



Radiological Health, Safety and Environmental Services
A USA Environment, L.P. Company

WEST LAKE LANDFILL
PERIMETER AIR MONITORING
YEAR THREE QUARTER FOUR REPORT
FEBRUARY, MARCH AND APRIL 2018

November 2018

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CONTENTS

SECTION	PAGE
1. INTRODUCTION.....	5
1.1 Site Description.....	5
1.2 Background.....	5
1.3 Constituents of Concern.....	6
2. AIR MONITORING APPROACH AND SAMPLING METHODS.....	8
2.1 Data Evaluation.....	13
2.2 Sample Collection and Analyses	13
2.2.1 Air Particulates.....	13
2.2.2 VOCs.....	13
2.2.3 Gamma	14
2.2.4 Radon	14
2.2.5 Accredited Laboratories and Contacts	15
2.2.6 Data Management	15
2.2.7 Data Verification, Validation, Quality Assessment, and Delivery	15
3. Results Summaries	17
3.1 Off-Normal Events.....	17
3.2 Air Particulate Results	17
3.2.1 Gross Alpha and Gross Beta Results	17
3.2.2 Gross Alpha and Gross Beta Field Duplicates.....	25
3.2.3 Isotopic Results	26
3.2.4 Isotopic Field Duplicates.....	27
3.3 VOC Results	31
3.4 TLD Results	33
3.5 Radon Results	33
4. REFERENCES.....	34

FIGURES

Figure 1 Site Location.....	7
Figure 2 Air Sampling Locations.....	9
Figure 3 Predominant Wind Directions	10
Figure 4 Predominant Wind Directions	11
Figure 5 Wind Rose for January 2018	18
Figure 6 Wind Rose for February 2018	19
Figure 7 Wind Rose for March 2018	20
Figure 8 Wind Rose for April 2018	21
Figure 9 Graphical Representation of Gross Alpha Results in pCi/m ³	24
Figure 10 Graphical Representation of Gross Beta Results in pCi/m ³	24

TABLES

Table 1	List of Samplers for Perimeter Monitoring.....	8
Table 2	Field Sampling Summary	12
Table 3	Sample Analyses and Methods.....	15
Table 4	Summary of On-Site Gross Alpha Results 5/1/2015 through 5/2/2018 Results.....	22
Table 5	Summary of Off-Site EPA Gross Alpha Results (Tetra Tech 2015).....	22
Table 6	Summary of On-Site Gross Beta Results 5/1/2015 through 5/2/2018 Results.....	23
Table 7	Summary of Off-Site EPA Gross Beta Results (Tetra Tech 2015)	23
Table 8	GAGB Normalized and Relative Percent Difference	25
Table 9	Thorium-230 Statistics.....	28
Table 10	Uranium-238 Statistics	28
Table 11	Total Radium Statistics.....	29
Table 12	Isotopic Normalized and Relative Percent Difference	29
Table 13	Summary of Isotopic and Radium Results (Tetra Tech 2015)	30
Table 14	VOC Statistical Summary.....	32
Table 15	Common Analytes ($\mu\text{g}/\text{m}^3$).....	33
Table 16	TLD Statistics	33

APPENDICES

Appendix A	Validated Gross Alpha and Gross Beta Air Particulate Results
Appendix B	Validated Isotopic Air Particulate Results
Appendix C	Comparison of Isotopic Results to NRC Appendix B Effluent Limits
Appendix D	Validated Volatile Organic Compound Results
Appendix E	Gamma Dosimetry Results
Appendix F	Alpha Track Etch Detector Results
Appendix G	Meteorological Station Data
Appendix H	Auxier and Associates Procedures
Appendix I	Field Data Forms
Appendix J	Chains of Custody

Executive Summary

Air monitoring along the perimeter of OU-1 Areas 1 and 2 of the West Lake Landfill (the Site) began in May 2015. This report summarizes the air monitoring results for the particular quarter in which the sampling took place, as well as the sampling results to date. The results are then compared with the off-site air monitoring performed by the EPA during 2014 and 2015.

In summary, the gross alpha results obtained from the 13 on-site stations are similar to or slightly higher than the results obtained from EPA's five off-site stations. The differences in the minimum and median gross alpha results may reflect dust levels, seasonal conditions (pollen levels), differences in precipitation (i.e., soil moisture), or differences in the total particulate levels between the period covered by EPA's air monitoring program and the periods covered by the on-site air monitoring program. The shorter collection period of one week for off-site sampling (versus a 28-day sampling period for on-site sampling) likely increased the off-site result variability.

The Nuclear Regulatory Commission (NRC) has promulgated standards for protecting against ionizing radiation in ambient air that results from activities conducted under licenses issued by the NRC (10 CFR Part 20). Although these regulations do not apply to the Site, and therefore cannot be used for regulatory or enforcement purposes, they are nonetheless appropriate for comparison purposes. Using the most conservative approach, the on-site measured activity is one order of magnitude less than the thorium-230 limit of 1×10^{-14} $\mu\text{Ci/ml}$ listed in 10 CFR Part 20 Appendix B. Gross beta results are similar to the EPA off-site monitoring results.

For uranium-238, thorium-230 and total radium isotopic results, the maximum on-site air monitoring results are an order of magnitude lower than the comparable off-site air monitoring results for uranium-238, thorium-230, and total radium.

Ten different volatile organic compounds (VOCs) were detected in both the on- and off-site monitoring results. Eight of the on-site VOC results were less than the off-site VOC results, two were slightly higher than the off-site results, and one on-site analyte was not detected in the off-site results.

Review of the GammaTRACER data for the EPA off-site monitoring revealed that exposure rates at the five monitoring stations fluctuated around 10 $\mu\text{R/hr}$. The on-site gamma dose ranged from 9 to 11 $\mu\text{R/hr}$ for the Year 3 Quarter 4 monitoring period.

1. INTRODUCTION

This West Lake Landfill Perimeter Air Monitoring Quarterly Report (Report) summarizes the Year 3 Quarter 4 (February, March, and April 2018) perimeter air monitoring results at Operable Unit-1 (OU-1) of the West Lake Landfill Superfund Site (the Site). The purpose of the monitoring is to obtain baseline air monitoring data prior to implementation of future remedial actions at the Site.

The air monitoring activities include sampling for airborne radioactive particulates, radon gas, volatile organic compounds (VOCs), and measurements of gamma radiation. Sampling is performed continuously at the perimeters of OU-1. Data collected from the monitoring activities are used to assess and document the air quality along the boundaries of OU-1. The monitoring was performed according to the requirements described in the Air Monitoring, Sampling, and Quality Assurance/Quality Control (QA/QC) Plan (Plan) (Auxier and Associates (A&A) 2014), as required by Paragraph 30d of the April 14, 2014 Administrative Settlement Agreement and Order on Consent for Removal Action – Preconstruction Work (Preconstruction ASAOC) entered into between the U.S. Environmental Protection Agency (EPA) and Respondents Bridgeton Landfill, LLC and Rock Road Industries, Inc. EPA approval of the Plan was received on December 8, 2014.

1.1 SITE DESCRIPTION

The West Lake Landfill Superfund Site is located at 13570 St. Charles Rock Road in Bridgeton, St. Louis County, Missouri, approximately one mile north of the intersection of Interstate 70 and Interstate 270. The Site is divided into two Operable Units. Operable Unit-1 (OU-1) is composed of the two disposal areas (Area 1 and Area 2) where waste materials containing radionuclides have been identified, as well as a smaller parcel of land to the north of Area 2 called the Buffer Zone/Crossroads Property (formerly known as the Ford Property). Municipal solid waste (MSW) and industrial wastes were disposed of in Areas 1 and 2 from approximately the early 1950s until 1974. No waste materials were disposed of on the Buffer Zone/Crossroads Property, although radiologically-impacted soil has previously been identified on this property.

Operable Unit-2 (OU-2) consists of the remainder of the Site and includes several inactive landfilled areas containing sanitary waste or demolition debris and a permitted sanitary landfill (the Bridgeton Sanitary Landfill), which stopped receiving waste on December 31, 2004. The Bridgeton Sanitary Landfill is a quarry-fill landfill containing municipal waste, and consists of the North Quarry and South Quarry landfill units. Since late 2010, the Bridgeton Sanitary Landfill South Quarry unit has been experiencing a subsurface reaction (SSR). The southern border of OU-1 Area 1 is contiguous with the North Quarry cell of the Bridgeton Sanitary Landfill. OU-1 Area 2 is located along the northern portion of the Site, approximately 1,000 feet (at the closest) from the outer boundary of the North Quarry landfill unit, and is separated from it by a road and by the closed demolition landfill (Figure 1).

Land use surrounding the Site is primarily commercial and industrial. The nearest residential area to the Site is the Terrisan Reste mobile home park, which is located to the southeast of the Site, approximately 0.7 miles from Area 1 and 1.1 miles from Area 2. The “Spanish Village,” residential subdivision is located to the south of the Site near the intersection of St. Charles Rock Road and I-270, approximately 1 mile from Area 1 and 1.25 miles from Area 2.

1.2 BACKGROUND

According to the Nuclear Regulatory Commission (NRC), in 1973, approximately 8,700 tons of leached barium sulfate residue (a remnant from Manhattan Engineer District/Atomic Energy

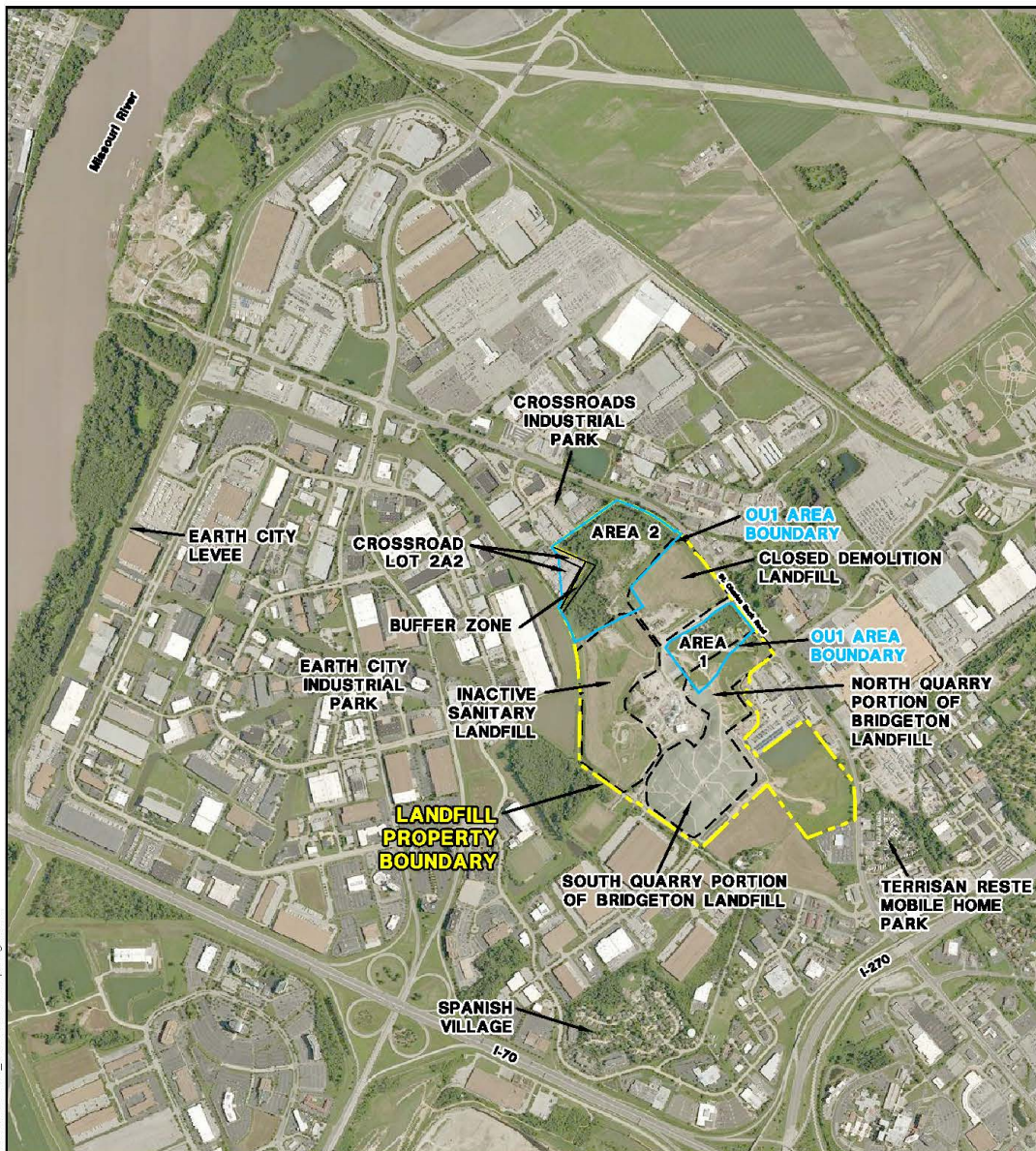
Commission projects) were reportedly mixed with approximately 39,000 tons of soil from the 9200 Latty Avenue property in Hazelwood, Missouri, transported to the West Lake Landfill, and reportedly used as daily or intermediate cover material (NRC 1988, RMC 1982, and 1981).

EPA added the West Lake Landfill Superfund Site to its National Priorities List in 1990. In May 2008, EPA signed a Record of Decision (ROD) for OU-1, which selected a remedial action for the radiologically contaminated landfill areas and the Buffer Zone/Crossroads property. The 2008 ROD required installation of a modified solid waste landfill cover over OU-1 Areas 1 and 2. In September, 2018, the EPA signed the Record of Decision (ROD) Amendment for the West Lake Landfill Superfund Site in Bridgeton, Missouri. This document amends the 2008 ROD and finalizes the Agency's cleanup decision for Operable Unit 1. The ROD Amendment requires excavation of radiologically impacted material (RIM) greater than 52.9 picocuries per gram generally down to a depth of 12 feet. The remedy also calls for an optimization during remedial design, which will identify certain areas for continued excavation beyond 12 feet down to as deep as 20 feet. It also will identify limited instances of isolated pockets of RIM at concentrations greater than 52.9 picocuries per gram between 8 and 12 feet to remain in place. After completion of the excavation, an engineered cover will be installed over the landfill, consistent with landfill closure requirements and the Uranium Mill Tailings and Radiation Control Act (UMTRCA).

1.3 CONSTITUENTS OF CONCERN

West Lake Landfill contains both municipal solid waste and construction and demolition wastes. In a March 7, 2014 meeting, representatives from the EPA met with representatives from Engineering Management Support, Inc. (EMSI) and requested that air monitoring be performed for airborne radiological contaminants and VOCs. Baseline Risk Assessments (BRAs) were published in 2000 and 2018 and identified the radionuclides of concern at the West Lake Landfill¹. These compounds, plus EPA's requested VOC sampling, are the constituents of concern (COCs) for the air monitoring activities described in this report.

¹ An updated BRA was submitted to EPA on January 25, 2018, and was approved on February 2, 2018 in accordance with the Remedial Investigation/Feasibility Study Administrative Settlement Agreement and Order on Consent, Docket Number VII-93-F-0005, and the May 6, 2016 Abbreviated Work Plan for Remedial Investigation Addendum and Final Feasibility Study.



M:\clients\EMSI\Westlake\2017\Aurier_Air_and_Radon\FIG1_Site_Location_Map.dwg 7/6/17

Source: USGS Aerial Photography

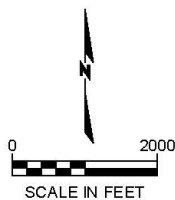


Figure 1

Site Location Map

West Lake Landfill OU-1

EMSI Engineering Management Support, Inc.

Figure 1 Site Location

2. AIR MONITORING APPROACH AND SAMPLING METHODS

An integrated system of 13 air monitoring stations has been installed at the Site. Twelve of these stations are located around the perimeters of OU-1, with two located close to the nearest on-site buildings (the landfill office and the transfer station building) and one located on the Buffer Zone/Crossroads property. The thirteenth station is located in the southwest corner of the Site (which is the farthest distance on-site from Areas 1 and 2). These 13 locations were selected to ensure that the monitoring network encompassed Areas 1 and 2 and the Buffer Zone/Crossroads property, including the Site entry road and the road through the center of the Site (Figure 1).

An on-site meteorological station (the “met station”) measures and logs temperature, barometric pressure, relative humidity, wind speed and direction. The station is located adjacent to the landfill office building (13570 St. Charles Rock Road).

The air sampling network shown in Figure 2 provides coverage around OU-1 under all wind direction conditions. The air monitoring and sampling locations near the center of the Site are arranged in a broad line oriented approximately southeast to northwest and parallel to the predominant wind directions. Additional stations are located transverse to this orientation, parallel to the less dominant southwest and northeast wind directions. Stations A-1 through A-4 and A-9 bound the perimeter of Area 2. Station A-6 is located on the southwestern boundary of the Buffer Zone/Crossroads Property. Stations A-5, A-7, A-8, A-10 and A-11 bound Area 1. Station A-12 is located at the southern boundary of the North Quarry pit area. Station A-13 is at the southern boundary of the South Quarry pit area, and is located upwind of Areas 1 and 2 based on the predominant southerly wind direction as shown in Figure 3 and Figure 4.

Table 1 lists the types and quantities of air monitoring equipment used in the different monitoring stations depicted in Figure 2. The table also lists the COCs measured by the equipment housed at each station.

Table 1 List of Samplers for Perimeter Monitoring

Perimeter Monitor Inventory per Location	Sampling Mode and Collection Frequency	Contaminants Measured
List of samplers at A-1, A-5, A-7, A-8, A-12 (located at A-11 through 10/27/15)		
Metered air pump with dual chamber sampler for particulate fiber filter	Continuous / Every 28 days	Total alpha and beta activity
Alpha Track Etch Detector for radon gas	Continuous / Quarterly	Radon-222 and radon daughters
Radiello 130 Canister	Continuous / Every 14 days	Volatile Organic Compounds ¹
Radiation dosimeter (TLD)	Continuous / Quarterly	Gamma radiation levels
List of samplers at remaining on-site and perimeter locations (x8)		
Metered air pump with filter to collect particulates	Continuous / Monthly	Total alpha and beta activity
Alpha Track Etch Detector for radon gas	Continuous / Quarterly	Radon-222 and radon daughters
Radiation dosimeter (TLD)	Continuous / Quarterly	Gamma radiation levels
Meteorological monitoring station		
High resolution wind sensor	Continuous	Wind speed and direction

¹ The Radiello 130 media are analyzed for the list of analytes included in Appendix F of the Plan. This list was provided by the laboratory and reflects common analytes for which sampling rates have been calculated for the Radiello 130 media.

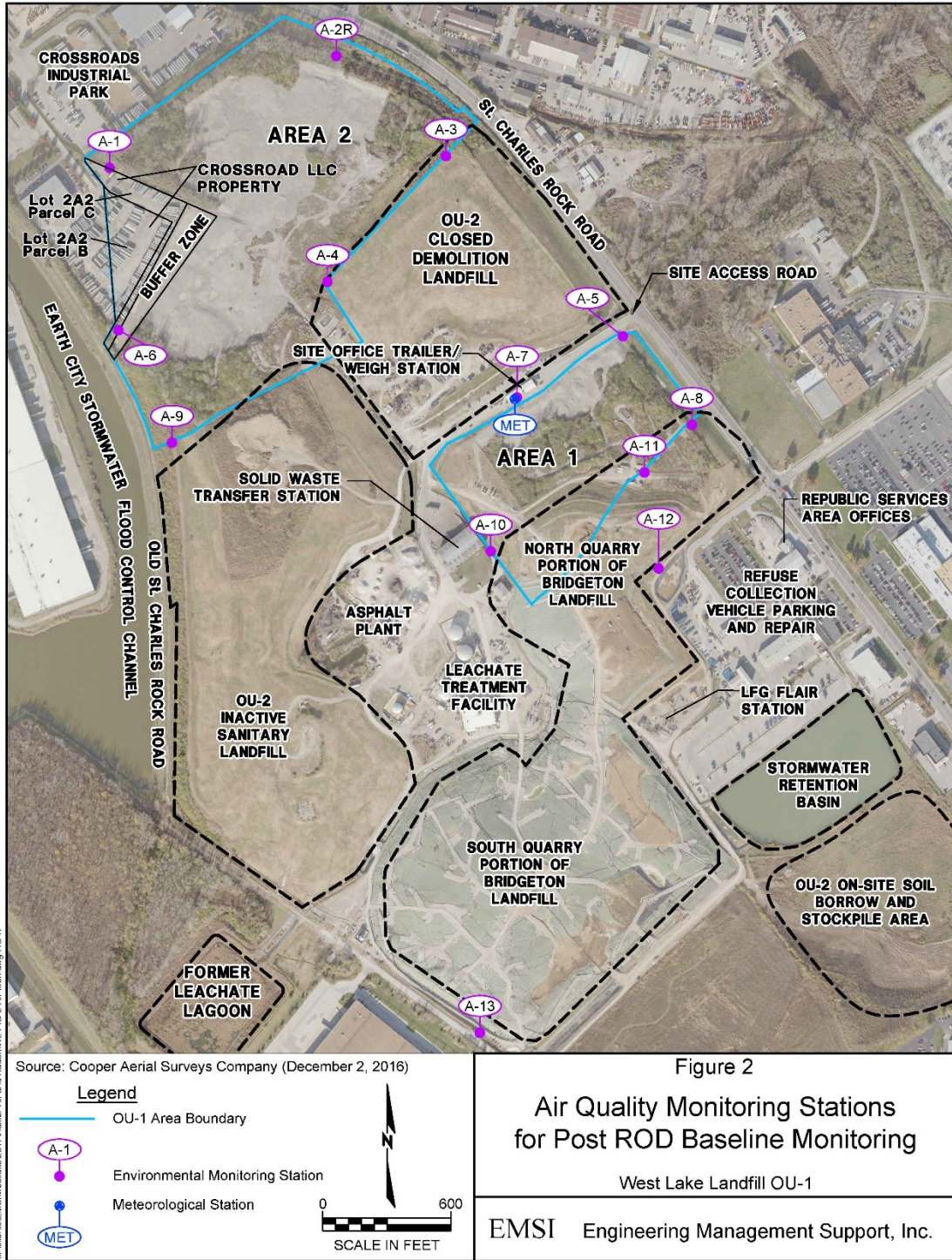


Figure 2 Air Sampling Locations

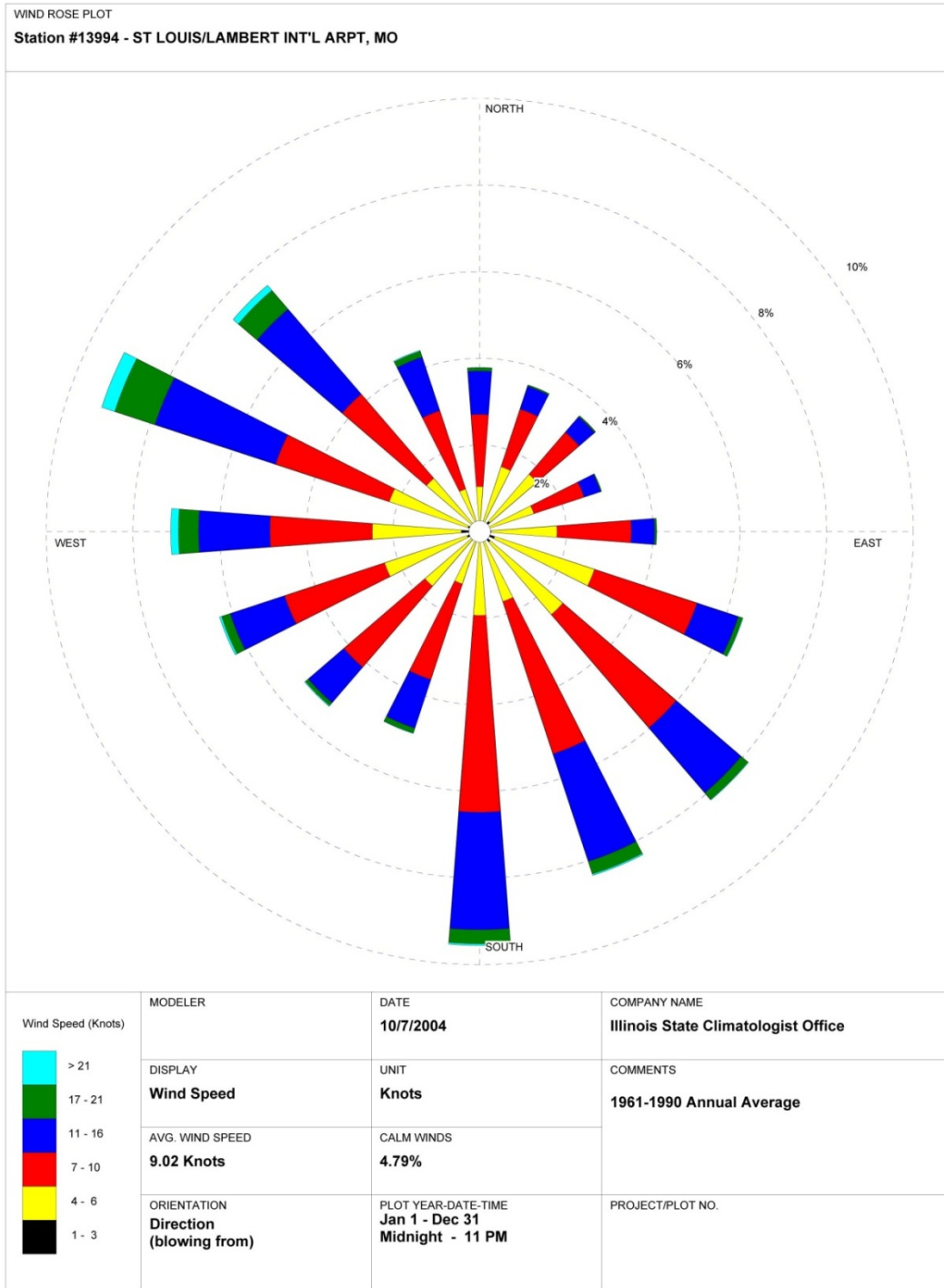
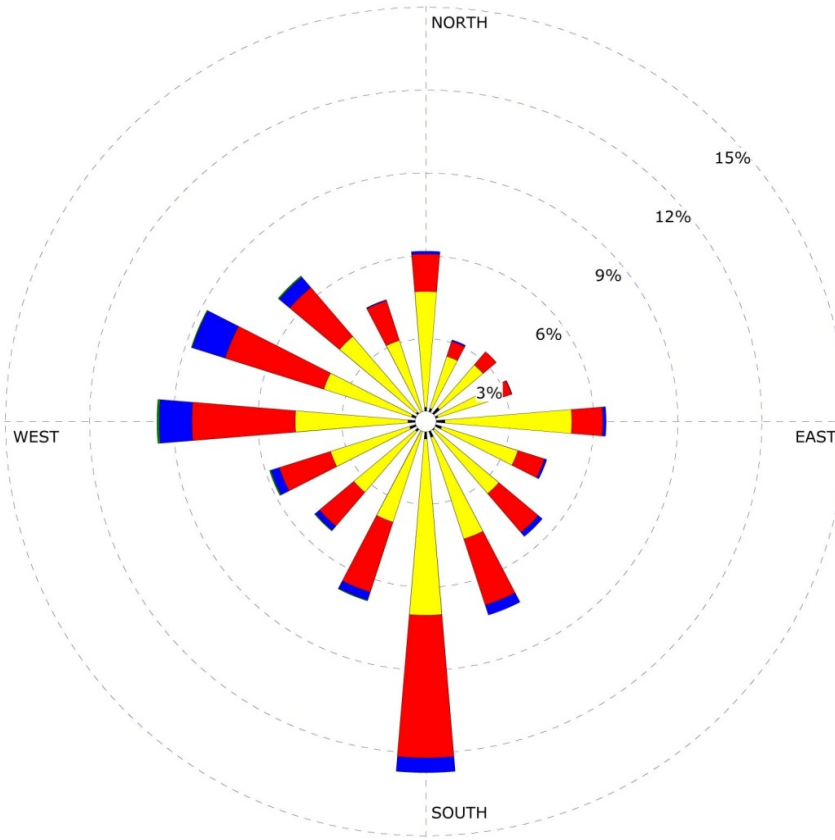


Figure 3 Predominant Wind Directions

WIND ROSE PLOT:
St. Louis, MO Airport

Wind Speed
Direction (blowing from)



WIND SPEED
(mph)

- >= 20.0
- 15.0 - 20.0
- 10.0 - 15.0
- 5.0 - 10.0
- 1.0 - 5.0

Calms: 0.16%

COMMENTS:
Based on hourly average wind speed and direction from the airport at St. Louis (measured at 10 meters)

DATA PERIOD:
1991-2006
Jan 1 - Dec 31
00:00 - 23:00

CALM WINDS (less than 1 mph):
0.16%

AVG. WIND SPEED:
9.12 mph

TOTAL COUNT:
5788 hrs.

DATE:
3/13/2007



WRPLOT View - Lakes Environmental Software

Figure 4 Predominant Wind Directions

The sampling and sensor equipment in each air monitoring station enclosure operate continuously. The equipment in these stations consists of a high volume air sampler for airborne particulates, a continuous radon monitor (alpha track etch), and an environmental radiation detector called a thermoluminescent dosimeter (TLD). Alpha track etch monitors provide a cumulative measurement of radon gas and allow determination of average radon levels for the sampling period. TLDs measure ambient gamma radiation levels.

Particulates gathered on air sample filters are collected every four weeks (28 days) and analyzed for alpha and beta emitters. Radiation dosimeters and alpha track etch detectors are exchanged and sent for analysis every calendar quarter.

Five of the monitoring stations house continuous passive samplers to monitor for VOCs. Monitoring of VOCs is performed using the Radiello 130 chemical adsorbing cartridge diffusion samplers that are left in place for periods of 14 days. The Radiello 130 cartridges consist of a stainless steel net cylinder with 100 mesh grid openings and a 5.8 mm diameter cartridge, packed with approximately 530 milligrams of activated charcoal. VOCs are trapped by adsorption and recovered by carbon disulfide displacement.

Table 2 provides a summary of the types of measurements, sampling numbers and frequency as listed in the Plan.

Table 2 Field Sampling Summary

Analytical Parameter	Level of Sensitivity	Matrix	Sample Frequency	Container Type	Annual Subtotal Target Field Samples	Field QC Extras			Total Annual Field Samples
						Trip Blank	Filter Blanks	Field Duplicates	
Gross Alpha/Beta	1 dpm/sample	Air Filter	13 x Continuous Air Samplers /Monthly	Glassine Envelope	156	NA	12	NA	168 ¹
Radon	0.5 pCi/l	Track Etch Detector	13 x Continuous Samplers /Quarter	Track Etch Detector	52	NA	NA	4	56
Gamma Dose	1 mrem	TLD	13 x Stations/ Quarter	TLD	52	4	NA	1/quarter	56
VOC	See Plan Appendix B for MDL and RL	Radiello Canister	5 Continuous Every 14 Days	Radiello Canister	130	26	NA	25	156

¹ There are no true Field Duplicates for Gross Alpha/Beta. The laboratory collects a duplicate from the other side of the large area filters.

2.1 DATA EVALUATION

The purpose of the air monitoring program is to provide baseline data regarding air quality prior to implementation of remedial actions. Ultimately, baseline data will be compared to future data obtained during implementation of remedial actions to assess whether such actions contribute to any release of radionuclides or VOCs.

2.2 SAMPLE COLLECTION AND ANALYSES

2.2.1 Air Particulates

Air sampling equipment is calibrated, and the functionality of the equipment is checked, according to manufacturer specifications and A&A procedures 5.1 and 5.2, “Calibration Procedure for PM 2.5 Air Monitoring” and “One Point Flow Audit for PM 2.5 Air Monitoring.” Samples are collected according to the instructions contained in A&A procedure 5.3 “Sampling Procedure for PM 2.5 Monitoring”² (Appendix H).

Air particulate samples are collected every 28 days and submitted for analysis. The operability of air sampling equipment is verified at the time of sample collection according to the One Point Flow Audit portion of Procedure 5.1 (Appendix H). Air flow meters, differential pressure indicators, and other devices used to determine volumetric flow rates of air particulate samplers are calibrated annually. Copies of the calibration records are maintained on-site as well as in A&A’s corporate offices.

The air particulate samples are collected on 8-inch by 10-inch quartz filters. The laboratory removes five independent 47 millimeter (mm) pieces for the aliquot. Each 47 mm piece is adhered to a planchet. Each planchet is counted, and the counts summed. In addition to the five pieces removed for the sample, five pieces from one of the filters are removed from the other side of the filter for the duplicate. Each set of five pieces is counted and summed separately. The duplicate is collected from a different sample location each month. A blank filter is submitted and analyzed with each batch of samples submitted to the laboratory.

At least one set of samples from each three-month sampling event is submitted for isotopic analysis and gamma spectroscopy in addition to the gross alpha and gross beta analysis. For this three month period, samples from particulate filters collected on April 2 and 3, 2018 were submitted for isotopic analysis.

2.2.2 VOCs

Passive Radiello samplers for VOCs are deployed on Stations A-1, A-5, A-7, A-8 and A-12 (A-11 was formerly used as a sampling location, but that location was changed to A-12 as of October 27, 2015 per EPA request). Samples are collected every 14 days and submitted for analysis. On a rotating basis, a field duplicate is placed in one of the stations during each 14-day sampling cycle. The Radiello passive/diffusive samples are analyzed by gas chromatography mass spectrometry (GCMS) using EPA Method TO-15. In August 2015 trip blanks were included with the shipment of VOC samples to the laboratory for analysis. The trip blank consists of an unopened cartridge (still in its stoppered glass

² Procedure 5.3 “Sampling Procedure for PM 2.5 Monitoring” sets a goal of less than 10% flow rate variability from filter deployment to collection. Some field data forms in Appendix I show variability greater than 10%. Maintenance operations are being implemented to attempt to lower the instances of variability greater than 10%. While the increased variability may increase the measurement uncertainty, the instances in which flow rate varied by more than 10% had minimal impact on the results.

tube and cellophane wrapper) placed in the FedEx envelope or small shipping box with the 6 samples collected from the field for a given shipment. Each cartridge collected in the field (5 stations + 1 duplicate per event) is taken out of its diffusive holder and placed back in its original glass tube, stoppered, and shipped.

2.2.3 Gamma

Gamma radiation is measured by installing TLDs at each of the 13 air monitoring stations. The TLDs are installed approximately three feet above the ground surface inside a housing shelter. A duplicate TLD is installed at one of the stations.



Mirion Technologies forwards 16 new TLDs to the Site approximately 5-7 days prior to the quarterly change-out event. The 16 TLDs include 13 for each sampler, a duplicate TLD for one of the samplers (the location is rotated), a field (control) blank, and a trip blank. Upon arrival, the packages are examined to verify the number and designations of the new TLDs.

TLD change-outs consist of unclipping the exposed TLD at each station and attaching its replacement to the metal bracket. A duplicate TLD is placed at one of the stations. Trip blanks have been included with samples since January 2016 to better evaluate potential exposures during transit. The trip blank TLD is kept in a lead-lined box in the Health Physics on-site office, and is included with the station TLDs upon return for analysis.

The TLDs are placed in the shipping envelope provided by Mirion. The envelope is sealed and placed into a FedEx envelope that is labeled with the following statement cautioning against X-raying the package.

CAUTION: DOSIMETERS
DO NOT SANITIZE, X-RAY, IRRADIATE, OR
NEUTRALIZE PACKAGE AS PRODUCT WILL BE
DAMAGED. KEEP AWAY FROM RADIOACTIVITY,
EXCESSIVE HEAT, AND MOISTURE.

2.2.4 Radon

Radon alpha track detectors are used at the monitoring stations to measure alpha particles emitted from radon and its associated decay products. Radon detectors are co-located with TLDs approximately three feet above the ground surface in housing shelters at the monitoring stations. The radon detectors are collected every three months and sent to an off-site laboratory for analysis. Recorded radon

concentrations are listed in picocuries per liter (pCi/l). A duplicate detector is included at one of the stations.

Table 3 details the analytical methods required for each COC.

Table 3 Sample Analyses and Methods

Analyte (COC)	Collection Method	Test	Sensitivity Level	Test Facility	Facility Location
Thorium Uranium Radium-226	Particulate Air Sample (4 in)	EPA Method 900.0 Gross Alpha/ Beta (GAGB)	1 dpm/sample	Eberline Analytical	Oak Ridge, TN
Rn-222	Track Etch	Alpha Track Etch	0.5 pCi/L	Inspect USA	Marshall, NC
Radiation Dose	TLD	TLD	<1 mrem	Mirion Tech	Irvine, CA
VOC	Radiello 130 Passive sorbent diffusion sampler	carbon disulfide desorption followed GC/MS analysis by EPA Method TO-15	See Plan Appendix E	Eurofins Air Toxics	Folsom, CA

2.2.5 Accredited Laboratories and Contacts

Eberline Analytical
Mike McDougall
601 Scarboro Road
Oak Ridge, TN 37830
Tel 865-481-0683

Eurofins Air Toxics
Kelly Buettner
180 Blue Ravine Road, Suite B
Folsom, CA 95630
Tel 800-985-5955

AccuStar
11 Awl Street
Medway, MA 02053
Tel 888-480-8812

Mirion Technologies, Inc.
17192 Murphy Avenue
Irvine, CA 92614
800-251-3331

2.2.6 Data Management

The laboratories performing radioanalytical and VOC analyses supply Level IV CLP-like data reports with all analytical results to A&A and EMSI. These laboratories also supply analytical results in electronic spreadsheet format to EMSI and the A&A Project Manager.

2.2.7 Data Verification, Validation, Quality Assessment, and Delivery

The primary goal of data verification and validation (V&V) is to ensure that decisions are supported by data of the type and quality needed and expected for the intended use. Data verification is the process of evaluating the completeness, correctness, and consistency of a laboratory package or final data to assure that laboratory conditions and operations are compliant with project plan documents. Data validation addresses the reliability of the data. Radioanalytical and VOC results are evaluated to

determine the presence or absence of an analyte and the uncertainty of the measurement process for contaminants of concern. Finally, scientific and statistical evaluation of the data may be required to determine if the quality of the data can support its intended use (MARLAP 2004). V&V and summary reports are generated and submitted to EMSI project management.

3. RESULTS SUMMARIES

The fourth quarter of the third year of sampling began January 4, 2018 and concluded May 2, 2018. The wind roses for each sampling period are shown in Figure 5, Figure 6, Figure 7, and Figure 8.

3.1 OFF-NORMAL EVENTS

Between January 4, 2018 and January 31, 2018 the motor on station A-6 stopped functioning. The motor was replaced, however, the volume of air pulled through the filter was unknown. The result for this filter was reported as pCi/sample, and excluded from the statistical treatment of the results presented in the tables below. No other off-normal events were observed for the Year Three, Quarter Four sampling period.

3.2 AIR PARTICULATE RESULTS

The particulate air sampling duration is approximately 28 days, after which time the air filters are collected, packaged, and shipped under chain-of-custody to the radioanalytical laboratory. Because of the 28-day sampling period, the collection dates became out of sync with the calendar months over time. The “February” sampling period began January 4 and 5, and concluded January 31 and February 1, 2018. The “March” sampling period concluded on March 2. The “April” sampling period consisted of two sampling events ending April 2 and 3 and May 1 and 2, 2018. In addition to gross alpha and gross beta analysis, the samples collected on April 2 and 3, 2018 were analyzed for isotopic uranium, isotopic thorium and by gamma spectroscopy. The laboratory acknowledged receipt of the samples on February 2, March 6, April 4, and May 4, 2018.

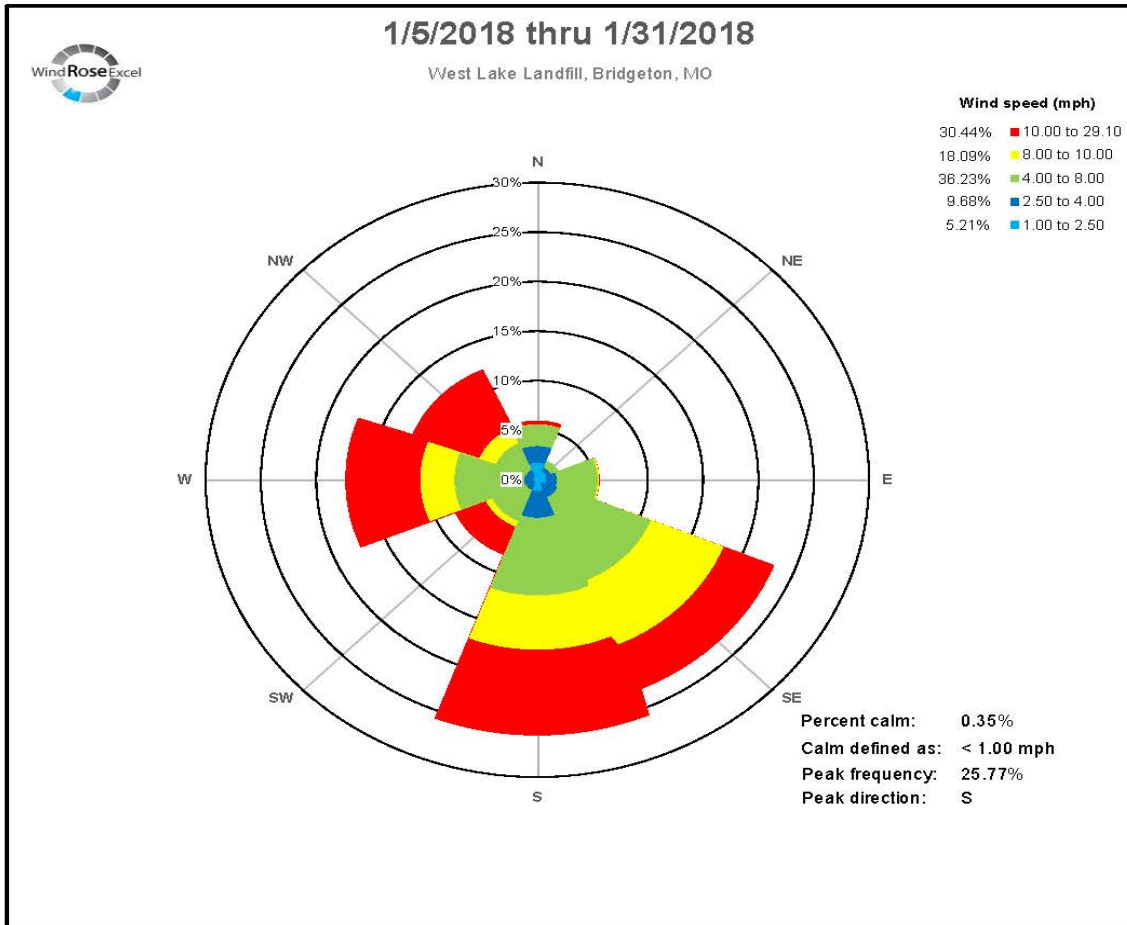
A meteorological data logger was installed on the Bridgeton Landfill property and began operations on May 26, 2015, allowing collection of site-specific temperature and barometric pressure. Using the met station data, the total volume of air sampled is calculated and submitted with the particulate filters. The met station data is presented in Appendix G.

3.2.1 Gross Alpha and Gross Beta Results

Statistical analysis for gross alpha and beta results for each station in pCi/m³ from May 1, 2015 through May 2, 2018 are shown in Table 4 and Table 6. The Year Three, Quarter Four results are reflected graphically in Figure 8 and Figure 9. A summary of the validated results is shown in Appendix A.

The results of on-site monitoring for gross alpha and gross beta were compared to the results obtained from the EPA off-site monitoring program. The EPA off-site sampling results from May 2014 through February 2015 are shown in Table 5 and Table 7. Overall, the gross alpha results obtained from the 13 on-site stations are similar to or slightly higher than the results obtained from EPA’s 5 off-site stations. However, if thorium-230 is assumed for all alpha activity measured (which is the most conservative approach³), in all cases the measured activity is one order of magnitude less than the Th-230 limit of 1×10^{-14} $\mu\text{Ci/ml}$ listed in 10 CFR Part 20 Appendix B. The differences may reflect dust

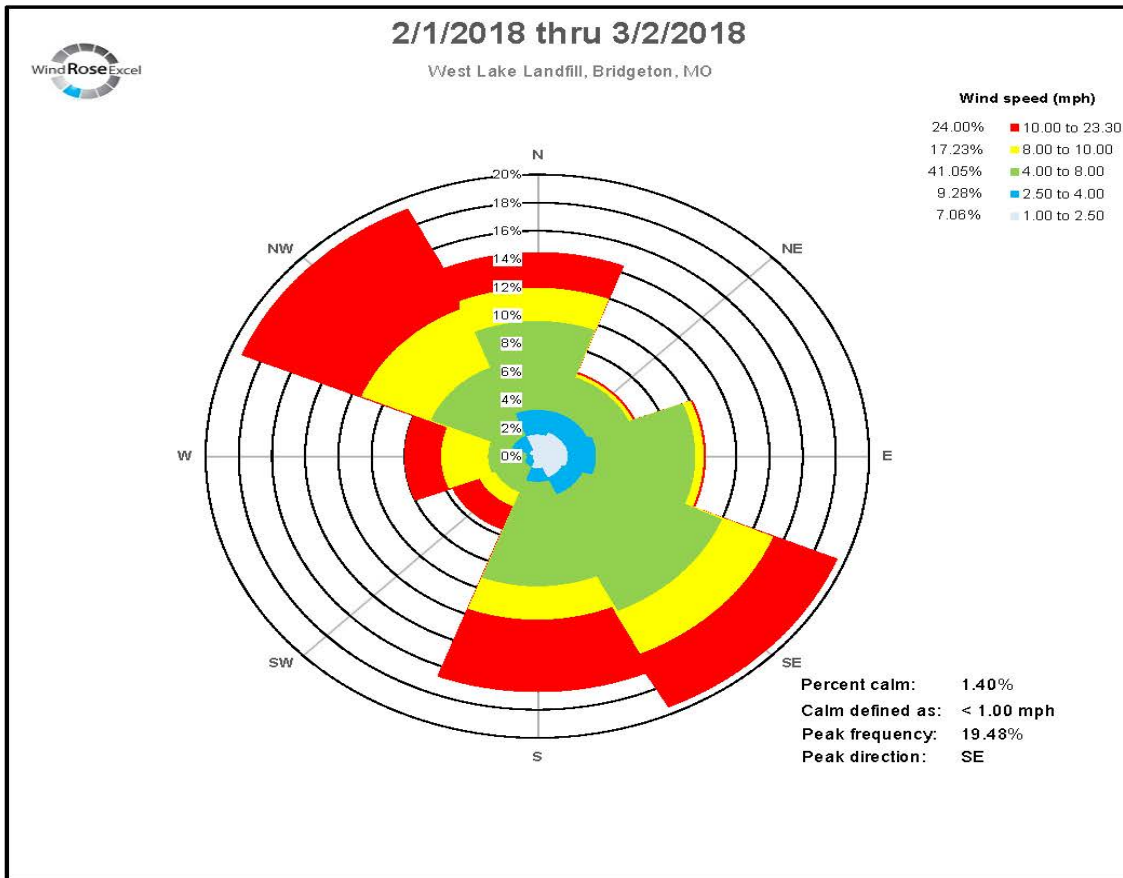
³ Thorium-230 has the most restrictive allowable air concentration of all the radioisotopes associated with the RIM.



Wind Rose based on 2,592 measurements taken on 15-minute intervals over a period of 27 consecutive days (00:00 1/5/18 thru 23:45 1/31/18)

<u>Occurrences by Wind Speed:</u>			<u>Occurrences by Direction:</u>		
Calm	9	0.35%	North	154	5.94%
1.0 to 2.5 mph	135	5.21%	Northeast	53	2.04%
2.5 to 4.0 mph	251	9.68%	East	145	5.59%
4.0 to 8.0 mph	939	36.23%	Southeast	598	23.07%
8.0 to 10.0 mph	469	18.09%	South	668	25.77%
10.0 to 29.1 mph	789	30.44%	Southwest	210	8.10%
			West	449	17.32%
			Northwest	315	12.15%

Figure 5 Wind Rose for January 2018



Wind Rose based on 2,792 measurements taken on 15-minute intervals over a period of 29.5 consecutive days (12:15 2/1/18 thru 00:00 3/3/18). 10 hours of wind speed/direction data (40 measurements from 2/21/18) were deemed invalid and removed from the dataset.

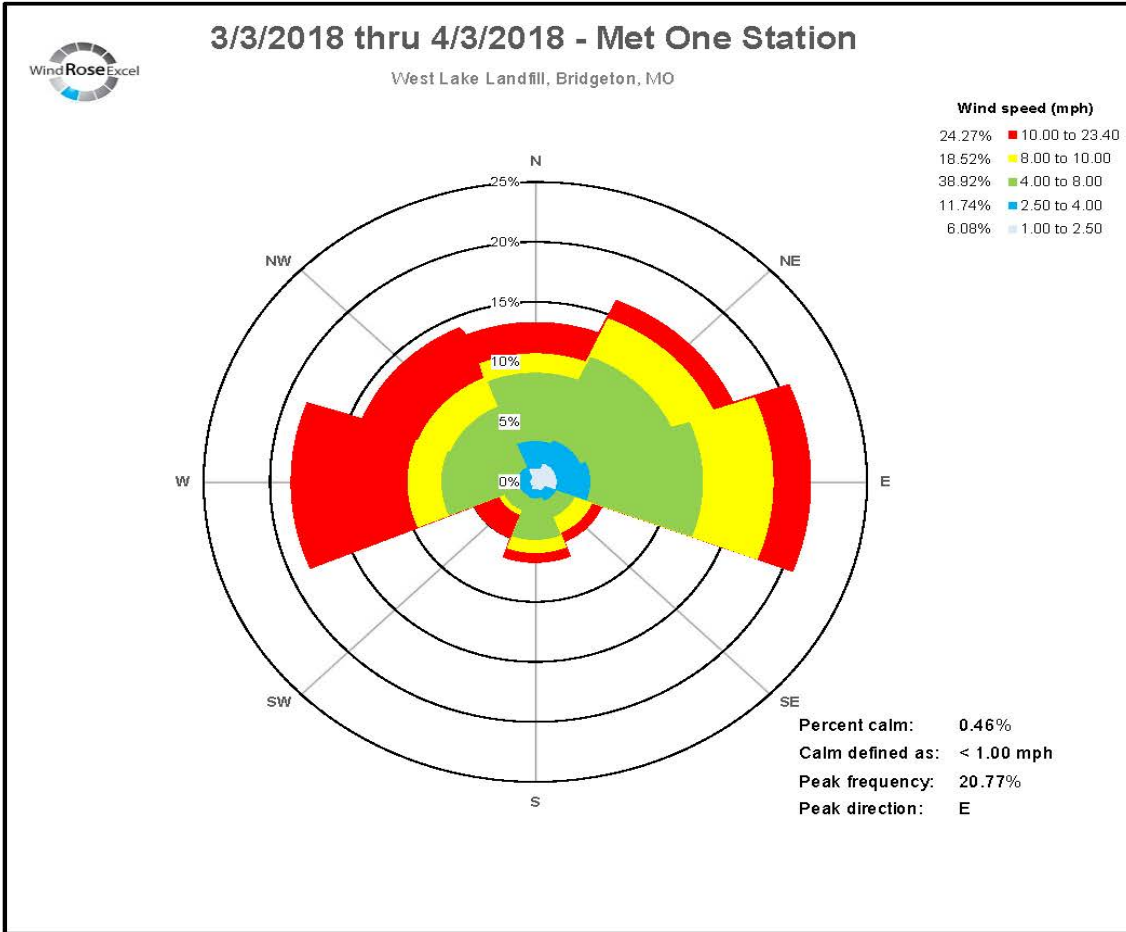
Occurrences by Wind Speed:

Wind Speed (mph)	Occurrences	Percentage
Calm	39	1.40%
1.0 to 2.5 mph	197	7.06%
2.5 to 4.0 mph	259	9.28%
4.0 to 8.0 mph	1,146	41.05%
8.0 to 10.0 mph	481	17.23%
10.0 to 23.3 mph	670	24.00%

Occurrences by Direction:

Direction	Occurrences	Percentage
North	404	14.47%
Northeast	179	6.41%
East	283	10.14%
Southeast	544	19.48%
South	467	16.73%
Southwest	156	5.59%
West	223	7.99%
Northwest	536	19.20%

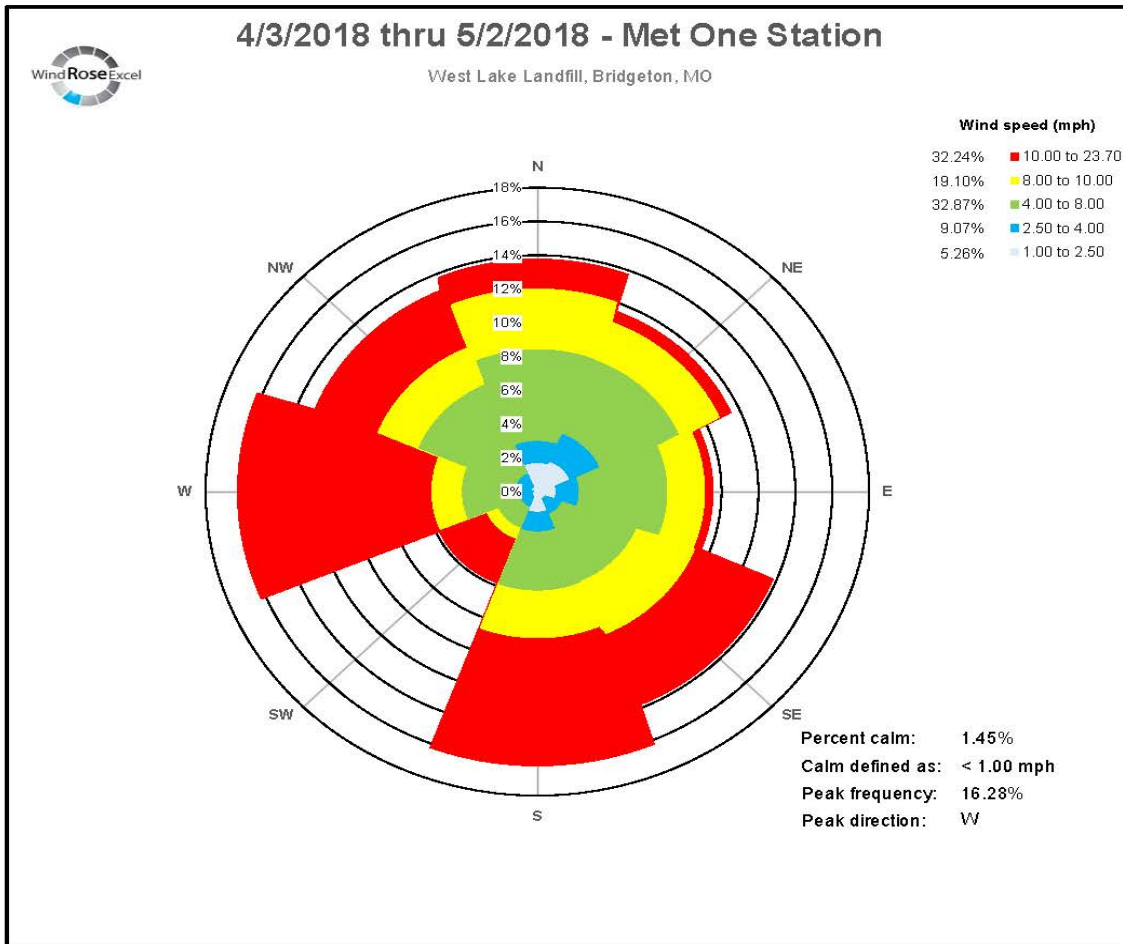
Figure 6 Wind Rose for February 2018



Wind Rose based on 3,024 measurements taken on 15-minute intervals over a period of 31.5 consecutive days (00:15 3/3/18 thru 12:00 4/3/18).

<u>Occurrences by Wind Speed:</u>			<u>Occurrences by Direction:</u>		
Calm	14	0.46%	North	402	13.29%
1.0 to 2.5 mph	184	6.08%	Northeast	493	16.30%
2.5 to 4.0 mph	355	11.74%	East	628	20.77%
4.0 to 8.0 mph	1177	38.92%	Southeast	164	5.42%
8.0 to 10.0 mph	560	18.52%	South	203	6.71%
10.0 to 29.0 mph	734	24.27%	Southwest	152	5.03%
			West	557	18.42%
			Northwest	425	14.05%

Figure 7 Wind Rose for March 2018



Wind Rose based on 2,832 measurements taken on 15-minute intervals over a period of 29.5 consecutive days (12:15 4/3/18 thru 00:00 5/3/18).

<u>Occurrences by Wind Speed:</u>			<u>Occurrences by Direction:</u>		
Calm	41	1.45%	North	390	13.77%
1.0 to 2.5 mph	149	5.26%	Northeast	326	11.51%
2.5 to 4.0 mph	257	9.07%	East	270	9.53%
4.0 to 8.0 mph	931	32.87%	Southeast	391	13.81%
8.0 to 10.0 mph	541	19.10%	South	460	16.24%
10.0 to 32.0 mph	913	32.24%	Southwest	165	5.83%
			West	461	16.28%
			Northwest	369	13.03%

Figure 8 Wind Rose for April 2018

Table 4 Summary of On-Site Gross Alpha Results 5/1/2015 through 5/2/2018 Results

Summary Statistic	Station A-1 (pCi/m ³)	Station A-2 (pCi/m ³)	Station A-3 (pCi/m ³)	Station A-4 (pCi/m ³)	Station A-5 (pCi/m ³)	Station A- 6 (pCi/m ³)	Station A-7 (pCi/m ³)
Detections	38/38	35/35 ¹	39/39	38/38	39/39	38/38	39/39
Minimum Concentration	1.39E-03 J	1.41E-03	1.23E-03	4.09E-04 J+	1.40E-03	5.27E-04 J+	1.18E-03
Median Concentration	3.39E-03	3.15E-03	3.26E-03	3.14E-03	3.20E-03	3.36E-03	2.77E-03
Maximum Concentration	5.31E-03 J+	4.60E-03 J+	5.95E-03 J+	6.09E-03 J+	5.46E-03 J+	5.11E-03 J+	5.70E-03 J+

Summary Statistic	Station A-8 (pCi/m ³)	Station A- 9 (pCi/m ³)	Station A-10 (pCi/m ³)	Station A- 11 (pCi/m ³)	Station A-12 (pCi/m ³)	Station A-13 (pCi/m ³)
Detections	39/39	38/38 ²	39/39	39/39	39/39	38/38
Minimum Concentration	1.50E-03	1.46E-03	5.70E-04	6.56E-04	1.55E-03 J+	1.40E-03
Median Concentration	3.29E-03	3.19E-03	2.90E-03	3.39E-03	3.29E-03	3.32E-03
Maximum Concentration	5.82E-03 J+	5.20E-03 J+	5.82E-03 J+	6.16E-03 J+	5.72E-03 J+	5.61E-03 J+

¹ Station A-2 was out of service for a 4 month period in 2015 due to flooding.

² Station A-9 was out of service for 1 month in 2015 due to power failure.

Table 5 Summary of Off-Site EPA Gross Alpha Results (Tetra Tech 2015)

Summary Statistic	Station 1 (pCi/m ³)	Station 2 (pCi/m ³)	Station 3 (pCi/m ³)	Station 4 (pCi/m ³)	Station 5 (background) (pCi/m ³)
Detections	36/44	34/44	30/44	40/64	32/44
Minimum Concentration	1.99E-04 U	1.93E-04 U	1.02E-04 U	1.17E-04 U	1.10E-04 U
Median Concentration	6.42E-04	6.25E-04	6.32E-04	6.06E-04	6.97E-04
Maximum Concentration	1.63E-03 J	1.68E-03 J	1.58E-03 J	1.38E-03 J	1.65E-03 J

Table 6 Summary of On-Site Gross Beta Results 5/1/2015 through 5/2/2018 Results

Summary Statistic	Station A-1 (pCi/m ³)	Station A-2 (pCi/m ³)	Station A-3 (pCi/m ³)	Station A-4 (pCi/m ³)	Station A-5 (pCi/m ³)	Station A-6 (pCi/m ³)	Station A-7 (pCi/m ³)
Detections	39/39	351/35 ¹	39/39	38/38	39/39	39/39	39/39
Minimum Concentration	9.25E-03 J+	1.03E-02 J+	1.14E-02 J+	3.79 E-03 J+	1.17E-02 J+	4.06E-03 J+	9.88E-03 J+
Median Concentration	2.92E-02	2.87E-02	2.84E-02	2.81E-02	2.76E-02	2.98E-02	2.23E-02
Maximum Concentration	5.17E-02 J+	4.39E-02 J+	4.80E-02 J+	4.77E-02 J+	4.31E-02 J+	4.59E-02 J+	4.35E-02 J+

Summary Statistic	Station A-8 (pCi/m ³)	Station A-9 (pCi/m ³)	Station A-10 (pCi/m ³)	Station A-11 (pCi/m ³)	Station A-12 (pCi/m ³)	Station A-13 (pCi/m ³)
Detections	39/39	38/38 ²	39/39	38/38	39/39	38/38
Minimum Concentration	1.30E-02 J+	9.97E-03 J+	9.79E-03 J+	1.19E-02 J+	1.05E-02 J+	1.35E-02 J+
Median Concentration	2.82E-02	2.79E-02	2.27E-02	2.68E-02	2.75E-02	2.85E-02
Maximum Concentration	4.87E-02 J+	4.94E-02 J+	4.07E-02 J+	4.76E-02 J+	4.46E-02 J+	4.72E-02 J+

¹ Station A-2 was out of service for a 4 month period in 2015 due to flooding.

² Station A-9 was out of service for 1 month in 2015 due to power failure.

Table 7 Summary of Off-Site EPA Gross Beta Results (Tetra Tech 2015)

Summary Statistic	Station 1 (pCi/m ³)	Station 2 (pCi/m ³)	Station 3 (pCi/m ³)	Station 4 (pCi/m ³)	Station 5 (background) (pCi/m ³)
Detections	44/44	44/44	44/44	64/64	44/44
Minimum Concentration	1.15E-02	4.13E-03 J	1.32E-02 J	1.16E-02 J	1.21E-02 J
Median Concentration	1.98E-02	2.05E-02	2.04E-02	1.87E-02	1.93E-02
Maximum Concentration	3.95E-02	4.36E-02	3.96E-02	4.15E-02	4.31E-02

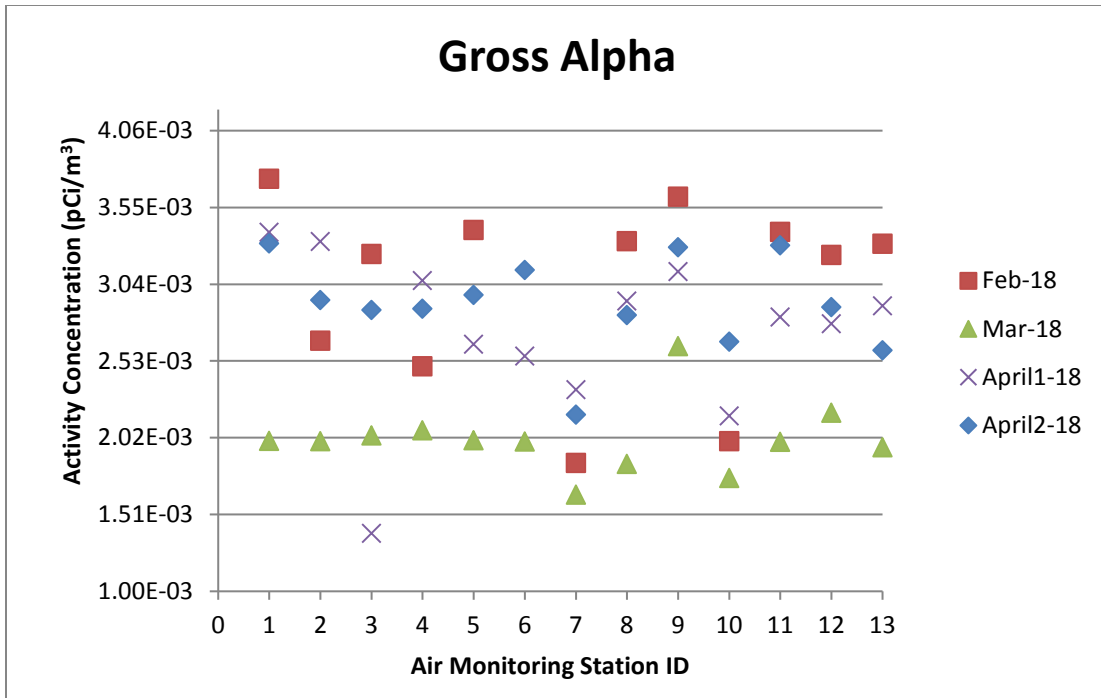


Figure 9 Graphical Representation of Gross Alpha Results in pCi/m³

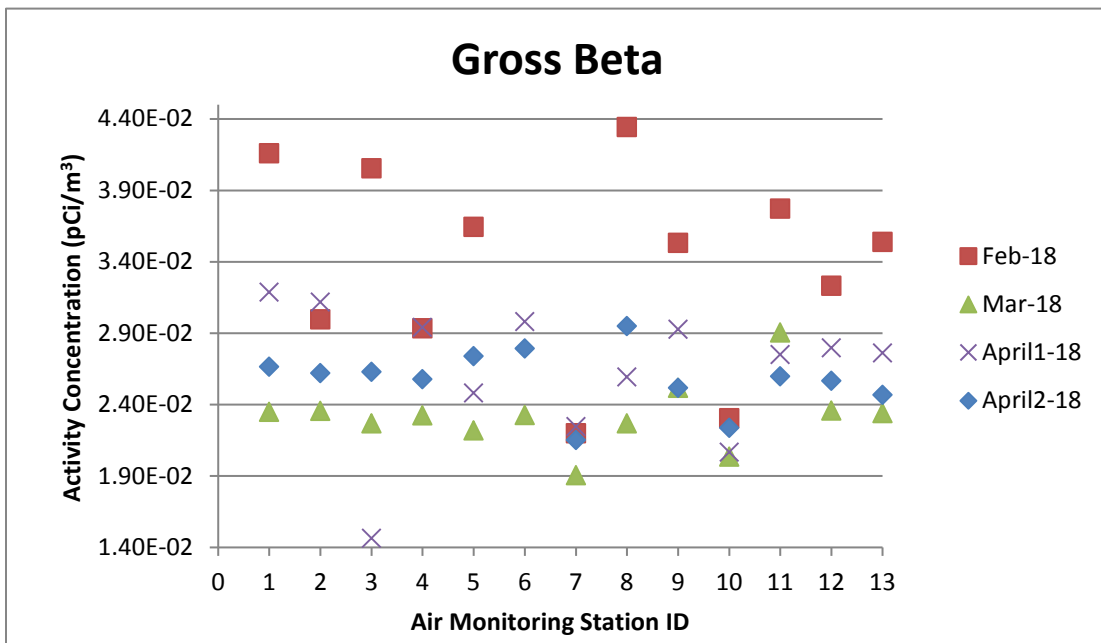


Figure 10 Graphical Representation of Gross Beta Results in pCi/m³

levels, seasonal conditions (pollen levels), differences in precipitation (i.e., soil moisture), or differences in the total particulate levels between the period covered by EPA’s air monitoring program and the period covered by the on-site air monitoring program. The shorter collection period of 1-week for off-site sampling likely increased the variability of off-site results. The gross beta results obtained from the 13 on-site stations are similar to the gross beta results obtained from the EPA off-site monitoring locations.

3.2.2 Gross Alpha and Gross Beta Field Duplicates

Field duplicates for gross alpha and gross beta are collected in the field but prepared in the laboratory according to the description in Section 2.2.1. For duplicate analyses where the results are relatively close to the detection limits, the normalized difference (ND) comparison is an appropriate method for determining the statistical agreement of the two values. The relative percent difference (RPD) calculation is generally useful when two duplicate results are significantly elevated above their detection limits. The duplicate/replicate analyses are compared using either the ND comparison or RPD. The ND result should be less than or equal to a value of 3.0 and the RPD result should be less than or equal to 20%. When either the RPD or the ND pass, then the duplicate is acceptable. If the duplicate fails both tests, the samples may require reanalysis or the situation may require further investigation. The ND and RPD is calculated for each original and duplicate sample, and reflected in Table 8. The ND and RPD are calculated as described below. Note that the ND and RPD for gross alpha analysis in November 2016 failed both tests. This filter was analyzed isotopically, and the ND and RPD for uranium, thorium and radium passed both tests.

$$\text{Normalized Difference} = \frac{|\text{Result}_1 - \text{Result}_2|}{\sqrt{\text{Uncertainty}_1^2 + \text{Uncertainty}_2^2}}$$

$$\text{Relative Percent Difference} = \frac{|\text{Result}_1 - \text{Result}_2|}{\frac{\text{Result}_1 + \text{Result}_2}{2}} * 100$$

Table 8 GAGB Normalized and Relative Percent Difference

Client ID	Sample Date	Gross Alpha		Gross Beta	
		ND	RPD	ND	RPD
ENGWESA013	5/27/2015	1.42	25.24	0.53	10.42
ENGWESA012	6/23/2015	0.19	3.21	0.01	0.17
ENGWESA011	7/22/2015	0.78	12.76	0.44	8.54
ENGWESA010	8/19/2015	0.68	11.10	0.21	4.17
ENGWESA009	9/17/2015	0.16	2.58	0.57	11.16
ENGWESA013	10/15/2015	0.08	1.24	0.08	1.48
ENGWESA007	11/9/2015	2.09	35.34	1.25	24.69
ENGWESA005	12/8/2015	0.87	14.05	0.22	4.39
ENGWESA005	1/8/2016	0.47	7.56	0.18	3.45
ENGWESA004	2/4/2016	0.22	3.53	0.32	6.29

Client ID	Sample Date	Gross Alpha		Gross Beta	
		ND	RPD	ND	RPD
ENGWESA003	3/3/2016	1.23	28.89	0.49	9.68
ENGWESA008	3/31/2016	0.19	3.14	0.31	6.00
ENGWESA004	4/27/2016	0.34	5.70	0.30	5.88
ENGWESA003	5/27/2016	0.74	12.69	0.04	0.74
ENGWESA002	6/23/2016	0.43	7.02	0.31	6.06
ENGWESA012	7/20/2016	1.24	18.50	0.38	7.53
ENGWESA013	8/19/2016	0.18	3.05	0.26	5.18
ENGWESA012	9/14/2016	0.63	10.25	1.11	21.91
ENGWESA011	10/19/2016	0.24	3.81	0.68	13.44
ENGWESA010	11/16/2016	5.20	128.30	1.96	39.42
ENGWESA010	12/14/2016	0.05	0.84	5.02	1.94
ENGWESA009	1/10/2017	0.71	11.57	0.19	3.72
ENGWESA008	2/6/2017	0.94	26.86	0.10	1.94
ENGWESA007	3/3/2017	0.01	6.64	0.08	1.62
ENGWESA006	4/3/2017	0.22	3.52	0.30	5.91
ENGWESA005	4/27/2017	0.29	7.39	0.03	0.55
ENGWESA004	5/25/2017	0.35	5.82	0.19	3.82
ENGWESA003	6/22/2017	0.44	7.34	0.06	1.13
ENGWESA002	7/20/2017	0.29	4.71	0.42	8.26
ENGWESA001	8/18/2017	0.05	0.93	0.04	0.77
ENGWESA013	9/14/2017	0.57	9.37	0.08	1.55
ENGWESA012	10/14/2017	0.34	5.62	0.07	1.31
ENGWESA009	1/5/2018	0.39	6.31	0.14	2.75
ENGWESA008	1/31/2018	1.25	20.57	0.80	15.70
ENGWESA007	3/2/2018	0.64	11.07	0.54	10.59
ENGWESA005	4/2/2018	0.87	14.44	0.09	1.84
ENGWESA004	5/1/2018	0.02	0.32	0.10	2.00

3.2.3 Isotopic Results

Particulate samples collected in the months of May, June, and September, and December 2015, March, May, August, and November 2016, February, April, July, and October 2017, and January and April 2018 were analyzed for isotopic thorium, uranium, and by gamma spectroscopy. The isotopic and gamma spectroscopy results demonstrate only naturally occurring radioactive materials. Statistics for thorium-230, uranium-238, and combined radium results (the sum of actinium-228 (for radium-228) and bismuth-214 (for radium-226) from gamma spectrometry) for each station in pCi/m³ for the samples analyzed isotopically are shown in Table 9, Table 10, and Table 11. Where both the actinium-228 and bismuth-214 results were qualified as non-detect (U), the total radium result was qualified as non-detect. If either the actinium-228 or the bismuth-214 was detected, the total radium result was considered to be detected. A summary of the validated results are shown in Appendix B.

The results of on-site monitoring for uranium-238, thorium-230, and combined radium were also compared to the results obtained from the EPA off-site monitoring program over the period from May 2014 through February 2015. The EPA off-site sampling results are shown in Table 13. In all cases, the maximum isotopic uranium and thorium and combined radium results obtained from the 13 on-site stations are lower than the results obtained from EPA's five off-site stations.

The isotopic results were converted to $\mu\text{Ci/ml}$ and compared to 10 CFR Part 20 Appendix B Effluent Limits. These effluent limits, established by the U.S. Department of Energy, set forth standards for protection of the public against radiation emissions. The results are well below the applicable effluent limits, as shown in Appendix C.

3.2.4 Isotopic Field Duplicates

For isotopic analyses, the five 47 mm extractions for the Gross Alpha and Gross Beta analyses were recombined with the remaining pieces of the filter. The total sample was then digested and diluted, and aliquots were taken from the dilution. Therefore, while the laboratory data sheets list these samples as field duplicates, because the aliquots are taken from the same digestion, these samples are actually laboratory replicates. The same ND and RPD calculations and acceptance criteria listed in Section 3.2.2 apply to the isotopic replicate evaluation. Radium-226 and radium-228 are used to calculate total radium. Field duplicates were not analyzed for May or June 2015 due to miscommunication with the analytical laboratory. The normalized and percent differences for the duplicate results are reflected in Table 12. All samples for the Year Three, Quarter Four monitoring event demonstrated acceptable results.

Table 9 Thorium-230 Statistics

Summary Statistic	Station A-1 (pCi/m ³)	Station A-2 (pCi/m ³)	Station A-3 (pCi/m ³)	Station A-4 (pCi/m ³)	Station A-5 (pCi/m ³)	Station A-6 (pCi/m ³)	Station A-7 (pCi/m ³)
Detections	13/14	12/13 ¹	14/14	12/13	14/14	14/14	14/14
Minimum Concentration	8.21E-06 J+	7.20E-06 U	1.90E-05	1.37E-05 J+	1.67E-05 J+	1.05E-05 J	1.60E-05 J+
Median Concentration	1.99E-05	2.32E-05	2.80E-05	3.14E-05	2.89E-05	2.38E-05	3.59E-05
Maximum Concentration	6.58E-05 J+	8.02E-05 J+	7.03E-05 J+	4.94E-05 J+	7.02E-05 J+	8.06E-05 J+	7.22E-05 J+

Summary Statistic	Station A-8 (pCi/m ³)	Station A-9 (pCi/m ³)	Station A-10 (pCi/m ³)	Station A-11 (pCi/m ³)	Station A-12 (pCi/m ³)	Station A-13 (pCi/m ³)
Detections	14/14	13/13 ²	14/14	14/14	14/14	14/14
Minimum Concentration	1.15E-05 J+	1.32E-05	1.00E-05 J+	8.67E-06 J	8.97E-06 J+	1.45E-05 J
Median Concentration	2.29E-05	2.64E-05	2.69E-05	2.84E-05	2.12E-05	2.36E-05
Maximum Concentration	6.66E-05 J+	5.62E-05 J+	8.02E-05 J+	2.09E-04 J+	8.64E-05 J+	4.39E-05 J

¹ Station A-2 was out of service for a 4 month period in 2015 due to flooding.

² Station A-9 was out of service for 1 month in 2015 due to power failure.

Table 10 Uranium-238 Statistics

Summary Statistic	Station A-1 (pCi/m ³)	Station A-2 (pCi/m ³)	Station A-3 (pCi/m ³)	Station A-4 (pCi/m ³)	Station A-5 (pCi/m ³)	Station A-6 (pCi/m ³)	Station A-7 (pCi/m ³)
Detections	14/14	13/13 ¹	14/14	13/13	14/14	14/14	14/14
Minimum Concentration	1.34E-05 J+	1.84E-05 J+	1.03E-05 J+	1.60E-05 J+	1.37E-05 J	8.94E-06 J+	1.77E-05 J+
Median Concentration	2.52E-05	2.42E-05	2.59E-05	2.38E-05	2.72E-05	2.41E-05	2.75E-05
Maximum Concentration	3.64E-05 J+	8.95E-05 J+	5.08E-05 J	4.06E-05 J	5.72E-05 J+	3.71E-05 J+	5.37E-05 J+

Summary Statistic	Station A-8 (pCi/m ³)	Station A-9 (pCi/m ³)	Station A-10 (pCi/m ³)	Station A-11 (pCi/m ³)	Station A-12 (pCi/m ³)	Station A-13 (pCi/m ³)
Detections	14/14	13/13 ²	14/14	14/14	14/14	14/14
Minimum Concentration	1.30E-05 J+	1.71E-05 J+	1.66E-05 J+	1.34E-05 J+	1.27E-05 J+	1.26E-05 J+
Median Concentration	2.56E-05	2.86E-05	2.63E-05	2.33E-05	2.31E-05	2.47E-05
Maximum Concentration	5.05E-05 J	4.52E-05 J+	4.34E-05 J+	5.05E-05 J+	4.13E-05	4.26E-05 J+

¹ Station A-2 was out of service for a 4 month period in 2015 due to flooding.

² Station A-9 was out of service for 1 month in 2015 due to power failure.

Table 11 Total Radium Statistics

Summary Statistic	Station A-1 (pCi/m ³)	Station A-2 (pCi/m ³)	Station A-3 (pCi/m ³)	Station A-4 (pCi/m ³)	Station A-5 (pCi/m ³)	Station A-6 (pCi/m ³)	Station A-7 (pCi/m ³)
Detections	10/14	11/13 ¹	7/14	10/13	9/14	7/14	9/14
Minimum Concentration	2.07E-05 U	1.21E-04 U	3.74E-05 U	5.15E-05 U	3.71E-05 U	4.51E-05 U	4.15E-05 U
Median Concentration	1.06E-04	2.05E-04	1.53E-04	1.44E-04	1.20E-04	1.85E-04	2.19E-04
Maximum Concentration	3.22E-04	3.57E-04	8.75E-04	3.33E-04 J	5.51E-04 U	3.50E-04 J	3.94E-04

Summary Statistic	Station A-8 (pCi/m ³)	Station A-9 (pCi/m ³)	Station A-10 (pCi/m ³)	Station A-11 (pCi/m ³)	Station A-12 (pCi/m ³)	Station A-13 (pCi/m ³)
Detections	11/14	5/13 ²	8/14	9/14	9/14	9/14
Minimum Concentration	2.85E-05 U	2.75E-05 U	1.11E-05 U	6.04E-05 U	3.63E-05 U	9.67E-06 U
Median Concentration	1.38E-04	9.42E-05	1.66E-04	2.88E-04	1.49E-04	1.23E-04
Maximum Concentration	5.21E-04	3.09E-04	2.90E-04	4.44E-04	6.14E-04 J	3.50E-04

¹ Station A-2 was out of service for a 4 month period in 2015 due to flooding.

² Station A-9 was out of service for 1 month in 2015 due to power failure.

Table 12 Isotopic Normalized and Relative Percent Difference

Sample No.	Date	Th-230		U-238		Total Radium	
		ND	RPD	ND	RPD	ND	RPD
ENGWESA009	9/17/2015	1.85	1.01	0.78	0.45	0.14	1.29
ENGWESA005	12/8/2015	1.42	0.78	0.94	0.52	0.10	0.50
ENGWESA003	3/3/2016	0.32	0.24	0.48	0.31	0.27	0.90
ENGWESA003	5/27/2016	0.45	0.33	0.11	0.06	0.38	1.22
ENGWESA013	8/19/2016	0.15	0.15	0.66	0.41	0.04	0.72
ENGWESA010	11/16/2016	0.06	0.06	0.73	0.54	0.14	0.87
ENGWESA008	2/6/2017	0.36	0.30	0.35	0.19	0.39	1.39
ENGWESA005	4/27/2017	0.51	0.29	0.07	0.05	0.28	0.61
ENGWESA002	7/20/2017	0.11	0.07	0.21	0.17	0.11	0.33
ENGWESA012	10/14/2017	0.72	0.52	1.08	0.81	0.28	0.36
ENGWESA009	1/5/2018	0.51	0.33	0.38	0.24	0.24	0.69
ENGWESA005	4/2/2018	0.21	0.16	0.08	0.04	0.46	0.95

Table 13 Summary of Isotopic and Radium Results (Tetra Tech 2015)

SUMMARY STATISTICS OF URANIUM-238 RESULTS	Station 1 (pCi/m ³)	Station 2 (pCi/m ³)	Station 3 (pCi/m ³)	Station 4 (pCi/m ³)	Station 5 (reference) (pCi/m ³)
Detections	19/44	24/44	22/44	21/64	14/44
Minimum Concentration	-1.61E-04 U	-8.55E-05 U	-4.42E-05 U	-1.34E-05 U	-2.39E-05 U
Median Concentration	9.38E-05	1.24E-04	1.12E-04	1.03E-04	1.02E-04
Maximum Concentration	6.22E-04 J	1.08E-03 J	3.86E-04 J	3.07E-04 J	2.25E-04 J
SUMMARY STATISTICS OF THORIUM-230 RESULTS	Station 1 (pCi/m ³)	Station 2 (pCi/m ³)	Station 3 (pCi/m ³)	Station 4 (pCi/m ³)	Station 5 (reference) (pCi/m ³)
Detections	42/44	39/44	42/44	55/64	42/44
Minimum Concentration	1.77E-04 U	2.63E-04 J	1.37E-04 J	1.81E-04 J	2.71E-04 U
Median Concentration	4.71E-04	5.66E-04	5.10E-04	5.38E-04	5.17E-04
Maximum Concentration	4.37E-03	1.36E-03 J	8.86E-04 J	1.80E-03 J	1.99E-03 J
SUMMARY STATISTICS OF TOTAL ALPHA-EMITTING RADIUM RESULTS	Station 1 (pCi/m ³)	Station 2 (pCi/m ³)	Station 3 (pCi/m ³)	Station 4 (pCi/m ³)	Station 5 (reference) (pCi/m ³)
Detections	3/43	4/43	3/43	3/63	2/43
Minimum Concentration	-2.50E-04 U	-6.83E-04 U	1.56E-04 U	-4.86E-04 U	-4.34E-04 U
Median Concentration	4.49E-04	4.55E-04	3.05E-04	4.58E-04	4.68E-04
Maximum Concentration	1.10E-03 J	1.80E-03 JG	2.01E-03	3.66E-03 J	4.40E-03

3.3 VOC RESULTS

Prior to August 2015, the laboratory reported 26 VOCs from the analysis of the Radiello passive/diffusive samples. In August 2015, the laboratory issued a request to discontinue reporting 2-propanol (rubbing alcohol) from the Radiello 130 reporting list. The EPA approved this request via email on August 11, 2015. In accordance with an EPA suggestion received October 16, 2015, VOC sampling was moved for the third quarter sampling period from Station 11 to Station 12. Laboratory results for the first two quarters of sampling did not include results for 1,2,4, trimethylbenzene. The validated VOC results are presented in Appendix D.

Table 14 provides a statistical sampling summary for the 15 VOCs with results above the laboratory reporting limits. Values are presented in $\mu\text{g}/\text{m}^3$. The table reflects the range of “detected” values only. The number of non-detect results can be determined by subtracting the number of detects from the number of samples. The remaining 10 VOCs analyzed were not detected above the reporting limit, and include 1,1,1-trichloroethane, 1,4-dichlorobenzene, 4-methyl,-2-pentanone, chlorobenzene, ethanol, methyl-tert-butyl ether, naphthalene, propylbenzene, styrene, and trichloroethene. 1,2-Dichloroethane was not detected at any of the stations this event, but has been detected previously. 1,2-Dichloroethane was detected one (1) time out of 32 measurements at Stations A-1, A-5, and A-7 at 0.06, 0.066, and 0.064 $\mu\text{g}/\text{m}^3$ respectively. 1,2-Dichloroethane was detected twice at Station A-8 at 0.078 and 0.068 $\mu\text{g}/\text{m}^3$. This analyte will be included in future statistical summaries if detected.

EPA performed similar off-site sampling for VOCs using passive/diffusive samplers from December 2014 to March 2015. However, the EPA sampled for seven days except for one period in January in which they sampled for 14 days. EPA noted no significant difference between the 7- and 14-day sample results. Table 15 presents the results obtained from the five on-site monitoring stations compared to the results obtained from the EPA’s off-site monitoring program for those VOCs that were analyzed and detected by both programs (Tetra Tech 2015).

The on-site results are similar to those obtained by the EPA from the off-site monitoring locations.

Table 14 VOC Statistical Summary

Station	A-1 (µg/m3)	A-5 (µg/m3)	A-7 (µg/m3)	A-8 (µg/m3)	A-11 (µg/m3)	A-12 (µg/m3)
Analyte	1,2,4 Trimethylbenzene (October 30, 2015)					
# Detects/# samples	49/65	55/65	54/58	41/58	NA	49/65
Min	0.09	0.09	0.10	0.10	NA	0.10
Median	0.13	0.14	0.18	0.14	NA	0.14
Max	0.24	0.34	0.33	0.49	NA	0.22
Analyte	Benzene					
# Detects/# samples	57/78	61/78	57/71	56/71	9/13	56/65
Min	0.24	0.25	0.24	0.24	0.28	0.24
Median	0.40	0.41	0.42	0.42	0.30	0.45
Max	0.66	0.63	0.74	0.76	0.48	0.79
Analyte	Cyclohexane					
# Detects/# samples	34/78	48/78	62/71	26/71	5/13	32/65
Min	0.07	0.09	0.07	0.10	0.10	0.09
Median	0.13	0.12	0.13	0.12	0.12	0.12
Max	0.20	0.20	0.25	0.16	0.15	0.18
Analyte	Heptane					
# Detects/# samples	78/78	78/78	71/71	71/71	13/13	64/65
Min	0.13	0.11	0.13	0.10	0.12	0.13
Median	0.28	0.21	0.26	0.19	0.18	0.20
Max	0.84	0.35	0.47	0.33	0.41	0.34
Analyte	o-Xylene					
# Detects/# samples	61/78	62/78	67/71	46/71	9/13	48/65
Min	0.07	0.08	0.08	0.08	0.08	0.08
Median	0.10	0.11	0.14	0.11	0.10	0.10
Max	0.28	0.19	0.27	0.20	0.17	0.17

A-1 (µg/m3)	A-5 (µg/m3)	A-7 (µg/m3)	A-8 (µg/m3)	A-11 (µg/m3)	A-12 (µg/m3)
2- Butanone (Methyl Ethyl Ketone)					
78/78	78/78	71/71	71/71	12/13	65/65
0.07	0.08	0.10	0.07	0.14	0.09
0.20	0.24	0.25	0.22	0.19	0.26
0.40	0.46	0.56	0.44	0.27	0.77
Carbon Tetrachloride					
78/78	78/78	71/71	71/71	13/13	65/65
0.22	0.20	0.22	0.22	0.19	0.24
0.34	0.34	0.34	0.32	0.27	0.36
0.51	0.49	0.52	0.46	0.34	0.53
Ethyl Acetate					
2/78	16/78	46/71	8/71	2/13	3/65
0.29	0.21	0.25	0.25	0.25	0.27
0.31	0.30	0.44	0.37	0.26	0.34
0.33	0.44	0.99	0.52	0.26	0.43
Hexane					
78/78	78/78	71/71	71/71	13/13	65/65
0.13	0.15	0.21	0.15	0.21	0.18
0.33	0.36	0.40	0.32	0.32	0.34
0.68	2.00	0.68	0.66	1.20	0.58
Tetrachloroethene					
62/78	24/78	49/71	12/71	3/13	11/65
0.08	0.06	0.07	0.07	0.10	0.08
0.19	0.09	0.11	0.10	0.12	0.10
0.84	0.18	0.25	0.15	0.20	0.17

A-1 (µg/m3)	A-5 (µg/m3)	A-7 (µg/m3)	A-8 (µg/m3)	A-11 (µg/m3)	A-12 (µg/m3)
Acetone					
68/78	68/78	66/71	60/71	7/13	57/65
0.12	0.12	0.13	0.13	0.15	0.12
0.39	0.41	0.42	0.38	0.28	0.47
1.30	1.30	2.20	1.30	0.36	1.50
Chloroform					
35/78	42/78	31/71	26/71	2/13	36/65
0.05	0.05	0.06	0.05	0.07	0.05
0.08	0.08	0.08	0.08	0.08	0.08
0.18	0.14	0.11	0.14	0.10	0.14
Ethyl Benzene					
67/78	76/78	71/71	62/71	12/13	58/65
0.07	0.08	0.07	0.07	0.08	0.08
0.11	0.11	0.14	0.10	0.11	0.11
0.26	0.19	0.27	0.26	0.15	0.18
m,p-Xylene					
78/78	78/78	71/71	71/71	13/13	65/65
0.13	0.16	0.15	0.15	0.18	0.15
0.28	0.30	0.40	0.26	0.31	0.26
0.87	0.53	0.90	0.50	0.49	0.51
Toluene					
78/78	77/78	71/71	71/71	13/13	65/65
0.31	0.42	0.39	0.34	0.32	0.40
0.61	0.68	0.88	0.56	0.57	0.58
1.30	1.10	1.60	1.40	0.87	0.97

Table 15 Common Analytes ($\mu\text{g}/\text{m}^3$)

VOC	EPA Off-site Result Range	EPA MDL	On-site Range	On-site MDL
Benzene	0.41-0.7	0.05-1 ¹	0.24-0.79	0.052
Ethylbenzene	0.13-0.37	0.05-1	0.07-0.27	0.010
m,p-Xylene	0.32-1.1	0.05-1	0.13-0.90	0.026
o-Xylene	0.12-0.39	0.05-1	0.07-0.28	0.014
Methyl Tert-butyl ether	0.022-0.041	0.05-1	ND	0.029
Toluene	1.1-1.2	0.05-1	0.31-1.60 ²	0.013
Trichloroethene	0.041-0.51	0.05-1	ND	0.012
Tetrachloroethene	0.084-0.46	0.05-1	0.06-0.84	0.014
1,2,4-Trimethylbenzene	0.075-0.45	0.05-1	0.09-0.49	0.014

¹ The limit of quantitation for 7 days exposure usually ranged from 0.05 to 1 $\mu\text{g}/\text{m}^3$, depending on the compound (Tetratech 2015)

² Maximum value does not include the value of 19 $\mu\text{g}/\text{m}^3$ reported for the July 8, 2015 sample as this result appears to be anomalous.

3.4 TLD RESULTS

Prior to January 2016, TLDs more suited to occupational monitoring were deployed in the stations. TLDs better suited to outdoor conditions were deployed for the Year One, Quarter Four sampling event and going forward. Sixteen environmental TLDs are used for each sampling event. The 16 TLDs included 13 for station monitoring, a duplicate TLD, a control, and a trip blank to assist in evaluating the source of sample exposures. The trip blank is stored in a lead-lined container during the sampling period, but shipped normally with the other TLDs. This allows for differentiating exposures that occur during shipping from exposures that occur during deployment.

The Year Three, Quarter Four gross TLD measurements for the 13 monitoring stations, the trip blank, the control, and the duplicate placed at Station A-1 are shown in Appendix E. The statistics for Year 1, Year 2, and Year 3 are presented in Table 16.

Table 16 TLD Statistics

Statistic	Year 1	Year 2	Year 3
Min	17	15	16
Med	23	20	21
Max	70	32	23

3.5 RADON RESULTS

Radon results for the 13 stations ranged from < 0.4 pCi/L to 0.4pCi/L for the Year Three, Quarter Four monitoring event. The results are presented in Appendix G.

4. REFERENCES

- A&A 2014 *Air Monitoring, Sampling, and QA/QC Plan, West Lake Superfund Site Operable Unit 1*, October, 2014.
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