effects of precipitation during the direct loading season.
  - Ponds 1, 2, 5 and stringer pond material were observed to have material properties that would likely not allow them to be dewatered with a screw during the cold and wet seasons.
  - Dewatering of Ponds 3 and 4 (~46,000 tons) is feasible only at material temperatures above 32°F and 45°F, respectively. Ambient temperatures near or below freezing limit operations or make them technically infeasible without warming the residue. Utilizing the ERSTS dewatering screw system and belt conveyors for Ponds 3 and 4 at or above these material temperatures produces a material that is suitable for transport as a solid (*i.e.,* no free liquids).
- Off-site transport
  - Material was successfully transported with roll-offs and dump trailers double-lined with plastic liners and covered with a cement-based or fiber-based spray cover and plastic tarp covers. Plastic liner thicknesses tested included 3, 4, 6, and 8-mil. GAR reportedly did not observe any improvements in processing from utilizing different liner thicknesses. However, the optimum liner thickness may be temperature dependent, based on the ability to separate the liner from the Semet material.
  - The fiber-based spray cover was observed to be a more effective container surface cover than the cement-based spray cover, likely due to the water content of the cement-based product.
  - The use of 25-cy and 30-cy roll-offs limits loads to approximately 15 tons, due to total weight restrictions for the truck and roll-off.
  - The use of dump trailers facilitates increased shipment loads to approximately 22 tons.

- On-site thermal treatment
  - Feed preparation would likely be required that includes transfer of Semet Residue to a bunker or pit located in a material handling building, mixing of recycled solids and lime with Semet Residue using a pug mill, and loading of the mix to the thermal treatment system.
  - Pre-design investigations would be necessary to evaluate optimum temperature and feed mix, operability issues due to coking in the thermal desorber, and potential product marketability/pricing.
- Aqueous phase treatment
  - Treating Semet aqueous phase at the GWTP at the blends evaluated is technically feasible for regulated parameters.

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