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Revitalizing Automotive Communities Environmental Response (RACER) Trust

DRAFT -

Response to MDEQ Comments on the Human Health Pathway Analysis for Unsaturated Soil (HHPA)

Plant 2 Landfill
Saginaw, Michigan

October 31, 2013

ARCADIS

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1. Introduction

Representatives from ARCADIS, the Revitalizing Automotive Communities Environmental Response (RACER) Trust, and the Michigan Department of Environmental Quality (MDEQ) participated in a conference call on June 10, 2013 to discuss the *Human Health Pathway Analysis for Unsaturated Soil (HHPA)* for the RACER Trust facility, SMI Plant 2 Landfill site, in Saginaw, MI (April 2013)[1]. The purpose of the call was to discuss questions or concerns identified by Dr. Divinia Ries, MDEQ Remediation and Redevelopment Division (RRD) Toxicologist, during her preliminary review of the report. The conference call summary prepared by Dr. Ries is included as Appendix A.

Items that were resolved during the call are noted in the call summary and are not discussed in the body of this report. This document, an Addendum to the HHPA, provides responses to issues requiring additional work and/or clarification. Additional work was completed to address comments on soil lead (Pb) data and analyses completed by ARCADIS and the calculated site-specific PSIC developed for manganese (Mn). This Addendum presents the following:

- The results of a near-surface soil lead investigation requested by MDEQ.
- Revised soil lead analysis.
- Revised site-specific soil PSIC criteria for Mn.

2. Soil Lead – Additional Analysis

The following is the soil lead discussion provided in the call summary prepared by Dr. Ries.

1) "*Lead analysis: a) use of arithmetic mean in place of 95% UCL, and b) fine and coarse fraction Pb concentrations*

[1] Call participants included: Divinia Ries, Ph.D., RRD Toxicologist, Sue Matlock, RRD Project Manager, David Favero, RACER site Manager, and Betty Locey, Ph.D., DABT, ARCADIS Toxicologist.

a) *The soil lead concentrations were compared to an arithmetic mean (460 ppm) even though the report includes a statistical 95% UCL for the mean value (1,225 ppm). The nonresidential DCC is 900 ppm. Divinia stated that the department prefers the use of a 95% UCL for the mean. It was noted that the range of the concentrations (5.4 to 10,100 ppm) and standard deviation is so large. For data with a large variance, an outlier test could be used to remove the outliers before calculating the 95%UCL for the mean. Betty indicated that they use the arithmetic mean for soil lead level assessment consistent with US EPA's response to one of the "Adult Lead Model Frequently Asked Questions". Divinia was provided this reference. Divinia will discuss the issue with the Toxicology Unit and provide the group the final recommendation.*

b) *The weighted total of Pb in both fine and coarse fractions of the soil (referred to as total calculated Pb) is the soil Pb concentration used to compare to the DCC or PSIC. The data for fine and coarse fraction Pb has not been determined for this site. Sue will discuss with Dave the additional sampling needed generate the calculated total Pb levels. RRD has published a protocol that describes a threshold Pb level of 75 ppm at or below which total calculated Pb or analyses for fine and coarse fraction Pb may not be required. A copy of the protocol will be sent to the group."*

Response to Comments:

In response to the June 10, 2013 discussion and subsequent discussions between ARCADIS and MDEQ, three additional surface soil samples were collected consistent with the MDEQ-approved work plan (included in Appendix B). This work is briefly described in the sections below. Soil samples collected from an interval of the surface to 6 inches below the surface were analyzed for fine fraction lead and coarse fraction lead, and total lead concentrations were calculated from the fine and coarse fractions. Data were tabulated and are included in Table 1. The analytical laboratory report is included in Appendix C.

For the direct contact pathway, the total lead concentrations representing surface soil, exposure point concentrations (EPCs), were recalculated using the updated dataset (2010 data and 2013 data). A description of the field work, analysis of the results and the statistical analyses are presented in the following sections.

2.1 Data Collection – Total Lead, Fine Fraction Lead, and Coarse Fraction Lead

In 2010, RACER collected 70 surface soil samples (66 locations and 4 duplicates) on the 3.4-acre RACER SMI Plant 2 Landfill site. Sample locations were chosen based on a 50-foot grid across the property (see attached figure). Lead was detected in five of the samples (three general areas) at a concentration greater than the 900 milligrams per kilogram (mg/kg) nonresidential Direct Contact Criterion (DCC). Three of the five samples were located in relatively close proximity to each other on the northern portion of the site. Data for these five locations are presented on Figure 1. These data were compared to Part 201 generic criteria in Table 4 in the HHPA. There were no exceedances of the nonresidential or residential Particulate Soil Inhalation Criteria (PSIC) for lead, and four samples exceeded the Groundwater Surface Water Interface Protection (GSIP) criterion.

Based on the 2010 lead results, the MDEQ requested collection of additional soil samples in the three areas of the site where the sample concentrations exceeded the nonresidential DCC. MDEQ requested that the samples be analyzed to establish the concentrations of total lead, fine fraction lead, and coarse fraction lead. This data was requested to more thoroughly evaluate lead in surface soil with respect to the direct contact and particulate inhalation exposure pathways.

ARCADIS completed this additional lead sampling in August 2013.

2.1.1 Field Activities

The following briefly describes the procedures used to collect the additional surface soil samples in August 2013 at the SMI Plant 2 Landfill site for lead fraction analysis.

RACER collected three additional surface soil samples (SB10-104-2013, SB10-114-2013, and SB10-153-2013) on August 15, 2013 in locations near the previous exceedances of the nonresidential DCC for further evaluation of lead in the fine and coarse fractions. Historical soil borings SB10-104, SB10-114, and SB10-153 were located using a GPS unit and field measurements. Locations are depicted on Figure 1.

Samples were collected adjacent to historical soil borings SB10-104, SB10-114, and SB10-153 from the 0- to 6-inch below ground surface (bgs) interval using a hand auger. Sample portions from the 0 to 6-inch interval at each location were composited and then placed in laboratory-supplied containers and shipped on ice to Merit

Laboratories, Inc. (Merit) in East Lansing, Michigan under appropriate chain of custody procedures. The hand auger was decontaminated between each soil boring.

The soil samples generally consisted of topsoil, with glass and metal debris noted in the sampled collected at SB10-104-2013, and clay soils noted in the SB10-114-2013 sample. The visible glass and metal fragments were not included in the sample for SB10-104-2013.

2.1.2 Laboratory Analysis

Samples were analyzed for fine fraction lead and coarse fraction lead by Merit following USEPA SW-846 Method 6020. Total lead concentrations were calculated based on the fine and coarse fraction concentrations and the proportional weight percentages of the fine and coarse fractions. Analytical data are included in Appendix C.

2.2 Data Summary and Discussion

Total, coarse fraction, and fine fraction lead data for the three new samples are summarized in Table 1, included in Table 2 with the total lead data collected in 2010, and presented on Figure 1.

Part 201 criteria are included on Table 2. The maximum detected concentration does not exceed either the residential or nonresidential PSIC (total and fines) or the final acute GSIP criterion. The maximum detected concentration did exceed the nonresidential DCC and the GSIP criterion.

2.2.1 2013 Data

Three samples were analyzed for lead in 2013. The fine fraction lead ranged from 64.2 mg/kg to 9,050 mg/kg; the coarse fraction lead ranged from 22.0 mg/kg to 28,300 mg/kg; and the calculated total lead concentrations ranged from 32.6 mg/kg to 17,700 mg/kg. The weight percent fine-grained soils ranged from 25 percent to 54.8 percent.

The total lead concentrations in two of the three samples analyzed for fine fraction lead, SB10-114-2013 (795 mg/kg) and SB10-153-2013 (32.6 mg/kg), were below the nonresidential DCC for lead, indicating that the previously identified elevated concentrations associated with soil borings SB10-114 (10,100 mg/kg) and SB10-153 (4,180 mg/kg) are likely limited to small localized areas, and the elevated concentrations may also be associated with soils below the surface (greater than 6 inches deep). The total lead concentration (17,700 mg/kg) in the third sample (SB10-

104-2013) analyzed for fine fraction confirmed the presence of lead at a concentration greater than the nonresidential DCC in the surface soil at SB10-104 (2010).

The fine fraction lead concentrations in all three samples analyzed were below the residential and nonresidential PSIC. The total lead, fine fraction lead, and coarse fraction lead in sample SB10-153-2013 did not exceed the nonresidential DCC of 900 mg/kg. The total lead and coarse fraction lead in sample SB10-114-2013 did not exceed the nonresidential DCC, but the fine fraction lead (1,360 mg/kg) did exceed the nonresidential DCC. The total lead (17,700 mg/kg), fine fraction lead (9,050 mg/kg), and coarse fraction lead (28,300 mg/kg) in sample SB10-104-2013 were above the nonresidential DCC.

2.2.2 2010 and 2013 Dataset

The combined 2010 and 2013 dataset for lead in soil was evaluated to determine if additional actions should be taken to reduce exposure to lead in the surface soil at the site. The evaluation presented in the February 2013 HHPA was updated to include the 2013 data and to address MDEQ concerns. Following is a discussion of the 2010 and 2013 lead dataset with comparisons to potentially applicable criteria.

Total lead concentrations along the western and southern site boundaries and in the southern portion of the site were below the level above which fine fraction lead analysis is recommended (75 mg/kg), and all but four samples along all four site boundaries were below the residential DCC of 400 mg/kg. A total of 16 samples, including two samples collected in 2013, exceeded the residential DCC, and seven samples, including two collected in 2013, exceeded the nonresidential DCC. Six of the seven samples exceeding the nonresidential DCC were located in the northern half of the site, while one sample was located in the southern half. Following is a summary of the exceedances of the nonresidential DCC.

- Northern portion
  - SB10-104 (2010) at 2,680 mg/kg total lead
  - SB10-104-2013 at 17,700 mg/kg total lead and 9,050 mg/kg fine fraction lead
  - SB10-113 (2010) at 2,640 mg/kg total lead
  - SB10-114 (2010) at 10,100 mg/kg total lead
  - SB10-114-2013 at 1,360 mg/kg fine fraction lead (total lead, at 795 mg/kg, did not exceed the nonresidential DCC)
  - SB10-119 (2010) at 2,120 mg/kg total lead

- Southern portion
  - SB10-153 (2010) at 4,180 mg/kg total lead

2.2.3 Summary

Because the maximum detected concentration did not exceed either the residential or nonresidential PSIC (total and fines) or the final acute GSIP criterion, additional analysis is not needed to demonstrate conditions are acceptable for these pathways. Statistical analyses were used to derive EPCs for comparison to the GSIP criterion and nonresidential DCC.

2.2.4 Lead Soil Exposure Point Concentrations

The 2013 total lead data was added to data collected in 2010 and EPCs were developed based on the combined dataset.

During the call, it was stated that MDEQ prefers the use of the 95th percentile upper confidence limits on the mean (UCL) as the basis for the DCC EPCs; however, in follow-up discussions Dr. Ries indicated the 90th percentile UCL would be acceptable. Therefore, a set of EPCs were developed for comparison purposes.

Lead EPCs were calculated based on the 90th percentile UCL, consistent with follow-up discussions with Dr. Ries. In addition, EPCs were developed based on the 95th percentile UCL and the arithmetic mean, consistent with USEPA's lead guidance (USEPA 2003, 2012), as an additional reference value. EPCs were also developed for the entire site based on the 95th percentile UCL for comparison to other pathway-specific criteria.

- EPCs were calculated for the northern and southern portions of the property for comparison to the DCC. Due to the size of the site (greater than 2 acres), it was divided into two exposure units (northern portion and southern portion) for comparison to the DCC.

- The 95th percentile UCL total lead concentration for the entire site was recalculated and compared to the GSIP criterion.

Statistical analyses were completed using USEPA's ProUCL software (USEPA 2010a, b). For the 95th percentile UCL, ProUCL recommendations for the statistical method were used. Because recommendations are not provided for 90th percentile UCL, the

appropriate statistical approach was discussed with ARCADIS statistical specialists, and for each dataset, the selected statistical method used to derive the 90th percentile UCL was consistent with the ProUCL-recommended method for the 95th percentile UCL for that dataset.

2.2.4.1 Hot Spot Analysis

The site is well characterized (73 samples in 3.4 acres) and lead concentrations vary across the site. If select areas are identified as "hot spots", then the data within that area is generally not used to calculate EPCs. Data were further evaluated to determine the appropriate dataset for calculation of EPCs.

In addition to the statistical analysis completed for the full datasets, a "hot spot" analysis was completed following the guidance provided in the MDEQ's *Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria* (S3TM) guidance (MDEQ 2002). In this guidance, MDEQ defines a hotspot as "two or more adjacent sample locations in reasonable close proximity at which concentrations are significantly above criteria and surrounding location (i.e., spatially correlated concentrations sufficiently above criteria) to indicate that they represent a different statistical population and pose a potential risk that should not be masked by a statistical analysis." Based on this definition, one area was identified as a hot spot and one a potential hot spot.

- Hot spot #1: Samples SB10-113 (2010), SB10-114 (2010), and SB10-119 (2010)
- Potential Hot spot #2: Samples SB10-104 (2010) and SB10-104-2013

Hot spot #1 has been delineated to below the nonresidential DCC by the adjacent soil borings. Potential hot spot #2 is located along the northern property boundary, and adjacent on-site samples were all below the nonresidential DCC, indicating that the area of exceedances on-site is small. Potential hot spot #2 may not meet the MDEQ's definition of a hot spot, as the two soil samples that comprise hot spot #2 are the 2010 sample SB10-104 and the 2013 re-sample (collected at the same location as SB10-104) SB10-104-2013.

Statistical analyses are included in Appendix D. EPCs for the different options are presented in Table 3.

2.2.5 Exposure Point Concentration Comparison to Part 201 Criteria

Maximum lead concentrations are compared to the MDEQ Part 201 criteria in Table 2. EPCs are presented and compared to MDEQ Part 201 lead criteria in Table 4. Fines were compared to both the PSIC and nonresidential DCC. The following summarize the results.

- PSIC: The maximum detected concentrations for total lead (17,700 mg/kg) and fine fraction lead (9,050 mg/kg) do not exceed either the residential or nonresidential PSIC of 100,000 mg/kg and 44,000 mg/kg, respectively.

- GSIP: The 95th percentile UCL, 2,026 mg/kg does not exceed the GSIP criterion of 2,500 mg/kg.

- Direct Contact:
  - 90th percentile EPCs
    - North: 2,668 mg/kg
    - North (excluding hot spot #1): 2,267 mg/kg
    - North (excluding hot spots #1 and #2): 239 mg/kg
    - South: 686 mg/kg
  - Average
    - North: 1,085 mg/kg
    - North (excluding hot spot #1): 753 mg/kg
    - North (excluding hot spots #1 and #2): 181 mg/kg
    - South: 275 mg/kg

The 90th percentile UCL for the northern portion of the site (whole dataset), the 90th percentile UCL for the northern portion of the site excluding hot spot #1, and the average for the northern portion of the site (whole dataset) exceeded the nonresidential DCC. The 90th percentile UCLs for the northern portion of the site excluding hot spots #1 and #2, the 90th percentile UCL for the southern portion of the site, the average concentration for the northern portion of the site excluding hot spot #1, the average concentration for northern portion of the site excluding hot spots #1 and #2, and the average concentration for the southern portion of the site did not exceed the nonresidential DCC.

2.3 Summary and Options

2.3.1 Summary

Based on the site data and the analysis presented above, the lead concentrations detected at the site are not likely to pose a concern for the ambient air inhalation or protection of the groundwater surface water interface pathways. However, additional actions are needed to address exceedances of the DCC in surface soil.

2.3.2 Options

RACER and ARCADIS evaluated options for addressing exceedances of the generic nonresidential lead DCC and will work with MDEQ to identify a path forward. Options considered included installation of an exposure barrier (e.g., a soil cover in a limited area); focused surface soil removal; and administrative exposure controls (e.g., restricted site access reducing exposure frequency). These are briefly discussed in the following sections.

Based on the evaluation completed thus far and a conversation with MDEQ, ARCADIS recommends and RACER proposes the placement of a limited cover as the most cost-effective alternative for short- and long-term protection of human health.

In conjunction with the placement of a cover, the following actions or restrictions will also be implemented as described in the February 2013 HHPA and listed below:

- The property use will continue to be for nonresidential purposes.
- Use of groundwater as drinking water will be prohibited by a restrictive covenant.
- Excavated soils will be appropriately characterized and evaluated for proper handling and/or disposal. In addition, a health and safety plan prepared by a trained professional that reviews site groundwater and soil data will be required prior to conducting excavation activities to address worker safety.
- No unpaved roads will be constructed on the property.

It is noted that a restriction to account for potential impacts of volatile organic compounds that have migrated to beneath the site from an adjacent property will also be placed on the site.

2.3.2.1 Focused Actions

RACER and ARCADIS evaluated options for either covering select areas or conducting focused soil removal to reduce potential contact with surface soils, and therefore address DCC exceedances in the northern portion of the site. Based on the statistical analysis completed, remedial actions are recommended in the two areas identified as a hot spot or potential hot spot to address the direct contact pathway.

Focused soil cover provides a more cost-effective option, and is therefore preferred over focused soil removal. The two areas of interest would be covered with 6 inches of clean soil capable of sustaining vegetation on northern portion of the site. The cover will extend half-way to the closest adjacent boring that did not contain lead at a concentration greater than the nonresidential DCC or to the north site property boundary, as appropriate.

2.3.2.2 Restricted Access

Potential exposure to lead in soil can be reduced by restricting the amount of time a worker can spend on the site by way of deed restrictions. Site-specific soil direct contact criteria were developed, consistent with Part 201, to support decision making.

The Part 201 nonresidential criterion is considered protective for an on-site worker and assumes the worker is there for 250 days a year for 21 years. The site is vacant and there are no plans at this time to redevelop it. If access to the site is restricted and activities are limited to maintenance (i.e. cutting the grass, inspections, etc.), the receptor-specific lead DCC increase.

Site-specific worker lead DCC were developed as part of the initial evaluation of options. If the time workers spend on the site is limited to 1 work day a week (52 days) (e.g., for maintenance activities such as cutting the lawn) for 21 years, levels on the property are acceptable based on EPCs for both the northern and southern portions of the property based on both the 90^{th} percentile and 95^{th} percentile UCLs. Such exposures are unlikely given the restricted access and limited activities anticipated at the site.

If this option were chosen, RACER or any future owners of the property would need to ensure through a deed restriction and follow-up tracking that site activities were consistent with this restriction. Though this manner of addressing the site provides a low cost solution for potentially addressing future exposures to lead in near surface

soils, ARCADIS and RACER believe that documenting and controlling activities over time could be a challenge.

2.3.3 Recommendation

ARCADIS recommends and RACER proposes to place 6 inches of clean soil capable of sustaining vegetation over two limited areas in the northern portion of the site (i.e., hot spot defined by samples SB10-113, [2010], SB10-114 [2010], and SB10-119 [2010] and potential hot spot defined by samples SB10-104 [2010] and SB10-104-2013). The cover would extend half-way to the closest adjacent boring that did not exceed the nonresidential DCC for lead or to the north site property boundary, as appropriate.

3. Site-specific PSIC for Manganese

MDEQ commented on the approach used to derive the site-specific Mn PSIC. The following discussion of the discussion was included in the conference call summary prepared by Dr. Ries.

2) Site-specific criterion for manganese:

- *a) Use of the adjustment for air inhalation rate (AIR)*
  Divinia indicated that the "AIR" factor is not applicable to noncarcinogen PSIC. This adjustment factor is applied only to the PSIC derivation for carcinogens. According to EPA guidance (RAGS F), this type of adjustment is not appropriate. It was suggested that in place of the AIR adjustment, the use of worker exposure time (ET) adjustment from 24 hours to 8 hours per 24 hour-day or 0.33 for nonresidential PSIC will be acceptable. The current equation assumes 24 hours per 24 hour-day or 1. This will increase the PSIC value by 3. Betty indicated that the adjustment to the "AIR" factor was intended to account for a worker being present on site a portion of the day and agreed with Divinia's proposed adjustment based on time rather than inhalation rate.
- *b) Use of more appropriate regional dispersion factor or Q/C is suggested by Divinia since updated meteorological data from AQD Midland/Saginaw Bay monitoring station is available and could be used to develop regional-specific Q/C for the facility. Divinia will request AQD to generate the Q/C for this region.*

c) *Sue indicated that the RAP for the adjacent GM property includes no unpaved roads, no construction and 50% or more vegetation cover consistent with assumptions used in this assessment. These requirements will also be applied to this property. Therefore, under these conditions, the proposed PEF without the emissions due to vehicle (Ev) for this property would be an acceptable approach.*

ARCADIS has addressed each of the sub-lettered items listed above in the manner described below.

Response to 2a

ARCADIS agreed with the MDEQ recommendation to use the exposure time (ET) factor to account for a reduced exposure time instead of the AIR factor to adjust the inhalation rate. Therefore, ARCADIS replaced the AIR in the numerator of the equation with the proposed exposure time (ET) factor (in the denominator). For non-residential receptors the ET was set at 0.33 (8 hours per 24 hours), and for residential receptors, the ET was set at 1 (24 hours per 24 hours). Table 5 presents the updated, site-specific exposure parameters and the previously proposed site-specific exposure parameters from the February 2013 HHPA. Table 6 presents the equations and calculations for the revised site-specific PSIC. The equations and calculations from the February 2013 HHPA are provided in Table E-1 in Appendix E.

Response to 2b

ARCADIS agrees with this recommendation. ARCADIS updated the calculations to use the Q/C and the average wind speed (measured at 10 meters) established for the Midland-Bay City-Saginaw (MBS) area that were provided by Dr. Ries. MBS meteorological data provided by MDEQ is included as Table 7. The calculation sheet (provided by Dr. Ries) for the site-specific emissions due to wind term (Ew) is provided as Table 8.

Response to 2c

ARCADIS agrees that restrictions will be placed prohibiting unpaved roads and construction. The 2013 version of the MDEQ proposed Part 201 Rules included a default vegetative cover for nonresidential sites of 10 percent. This was used in the revised calculations, and the resulting site-specific PSIC were above the maximum detected concentration of 27,700 mg/kg Mn on the site. Therefore, a nonresidential vegetative cover value of 10 percent is proposed. In addition, ARCADIS calculated criteria based on 0 percent vegetative cover and levels on the site still do not exceed, indicating that ground cover is not needed to protect workers for this pathway at the site. Based on the updated site-specific PSIC, the requirement for 50 percent vegetative cover is no longer required. The updated site-specific PSIC are provided in Table 5.

3.1 Comparison of Data to Criteria

The maximum detected concentration of Mn at the site (27,700 mg/kg) does not exceed the site-specific PSIC, which ranged from 88,481 mg/kg to 737,338 mg/kg (see Table 5). Based on this analysis manganese does not pose a concern for the particulate inhalation exposure pathway.

4. Conclusions and Recommendations

Additional evaluations were completed for lead data collected at the site and for the particulate inhalation pathway for manganese based on requests made by the MDEQ during a June 10, 2013, conference call between the MDEQ, ARCADIS, and RACER. Following is a summary of the conclusions and recommendations for lead and manganese.

4.1 Lead

Additional surface soil samples from three locations were collected and analyzed for total lead, fine fraction lead, and coarse fraction lead. Statistical analyses were completed and updated EPCs were developed for the site. Total lead concentration results indicated that samples SB10-113, SB10-114, SB10-119, and SB10-104 (2010)/SB10-104-2013) exceed the nonresidential DCC in surface soils. However based on the additional lead data and the updated lead evaluation, lead concentrations at the site do not pose a concern for the particulate inhalation exposure pathway.

RACER and ARCADIS evaluated approaches for addressing the direct contact exceedances and will work with MDEQ to develop an acceptable plan.

Options reviewed for addressing soil lead concentrations included engineering controls (e.g., clean soil barrier) to limit the potential for unacceptable exposure to lead in soil; establishing and filing appropriate deed restrictions on the site such as institutional controls (e.g., limiting the exposure frequency of site workers); or conducting limited soil removal as discussed in Section 2.3.

ARCADIS recommends and RACER proposes to place 6 inches of clean soil capable of sustaining vegetation over two limited areas in the northern portion of the site (i.e., hot spot defined by samples SB10-113, [2010], SB10-114 [2010], and SB10-119 [2010] and potential hot spot defined by samples SB10-104 [2010] and SB10-104-2013). The cover would extend half-way to the closest adjacent boring without exceedances of the nonresidential DCC for lead or to the north site property boundary, as appropriate.

4.2 Manganese

ARCADIS revised the site-specific PSIC for manganese based on recommendations made by the MDEQ. The maximum detected concentration of manganese at the site, 27,700 mg/kg, did not exceed the revised PSIC, which ranged from 88,481 mg/kg to 737,338 mg/kg.

Based on the evaluation presented above and the HHPA, Mn in soil is not a potential concern for the particulate inhalation pathway. No additional evaluation is recommended for Mn at the site.

5. References

Michigan Department of Environmental Quality (MDEQ). 2002. Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria.

USEPA. 2003. Recommendations of the Technical Working Group for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001, OSWER Dir #9285.7-54 December 1996 (January 2003).

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USEPA. 2012. Frequent Questions from Risk Assessors on the Adult Lead Methodology. Available at website http://www.epa.gov/superfund/lead/almfaq.htm#input . Last updated March 27.

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Tables

Table 1. Summary of August 2013 Lead Analytical Data

Sample		MDEQ Criteria (mg/kg)						Data (mg/kg)		
		DC NR	Ambient Air NR	Ambient Air R	GW contact	GSIP. Surface water. Leach to groundwater. Not potable.		SB10-153-2013	SB10-104-2013	SB10-114-2013
						GSIP	Final Acute Value	8/15/2013	8/15/2013	8/15/2013
Lead total calculated	mg/kg	900	NA	NA	ID	2,500	97,000	32.6	17,700	795
Lead, Fines	mg/kg	900	44,000	100,000	ID	NA	NA	64.2	9,050	1,360
Lead, Coarse	mg/kg	900	NA	NA	ID	NA	NA	22.0	28,300	583
% Fine by Weight/ 0.xy (a)	% /0.x							0.25	0.548	0.27
% Coarse by Weight / 0.xy (a)	% /0.x							0.75	0.452	0.73

Notes

DC - Direct contact

GSIP - Groundwater Surface Water Interface Protection

GW - Groundwater

mg/kg - milligrams per kilogram

NA - Not applicable - Fines data only compared to ambient air criteria.

NR - Nonresidential

R - Residential

a) Fine and coarse concentrations based on a weighted average. % of sample times concentration in that sample. Values to used to calculated total concentration

Table 2. Summary of Lead Analytical Data and Comparison to MDEQ Part 201 Criteria

Sample		Data Summary	MDEQ Criteria (mg/kg)						Data (mg/kg)																																	
		Maximum Detect	DC NR	Ambient Air NR	Ambient Air R	GW contact	GSIP. Surface water. Leach to groundwater. Not potable. GSIP	GSIP. Surface water. Leach to groundwater. Not potable. Final Acute Value	SB10-153-2013	SB10-153 2010	SB10-104-2013	SB10-104-2010	SB10-114-2013	SB10-114-2010	SB10-113-2010	SB10-119-2010	SB10-100	SB10-101	SB10-102	SB10-103	SB10-105	SB10-106	SB10-107	SB10-108	SB10-109	SB10-110	SB10-111	SB10-112	SB10-115	SB10-115 DUP	SB10-116	SB10-117	SB10-118	SB10-120	SB10-121	SB10-122	SB10-123	SB10-124	SB10-125	SB10-126	SB10-126 Dup	SB10-127	SB10-128
									8/15/2013	1/21/2010	8/15/2013	1/19/2010	8/15/2013	1/20/2010	1/20/2010	1/20/2010	1/19/2010	1/19/2010	1/19/2010	1/19/2010	1/19/2010	1/19/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010	1/22/2010	1/19/2010	1/21/2010	1/21/2010	1/21/2010	1/22/2010	1/19/2010	1/20/2010	1/21/2010	1/21/2010	1/22/2010	1/19/2010	1/20/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010
Lead total calculated	mg/kg	17,700	900	NA	NA	ID	2,500	97,000	32.6	4180	17700	2680	795	10100	2640	2120	30.9	279	24.7	109	363	29.7	42.1	23.2	214	595	27.4	17.1	23.6	18.2	32.3	424	41.8	485	257	60.2	149	57.1	715	213	174	191	251
Lead, Fines	mg/kg	9,050	900	44,000	100,000	ID	NA	NA	64.2		9050		1360																														
Lead, Coarse	mg/kg	28,300	900	NA	NA	ID	NA	NA	22.0		28300		583																														

Notes

DC - Direct contact

GSIP - Groundwater Surface Water Interface Protection

GW - Groundwater

mg/kg - milligrams per kilogram

NA - Not applicable - Fines data only compared to ambient air criteria.

NR - Nonresidential

R - Residential

2013 data

2010 data

Blue values exceed criteria

Table 2. Summary of Lead Analytical Data and Comparison to MDEQ Part 201 Criteria

Sample		Data (mg/kg)																																					
		SB10-129	SB10-130	SB10-131	SB10-132	SB10-133	SB10-134	SB10-135	SB10-136	SB10-137	SB10-138	SB10-139	SB10-140	SB10-141	SB10-142	SB10-143	SB10-144	SB10-144 Dup	SB10-145	SB10-146	SB10-147	SB10-148	SB10-149	SB10-149 Dup	SB10-150	SB10-151	SB10-152	SB10-154	SB10-155	SB10-156	SB10-157	SB10-158	SB10-159	SB10-160	SB10-161	SB10-162	SB10-163	SB10-164	SB10-165
		1/22/2010	1/19/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010	1/22/2010	1/19/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010	1/22/2010	1/19/2010	1/19/2010	1/20/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010	1/19/2010	1/19/2010	1/19/2010	1/20/2010	1/20/2010	1/21/2010	1/19/2010	1/19/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010	1/19/2010	1/19/2010	1/20/2010	1/20/2010	1/21/2010	1/21/2010
Lead total calculated	mg/kg	23.8	9.3	8.5	113	83.9	75.5	209	33.4	899	34.3	233	72.9	42.8	22.7	470	721	721	547	567	11.1	11.4	116	130	5.4	20.3	125	15.7	63.9	10.1	36.5	114	22.8	19	17.6	19.3	9.8	11.8	33
Lead, Fines	mg/kg																																						
Lead, Coarse	mg/kg																																						

Table 3. Summary of Lead Exposure Point Concentrations.

Dataset	# Samples	"Hotspots" removed	Max Detect (mg/kg)	Mean Detect (mg/kg)	Distribution	Recommended 95% UCL (mg/kg) (1)	Recommended 90% UCL (mg/kg) (1)	Recommended UCL Method (1)	Non-residential Direct Contact Criteria (mg/kg)	95% UCL Exceeds?	90% UCL Exceeds?	Groundwater Surface Water Interface Protection Criteria (mg/kg)	95% UCL Exceeds?	90% UCL Exceeds?
Lead total-all	69	none	17,700	721	None	2,026	1,619	Chebyshev (Mean, Sd) UCL	900	Yes	Yes	2,500	No	No
Lead total-all-no hotspot-1	66	Hotspot 1	17,700	529	None	1,727	1,353	Chebyshev (Mean, Sd) UCL	900	Yes	Yes	2,500	No	No
Lead total-all-no hotspot-1-2	64	Hotspots 1 and 2	4,180	227	None	526	432	Chebyshev (Mean, Sd) UCL	900	No	No	2,500	No	No
Lead total-north	38	none	17,700	1,085	Lognormal	3,385	2,668	Chebyshev (Mean, Sd) UCL	900	Yes	Yes	2,500	Yes	Yes
Lead total-north-no hotspot1	35	Hotspot 1	17,700	753	Lognormal	2,953	2,267	Chebyshev (Mean, Sd) UCL	900	Yes	Yes	2,500	Yes	No
Lead total-north-no hotspots-1-2	33	Hotspots 1 and 2	795	181	Gamma	259	239	Approximate Gamma UCL	900	No	No	2,500	No	No
Lead total-south	31	none	4,180	275	None	872	686	Chebyshev (Mean, Sd) UCL	900	No	No	2,500	No	No

Notes:
1) The ProUCL recommended UCL is provided. ProUCL does not recommend 90 percent UCLs; therefore, for the 90 percent UCLs, ARCADIS recommends the 90 percent UCL that was calcualted using the same method as the recommended 95 pecent UCL.

mg/kg - milligrams per kilogram.
UCL - upper confidence limit on the mean.
Hotspot 1 consists of Soil Borings SB10-113, SB10-114, and SB10-119 (all collected in 2010)
Hotspot 2 consists of Soil Borings SB10-104 (2010) and SB10-104 (2013)

Table 4. Exposure Point Concentrations for Lead Compared to Direct Contact Criteria.

	MDEQ Criteria (mg/kg)	Southern Portion of the Site								Northern Portion of the Site							
Lead Dataset	DC NR	Max	Exceeds Y/N?	95% UCL	Exceeds Y/N?	90% UCL	Exceeds Y/N?	Mean	Exceeds Y/N?	Max	Exceeds Y/N?	95% UCL	Exceeds Y/N?	90% UCL	Exceeds Y/N?	Mean	Exceeds Y/N?
All data	900	4,180	Y	872	N	686	N	275	N	17,700	Y	3,385	Y	2,668	Y	1,085	Y
Data without hot spot 1	900	--	--	--	--	--	--	--	--	17,700	Y	2,953	Y	2,267	Y	753	N
Data without hot spots 1 and 2	900	--	--	--	--	--	--	--	--	795	N	259	N	239	N	181	N

Notes

-- - Not calculated
DC - Direct contact
mg/kg - milligrams per kilogram
NR - Nonresidential
Blue values exceed criteria
Hotspot 1 consists of Soil Borings SB10-113, SB10-114, and SB10-119 (all collected in 2010)
Hotspot 2 consists of Soil Borings SB10-104 (2010) and SB10-104 (2013)

Table 5. Input Parameters and Calcuated Site-specific Manganese PSIC.

Receptor	Units	Proposed Site-specific PSIC	HHRA (Feb. 2013) Site-specific PSIC Based on Default Met data and promulgated Part 201 equation (b)
		Area-specific Met data, proposed Part 201 Equation and Defaults (a)	
PSIC Criteria			
Residential	mg/kg	227,190	10,303
Non-Residential	mg/kg	88,481	29,400
Maintenance Worker	mg/kg	138,251	45,018
Construction Worker	mg/kg	737,338	240,097
Met data - Q/C and wind speed		MBS	State-wide
Maximum Detected	mg/kg	27,700	27,700
Input Parameters			
Q/C	g/m^2-s per kg/m^3	62.27	82.33
Source Size (site = 3.4 acres)	acres	5	5
Adjustment factor	unitless	0.67	0.66
Adjusted Q/C (5-acre adjustment factor)	g/m^2-s per kg/m^3	41.72	54.34
EF - res	d/yr	350	350
EF - non-res	d/yr	250	245
EF - maintenance	d/yr	160	160
EF - construction	d/yr	30	30
ED - res	yr	30	30
ED - non-res	yr	25	21
ED - maintenance	yr	25	21
ED - construction	yr	1	1
AIR - res	unitless	NA	NA
AIR - non-res (20 m^3/d / 10 m^3/d)	unitless	replaced by ET	2
ET - res (assumes 24 hours)	unitless	1	NA
ET - non-res (assumes 8 hours)	unitless	0.33	NA
ET - maintenance (assumes 8 hours)	unitless	0.33	NA
ET - construction (assumes 8 hours)	unitless	0.33	NA
Ew - res (includes (1-V) term)	g/m^2-s	9.58E-09	2.75E-07
Ew - non-res (includes (1-V) term)	g/m^2-s	1.03E-07	2.75E-07
V - res (vegetative cover)	unitless	0.5	0.5
V - nr (vegetative cover) (c)	unitless	0.1	0.5
Ev (emissions due to veichles)	g/m^2-s	0	0
PEF - res (particulate emission factor)	m^3/kg	6.50E+09	2.99E+08
PEF - non-res (particulate emission facto	m^3/kg	6.03E+08	2.99E+08

Notes:
NA - not applicable
MBS - Midland-Bay City-Saginaw Met Data Station
res - residential
nr- nonresidential
Ew - Soil particulate emissions due to wind erosion. Calculated on "Ew (RACER)" worksheet

a) MBS Met data, PEF calculated following proposed method (PEF not divided by 2, non-residential vegetative cover default 0.1), proposed Part 201 defualt exposure parameters. See Table 4 for equations and calculations.
b) Site-specific values presented in the February 2013 Human Health Pathway Assessment (HHPA). Promulgated default Part 201 exposure parameters and PEF input paramters; however, assumes no vehicular traffic. See Table E-1 for equations and
c) Vegetative cover can be 0 and levels acceptable.

Table 6. Proposed Site-specific Manganese PSIC Using the Proposed Part 201 Equations and Input Parameters with Area-Specific Meteorological Data.

Estimated source area:	acres	
Site	**3.4**	
adjustment factor due to site size (AdjF)	**0.67**	

A. Proposed Part 201 Generic PSIC	**=(THQ*ED*365)/(EF*ED*ET*(1/RfC)*(1/(PEF)))**	**Assumptions/Comments**
Residential	=(1*30*365)/(350*30*(24/24)*(1/0.00005)*(1/(**138000000**)))	**for a 0.5-acre site, PEF =** 1.38E+08
	7,185 mg/kg *approx 7,200*	
Non-residential	=(1*25*365)/(250*25*(8/24)*(1/0.00005)*(1/(**43300000**))	**for a 2-acre site, PEF =** 4.33E+07
	9,490 mg/kg *approx 9,500*	

B. Site-specific calculation:

Site-specific PSIC	**=(THQ*ED*365)/(EF*ET*ED*(1/RfC)*(1/(PEF)))*AdjF**	Proposed equation, proposed defaults; need to adjust because Q/C provided by MDEQ based on MBS Met data was for a 0.5-acre site
Residential (adjusted) PSIC:	=((1*30*365)/(350*(24/24)*30*(1/0.00005)*(1/(6500000000))))*0.6	**assuming the site is 3.4 acres (0.5-acre PEF)**
Assuming no vehicular traffic	**227,190**	
Non-residential (adjusted) PSIC:	=(1*25*365)/(250*(8/24)*25*(1/0.00005)*(1/(603000000)))*0.67	**assuming the site is 3.4 acres (0.5-acre PEF)**
Assuming no vehicular traffic	**88,481**	
Maintenance Worker PSIC:	=(1*25*365)/(160*(8/24)*25*(1/0.00005)*(1/(603000000)))*0.67	**for 3.4 acres (0.5-acre PEF); using MDEQ factors except EF is 160 days**
Assuming no vehicular traffic	**138,251**	
Construction Worker PSIC:	=(1*1*365)/(30*(8/24)*1*(1/0.00005)*(1/(603000000)))*0.67	**for 3.4 acres (0.5-acre PEF); Construction worker EF = 30 days and ED = 1 year**
	737,338	

Proposed Part 201 Default Particulate Emission Factor (PEF) Calculation and Assumptions

PEF =(Q/C)*(1/Ew)				--Proposed Ew equation includes the (1-V) term
	1.38E+08	**for residential**		--based on Michigan sites; 50% vegetation cover; 0.5-acre source size
	4.33E+07	**for industrial**		--based on Michigan sites; 10% vegetation cover; 2-acre source size
where:				
Dispersion factor (Q/C) (res) =		**68.9**	g/m^2-s per kg/m^3	--based on Michigan sites; 0.5-acre source size
Dispersion factor (Q/C) (nr) =		**54.6**	g/m^2-s per kg/m^3	--based on Michigan sites; 2-acre source size
Emission due to wind (Ew) (res) =		5.00E-07	g/m^2-s	--default vegetation cover is 50%
Emission due to wind (Ew) (nr) =		1.26E-06	g/m^2-s	--default vegetation cover is 10%

Site-Specific Part 201 Particulate Emission Factor (PEF) Calculation and Assumptions Assuming NO Vehicular Traffic

PEF =(Q/C)*(1/Ew)				--Proposed PEF equation takes into account the (1-V) factor
	6.50E+09	**Residential**		
	6.03E+08	**Non-residential**		
where:				
Dispersion factor (Q/C) =		**62.27**	g/m^2-s per kg/m^3	--based on MBS Met data; 0.5-acre source size
Emission due to wind (Ew) (res) =		9.58E-09	g/m^2-s	--based on MBS Met data (wind speed); default vegetation cover is 50%
Emission due to wind (Ew) (non-res) =		1.03E-07	g/m^2-s	--based on MBS Met data (wind speed); default vegetation cover is 10%
Vegetation cover (V) (res) =		50%		
Vegetation cover (V) (non-res) =		10%		

Notes:
Adjusted: Source size and no vehicular traffic

Table 7. Area-Specific Meterological Data - Midland Bay City Saginaw (MBS) Met Data Station

Source Size (sq. ft. or acres)	Q/C (g/m^2-s kg/m^3)	modifier
100 sq ft	439.22	4.23
400 sq ft	185.8	2.98
1000 sq ft	126.57	2.03
2000 sq ft	103.79	1.67
1/2 acre	62.27	1
1 acre	55.03	0.88
5 acres	41.91	0.67
10 acres	38.04	0.61
32 acres	31.88	0.51
100 acres	27	0.43
200 acres	24.48	0.39
300 acres	23.16	0.37
500 acres	21.6	0.35
1000 acres	19.49	0.31
1500 acres	18.34	0.29

Notes:

Wind speed at 10 meters (m/s): 2002-06 4.16 m/s
Provided by MDEQ

Table 8. Soil particulate emissions due to wind erosion (Ew)

$$Ew = \frac{0.036 \times (1 - V) \times \left(\frac{U_m}{Ut_{adj}}\right)^3 \times F(x)}{3600 \text{ sec/ hr}}$$

Scenario and Assumptions:

Residential Scenario: Contaminated surficial soil (up to 12 in. below ground) area is 50% vegetated and assumes no unpaved driveways and roads within the site. Preferably, the entire contamination area above state background level, if appropriate, is the source area size. Non-contiguous sites may be considered separate source sizes based on professional judgment, adequate sampling and appropriate delineation of the extent of contamination. The EPA RAGS (A and B), Soil Screening Guidance (1996), Supplemental to SSG (2002) and Michigan meteorological data (2006-2010) are used in establishing the equations and default inputs. The annual wind speed is the wind speed value from the meterological data used to derive the Q/C. The use of mean wind speed does not account for fast mile winds, wind peaks, or peak particulate emissions.

Nonresidential scenario: Contaminated surficial soil (up to 12 in. below ground) area is 50% vegetated and assumes no unpaved driveways and roads within the site. Preferably, the entire contamination area, that is above state background level, if appropriate, is the source area size. The EPA RAGS (A and B), SSG (1996), Supplemental Soil Guidance (2002), AP-42-Industrial Wind Erosion (2006), and Michigan meteorological data (2006-2010) are used in establishing the equations and default inputs. Non-contiguous sites may be considered separate source sizes based on professional judgment, adequate sampling and appropriate delineation of the extent of contamination. The annual wind speed is the wind speed value from the meterological data used to derive the Q/C. The use of mean wind speed does not account for fast mile winds, wind peaks, or peak particulate emissions.

				Residential	Non-residential	Source/Reference
	Emissions due to wind erosion (Ew)	=	g/m^2-s	**9.58E-09**	**1.03E-07**	**Calculated**
			constant, in g/m^2-s			
	Respirable fraction emission rate	=	hr	0.036	0.036	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Adjusted mean annual wind speed to height H (Um)	=	m/s	**3.94**	**3.94**	**Calculated (see below)**
	Adjusted equiv threshold friction velocity at ht. 7 m (Utadj)	=	m/s	11.32	9.69	**Calculated (see below)**
	Function dependent on Cowherd derived x (F(x))	=	unitless	**0.045**	**0.170**	**Derived (see below)**
	Fraction of vegetative cover (V)	=	50%	0.5	**0.1**	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Conversion factor	=	sec/hr	3,600	3,600	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Ew Derivation Steps: (Equations are from EPA Supplemental SSG, 2002 and Cowherd, 1985)					
Step 1	**Calculate adjusted annual wind speed (Um)**		**m/s**	**3.94**	**3.94**	
	$Um = Um_{(z)} * (h/z)^{0.15}$					EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Actual annual windspeed at height z ($Um_{(z)}$) (MBS)	=	m/s	**4.16**	**4.16**	Input value from the met data used to derive the Q/C (MBS Area-specific data from MDEQ)
	Wind measurement height (z)	=	m	10.0	10.0	Input height at which wind was measured
	Default height (h)	=	m	7.0	7.0	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Adjusted annual wind speed to height h (Um)	=	**m/s**	**3.94**	**3.94**	Calculated
Step 2	**Calculate adjusted threshold friction velocity (Utadj)**					
	$Ut_{adj} = ((Ut*Cf)/0.4)*(\ln(7.0/z_0))$					EPA-SSG, 2002 Supplemental & RSL
	2-1) Determine Surface material mode aggregate size					
	Surface material mode aggregate size (As)	=	mm	0.52	0.52	EPA-SSG (1996), Cowherd (1985), AP-42 (2006)
	2-2) Find threshold friction velocity corresponding to mode size					
	Threshold friction velocity (Ut)	=	m/s	0.5	0.5	EPA-SSG (1996), Cowherd (1985), AP-42 (2006)
	2-3) Determine correction factor for non-erodible elements (Cf); U.S. EPA SSG default is 1.25					
	Correction factor (Cf)	=	unitless	1.25	1.00	EPA-SSG (1996), Cowherd (1985), AP-42 (2006)
	2-4) Determine roughness height:					
	Default roughness height (z_0)	=	meter	0.005	0.003	EPA-SSG (1996), Cowherd (1985), AP-42 (2006)
	2-5) Calculate adjusted equiv threshold friction velocity at ht. 7 m (Ut_{adj})					
	Adjusted threshold friction velocity (Ut_{adj})	=	**m/s**	**11.32**	**9.69**	Calculated
Step 3	**Calculate x and determine F(x) using Cowherd's graph (Fig. 4-3) or Appendix B equation.**					
	3-1) X = 0.886*(Utadj/Um)	=	unitless	**2.543**	**2.178**	Calculated; EPA-SSG (1996), Cowherd (1985)
	3-2) Function dependent on Cowherd derived *x* **(F(*x*))**	=				
	If x<2, find F(*x*) estimate using Cowherd Figure; F(*x*)	=	unitless	NA	NA	EPA-SSG (1996), Cowherd (1985)
	***If x*≥2, F(*x*) estimate = $0.18*(8x^3 + 12x)\exp(-x^2)$**	=	**unitless**	**0.045**	**0.170**	EPA-SSG (1996), Cowherd (1985)
Step 4	**Determine fraction of vegetative cover (V); default residential - 50%, non-residential - 10%**	=	**unitless**	**0.5**	**0.1**	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
Step 5	**Calculate soil particulate emissions due to wind erosion (Ew)**					
	Soil particulate emissions due to wind erosion (Ew)	=	g/m^2-s	**9.58E-09**	**1.03E-07**	EPA-SSG (1996), Supplemental (2002) & RSL (2012) Calculated
	Respirable fraction emission rate	=	constant, in g/m^2-s	0.036	0.036	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Adjusted mean annual wind speed (Um)	=	m/s	**3.94**	**3.94**	Calculated (see above)
	Adjusted equivalent threshold friction velocity (Utadj)	=	m/s	11.32	9.69	Calculated (see above)
	Function dependent on Cowherd derived x (F(x))	=	unitless	**0.045**	**0.170**	Derived (using Cowherd or equation; see above)
	Fraction of vegetative cover (V)	=	50%	0.5	**0.1**	EPA-SSG (1996), Supplemental (2002) & RSL (2012)
	Unit conversion factor	=	sec/hr	3,600	3,600	EPA-SSG (1996), Supplemental (2002) & RSL (2012)

MBS - Midland Bay City Saginaw Met Data Station provided by MDEQ

ARCADIS

Figure

CITY: SYRACUSE DIV/GROUP: 141 DB: G.STOWELL PM:(Reqd) LYR:ON=*;OFF=*REF
G:\ENVCAD\SYRACUSE\ACT\B0086991\2012\00001\DWG\PROP-SAMPLING\86991P01.DWG LAYOUT: 3 SAVED: 12/5/2012 1:36 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: C-PD2B-PDF-GMS PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/5/2012 1:36 PM BY: STOWELL, GARY

XREFS: IMAGES: PROJECTNAME: --
86991X01

TANK FARM BUILDING
(ABOVEGROUND TANKS)

GATE

UNPAVED AREA

GRASSY AREA

DELPHI AUTOMOTIVE
SYSTEMS PLANT 2
PROPERTY

GRASSY AREA

(FORMER DELPHI PLANT 2)
PENINSULA PROPERTY

(FORMER GM SMI PLANT)
PROPERTY

SMI PLANT PROPERTY

(FORMER GM SMI PLANT)
PROPERTY

STAFF GAUGE

Pb = 2,680 mg/kg

Pb, Total = 17,700 mg/kg
Pb, Coarse = 28,300 mg/kg
Pb, Fine = 9,050 mg/kg

Pb = 2,640 mg/kg

Pb = 10,100 mg/kg

Pb, Total = 795 mg/kg
Pb, Coarse = 583 mg/kg
Pb, Fine = 1,360 mg/kg

Pb = 2,120 mg/kg

Pb, Total = 32.6 mg/kg
Pb, Coarse = 22.0 mg/kg
Pb, Fine = 64.2 mg/kg

Pb = 4,180 mg/kg

MW97-106WT, PZ-36, MW04-5WT, MW04-5D, MW04-6WT, MW04-6D, MW04-10WT, MW-142WT, MW-142D, MW04-1D, MW04-1WT, MW04-2WT, MW04-2D, MW-201S, MW-201D, MW-01-119SI, MW04-119WT, SB10-100, SB10-101, SB10-102, SB10-103, SB10-104, SB10-105, TW98-111WT, MW98-111S1, TW98-110WT, MW98-110S1, SB10-106, SB10-107, SB10-108, SB10-109, SB10-110, SB10-111, MW04-122 WT, MW04-122 S1, SB10-112, SB10-113, MW97-104WT, MW97-104S1, SB10-114, SB97-110, SB10-115, SB10-116, SB10-117, MW01-118WT, MW04-118 S1, SB10-118, SB10-119, SB10-120, SB10-121, SB10-122, SB10-123, TW01-120, TW98-108WT, MW98-108S1, MW98-109S1, TW98-109WT, SB-310, SB10-124, SB10-125, SB10-126, SB10-127, SB10-128, SB10-129, MW04-123 WT, MW04-123 S1, SB10-130, SB10-131, SB10-132, SB10-133, SB10-134, SB10-135, B-3R,BAUG, SB-311, MW-143WT, SB98-119, MW04-124 S1, MW04-124 WT, SB10-136, SB10-137, SB10-138, SB10-139, SB10-140, SB10-141, SB-312, SB10-142, SB10-143, SB10-144, SB10-145, SB10-146, SB10-147, MW97-105S1, SB97-111, MW97-105WT, MW04-121 WT, MW04-121 S1, SB10-148, SB10-149, SB10-150, SB10-151, SB10-152, SB10-153, SB10-156, SB98-120, SB10-154, SB10-155, SB10-157, SB10-158, SB10-159, MW-144WT, SB10-160, SB10-161, SB10-162, SB10-163, SB10-164, SB10-165, SB-314, X-1A,B,C, X-1CR, SB-313

LEGEND:

- PROPERTY BOUNDARY
- FENCE LINE

SMI PLANT PROPERTY RI AND OTHER COMPLETIONS:

- B-2 — WATER TABLE MONITORING WELL
- X-1A,B,C — MONITORING WELL CLUSTER
- SB-312 — SOIL BORING
- SB10-100 — SOIL BORING LOCATION (WEEK OF JANUARY 18, 2010)

DELPHI PLANT 2 AND PENINSULA PROPERTY RI AND OTHER COMPLETIONS:

- MW-142D — MONITORING WELL
- TW98-108WT — TEMPORARY WELL
- SB98-120 — SOIL BORING
- PZ-36 — PIEZOMETER
- TW01-120 — GRAB GROUNDWATER SAMPLING LOCATION
- SOIL BORING LOCATION - AUGUST 15, 2013

NOTES:

1. BASE MAP DEVELOPED FROM THE FOLLOWING: PHOTOGRAMMETRIC BASE MAP PREPARED BY LOCKWOOD MAPPING, INC. OF ROCHESTER, NEW YORK., AERIAL PHOTOGRAPHY CONDUCTED ON 11/11/94; AND BASE MAP SUPPLIED BY AIR-LAND SURVEYS, INC., AERIAL PHOTOGRAPHY WAS CONDUCTED DURING 11/90.
2. SAMPLE LOCATIONS ARE APPROXIMATE.

0 30' 60'
GRAPHIC SCALE

RACER TRUST
PLANT 2 LANDFILL
SAGINAW, MICHIGAN

SAMPLE LOCATIONS AND LEAD DATA EXCEEDING NONRESIDENTIAL DIRECT CONTACT CRITERIA

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FIGURE
1

Appendix A

June 10th Call Summary

Meeting Summary: Discussion of HHPA Report for RACER

Date: 6/10/2013, 3:00-4:00 pm
Participants:
Sue Kaelber-Matlock - RRD site manager
Betty Locey, Arcadis Toxicologist
David Favero - RACER Trust Cleanup Manager
Divinia N Ries – RRD Toxicologist

The purpose of the meeting was to discuss questions or concerns identified by Divinia Ries during her preliminary review of the report, Human Health Pathway Anaysis for Unsaturated Soil (HHPA) for a RACER Trust facility in Saginaw, MI, that was submitted to the Toxicology Unit for review on April 10, 2013.

The discussion items and/or consensus were as follows:

1) *Are surface materials fill material in or soil in certain areas or are they mixed?* Sue indicated that the surface materials at the site are 60% or more fill soil mixed with native soil. The fill material consists of soil not gravel and cinder or other fill materials.
2) *VOCs and VI pathway applicability* – Two soil samples had TCE concentrations exceeding the SVIIC; however, the report concluded that the VI pathway is not complete due to current condition: absence of a building. Sue clarified that the GW contamination at the site is due to the adjacent property's (Delphi) GW contamination and GW contaminants have impacted the soil at the site. Sue indicated that the site has currently no buildings and the RAP restrictions will include the appropriate restriction (e.g. no building construction at the site). It was agreed that under the current and future use conditions, the assumption that the VI pathway is incomplete is acceptable.
3) *Lead analysis: a) use of arithmetic mean in place of 95% UCL, and b) fine and coarse fraction Pb concentrations*
   a) The soil lead concentrations were compared to an arithmetic mean (460 ppm) even though the report includes a statistical 95% UCL for the mean value (1,225 ppm). The nonresidential DCC is 900 ppm. Divinia stated that the department prefers the use of a 95% UCL for the mean. It was noted that the range of the concentrations (5.4 to 10,100 ppm) and standard deviation is so large. For data with a large variance, an outlier test could be used to remove the outliers before calculating the 95%UCL for the mean. Betty indicated that they use the arithmetic mean for soil lead level assessment consistent with US EPA's response to one of the "Adult Lead Model Frequently Asked Questions". Divinia was provided this reference. Divinia will discuss the issue with the Toxicology Unit and provide the group the final recommendation.
   b) The weighted total of Pb in both fine and coarse fractions of the soil (referred to as total calculated Pb) is the soil Pb concentration used to compare to the DCC or PSIC. The data for fine and coarse fraction Pb has not been determined for this site. Sue will discuss with Dave the additional sampling needed generate the

calculated total Pb levels. RRD has published a protocol that describes a threshold Pb level of 75 ppm at or below which total calculated Pb or analyses for fine and coarse fraction Pb may not be required. A copy of the protocol will be sent to the group.

4) *Site-specific criterion for manganese*
   a) Use of the adjustment for air inhalation rate (AIR)
      Divinia indicated that the "AIR" factor is not applicable to noncarcinogen PSIC. This adjustment factor is applied only to the PSIC derivation for carcinogens. According to EPA guidance (RAGS F), this type of adjustment is not appropriate. It was suggested that in place of the AIR adjustment, the use of worker exposure time (ET) adjustment from 24 hours to 8 hours per 24 hour-day or 0.33 for nonresidential PSIC will be acceptable. The current equation assumes 24 hours per 24 hour-day or 1. This will increase the PSIC value by 3. Betty indicated that the adjustment to the "AIR" factor was intended to account for a worker being present on site a portion of the day and agreed with Divinia's proposed adjustment based on time rather than inhalation rate.
   b) Use of more appropriate regional dispersion factor or Q/C is suggested by Divinia since updated meteorological data from AQD Midland/Saginaw Bay monitoring station is available and could be used to develop regional-specific Q/C for the facility. Divinia will request AQD to generate the Q/C for this region.
   c) Sue indicated that the RAP for the adjacent GM property includes no unpaved roads, no construction and 50% or more vegetation cover consistent with assumptions used in this assessment. These requirements will also be applied to this property. Therefore, under these conditions, the proposed PEF without the emissions due to vehicle (Ev) for this property would be an acceptable approach.

Appendix B

Lead Work Plan

Sue,

Good morning. Please find a brief description of the additional work we are proposing to further evaluate lead in surface soils at the RACER SMI Plant 2 Landfill for your review. Let us know if you have questions or would like to discuss this further.

Work Plan - Lead Sample Collection

The following briefly describes the proposed approach to collecting additional surface soil samples at the SMI Plant 2 Landfill site for lead fraction analysis as discussed on our June 10th call. This data was requested to more thoroughly evaluate lead in surface soil with respect to the particulate inhalation and direct contact exposure pathways.

Background

RACER collected 70 surface soil samples (66 locations and 4 duplicates) on the 3.4-acre RACER SMI Plant 2 Landfill site (see attached figure) in 2010. Lead was detected in 5 of the samples (3 general areas) at a concentration greater than the 900 mg/kg nonresidential direct contact criteria. Three of the five samples are located near each other. Data for these locations is included on the attached figure. There were no exceedances of the nonresidential or residential Particulate Soil Inhalation Criteria (PSIC).

Data Collection

RACER proposes to collect 3 additional surface soil samples in locations near the exceedances of the nonresidential direct contact criteria for further evaluation of lead in the fine fraction. Work will include the following:

- Collect surface soil samples in the 3 areas where lead was detected at concentrations that exceed nonresidential criteria (see attached figure).
  - SB10-104, SB10-153 and SB10-114.
  - Collect samples from 0-6 inches bgs (note previous samples collected 0 to 2 feet bgs).
- Analyze samples for lead for the following MDEQ Laboratory Standard Operating Procedure (SOP) #213.
  - Fine fraction.
  - Coarse fraction.
  - Total Lead.

Samples will be collected from the 0- to 6-inch bgs interval using a hand auger. Samples will be placed in laboratory-supplied containers and shipped on ice to the chosen laboratory under appropriate chain of custody procedures.

Field activities and preparation are expected to take one 10 hour day.

Reporting

Data will be tabulated and concentrations reported in each fraction compared to each other and to totals data previously collected at the site. The lead assessment in the "Human Health Pathway Analysis for Unsaturated Soil" report dated February 2013 will be updated using the additional data.

-oOo-

Sincere Regards,

Betty

Betty Locey, Ph.D., DABT | Betty.Locey@arcadis-us.com
ARCADIS U.S., Inc. | 10559 Citation Drive, Suite 500 | Brighton, Michigan 48116
T: 810 225-1919 | M: 248 467-7349
www.arcadis-us.com

Appendix C

Analytical Data

Analytical Laboratory Report

Report ID: S57651.01(01)
Generated on 08/29/2013

Report to

Attention: Renee Pionk
Arcadis
101 S. Washington Sq
Suite 400
Lansing, MI 48933

Phone: 517-648-8027 FAX: 810-229-8837
Email: renee.pionk@arcadis-us.com

Report produced by

Merit Laboratories, Inc.
2680 East Lansing Drive
East Lansing, MI 48823

Phone: (517) 332-0167 FAX: (517) 332-6333

Contacts for report questions:
Tabitha Faust (tfaust@meritlabs.com)
Barbara Ball (bball@meritlabs.com)

Report Summary

Lab Sample ID(s): S57651.01-S57651.03
Project: B0086991.2013
Collected Date: 08/15/2013
Submitted Date/Time: 08/15/2013 14:55
Sampled by: Renee Pionk
P.O. #: RACER SAGINAW

Report Notes

Results relate only to items tested as received by the laboratory.
Methods may be modified for improved performance.
Results reported on a dry weight basis where applicable.
'Not detected' indicates that parameter was not found at a level equal to or greater than the reporting limit (RL).
Samples are held by the lab for 30 days from the final report date unless a written request to hold longer is provided by the client.

Laboratory Certifications:
Michigan DNRE (#9956), DOD/ISO 17025 (#69699), WBENC (#2005110032), Ohio EPA (#CL0002), IN Drinking Water (#C-MI-07), NELAC NY (#11814)
Some analytes reported may not be certified. Full certification lists are available upon request.

Violetta F. Murshak
Laboratory Director

Analytical Laboratory Report

Sample Summary (3 samples)

Sample ID	Sample Tag	Matrix	Collected Date/Time
S57651.01	SB10-153-2013	Soil	08/15/2013 10:47
S57651.02	SB10-104-2013	Soil	08/15/2013 11:34
S57651.03	SB10-114-2013	Soil	08/15/2013 12:14

Analytical Laboratory Report

Lab Sample ID: S57651.01
Sample Tag: SB10-153-2013
Collected Date/Time: 08/15/2013 10:47
Matrix: Soil
COC Reference: 75363

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	4oz Glass	None	Yes	5.6	IR

Analysis	Results	Units	RL	Method	Run Date/Time	Analyst	CAS #	Flags
Extraction / Prep.								
Lead, Coarse Digestion	Completed			3050B	08/29/13 10:00	JRH		
Lead, Fine and Coarse Prep	Completed			3050B	08/28/13 13:30	CCM		
Lead, Fine Digestion	Completed			3050B	08/29/13 10:00	JRH		
Inorganics								
Total Solids	92	%	1	Std M 2540 B	08/28/13 13:30	CCM		
Metals								
% Coarse by Weight	74.8	%		SW6020	08/28/13 14:00	CCM		
% Fine by Weight	25.2	%		SW6020	08/28/13 14:00	CCM		
Lead, Coarse	22.0	mg/kg	0.30	SW6020	08/29/13 14:02	JRH	7439-92-1	
Lead, Fine	64.2	mg/kg	0.30	SW6020	08/29/13 14:04	JRH		
Lead, Total Calculated	32.6	mg/kg		SW6020	08/29/13 14:00	JRH	7439-92-1C	

Analytical Laboratory Report

Lab Sample ID: S57651.02
Sample Tag: SB10-104-2013
Collected Date/Time: 08/15/2013 11:34
Matrix: Soil
COC Reference: 75363

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	4oz Glass	None	Yes	5.6	IR

Analysis	Results	Units	RL	Method	Run Date/Time	Analyst	CAS #	Flags
Extraction / Prep.								
Lead, Coarse Digestion	Completed			3050B	08/29/13 10:00	JRH		
Lead, Fine and Coarse Prep	Completed			3050B	08/28/13 13:30	CCM		
Lead, Fine Digestion	Completed			3050B	08/29/13 10:00	JRH		
Inorganics								
Total Solids	91	%	1	Std M 2540 B	08/28/13 13:30	CCM		
Metals								
% Coarse by Weight	45.2	%		SW6020	08/28/13 14:00	CCM		
% Fine by Weight	54.8	%		SW6020	08/28/13 14:00	CCM		
Lead, Coarse	28,300	mg/kg	3	SW6020	08/29/13 14:23	JRH	7439-92-1	
Lead, Fine	9,050	mg/kg	3	SW6020	08/29/13 14:27	JRH		
Lead, Total Calculated	17,700	mg/kg		SW6020	08/29/13 14:00	JRH	7439-92-1C	

Analytical Laboratory Report

Lab Sample ID: S57651.03
Sample Tag: SB10-114-2013
Collected Date/Time: 08/15/2013 12:14
Matrix: Soil
COC Reference: 75363

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	4oz Glass	None	Yes	5.6	IR

Analysis	Results	Units	RL	Method	Run Date/Time	Analyst	CAS #	Flags
Extraction / Prep.								
Lead, Coarse Digestion	Completed			3050B	08/29/13 10:00	JRH		
Lead, Fine and Coarse Prep	Completed			3050B	08/28/13 13:30	CCM		
Lead, Fine Digestion	Completed			3050B	08/29/13 10:00	JRH		
Inorganics								
Total Solids	88	%	1	Std M 2540 B	08/28/13 13:30	CCM		
Metals								
% Coarse by Weight	72.7	%		SW6020	08/28/13 14:00	CCM		
% Fine by Weight	27.3	%		SW6020	08/28/13 14:00	CCM		
Lead, Coarse	583	mg/kg	0.30	SW6020	08/29/13 14:30	JRH	7439-92-1	
Lead, Fine	1,360	mg/kg	0.30	SW6020	08/29/13 14:32	JRH		
Lead, Total Calculated	795	mg/kg		SW6020	08/29/13 14:00	JRH	7439-92-1C	

Merit Laboratories, Inc.

2680 East Lansing Dr., East Lansing, MI 48823
Phone (517) 332-0167 Fax (517) 332-4034
www.meritlabs.com

C.O.C. PAGE # 1 OF 1

75363

CHAIN OF CUSTODY RECORD

REPORT TO

CONTACT NAME: RENEE PIONK / ROB BARKHOLZ (517-324-5057)
COMPANY: ARCADIS
ADDRESS: 101 S. WASHINGTON SQUARE, STE 400
CITY: LANSING STATE: MI ZIP CODE: 48933
PHONE NO.: 517-648-8037 FAX NO.: 517-337-0417 P.O. NO.: RACER SAGINAW -
E-MAIL ADDRESS: RENEE.PIONK@ARCADIS-US.COM QUOTE NO.: PLANT2 LF

INVOICE TO

CONTACT NAME: ACCOUNTS PAYABLE @ ARCADIS SAME: X
COMPANY:
ADDRESS:
CITY: STATE: ZIP CODE:
PHONE NO.: E-MAIL ADDRESS:

PROJECT NO./NAME: B0086991.0013 Also ROBERT.BARKHOLZ@ARCADIS-US.COM
SAMPLER(S) - PLEASE PRINT/SIGN NAME: RENEE PIONK / Renee Pionk

TURNAROUND TIME REQUIRED ☐ 1 DAY ☐ 2 DAYS ☐ 3 DAYS ☒ STANDARD ☐ OTHER

DELIVERABLES REQUIRED ☒ STD ☐ LEVEL II ☐ LEVEL III ☐ LEVEL IV ☐ EDD ☐ OTHER

MATRIX CODE: GW=GROUNDWATER WW=WASTEWATER S=SOIL L=LIQUID SD=SOLID SL=SLUDGE DW=DRINKING WATER O=OIL WP=WIPE A=AIR W=WASTE

ANALYSIS (ATTACH LIST IF MORE SPACE IS REQUIRED)

Certifications
☐ OHIO VAP ☐ Drinking Water
☐ DoD ☐ NPDES

Project Locations
☐ Detroit ☐ New York
☐ Other

Special Instructions

MERIT LAB NO. (FOR LAB USE ONLY)	YEAR DATE	YEAR TIME	SAMPLE TAG IDENTIFICATION-DESCRIPTION	MATRIX	# OF BOTTLES	# Containers & Preservatives: NONE	HCl	HNO_3	H_2SO_4	NaOH	MeOH	OTHER	LEAD (FINE, COARSE, TOTAL)
576510.01	8/15/13	10:47	SB10-153-2013	S	1	X							X
.02	↓	11:34	SB10-104-2013	S	1	X							X
.03	↓	12:14	SB10-114-2013	S	1	X							X

Please contact ROB BARKHOLZ IF THERE IS NOT ENOUGH OF EITHER THE FINE OR COARSE FRACTION TO ANALYZE.

RELINQUISHED BY: SIGNATURE/ORGANIZATION: RENEE PIONK / ARCADIS Renee Pionk ☒ Sampler DATE: 8/15/13 TIME:
RECEIVED BY: SIGNATURE/ORGANIZATION: DATE: TIME:
RELINQUISHED BY: SIGNATURE/ORGANIZATION: DATE: TIME:
RECEIVED BY: SIGNATURE/ORGANIZATION: DATE: TIME:

RELINQUISHED BY: SIGNATURE/ORGANIZATION: DATE: TIME:
RECEIVED BY: SIGNATURE/ORGANIZATION: Tabatha Fast DATE: 8/15/13 TIME: 1455

SEAL NO. SEAL INTACT YES ☐ NO ☐ INITIALS:
SEAL NO. SEAL INTACT YES ☐ NO ☐ INITIALS:

NOTES: TEMP. ON ARRIVAL 5.6

PLEASE NOTE: SIGNING ACKNOWLEDGES ADHERENCE TO MERIT'S SAMPLE ACCEPTANCE POLICY ON REVERSE SIDE

Rev. 5.18.12

ARCADIS

Appendix D

Lead Statistical Analysis

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\jmsmith\Desktop\RACER\GM Saginaw\2012\2013\Stats Sept 2013\RACER Saginaw Lead for stats.xls.w
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead total-all)

General Statistics

Number of Valid Observations	69	Number of Distinct Observations	69

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	17700	Maximum of Log Data	9.781
Mean	720.9	Mean of log Data	4.567
Median	63.9	SD of log Data	1.812
SD	2486		
Std. Error of Mean	299.3		
Coefficient of Variation	3.449		
Skewness	5.68		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.387	Lilliefors Test Statistic	0.136
Lilliefors Critical Value	0.107	Lilliefors Critical Value	0.107
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1220	95% H-UCL	899.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1121
95% Adjusted-CLT UCL (Chen-1995)	1432	97.5% Chebyshev (MVUE) UCL	1403
95% Modified-t UCL (Johnson-1978)	1254	99% Chebyshev (MVUE) UCL	1958

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.331	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2177		
MLE of Mean	720.9		
MLE of Standard Deviation	1253		
nu star	45.71		
Approximate Chi Square Value (.05)	31.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0465	95% CLT UCL	1213
Adjusted Chi Square Value	30.94	95% Jackknife UCL	1220
		95% Standard Bootstrap UCL	1213
Anderson-Darling Test Statistic	6.069	95% Bootstrap-t UCL	2297
Anderson-Darling 5% Critical Value	0.857	95% Hall's Bootstrap UCL	3111
Kolmogorov-Smirnov Test Statistic	0.207	95% Percentile Bootstrap UCL	1264
Kolmogorov-Smirnov 5% Critical Value	0.116	95% BCA Bootstrap UCL	1496
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2026
		97.5% Chebyshev(Mean, Sd) UCL	2590
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3699
95% Approximate Gamma UCL	1056		
95% Adjusted Gamma UCL	1065		

Potential UCL to Use	
Use 95% Chebyshev (Mean, Sd) UCL	2026

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-all-no hotspot-1)

General Statistics

Number of Valid Observations	66	Number of Distinct Observations	66

Raw Statistics		Log-transformed Statistics	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	17700	Maximum of Log Data	9.781
Mean	528.6	Mean of log Data	4.399
Median	58.65	SD of log Data	1.661
SD	2234		
Std. Error of Mean	274.9		
Coefficient of Variation	4.226		
Skewness	7.284		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.407	Lilliefors Test Statistic	0.135
Lilliefors Critical Value	0.109	Lilliefors Critical Value	0.109
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	987.3	95% H-UCL	551.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	695.9
95% Adjusted-CLT UCL (Chen-1995)	1244	97.5% Chebyshev (MVUE) UCL	863.5
95% Modified-t UCL (Johnson-1978)	1028	99% Chebyshev (MVUE) UCL	1193

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.352	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	1502		
MLE of Mean	528.6		
MLE of Standard Deviation	891		
nu star	46.46		
Approximate Chi Square Value (.05)	31.82	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0464	95% CLT UCL	980.8
Adjusted Chi Square Value	31.55	95% Jackknife UCL	987.3
		95% Standard Bootstrap UCL	976.2
Anderson-Darling Test Statistic	5.953	95% Bootstrap-t UCL	2717
Anderson-Darling 5% Critical Value	0.851	95% Hall's Bootstrap UCL	2682
Kolmogorov-Smirnov Test Statistic	0.199	95% Percentile Bootstrap UCL	1039
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	1293
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1727
		97.5% Chebyshev(Mean, Sd) UCL	2246
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3264
95% Approximate Gamma UCL	771.8		
95% Adjusted Gamma UCL	778.4		

Potential UCL to Use		
	Use 95% Chebyshev (Mean, Sd) UCL	1727

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-all-no hotspot-1-2)

General Statistics

Number of Valid Observations	64	Number of Distinct Observations	64

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	4180	Maximum of Log Data	8.338
Mean	226.6	Mean of log Data	4.261
Median	49.95	SD of log Data	1.474
SD	548.8		
Std. Error of Mean	68.6		
Coefficient of Variation	2.421		
Skewness	6.184		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.343	Lilliefors Test Statistic	0.134
Lilliefors Critical Value	0.111	Lilliefors Critical Value	0.111
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	341.2	95% H-UCL	329.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	422.3
95% Adjusted-CLT UCL (Chen-1995)	396.1	97.5% Chebyshev (MVUE) UCL	517.1
95% Modified-t UCL (Johnson-1978)	350	99% Chebyshev (MVUE) UCL	703.4

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.525	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	431.7		
MLE of Mean	226.6		
MLE of Standard Deviation	312.8		
nu star	67.2		
Approximate Chi Square Value (.05)	49.34	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0463	95% CLT UCL	339.5
Adjusted Chi Square Value	48.98	95% Jackknife UCL	341.2
		95% Standard Bootstrap UCL	341.6
Anderson-Darling Test Statistic	2.847	95% Bootstrap-t UCL	502.2
Anderson-Darling 5% Critical Value	0.812	95% Hall's Bootstrap UCL	772.4
Kolmogorov-Smirnov Test Statistic	0.183	95% Percentile Bootstrap UCL	350.4
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	415.1
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	525.7
		97.5% Chebyshev(Mean, Sd) UCL	655
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	909.2
95% Approximate Gamma UCL	308.7		
95% Adjusted Gamma UCL	310.9		

Potential UCL to Use		
	Use 95% Chebyshev (Mean, Sd) UCL	525.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-north)

General Statistics

Number of Valid Observations	38	Number of Distinct Observations	38

Raw Statistics		**Log-transformed Statistics**	
Minimum	8.5	Minimum of Log Data	2.14
Maximum	17700	Maximum of Log Data	9.781
Mean	1085	Mean of log Data	5.014
Median	131	SD of log Data	1.848
SD	3254		
Std. Error of Mean	527.8		
Coefficient of Variation	3		
Skewness	4.39		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.367	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.938	Shapiro Wilk Critical Value	0.938
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1975	95% H-UCL	2419
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2079
95% Adjusted-CLT UCL (Chen-1995)	2354	97.5% Chebyshev (MVUE) UCL	2656
95% Modified-t UCL (Johnson-1978)	2038	99% Chebyshev (MVUE) UCL	3791

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.332	**Data appear Lognormal at 5% Significance Level**	
Theta Star	3264		
MLE of Mean	1085		
MLE of Standard Deviation	1881		
nu star	25.26		
Approximate Chi Square Value (.05)	14.81	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0434	95% CLT UCL	1953
Adjusted Chi Square Value	14.48	95% Jackknife UCL	1975
		95% Standard Bootstrap UCL	1902
Anderson-Darling Test Statistic	3.275	95% Bootstrap-t UCL	4791
Anderson-Darling 5% Critical Value	0.848	95% Hall's Bootstrap UCL	5416
Kolmogorov-Smirnov Test Statistic	0.233	95% Percentile Bootstrap UCL	2032
Kolmogorov-Smirnov 5% Critical Value	0.155	95% BCA Bootstrap UCL	2375
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3385
		97.5% Chebyshev(Mean, Sd) UCL	4381
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6337
95% Approximate Gamma UCL	1850		
95% Adjusted Gamma UCL	1892		

Potential UCL to Use	
Use 95% Chebyshev (Mean, Sd) UCL	3385

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-north-no hotspot1)

General Statistics

Number of Valid Observations	35	Number of Distinct Observations	35

Raw Statistics		**Log-transformed Statistics**	
Minimum	8.5	Minimum of Log Data	2.14
Maximum	17700	Maximum of Log Data	9.781
Mean	752.9	Mean of log Data	4.736
Median	109	SD of log Data	1.634
SD	2986		
Std. Error of Mean	504.7		
Coefficient of Variation	3.966		
Skewness	5.702		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.252	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.934	Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1606	95% H-UCL	1100
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1031
95% Adjusted-CLT UCL (Chen-1995)	2103	97.5% Chebyshev (MVUE) UCL	1304
95% Modified-t UCL (Johnson-1978)	1687	99% Chebyshev (MVUE) UCL	1841

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.344	**Data appear Lognormal at 5% Significance Level**	
Theta Star	2189		
MLE of Mean	752.9		
MLE of Standard Deviation	1284		
nu star	24.07		
Approximate Chi Square Value (.05)	13.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0425	95% CLT UCL	1583
Adjusted Chi Square Value	13.54	95% Jackknife UCL	1606
		95% Standard Bootstrap UCL	1578
Anderson-Darling Test Statistic	3.653	95% Bootstrap-t UCL	9437
Anderson-Darling 5% Critical Value	0.844	95% Hall's Bootstrap UCL	4888
Kolmogorov-Smirnov Test Statistic	0.243	95% Percentile Bootstrap UCL	1710
Kolmogorov-Smirnov 5% Critical Value	0.16	95% BCA Bootstrap UCL	2323
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2953
		97.5% Chebyshev(Mean, Sd) UCL	3905
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	5775
95% Approximate Gamma UCL	1304		
95% Adjusted Gamma UCL	1339		

Potential UCL to Use	
Use 95% Chebyshev (Mean, Sd) UCL	2953

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-north-no hotspots-1-2)

General Statistics

Number of Valid Observations	33	Number of Distinct Observations	33

Raw Statistics		**Log-transformed Statistics**	
Minimum	8.5	Minimum of Log Data	2.14
Maximum	795	Maximum of Log Data	6.678
Mean	181	Mean of log Data	4.487
Median	83.9	SD of log Data	1.29
SD	210.5		
Std. Error of Mean	36.64		
Coefficient of Variation	1.163		
Skewness	1.603		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.778	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.931	Shapiro Wilk Critical Value	0.931
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	243.1	95% H-UCL	388.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	430.8
95% Adjusted-CLT UCL (Chen-1995)	252.2	97.5% Chebyshev (MVUE) UCL	532.6
95% Modified-t UCL (Johnson-1978)	244.8	99% Chebyshev (MVUE) UCL	732.4

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.775	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	233.5		
MLE of Mean	181		
MLE of Standard Deviation	205.6		
nu star	51.17		
Approximate Chi Square Value (.05)	35.74	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0419	95% CLT UCL	241.3
Adjusted Chi Square Value	35.08	95% Jackknife UCL	243.1
		95% Standard Bootstrap UCL	238.8
Anderson-Darling Test Statistic	0.733	95% Bootstrap-t UCL	257.4
Anderson-Darling 5% Critical Value	0.784	95% Hall's Bootstrap UCL	254.4
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL	243.3
Kolmogorov-Smirnov 5% Critical Value	0.159	95% BCA Bootstrap UCL	252.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	340.7
		97.5% Chebyshev(Mean, Sd) UCL	409.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	545.5
95% Approximate Gamma UCL	259.1		
95% Adjusted Gamma UCL	264		

Potential UCL to Use		
	Use 95% Approximate Gamma UCL	259.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-south)

General Statistics

Number of Valid Observations	31	Number of Distinct Observations	31

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	4180	Maximum of Log Data	8.338
Mean	275.2	Mean of log Data	4.019
Median	33.4	SD of log Data	1.635
SD	761.9		
Std. Error of Mean	136.8		
Coefficient of Variation	2.768		
Skewness	4.8		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.378	Shapiro Wilk Test Statistic	0.91
Shapiro Wilk Critical Value	0.929	Shapiro Wilk Critical Value	0.929
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	507.5	95% H-UCL	561.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	513.6
95% Adjusted-CLT UCL (Chen-1995)	626.4	97.5% Chebyshev (MVUE) UCL	652.1
95% Modified-t UCL (Johnson-1978)	527.2	99% Chebyshev (MVUE) UCL	924.3

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.392	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	702.3		
MLE of Mean	275.2		
MLE of Standard Deviation	439.7		
nu star	24.3		
Approximate Chi Square Value (.05)	14.08	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0413	95% CLT UCL	500.3
Adjusted Chi Square Value	13.64	95% Jackknife UCL	507.5
		95% Standard Bootstrap UCL	505.4
Anderson-Darling Test Statistic	2.786	95% Bootstrap-t UCL	1043
Anderson-Darling 5% Critical Value	0.83	95% Hall's Bootstrap UCL	1249
Kolmogorov-Smirnov Test Statistic	0.255	95% Percentile Bootstrap UCL	535.1
Kolmogorov-Smirnov 5% Critical Value	0.169	95% BCA Bootstrap UCL	680.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	871.7
		97.5% Chebyshev(Mean, Sd) UCL	1130
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1637
95% Approximate Gamma UCL	475.1		
95% Adjusted Gamma UCL	490.2		

Potential UCL to Use		
	Use 95% Chebyshev (Mean, Sd) UCL	871.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\jmsmith\Desktop\RACER\GM Saginaw\2012\2013\Stats Sept 2013\RACER Saginaw Lead for stats.xls.
Full Precision	OFF
Confidence Coefficient	90%
Number of Bootstrap Operations	2000

Result (lead total-all)

General Statistics

Number of Valid Observations	69	Number of Distinct Observations	69

Raw Statistics

Minimum	5.4
Maximum	17700
Mean	720.9
Median	63.9
SD	2486
Std. Error of Mean	299.3
Coefficient of Variation	3.449
Skewness	5.68

Log-transformed Statistics

Minimum of Log Data	1.686
Maximum of Log Data	9.781
Mean of log Data	4.567
SD of log Data	1.812

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic	0.387
Lilliefors Critical Value	0.107

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic	0.136
Lilliefors Critical Value	0.107

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

90% Student's-t UCL	1108

90% UCLs (Adjusted for Skewness)

90% Adjusted-CLT UCL (Chen-1995)	1251
90% Modified-t UCL (Johnson-1978)	1142

Assuming Lognormal Distribution

90% H-UCL	777.1
90% Chebyshev (MVUE) UCL	917.8
95% Chebyshev (MVUE) UCL	1121
97.5% Chebyshev (MVUE) UCL	1403
99% Chebyshev (MVUE) UCL	1958

Gamma Distribution Test

k star (bias corrected)	0.331
Theta Star	2177
MLE of Mean	720.9
MLE of Standard Deviation	1253
nu star	45.71
Approximate Chi Square Value (.05)	33.96
Adjusted Level of Significance	0.0962
Adjusted Chi Square Value	33.79
Anderson-Darling Test Statistic	6.069
Anderson-Darling 5% Critical Value	0.857
Kolmogorov-Smirnov Test Statistic	0.207
Kolmogorov-Smirnov 5% Critical Value	0.116

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Approximate Gamma UCL	970.3
90% Adjusted Gamma UCL	975.3

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

90% CLT UCL	1105
90% Jackknife UCL	1108
90% Standard Bootstrap UCL	1098
90% Bootstrap-t UCL	1666
90% Hall's Bootstrap UCL	2923
90% Percentile Bootstrap UCL	1125
90% BCA Bootstrap UCL	1366
90% Chebyshev(Mean, Sd) UCL	1619
95% Chebyshev(Mean, Sd) UCL	2026
97.5% Chebyshev(Mean, Sd) UCL	2590
99% Chebyshev(Mean, Sd) UCL	3699

Potential UCL to Use

Recommendation Provided only for 95% Confidence Coefficient

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-all-no hotspot-1)

General Statistics

Number of Valid Observations	66	Number of Distinct Observations	66

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	17700	Maximum of Log Data	9.781
Mean	528.6	Mean of log Data	4.399
Median	58.65	SD of log Data	1.661
SD	2234		
Std. Error of Mean	274.9		
Coefficient of Variation	4.226		
Skewness	7.284		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.407	Lilliefors Test Statistic	0.135
Lilliefors Critical Value	0.109	Lilliefors Critical Value	0.109
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
90% Student's-t UCL	884.5	90% H-UCL	484.2
		90% Chebyshev (MVUE) UCL	575.1
90% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	695.9
90% Adjusted-CLT UCL (Chen-1995)	1057	97.5% Chebyshev (MVUE) UCL	863.5
90% Modified-t UCL (Johnson-1978)	925.6	99% Chebyshev (MVUE) UCL	1193

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.352	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	1502		
MLE of Mean	528.6		
MLE of Standard Deviation	891		
nu star	46.46		
Approximate Chi Square Value (.05)	34.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.096	90% CLT UCL	880.9
Adjusted Chi Square Value	34.43	90% Jackknife UCL	884.5
		90% Standard Bootstrap UCL	878.7
Anderson-Darling Test Statistic	5.953	90% Bootstrap-t UCL	1905
Anderson-Darling 5% Critical Value	0.851	90% Hall's Bootstrap UCL	2296
Kolmogorov-Smirnov Test Statistic	0.199	90% Percentile Bootstrap UCL	896.4
Kolmogorov-Smirnov 5% Critical Value	0.118	90% BCA Bootstrap UCL	1140
Data not Gamma Distributed at 5% Significance Level		90% Chebyshev(Mean, Sd) UCL	1353
		95% Chebyshev(Mean, Sd) UCL	1727
		97.5% Chebyshev(Mean, Sd) UCL	2246
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3264
90% Approximate Gamma UCL	709.5		
90% Adjusted Gamma UCL	713.2		

Potential UCL to Use	**Recommendation Provided only for 95% Confidence Coefficient**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-all-no hotspot-1-2)

General Statistics

Number of Valid Observations	64	Number of Distinct Observations	64

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	4180	Maximum of Log Data	8.338
Mean	226.6	Mean of log Data	4.261
Median	49.95	SD of log Data	1.474
SD	548.8		
Std. Error of Mean	68.6		
Coefficient of Variation	2.421		
Skewness	6.184		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.343	Lilliefors Test Statistic	0.134
Lilliefors Critical Value	0.111	Lilliefors Critical Value	0.111
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
90% Student's-t UCL	315.5	90% H-UCL	278.9
		90% Chebyshev (MVUE) UCL	354
90% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	422.3
90% Adjusted-CLT UCL (Chen-1995)	352.4	97.5% Chebyshev (MVUE) UCL	517.1
90% Modified-t UCL (Johnson-1978)	324.3	99% Chebyshev (MVUE) UCL	703.4

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	0.525	**Data do not follow a Discernable Distribution (0.05)**
Theta Star	431.7	
MLE of Mean	226.6	
MLE of Standard Deviation	312.8	
nu star	67.2	
Approximate Chi Square Value (.05)	52.84	**Nonparametric Statistics**
Adjusted Level of Significance	0.0959	90% CLT UCL 314.6
Adjusted Chi Square Value	52.6	90% Jackknife UCL 315.5
		90% Standard Bootstrap UCL 311.4
Anderson-Darling Test Statistic	2.847	90% Bootstrap-t UCL 448.2
Anderson-Darling 5% Critical Value	0.812	90% Hall's Bootstrap UCL 753.9
Kolmogorov-Smirnov Test Statistic	0.183	90% Percentile Bootstrap UCL 318.9
Kolmogorov-Smirnov 5% Critical Value	0.118	90% BCA Bootstrap UCL 374.5
Data not Gamma Distributed at 5% Significance Level		90% Chebyshev(Mean, Sd) UCL 432.4
		95% Chebyshev(Mean, Sd) UCL 525.7
		97.5% Chebyshev(Mean, Sd) UCL 655
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 909.2
90% Approximate Gamma UCL	288.3	
90% Adjusted Gamma UCL	289.5	

Potential UCL to Use	**Recommendation Provided only for 95% Confidence Coefficient**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-north)

General Statistics

Number of Valid Observations	38	Number of Distinct Observations	38

Raw Statistics		**Log-transformed Statistics**	
Minimum	8.5	Minimum of Log Data	2.14
Maximum	17700	Maximum of Log Data	9.781
Mean	1085	Mean of log Data	5.014
Median	131	SD of log Data	1.848
SD	3254		
Std. Error of Mean	527.8		
Coefficient of Variation	3		
Skewness	4.39		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.367	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.938	Shapiro Wilk Critical Value	0.938
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
90% Student's-t UCL	1773	90% H-UCL	1835
		90% Chebyshev (MVUE) UCL	1663
90% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2079
90% Adjusted-CLT UCL (Chen-1995)	2029	97.5% Chebyshev (MVUE) UCL	2656
90% Modified-t UCL (Johnson-1978)	1836	99% Chebyshev (MVUE) UCL	3791

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.332	**Data appear Lognormal at 5% Significance Level**	
Theta Star	3264		
MLE of Mean	1085		
MLE of Standard Deviation	1881		
nu star	25.26		
Approximate Chi Square Value (.05)	16.68	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0927	90% CLT UCL	1761
Adjusted Chi Square Value	16.45	90% Jackknife UCL	1773
		90% Standard Bootstrap UCL	1749
Anderson-Darling Test Statistic	3.275	90% Bootstrap-t UCL	3961
Anderson-Darling 5% Critical Value	0.848	90% Hall's Bootstrap UCL	5127
Kolmogorov-Smirnov Test Statistic	0.233	90% Percentile Bootstrap UCL	1792
Kolmogorov-Smirnov 5% Critical Value	0.155	90% BCA Bootstrap UCL	2174
Data not Gamma Distributed at 5% Significance Level		90% Chebyshev(Mean, Sd) UCL	2668
		95% Chebyshev(Mean, Sd) UCL	3385
		97.5% Chebyshev(Mean, Sd) UCL	4381
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6337
90% Approximate Gamma UCL	1642		
90% Adjusted Gamma UCL	1665		

Potential UCL to Use	**Recommendation Provided only for 95% Confidence Coefficient**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-north-no hotspot1)

General Statistics

Number of Valid Observations	35	Number of Distinct Observations	35

Raw Statistics		**Log-transformed Statistics**	
Minimum	8.5	Minimum of Log Data	2.14
Maximum	17700	Maximum of Log Data	9.781
Mean	752.9	Mean of log Data	4.736
Median	109	SD of log Data	1.634
SD	2986		
Std. Error of Mean	504.7		
Coefficient of Variation	3.966		
Skewness	5.702		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.252	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.934	Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
90% Student's-t UCL	1413	90% H-UCL	861.5
		90% Chebyshev (MVUE) UCL	833.8
90% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1031
90% Adjusted-CLT UCL (Chen-1995)	1747	97.5% Chebyshev (MVUE) UCL	1304
90% Modified-t UCL (Johnson-1978)	1494	99% Chebyshev (MVUE) UCL	1841

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.344	**Data appear Lognormal at 5% Significance Level**	
Theta Star	2189		
MLE of Mean	752.9		
MLE of Standard Deviation	1284		
nu star	24.07		
Approximate Chi Square Value (.05)	15.72	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0917	90% CLT UCL	1400
Adjusted Chi Square Value	15.46	90% Jackknife UCL	1413
		90% Standard Bootstrap UCL	1388
Anderson-Darling Test Statistic	3.653	90% Bootstrap-t UCL	7796
Anderson-Darling 5% Critical Value	0.844	90% Hall's Bootstrap UCL	4636
Kolmogorov-Smirnov Test Statistic	0.243	90% Percentile Bootstrap UCL	1358
Kolmogorov-Smirnov 5% Critical Value	0.16	90% BCA Bootstrap UCL	1855
Data not Gamma Distributed at 5% Significance Level		90% Chebyshev(Mean, Sd) UCL	2267
		95% Chebyshev(Mean, Sd) UCL	2953
		97.5% Chebyshev(Mean, Sd) UCL	3905
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	5775
90% Approximate Gamma UCL	1153		
90% Adjusted Gamma UCL	1172		

Potential UCL to Use	**Recommendation Provided only for 95% Confidence Coefficient**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-north-no hotspots-1-2)

General Statistics

Number of Valid Observations	33	Number of Distinct Observations	33

Raw Statistics		**Log-transformed Statistics**	
Minimum	8.5	Minimum of Log Data	2.14
Maximum	795	Maximum of Log Data	6.678
Mean	181	Mean of log Data	4.487
Median	83.9	SD of log Data	1.29
SD	210.5		
Std. Error of Mean	36.64		
Coefficient of Variation	1.163		
Skewness	1.603		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.778	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.931	Shapiro Wilk Critical Value	0.931
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
90% Student's-t UCL	228.9	90% H-UCL	329
		90% Chebyshev (MVUE) UCL	357.5
90% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	430.8
90% Adjusted-CLT UCL (Chen-1995)	235.3	97.5% Chebyshev (MVUE) UCL	532.6
90% Modified-t UCL (Johnson-1978)	230.6	99% Chebyshev (MVUE) UCL	732.4

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.775	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	233.5		
MLE of Mean	181		
MLE of Standard Deviation	205.6		
nu star	51.17		
Approximate Chi Square Value (.05)	38.71	**Nonparametric Statistics**	
Adjusted Level of Significance	0.091	90% CLT UCL	228
Adjusted Chi Square Value	38.26	90% Jackknife UCL	228.9
		90% Standard Bootstrap UCL	226.9
Anderson-Darling Test Statistic	0.733	90% Bootstrap-t UCL	238.3
Anderson-Darling 5% Critical Value	0.784	90% Hall's Bootstrap UCL	237.3
Kolmogorov-Smirnov Test Statistic	0.145	90% Percentile Bootstrap UCL	228.3
Kolmogorov-Smirnov 5% Critical Value	0.159	90% BCA Bootstrap UCL	232.1
Data appear Gamma Distributed at 5% Significance Level		90% Chebyshev(Mean, Sd) UCL	290.9
		95% Chebyshev(Mean, Sd) UCL	340.7
		97.5% Chebyshev(Mean, Sd) UCL	409.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	545.5
90% Approximate Gamma UCL	239.3		
90% Adjusted Gamma UCL	242		

Potential UCL to Use	**Recommendation Provided only for 95% Confidence Coefficient**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Result (lead total-south)

General Statistics

Number of Valid Observations	31	Number of Distinct Observations	31

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.4	Minimum of Log Data	1.686
Maximum	4180	Maximum of Log Data	8.338
Mean	275.2	Mean of log Data	4.019
Median	33.4	SD of log Data	1.635
SD	761.9		
Std. Error of Mean	136.8		
Coefficient of Variation	2.768		
Skewness	4.8		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.378	Shapiro Wilk Test Statistic	0.91
Shapiro Wilk Critical Value	0.929	Shapiro Wilk Critical Value	0.929
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
90% Student's-t UCL	454.6	90% H-UCL	436.1
		90% Chebyshev (MVUE) UCL	413.8
90% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	513.6
90% Adjusted-CLT UCL (Chen-1995)	534.9	97.5% Chebyshev (MVUE) UCL	652.1
90% Modified-t UCL (Johnson-1978)	474.2	99% Chebyshev (MVUE) UCL	924.3
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.392	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	702.3		
MLE of Mean	275.2		
MLE of Standard Deviation	439.7		
nu star	24.3		
Approximate Chi Square Value (.05)	15.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0903	90% CLT UCL	450.6
Adjusted Chi Square Value	15.6	90% Jackknife UCL	454.6
		90% Standard Bootstrap UCL	448.3
Anderson-Darling Test Statistic	2.786	90% Bootstrap-t UCL	855.3
Anderson-Darling 5% Critical Value	0.83	90% Hall's Bootstrap UCL	1213
Kolmogorov-Smirnov Test Statistic	0.255	90% Percentile Bootstrap UCL	457.4
Kolmogorov-Smirnov 5% Critical Value	0.169	90% BCA Bootstrap UCL	617.2
Data not Gamma Distributed at 5% Significance Level		90% Chebyshev(Mean, Sd) UCL	685.8
		95% Chebyshev(Mean, Sd) UCL	871.7
		97.5% Chebyshev(Mean, Sd) UCL	1130
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1637
90% Approximate Gamma UCL	420.6		
90% Adjusted Gamma UCL	428.6		

Potential UCL to Use	**Recommendation Provided only for 95% Confidence Coefficient**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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Appendix E

Original HHPA Manganese PSIC Calculations

Table E-1. Original Proposed Site-specific PSIC from the February 2013 Human Health Pathway Assessment

Estimated source areas:	acres		
Site	**3.4**		
Modifier for 3.4 acres:	**0.66**	(5-acre source area)	

A. Part 201 Generic PSIC	**=(THQ*ED*365)/(EF*ED*(1/RfC)*(1/(PEF/2)))**	**Assumptions/Comments**
Residential	=(1*30*365)/(350*30*(1/0.00005)*(1/(**128000000/2**)))	**for a 0.5-acre site, PEF =** 1.28E+08
	3,338 mg/kg ***approx 3,300***	
Non-residential	=(1*21*365)/(245*21*(1/0.00005)*(1/(**39500000/2**)))	**for a 0.5-acre site, PEF =** 3.95E+07
	1,471 mg/kg **approx 1,500**	

B. Site-specific calculation:		
Site-specific PSIC	**=(THQ*ED*365*AIR)/(EF*ED*(1/RfC)*(1/(PEF)))**	
Residential (adjusted) PSIC:	=((1*30*365)/(350*30*(1/0.00005)*(**1/(299000000)**)))*0.66	**assuming the site is 3.4 acres**
Assuming no vehicular traffic	**10,303**	
Non-residential (adjusted) PSIC:	=(1*21*365***2**)/(245*21*(1/0.00005)*(1/(**299000000**)))*0.66	**assuming the site is 3.4 acres**
Assuming no vehicular traffic	**29,400**	includes AIR of 2
Maintenance Worker PSIC:	=(1*21*365***2**)/(160*21*(1/0.00005)*(1/(**299000000**)))*0.66	**for 3.4 acres; using MDEQ factors except EF is 160 days**
Assuming no vehicular traffic	**45,018**	includes AIR of 2
Construction Worker PSIC:	=(1*1*365***2**)/(30*1*(1/0.00005)*(1/(**299000000**)))*0.66	**for 3.4 acres; Construction worker EF = 30 days and ED = 1 yea**
	240,097	includes AIR of 2

Generic Part 201 Particulate Emission Factor (PEF) Calculation and Assumptions

PEF =(Q/C)*(1/((Ew*(1-V))+Ev)
PEF =82.33*1/((0.00000055*(1-0.5))+0.00000181) --based on Michigan sites; 50% vegetation cover; 0.5-acre source si

1.28E+08 **for residential**
3.95E+07 **for industrial**

where:

Dispersion factor (Q/C) =	**82.33**	g/m^2-s per kg/m^3	--based on Michigan sites; 0.5-acre source size
Emission due to wind (Ew) =	5.50E-07	g/m^2-s	--default vegetation cover is 50%
Emission due to vehicle traffic (ind) (Ev) =	1.81E-06	g/m^2-s	--default value
Vegetation cover (V) =	50%		

Site-specific Part 201 Particulate Emission Factor (PEF) Calculation and Assumptions Assuming NO Vehicular Traffic

PEF =(Q/C)*(1/((Ew*(1-V))+Ev)
PEF =82.33*1/((0.00000055*(1-0.5))+0.0) --based on Michigan sites; 50% vegetation cover; 0.5-acre source si

2.99E+08 **for all receptors**

where:

Dispersion factor (Q/C) =	**82.33**	g/m^2-s per kg/m^3	--based on Michigan sites; 0.5-acre source size
Emission due to wind (Ew) =	5.50E-07	g/m^2-s	--default vegetation cover is 50%
Emission due to vehicle traffic (non-res) (Ev) =	0.00E+00	g/m^2-s	--assumes no vehicular traffic
Vegetation cover (V) =	50%		

Notes:
Adjusted: Source size and no vehicular traffic