RUBIK ENVIRONMENTAL, INC.

SWMU-6 RISK ASSESSMENT

Loveland Products, Inc. Billings, Montana Facility
1525 Lockwood Road
Billings, Montana

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Submitted to:
Ms. Ann M. Kron
Montana Department of Environmental Quality
Waste and Underground Tank Management
P.O. Box 200901
Helena, MT 59620

Prepared for:
Crop Production Services, Inc.
3005 Rocky Mountain Avenue
Loveland, Colorado 80538

Prepared by:
Rubik Environmental, Inc.
527 Lander Street, Suite 204
Reno, Nevada 89509

Prepared by:

Todd Leonard
Principal Risk Assessor

Reviewed by:

Stephen A. Meninger
Senior Scientist

EXECUTIVE SUMMARY

A risk assessment was conducted to evaluate potential risks associated with residual chemicals present in the soil in solid waste management unit #6 (SWMU-6) located at the Loveland Products, Inc. (LPI) facility in Billings, Montana. The assessment was conducted in accordance with the Montana Department of Environmental Quality (MDEQ) Hazardous Waste Permit for the site (Permit No. MWHWP-04-01) and guidance documents from the US Environmental Protection Agency (USEPA) and MDEQ.

SWMU-6 is comprised primarily of a former Resource Conservation and Recovery Act (RCRA) permitted surface impoundment (SI) that received process water and wastewater generated at the facility from 1978 through 1985. The SI consisted of three ponds that were used for evaporating the water and concentrating sludge. The primary chemicals in the water and sludge were 2,4-D, MCPA and MCPP and the associated phenolic breakdown products (MDEQ, 2010). The ponds were closed in 1985 and 1986 by removing the liquid, stabilizing the remaining sludge in place with quick lime and fly ash, and covering the solidified material with sand, gravel, a high-density polyethylene liner and asphalt pavement.

The hazardous waste permit requires 30 years of post-closure maintenance and monitoring from the date of certified closure. Groundwater beneath SWMU-6 is monitored pursuant to the site-wide corrective action program outlined in the hazardous waste permit. Per the permit, post-closure use of SWMU-6 that would result in disturbing the integrity of the final cover or containment system, or the function of the units monitoring systems, is not allowed unless the MDEQ finds that the disturbance is: 1) necessary to the proposed use of the property and will not increase the potential hazard to human health or the environment; or 2) necessary to reduce the threat to human health or the environment (MDEQ, 2004).

In 2005, due to increasing herbicide production demands at the already congested Billings plant, LPI began exploring options to expand the facility. The area encompassing SWMU-6 was identified as the preferred location to construct a new warehouse based on its proximity to other structures at the site. Additionally, by removing SWMU-6 potential risks to human health and the environment could be reduced.

Following receipt of analytical data for samples taken of the solidified sludge from the SI in 2011, the MDEQ provided a letter to LPI stating that the waste material from the permitted unit was corrective action management unit (CAMU) eligible and could therefore be disposed of offsite at a permitted hazardous waste landfill (MDEQ, 2011; AECOM, 2012). The sludge, liners and impacted soil were removed in 2012 and transported offsite for disposal at the appropriate facility.

Confirmation soil samples were collected from the perimeter and base of the excavations to verify that 2,4-D concentrations were less than the USEPA Regional Screening Level (RSL) for industrial receptors. Soil containing 2,4-D concentrations exceeding the RSL was excavated and the excavations were backfilled with road base which was compacted and graded to match the surrounding ground surface.

Additional soil samples were collected from the side walls of the excavations at approximately 4 to 6 feet bgs to evaluate potential risks within SWMU-6 (AECOM, 2012). The samples were analyzed for chlorinated herbicides, semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs). Concentrations of chemicals detected in the soil samples were compared to generic RSLs for direct exposure (dermal contact, ingestion and inhalation of particulates) to identify chemicals of potential concern (COPCs). Maximum concentrations of 2,4-D, MCPA and diallate exceeded the RSLs. Analytical reporting limits (RLs) for one herbicide, five SVOCs and four VOCs in the SWMU-6 soil samples also exceeded industrial RSLs.

A conceptual site model (CSM) was developed to identify the potentially complete exposure pathways and receptors based on the depth to the impacts in subsurface soil (ie. > 2 feet below the ground surface) and land use. The CSM indicated that direct exposure pathways for soil are potentially complete for excavation workers. Vapor inhalation by current outdoor industrial workers and future indoor industrial workers was also identified as a complete exposure pathway based on RLs for VOCs that exceeded the RSLs. Based on the depth to water beneath SWMU-6 (greater than 12 feet) and previous soil leaching evaluations indicating that leaching is not a concern for the site, all groundwater exposure pathways are incomplete. Ecological exposure pathways are also incomplete based on the depth to the COPCs in the soil and current and future land use.

Reasonable maximum exposure point concentrations (EPCs) were calculated for the detected COPCs using the USEPA ProUCL software. The 95% upper confidence limit on the arithmetic mean or greater was established as the EPC for the detected chemicals. The maximum reporting limit was used as the EPC for the non-detected chemicals. The risks at the site were characterized by comparing the EPCs to site-specific soil screening levels (SSLs) calculated with realistic exposure factors for the site using the USEPA RSL calculator.

Hazard levels and excess cancer risk (ECR) estimates established in the risk assessment were less the MDEQ acceptable endpoints of 1.0 and 1E-05, respectively, for all potential receptors and exposure pathways. Therefore, residual concentrations of the COPCs in the subsurface soil in SWMU-6 do not present an unacceptable risk to human health or the environment. Additionally, the residual chemicals in the soil in SWMU-6 will not present an unacceptable human health risk if a building is constructed in this area.

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ACRONYMS AND ABBREVIATIONS

2,4-D	2,4-dichlorophenoxyacetic acid
amsl	above mean sea level
AST	Above ground storage tank
bgs	below the ground surface
CalEPA	California Environmental Protection Agency
CAMU	Corrective action management unit
CMS	Corrective Measure Study
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CPS	Crop Production Services
DAF	Dilution Attenuation Factor
DBCP	1,2-Dibromo-3-chloropropane
ECR	Lifetime excess cancer risk
EDB	1,2-Dibromoethane or Ethylene dibromide
EPC	Reasonable maximum exposure point concentration
ft/ft	Feet per foot
HDPE	High-density polyethylene
HERD	Human and Ecological Risk Division
HI	Hazard index
HQ	Hazard quotient
Kg	Kilogram
L	Liter
LPI	Loveland Products Inc.
MCL	Maximum contaminant level
MDEQ	Montana Department of Environmental Quality
MDHES	Montana Department of Health and Environmental Sciences
MCPA	2-methyl-4chlorophenoxyacetic acid
MCPP	2-(2-Methyl-4-chlorophenoxy)propionic acid
mg	milligram
MNA	Monitored natural attenuation
MW	Monitoring well
ODEQ	Oregon Department of Environmental Quality
OBS	Observation well
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RL	Reporting limit

ACRONYMS AND ABBREVIATIONS cont.

RSL	Regional Screening Level
SI	Surface Impoundment
SLERA	Screening level ecological risk assessment
SOW	Statement of work
SPLP	Synthetic precipitation leaching procedure
SSL	Soil screening level
SVOC	Semi-volatile organic compound
SWMU	Solid Waste Management Unit
1,2,3-TCP	1,2,3-Trichloropropane
TCLP	Toxicity characteristic leaching procedure
UCL	Upper Confidence Limit
USEPA	U.S. Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound

1.0 INTRODUCTION

Rubik Environmental, Inc. (Rubik) prepared this Risk Assessment on behalf of Crop Production Services, Inc.(CPS) for Solid Waste Management Unit #6 (SWMU-6) at the Loveland Products, Incorporated (LPI) facility located east of the city of Billings, MT in the area locally known as Lockwood.

A facility location map is presented as **Figure 1** and a site plan identifying the location of SWMU-6 and soil sampling locations used in this risk assessment is presented as **Figure 2**.

2.0 OBJECTIVES

The objectives of the risk assessment were: 1) to evaluate potential risks to human health and the environment resulting from chemicals remaining in the soil in SWMU-6; and 2) determine if further evaluation or remedial action is needed prior to the construction of a warehouse in this area.

3.0 SITE DESCRIPTION

Transbas began operating an herbicide formulation and manufacturing plant at the site in 1975 and LPI took over operations of the facility in January 2009. Facility activities also include rail and truck transportation of incoming raw and intermediate materials, and outgoing finished products (MDEQ, 2010).

The herbicide formulation procedures include but are not limited to blending or reacting phenoxyalkanoic acid herbicides, primarily 2,4-dichlorophenoxyacetic acid (2,4-D), 2-methyl-4-chlorophenoxyacetic acid (MCPA), and 2-(2-methyl-4-chlorophenoxy)propionic acid (MCPP), with alcohols, solvents, amines, or water to produce commercial herbicide products (Pentacore, 2002).

The site encompasses 27 acres of land, approximately 12 acres of which is occupied by the plant and appurtenances. This site and surrounding properties are zoned heavy industrial. Property to the east of the site is occupied by Weldcon Inc., an industrial facility that does welding and fabrication primarily for the petroleum industry. An Exxon Mobile refinery is located further to the east and Exxon also owns property to the north of the site, north of Coulson Ditch. Coulson Ditch extends the northern border of the site is bounded by 2-to 3-foot high berms. A road extends along the southern property boundary followed by the railroad and associated spurs and right-of-ways. The adjacent property to the west of the site is vacant.

3.1 SWMU-6 Background

3.1.1 Surface Impoundment Operation and Closure

SWMU-6 is comprised primarily of a former Resource Conservation and Recovery Act (RCRA) permitted surface impoundment (SI) that received facility process water and wastewater containing 2,4-dichlorophenoxyacetic acid (2,4-D) from 1978 through 1985. The SI consisted of three ponds (Ponds A, B and C, see **Figure 2**) that were used for evaporating the water and concentrating sludge. The primary chemicals in the water and sludge were 2,4-D, MCPA and MCPP and the associated phenolic breakdown products (MDEQ, 2010). The ponds were closed in 1985 and 1986 by removing the liquid, stabilizing the remaining sludge in place with quick lime and fly ash, and covering the solidified material with sand, gravel, and a high-density polyethylene (HDPE) liner (AECOM, 2102). An asphalt cap was added to the cover in 1991 (MDEQ, 2010). The liners beneath the ponds were left in place during closure.

The Transbas Closure Certificate was approved by the Montana Department of Health and Environmental Sciences (MDHES, now the MDEQ) in July 1987 (MDEQ, 2004) and the post-closure permit was issued in January 2003. Post-closure care for the regulated unit (the SI) is mandated by the current MDEQ hazardous waste permit for the facility (Permit No. MWHWP-04-01), which was issued in 2004 and expires in 2014. The SI is identified in the permit as the “regulated unit” or SWMU-6 (MDEQ, 2004).

3.1.2 Permit Requirements

The hazardous waste permit requires 30 years of post-closure maintenance and monitoring from the date of certified closure. The required maintenance and monitoring consists of inspecting the integrity of the asphalt, monitoring subsidence, erosion or animal burrowing, and conducting groundwater monitoring to ensure groundwater isn’t impacted by hazardous waste from the closed SI (MDEQ, 2004). Groundwater beneath SWMU-6 is monitored pursuant to the site-wide corrective action program outlined in hazardous waste permit MWHWP-04-01.

Per the permit, post-closure use of the SI that would result in disturbing the integrity of the final cover or containment system, or the function of the units monitoring systems, is not allowed unless the MDEQ finds that the disturbance is: 1) necessary to the proposed use of the property and will not increase the potential hazard to human health or the environment; or 2) necessary to reduce the threat to human health or the environment (MDEQ, 2004).

3.1.3 Facility Expansion and SWMU-6 Closure Evaluation

In 2005, due to increasing herbicide production demands at the already congested Billings plant, LPI began exploring options to expand the facility. The area encompassing SWMU-6 was identified as the preferred location to construct a new warehouse based on its proximity to other structures at the site. Additionally, by removing SWMU-6 potential risks to human health and the environment could be reduced.

In 2010, LPI requested authorization from MDEQ to excavate the waste sludge material remaining in the closed evaporation ponds and transfer it to a RCRA-permitted hazardous waste landfill or corrective action management unit (CAMU) (AECOM, 2011). The MDEQ responded with a letter in October 2010 indicating LPI must provide sampling evidence to show that the treatment of the sludge at the time of the pond closures was effective in reducing the toxicity and mobility of the principal hazardous waste constituent, 2,4-D (AECOM, 2011).

In 2011, samples of the solidified sludge were collected from trenches excavated into each of the former ponds in SWMU-6. The 2,4-D concentrations in the samples were compared to the concentration in current untreated wastewater sludge at the facility from a waste stream consistent with what was transferred to the ponds in the 1970s and 1980 (LPI, 2011; AECOM, 2012). The 2,4-D concentrations in the solidified sludge were on average 84% lower than the 2,4-D concentrations in the untreated sludge from the representative waste stream (AECOM, 2012). The average 2,4-D concentration in leachate from a toxicity characteristic leaching procedure (TCLP) completed on the samples was also approximately 64% lower than the average concentration for the untreated sludge.

In an August 2011 letter to LPI, the MDEQ indicated that the waste material from the permitted unit was CAMU eligible and could therefore be disposed of offsite at a permitted hazardous waste landfill (MDEQ, 2011; AECOM, 2012).

3.1.4 2012 Surface Impoundment Removal Activities

Following the receipt of authorization from the MDEQ (MDEQ, 2012a), the asphalt pavement covering the SI and the underlying soil, stabilized sludge, and liners were excavated Confirmation samples were collected at the extents of the excavations to ensure that soil containing 2,4-D concentrations exceeding the United States Environmental Protection Agency (USEPA) Regional Screening Level (RSL) had been removed. The RSL for 2,4-D based on dermal contact for industrial land use is 7,700 milligrams per kilogram (mg/kg).

A 2,4-D concentration of 7,100 mg/kg was detected at the northwest corner of the Pond A excavation in sample SI A-1A. Although the concentration was less than the RSL, additional soil was removed from this area (personal communication with AECOM project manager). No soil samples were collected after the additional soil was removed; however, it can be assumed that concentrations of 2,4-D, and any other chemicals related to the SI, were lower than what was detected in sample SI A-1A.

Ponds A, B and C were excavated to depths of 8 feet below the ground surface (bgs), 12 feet bgs and 10 feet bgs, respectively, and a total of 12,744 tons of solidified sludge and soil was removed from the SI and transported offsite for disposal (AECOM, 2012).

The excavations were backfilled in 1-foot lifts with overburden soil from the stockpiles pending analytical results and with pit run material imported from a local gravel pit (AECOM, 2012). The final surface grade was sloped to route storm water away from the building. Monitoring well MW-19, which was located between the ponds in SWMU-6, was abandoned during SI removal activities.

3.1.4.1 SWMU-6 Investigation

The presence of the SI precluded conducting an investigation in SWMU-6 during the Phase II RCRA Facility Investigation (RFI) completed in 1999 (Pentacore, 2002). Following the removal of the SI in 2012, soil samples were collected to identify and quantify residual chemicals in the soil in SWMU-6, and to provide data with which to perform a risk assessment and evaluate the need for further action (AECOM, 2012).

Fourteen soil samples were collected from the side walls of the excavations from approximately 4 to 6 feet bgs. Additional samples were collected from the base of the excavation at the soil/groundwater interface in Ponds A and B (one sample each) and from the saturated zone in

Pond C (two samples). The samples were collected at the same time that the excavation confirmation samples were collected. The samples were analyzed for chlorinated herbicides by USEPA method 8151, semi-volatile organic compounds (SVOCs) by USEPA method 8270C and volatile organic compounds (VOCs) by USEPA method 8260B.

Concentrations of 2,4-D were detected in all of the samples and were less than the RSLs. The concentrations from the base excavations at 12.5 feet bgs in Pond A, 14 feet in Pond B and 13.5 feet in Pond C were generally 2 to 3 orders of magnitude less than the concentrations in samples collected at 4-6 feet. Concentrations of MCPA were detected in 50% of the samples and were less than the RSLs. No MCPA was detected in the samples from the base of the excavations and no MCPP was detected in any of the samples.

The analytical results and data validation reports were presented in the Surface Impoundment Excavation Completion Report (AECOM, 2012). The analytical data is summarized in **Table 1** of this report and further evaluation of the data is presented below.

4.0 SWMU-6 RISK ASSESSMENT METHODOLOGY

The risk assessment was completed for SWMU-6 in general accordance with MDEQ Hazardous Waste Permit No. MTHWP-04-01 (MDEQ, 2004), and guidance from the USEPA and MDEQ (USEPA, 1996 and 1989; MDEQ, 2013). The risk assessment consisted of the following elements that were completed sequentially:

- Evaluating the data to be used in the risk assessment;
- Defining the chemicals of potential concern (COPCs) by comparing concentrations of chemicals detected in the soil, or analytical reporting limits (RLs) in SWMU-6, to generic soil screening levels (SSLs; i.e. RSLs for industrial receptors);
- Completing an Exposure Assessment which included:
    1) Reviewing geology, hydrogeology, surface hydrology and climate data to characterize the exposure setting;
    2) Developing conceptual site models (CSMs) to identify potentially complete human health and ecological exposure pathways and receptors;
    3) Defining the applicable exposure factors for the site; and
    4) Estimating Reasonable maximum exposure point concentrations (EPCs);
- Calculating site-specific SSLs based on realistic receptor and exposure factors;
- Comparing the COPC concentrations to the site-specific SSLs;
- Completing an Uncertainty Analysis; and
- Summarizing the results.

5.0 DATA EVALUATION AND COPC IDENTIFICATION

5.1 Data Evaluation

Analytical data from 14 soil samples and 2 duplicate samples collected in 2012 from 4 to 6 feet bgs at the periphery of the three former evaporation ponds in SWMU-6 were used to evaluate potential risks to human health and the environment. The evaporation ponds were the source of potential impacts in SWMU-6 and the number and location of the soil samples (see **Figure 2**) provide representative data with which to assess risk. Additional samples could not be taken south of the excavations due to the presence of other SWMUs and soil further to the north, east or west of the ponds is not expected to be impacted or would have lower concentrations than the samples collected. Soil samples collected from the base of the SI excavations from between 12.5 and 15 feet bgs were not used in the risk assessment as they were beyond the depth of concern for direct exposure and within or near the saturated zone.

The soil samples from SWMU-6 were analyzed for chlorinated herbicides by USEPA method 8151A, SVOCs by USEPA method 8270C and VOCs by USEPA method 8260B. The analytical data was validated in the 2012 SI Completion Report (AECOM, 2012a). The highest concentration (or RL when no concentration was detected) between the duplicate and original sample was retained for evaluation in the risk assessment.

5.2 COPC Identification Process

The chemicals of potential concern (COPCs) for SWMU-6 were identified by comparing concentrations detected in the soil samples or RLs for non-detected chemicals to the USEPA November 2012 RSLs for industrial receptors (see **Table 1**). No comparison to residential RSLs was conducted based on the depth to the residual chemicals in SWMU-6 and the historical and the current and likely future land use for the site (MDEQ, 1997). The COPC identification process was conducted pursuant to the MDEQ's Soil Screening Process Direct Exposure flow chart (MDEQ, 2012). Per MDEQ guidance, the RSLs for non-carcinogens were divided by 10 to account for potential exposure to multiple chemicals (MDEQ, 2012).

5.2.1 COPCs

The maximum concentration of the following chemicals detected in soil samples from SWMU-6 exceeded the RSLs:

- <u>Herbicides:</u> 2,4-D and MCPA, and
- <u>SVOCs:</u> Diallate.

No VOCs were detected at concentrations exceeding the RSLs.

Although the following chemicals were not detected in the soil samples from SWMU-6, they were retained for further evaluation due to RLs exceeding RSLs:

- <u>Herbicides:</u> MCPP;

- SVOCs: Benzidine, Benzo(a)pyrene, dibenz(a,h)anthracene, N-Nitrosodimethylamine, and N-Nitroso-di-n-propylamine; and
- VOCs: 1,2,3-Trichloropropane (1,2,3-TCP); 1,2-Dibromo-3-chloropropane (DBCP); and 1,2-Dibromoethane (EDB).

The chemicals analyzed for in the soil samples from SWMU-6 are listed in **Table 1** along with concentrations detected, RLs, RSLs and an indication if the chemicals are carcinogens or non-carcinogens. Summary statistics including the number of detections, frequency of detection and maximum and minimum concentrations and RLs are present in **Table 2**.

5.2.1.1 Acrolein

The RLs for acrolein, a VOC and non-carcinogen, exceeded the RSL. However, acrolein has never been used or stored at the facility, nor has it been detected in soil, groundwater or waste generated at the site. A chemist for LPI who has worked at the facility conducting laboratory analyses for more than 25 years has no knowledge of this chemical being onsite. Additionally, facility personnel in charge of formulating and registering herbicides indicated this chemical has not been used at the facility. Acrolein is not an ingredient, by product or degradation product of any formulated herbicides or other chemicals onsite. Retention of acrolein as a COPC would provide a misrepresentation of site conditions and introduce error into the risk assessment. Therefore, it was not retained as a COPC.

6.0 EXPOSURE ASSESSMENT

An exposure assessment was conducted to characterize the exposure setting at SWMU-6, identify potentially exposed human and ecological receptors, identify potentially complete exposure pathways, define realistic and site-specific exposure factors, and estimate reasonable maximum EPCs.

6.1 Exposure Setting

6.1.1 Site Geology

The geology beneath the site consists of silty and sandy clay that extends from the ground surface to approximately 22 feet bgs along the southern site boundary and to 5 feet bgs along the northern property boundary. The clay is interspersed with minor lenses of silty and clayey sand and overlies a confined to semi-confined sandy gravel water-bearing unit that extends to between 22 and 42 feet bgs (Pentacore, 2002). The water-bearing unit is underlain by shale.

The clay layer is approximately 15 and 20 feet thick at the periphery of SWMU-6 and the water bearing unit beneath the clay is approximately 5 to 20 feet thick (AECOM, 2010). Soil in the former evaporation pond areas in SWMU-6 consists of compacted overburden and gravel from the ground surface to between 13 and 16 feet bgs.

The geologic cross section used to interpret the geology for this report is presented in **Appendix A** and was originally presented in the 2010 Groundwater Corrective Measure Study (AECOM, 2010).

6.1.2 Site Hydrogeology

Groundwater beneath the site occurs in the sandy gravel layer at depths ranging from 8 to 20 feet bgs and generally flows north-northwest, with gradients ranging from 0.0013 to 0.0075 feet/foot (ft/ft) across the site (AECOM, 2010). The depth to groundwater beneath SWMU-6 varies from between approximately 15 feet on the south end at well OBS-7R, 12 feet on the north end at well M-12, and 19 feet in the center at former well M-19.

The groundwater potentiometric surface near the center of the site extends into the overlying clay during seasonal highs which indicates that the gravel unit is confined or semi-confined (AECOM, 2010). The hydraulic conductivity varies across the site from 1.63 x 10^{-1} to 9.77 x 10^{-4} centimeters per second (cm/s) and a value of 3.0 x 10^{-2} cm/s has historically been used to estimate the groundwater flow velocities (Pentacore, 2002; AECOM, 2010). The estimated groundwater flow velocities beneath the site have ranged from 1.6 to 9.0 x 10^{4} cm/s (between 165 and 930 feet per year) (Pentacore 2002; AECOM, 2010 and 2012b).

Discharge of groundwater occurs to the Yellowstone River, which is approximately 1,500 feet north of the site. Coulson Ditch, a man-made surface feature located just north of the facility, appears to have little effect on groundwater flow direction or gradient (AECOM, 2010).

6.1.3 Surface Water

Based on the site topography, runoff across most of the site occurs as sheet flow off the paved areas in the north-northwest to northerly direction (AECOM, 2010). Both surface water bodies adjacent to the site, an unnamed creek and Coulson Ditch, are bounded by 2-foot to 3-foot-high dikes and do not receive surface runoff from the facility (AECOM, 2010). Breaches in the dike along Coulson Ditch have been observed. However, even at these locations, the ground surface along Coulson Ditch is flat or rises slightly and is vegetated with grasses, preventing overland flow to the ditch for all but the largest storm events (AECOM, 2010). The majority of runoff from the site appears to collect and infiltrate in the unpaved areas in the north and northeastern portions of the site (Terracon, 1998; AECOM, 2010).

A vertical infiltration rate of 0.1 meter per year for the shallow site soils (the silts, clays, and silty clays) was assumed for the soil leaching model during the 2005 risk assessment for the site (RETEC, 2005a). This value is typically used for low-permeability sediments and is consistent with the nature of the shallow fine-grained soils observed at LPI (Fetter, 1994; AECOM, 2010).

6.1.4 Climate

Average monthly rainfall near Billings ranges from 0.44 inches in February to 2.35 inches in June, and there are only a few months during the year when rainfall exceeds the potential losses to evapotranspiration (Olson and Smith 2007; AECOM; 2010). The average annual snowfall is 57 inches and the average monthly snowfall from October through April is 7.72 inches (WRCC, 2013). The average monthly high temperatures range from 32.6 degrees Fahrenheit (°F) in January to 86.4 °F in July (WRCC, 2013). The average monthly low temperatures range from 14.1°F in January to 58.2 °F in July (WRCC, 2013). The prevailing wind direction at the Billings airport is to the southwest from August through April and to the north in May through July (WRCC, 2013).

6.2 Exposure Pathway and Receptor Evaluation

6.2.1 Conceptual Site Models

Conceptual site models were developed to identify potentially complete exposure pathways for human and ecological receptors at SWMU-6. For an exposure pathway to be identified as potentially complete and warrant further consideration, each of the following elements had to be present: (1 a chemical source; (2 a transport mechanism within environmental media (soil or groundwater); (3 a point of exposure where contact can occur; (4 a route of exposure (dermal contact, ingestion or inhalation), and (5 a potentially exposed population (human and/or ecological receptors) (ATSDR, 2005).

The following information was considered when developing the CSMs:

- The site is zoned for heavy industrial land use, has been used for pesticide formulation and manufacturing for more than 30 years, and there are plans to expand current operations;
- Chemicals remaining in the soil in SWMU-6 may have resulted from releases through breaches in the evaporation pond liners prior to their closure in the mid-1980s (Unifield, 1994), and/or from residual solidified sludge that mixed with the soil during closure of the SI;
- Residual impacts are present in subsurface soil (i.e. greater than 2 ft bgs), and generally at depths greater than 4 feet. During the 2012 SI excavation, the top of the solidified waste was encountered at approximately 5 feet bgs in Pond A, 4 to 7.7 feet bgs in Pond B and 2 to 5 feet bgs in Pond C;
- SWMU-6 currently consists of vacant land that will be used by the facility as space for an additional warehouse and/or vehicular traffic;
- Soil leaching models have indicated that soil leaching to groundwater is not a concern at the site (see Section 6.2.2);
- SWMU-6 has not contributed to groundwater impacts at the site. Concentrations of chemicals in the groundwater exceeding regulatory limits appear to be related to releases up- and cross-gradient from SWMU-6;
- There is no vegetation in SWMU-6 and any vegetation that would occur (i.e. weeds), would be ephemeral based on the seasons and activities at the site;
- Facility operations don't include subgrade activities;
- Excavation may occur at SWMU-6 during the installation of footings for a new warehouse; and
- There are no water supply wells on or adjacent to the site used for drinking water. The USEPA recently required connections to the public water supply for the site and surrounding properties.

6.2.2 Human Health CSM

Based on the depth to the residual impacts in the soil in SWMU-6 and the current and future land use of the site, excavation workers were identified as the primary receptor. Exposure to excavation workers could occur by direct contact (i.e. ingestion, dermal contact and inhalation of particulates or vapor) in excavations greater than 2 feet bgs. If VOCs are present in SWMU-6, current outdoor industrial workers or future indoor workers could inhale to vapors emanating from the soil. No other receptors or potentially complete exposure pathways were identified in the CSM. As noted, historical data and leaching evaluations indicate that the soil leaching is not a concern for the site and groundwater exposure pathways are incomplete. Further discussion of soil leaching is presented below.

A graphical presentation of the CSM identifying the receptors and potentially complete exposure pathways is presented in **Appendix B**.

6.2.3 Soil Leaching

In 2008, a soil leaching evaluation was conducted to determine if chemicals in the soil had the potential to degrade the quality of groundwater (ENSR, 2008). The evaluation was conducted using site-specific soil analytical and aquifer testing data in soil leaching and groundwater transport models. The modeling results indicated that soil leaching is not a concern at the site, although concentrations exceeded USEPA screening levels for groundwater protection (ENSR, 2008; MDEQ, 2010).

A second leaching evaluation was conducted using site-specific SSLs calculated with the default USEPA dilution attenuation factor (DAF). The evaluation included a sensitivity analysis to illustrate how the DAF is influenced by site-specific factors including hydraulic conductivity and infiltration. The results of the evaluation indicated that chemical concentrations in the soil exceeded the site-specific SSLs protective of groundwater; however, based on concentrations in monitoring wells adjacent to and downgradient of where the soil data was collected, leaching wasn't occurring (ENSR, 2008). Based on the results of the evaluations it was determined that leaching was impeded due to chemicals being bound in the clay in the unsaturated zone and/or biodegradation occurring.

Groundwater analytical data collected for more than 25 years has not shown any evidence that leaching was occurring from SWMU-6. Because the primary COPC sources in SWMU-6 have been removed (wastewater, sludge and the majority of impacted soil) and the residual impacts are in clay, soil leaching to groundwater is not expected to occur in the future. Additionally, the depth to groundwater beneath SWMU-6 is greater than typical depths for utility and construction workers. Therefore, all groundwater exposure pathways are considered incomplete.

Groundwater will continue to be monitored beneath and downgradient of SWMU-6 pursuant to the Groundwater Corrective Measure Study (AECOM, 2010) and the Hazardous Waste Permit. LPI expects future groundwater monitoring results to provide evidence that leaching isn't occurring.

6.2.4 Ecological CSM

Based on the following information, all potential ecological exposure pathways are considered incomplete:

- Residual chemicals in the soil in SWMU-6 are located below the root zone that would be achieved seasonally by opportunistic grasses or weedy forbs that are common to the area (Weaver, 1958);
- The plant uptake of the residual chemicals will not occur and the ingestion exposure pathway for herbivorous mammals is incomplete. Additionally, because most soil macroinvertebrates consumed by insectivorous mammals live in the root zone, the ingestion exposure pathway for this receptor is also incomplete (EPA, 1997);
- The burrow depths of the potential mammalian receptors (mountain cottontail and deer mice) are less than 4 feet bgs (Gano, et al. 1982; Chapman, 1975; Weber, 2013). Mountain cottontail and deer mice identified as potential ecological receptors in a 2005 screening level ecological risk assessment (SLERA) for Study Area 1, an unpaved area of the site located adjacent to the eastern border of SWMU-6 (RETEC, 2005);
- Soil leaching to groundwater is not a concern for the site; and
- Groundwater data from monitoring wells downgradient of SWMU-6 indicates that the Yellowstone River is not being impacted by the chemicals from the site.

6.3 Exposure Factors

Exposure factors that represent realistic exposure scenarios based on the CSM were utilized to calculate site-specific SSLs (see Section 8.1). The critical exposure factors for excavation and industrial workers that differ from the default exposure factors used by the USEPA to calculate the RSLs include: exposure duration, exposure frequency, averaging time, the climatic zone and the target risk value. The soil ingestion rate is also a critical factor of excavation workers. The recommend values for these factors from the MDEQ were used to calculate the site-specific SSLs, except for the exposure frequency for excavation workers which was established based on the realistic exposure scenario for the site as described below.

The USEPA did not include exposure factors for excavation workers in the Exposure Factors Handbook: 2011 Edition (USEPA, 2011). However the Oregon Department of Environmental Quality (ODEQ, 2010) has published exposure factors for excavation workers and the MDEQ has made recommendations on the Frequently Asked Question page on their web site (MDEQ, 2013).

The recommended value for exposure frequency for an excavation worker was 9 days by the ODEQ and 124 days (4 months) by the MDEQ, although the MDEQ indicated the value should be based on professional judgment. The value of 9 days per year was based on standard dimensions for a residential excavation site from ODEQ (1997a) and construction worker excavation statistics from USEPA and Means Heavy Construction Cost Data, 8th Annual Edition, R.S. Means Company, Inc., Kingston, MA (ODEQ, 2010).

The likely excavation that would occur at SWMU-6 would be for footings for a new building. To provide a conservative evaluation risk, it was assumed the excavation would remain open for 30 days. The actual time an excavation worker would be exposed within the excavation would likely be much less than 30 days based on the following realistic timeframe for construction: 1 to 2 days for excavation of the footings; 1 day to install rebar for the footings; 1 day to set the forms for the footings; and 1 day to pour the footings with concrete. This equates to a total of 5 days. Little to no exposure would occur if the excavations sit idle and it is not in the best interest of the facility to have open excavations for an extended period as they will impede vehicular traffic and the ability to store containers in this location, and prevent an unnecessary health and safety risk.

The exposure factors for excavation and industrial workers used in the RSL calculator are presented in **Table 3**.

6.4 Reasonable Maximum Exposure Point Concentrations

An exposure unit or area (i.e. SWMU-6) is the area throughout which a receptor moves and encounters an environmental medium for the duration of the exposure (USEPA, 2002a). Unless there is site-specific evidence to the contrary, an individual receptor is assumed to be equally exposed to media within all portions of the exposure unit over the time frame of the risk assessment (USEPA, 2002a). Per the USEPA and MDEQ, the 95% upper confidence limit (UCL), or greater, on the arithmetic mean of a population (i.e. the COPC concentration) should be used as the reasonable maximum EPC in a risk assessment (USEPA, 2010; MDEQ, 2013).

The MDEQ recommends using the USEPA ProUCL software to calculate the EPC (MDEQ, 2013). The software is capable of estimating the 95% UCL or greater with data sets that contain both detected and non-detected concentrations. When the data set consists only of non-detected concentrations, no 95% UCL can be calculated (USEPA, 2010). Based on a variety of statistical analysis performed by the program, ProUCL identifies multiple potential EPC values, but also recommends a value. The EPC values recommended by the ProUCL software were selected as the EPCs values for the SWMU-6 risk assessment.

6.4.1 Outliers and EPC Calculation

Prior to calculating the EPC, the EPA ProUCL software was used to evaluate the data sets for the three detected COPCs (2,4-D, MCPA and diallate) and determine if there were any outliers. The presence of outliers is common in environmental data and inclusion of outlier in a data set can distort the EPC and the understanding of risk for an exposure unit (USEPA, 2010). The maximum concentrations detected for 2,4-D (7,100 mg/kg) and diallate (36 mg/kg) were identified as outliers. The maximum concentrations were detected in an area that was excavated after the samples were collected and no longer represent site conditions. Based on this information and the ProUCL outlier test, the maximum concentrations should not be used to determine the EPC for 2,4-D and diallate. No outliers were identified for MCPA and outlier tests could not be conducted for the remaining COPCs that were not detected (EPA, 2010).

The results for the ProUCL outlier tests are presented in **Appendix C**. The EPCs calculated with the outliers removed are presented in **Table 4**. EPCs were also calculated with the maximum concentrations for 2,4-D and diallate included in the data set for reference and are included in

Table 4. Toxicity values used to calculate the EPCs are presented in **Table 5** and are presented below.

7.0 TOXICITY ASSESSMENT

The default toxicity values from the USEPA's online RSL calculator were used to develop the site-specific SSLs and are presented in **Table 5** (USEPA, 2013). The calculator did not have an inhalation unit risk factor for 1,2,3-TCP, so a value assigned by the California EPA was used in the calculations (CalEPA, 2005b). All toxicity values were reviewed to ensure the most current information available was used.

The sources for the toxicity values used by the USEPA and recommend by the MDEQ in the order of preference are: (1) USEPA's Integrated Risk Information System (IRIS); (2) USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs), and (3) Other sources including: the Agency for Toxic Substances and Disease Registry (ATSDR), California EPA, USEPA Health Effects Assessment Summary Tables (HEAST) and the World Health Organization Toxicity Equivalent Factors (WHO/TEF).

8.0 RISK CHARACTERIZATION

Risk characterization is the process of integrating the exposure and toxicity assessments for the derivation of site-specific estimates of risk. Target hazard quotients (HQs) and a hazard index (HI) of 1.0 were used to develop site-specific SSLs and evaluate individual and cumulative hazards from non-carcinogens (MDEQ, 2013). A lifetime excess cancer risk (ECR) of 1 in 100,000 (1E-05) was used to develop site-specific SSLs and as the acceptable endpoint for evaluating risks from carcinogens (MDEQ, 2013). Per the MDEQ, site-specific SSLs can be derived such that they do not result in a cumulative ECR greater than 1E-05 (MDEQ, 2013).

8.1 Site-Specific SSLs and Risk Estimates

Site-specific SSLs were calculated for the direct exposure pathway for excavation workers and for the inhalation pathway for industrial workers using the USEPA online RSL Calculator (USEPA, 2013). The RSL Calculator allows users to input site-specific data for exposure factors (**Table 4**) and toxicity values (**Table 5**).

The risk characterization was completed by comparing the site-specific SSLs based on three scenarios: 1) EPCs calculated with the outliers (i.e. the maximum concentrations of 2,4-D and diallate) removed; 2) EPCs calculated with the outliers; and 3) the maximum concentrations. The assessment completed using EPCs estimated without the maximum 2,4-D and diallate concentrations provides the best approximation of potential risk based on: 1) the results of the ProUCL outlier test; and 2) because the soil in SWMU-6 where with the maximum concentrations were collected has been removed.

The potential risks from carcinogens were evaluated by dividing the EPCs or maximum concentrations for the carcinogenic COPCs by the site-specific SSLs and multiplying the result by 1E-05. These results were summed to provide an evaluation of cumulative risks from carcinogens. The resulting estimated lifetime individual and cumulative ECRs for all three scenarios were less than the acceptable limit of 1E-05.

The HQs for the non-carcinogens and for carcinogens with non-carcinogenic toxicity were estimated by dividing the EPCs or maximum concentrations by the site-specific SSLs. The resulting HQs and HIs for each scenario were less than the acceptable limit of 1.

The results indicated that the residual COPCs in the soil in SWMU-6 do not present an unacceptable risk or hazard for current potential receptors (excavation workers and outdoor industrial workers) and future receptors (indoor industrial workers).

The risk characterization results for excavation workers by the direct exposure pathways are presented in **Table 6** and results for industrial workers for the inhalation of VOC vapors is presented in **Table 7**.

9.0 UNCERTAINTY ANALYSIS

9.1 Uncertainty with Selection of COPCs

The factors that contribute to the uncertainties associated with the evaluation of COPCs are inherent in the data collection and data evaluation processes, including appropriate sample locations, adequate sample quantities, laboratory analyses, data validation, and treatment of environmental samples. There is particular uncertainty regarding the potential presence of absence of chemicals that weren't detected and are only being retained as potential COPCs because the RL exceed the RSL. Historical data and knowledge of the facility can be used to minimize the inclusion of these chemicals as COPCs.

9.2 Uncertainties Related To Exposure Assessment

For SWMU-6, inclusion of chemicals with RLs exceeding RSLs as COPCs resulted in identifying and evaluating potentially complete exposure pathways (i.e. vapor exposure to current outdoor workers and future indoor workers) that wouldn't otherwise warrant consideration based on the chemicals detected at the site. Inclusion of the VOCs that weren't detected increases the uncertainty in the receptors and complete exposure pathways.

Other uncertainties in exposure assessment include the degree of completeness and confidence the EPC estimation and the exposure factors used to evaluate each potentially complete exposure pathway. Variability or heterogeneity in exposure routes and exposure dynamics, such as age, gender, behavior, genetic constitution, state of health, and random movement of the potentially exposed populations, also results in uncertainty over the exposure estimates.

For exposure pathways besides direct contact, there is also inherent uncertainty and error by establishing the risk based on measurement in the soil rather than at the point of contact. (USEPA, 1989a and 1992b). Additionally, for the vapor migration and inhalation pathway, the use of soil data rather than soil gas data results in a high degree of uncertainty due to the estimated partitioning from the solid to vapor phase (CalEPA, 2005b).

9.3 Uncertainties Related To Toxicity Assessment

Uncertainties associated with toxicity values used in the risk assessment include: 1) using dose response information from animal studies to predict effects in humans; 2) using dose response information from effects observed at high doses to predict the adverse effects that may occur following human exposure to the low levels; 3) using dose response information from short term exposure studies to predict the effects of long term exposures and vice versa; and 4) using dose response information from homogeneous animal populations or healthy human populations to predict the effects likely to be observed in the general population consisting of individuals with a wide range of sensitivities.

9.4 Uncertainties Related to Risk Characterization

Uncertainties in risk characterization are the product of many factors affecting each component of the risk assessment process, namely data collection/evaluation and selection of COPCs, exposure assessment, and toxicity assessment. These factors generally include, at a minimum, measurement errors, conservative exposure and modeling assumptions, and uncertainty and variability of the values used in the assessment.

Another uncertainty may include the conservative assumption that COPC concentrations do not decrease over time in the environment due to source depletion and biodegradation but remain at the concentrations measured during sample collection. This assumption has a low to moderate effect on the health risk results for soils where risk drivers include biodegradable chemicals.

10.0 CONCLUSIONS

The residual impacts in the soil do not present an unacceptable risk to human health or the environment. The risk assessment indicated that hazard levels and ECR estimates for direct exposure by excavation workers and vapor inhalation by current and future industrial workers were less than the MDEQ acceptable endpoints of 1.0 and 1E-05. There are no ecological concerns from the chemicals remaining in the soil in SWMU-6 since all ecological exposure pathways are incomplete.

Based on the results of the risk assessment, no further action is necessary to address the residual chemicals in the subsurface soil in SWMU-6. Additionally, the chemicals will not present unacceptable direct exposure or inhalation risk if a building is constructed in this area.

Based historical data and previous evaluations, soil leaching is not a concern for the site. It is not expected that these conditions will change since the potential contaminant sources (process water, sludge and impacted soil) have been removed from SWMU-6 and the residual COPCs are located in clay soil at periphery of the SI. Construction of a building in this area would also limit the potential for surface water infiltration.

Ongoing groundwater monitoring will be used to verify leaching does not occur. If leaching were to occur, impacts to the groundwater would be mitigated with the current remedial strategy for the site, monitored natural attenuation (MNA) (AECOM, 2010).

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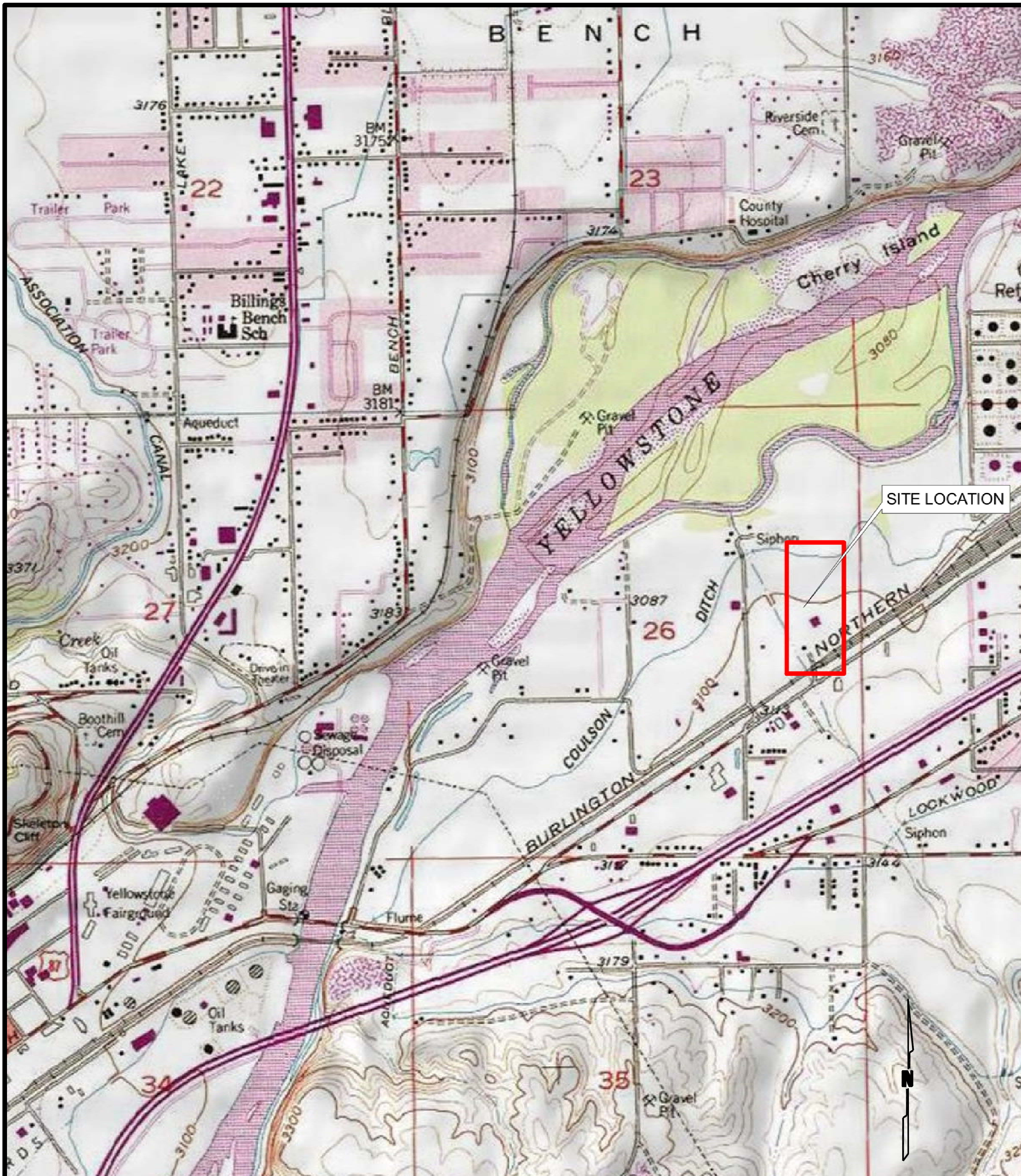
FIGURES

DRAFT SWMU-6 RISK ASSESSMENT

LOVELAND PRODUCTS, INC.
BILLINGS, MT

August, 2013



RUBIK ENVIRONMENTAL, INC.

527 Lander Street, Suite 204
Reno, Nevada 89509
(775) 622-0857

SITE VICINITY MAP

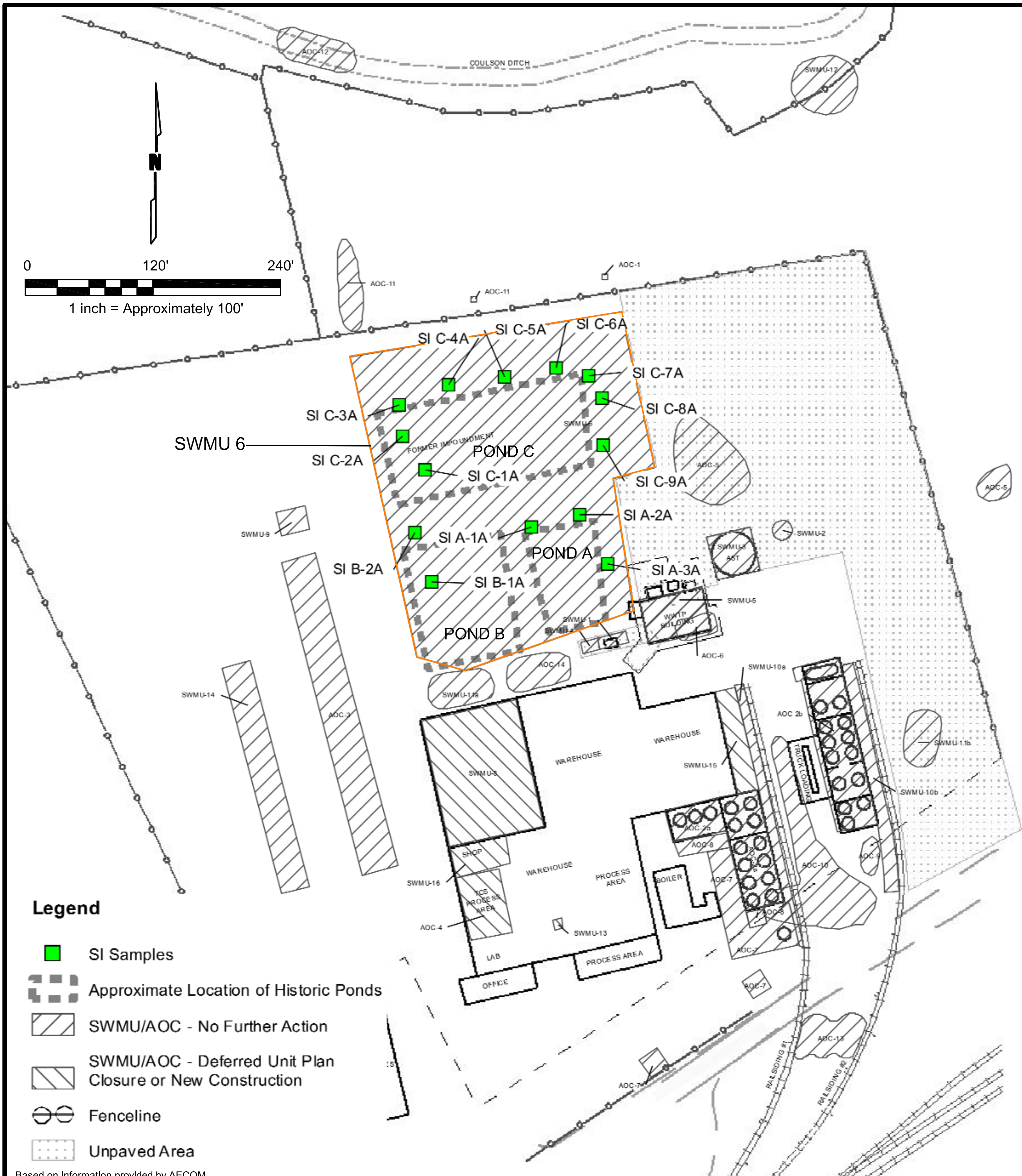
CPS Billings
1525 Lockwood Road
Billings, Montana

DESIGNED BY:	DETAILED BY:	CHECKED BY:
EDF	EDF	TLL

DATE:	ACAD FILE:
05/23/2013	20130523 RBK Billings MT DRAFT Figures.dwg
PROJECT NO.:	PLOT SCALE:
2013.158	APPROX. 1" = 1000'

FIGURE 1

L:\Rubik Environmental\Projects\CPS\Billings, MT\Risk Assessment\Rubik RA\Figures\20130523 RBK Billings MT DRAFT Figures.dwg



RUBIK ENVIRONMENTAL, INC.

527 Lander Street, Suite 204
Reno, Nevada 89509
(775) 622-0857

FACILITY LAYOUT AND SWMU 6 SOIL SAMPLE LOCATIONS

CPS Billings
1525 Lockwood Road
Billings, Montana

DESIGNED BY:	DETAILED BY:	CHECKED BY:
EDF	EDF	TLL

DATE:	ACAD FILE:
05/23/2013	20130523 RBK Billings MT DRAFT Figures.dwg
PROJECT NO.:	**PLOT SCALE:**
2013.158	APPROX. 1" = 120'

FIGURE 2

TABLES

DRAFT SWMU-6 RISK ASSESSMENT

LOVELAND PRODUCTS, INC.
BILLINGS, MT

August, 2013

Table 1. Analytical Results for SWMU-6 Soil Samples and Regional Screening Levels

Loveland Products, Inc.
Billings, MT

Chemical	RSL - Direct Contact, Industrial (mg/kg)		Sample Locations and Dates. Samples collected from 4 to 6 feet bgs. Concentrations are in mg/kg.															
	HQ =1 ECR = 1E-06	HQ = 0.1[a] ECR = 1E-06	Pond A (8/31/12)				Pond B (9/25/12)			Pond C (10/24/12)								
			SI A-1A	SI A-2A	SI A-3A	SI A-3A Dup	SI B-1A	SI B-2A	SI B-2A Dup	SI C-1A	SI C-2A	SI C-3A	SI C-4A	SI C-5A	SI C-6A	SI C-7A	SI C-8A	SI C-9A
Herbicides, Method 8151A																		
2,4,5-T	6,200	620	< 0.40	< 0.40	< 0.40	< 0.40	< 0.0040	< 0.040	< 0.040	**0.08**	**0.023**	**0.059**	**0.064**	**0.23**	**0.10**	< 0.40	**0.38**	**1.2**
2,4,5-TP (Silvex)	4,900	490	< 0.40	< 0.40	< 0.40	< 0.40	< 0.0040	< 0.040	< 0.040	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40	< 0.0040	< 0.40	< 0.40	< 0.40
2,4-D	7,700	770	**7,100**	**268 J**	**666**	**858**	**0.069 J**	**50**	**49**	**258**	**87**	**216**	**150**	**252**	**204**	**98**	**1350**	**3740**
2,4-DB	4,900	490	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	< 5.0 UJ	**0.12**	**0.77**	**0.81**	**3.1**	**1.5**	**3.8**	**4.0**	**6.1**	**1.8**	**0.30**	**4.9**	< 5.0
3,5-Dichlorobenzoic acid	---	---	< 1.0	< 0.10	< 0.10	< 0.10	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 1.0	< 1.0	< 0.010	< 0.010
4-Nitrophenol	---	---	< 1.0	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 1.0	< 1.0	< 1.0	< 0.010
Acifluoren	---	---	< 1.0	< 0.10	< 0.10	< 0.10	< 0.010	< 0.10	< 0.10	< 1.0	< 1.0	< 0.010	< 1.0	< 1.0	< 0.010	< 0.010	< 1.0	< 1.0
Bentazone	18,000	1,800	< 5.0	< 0.50	< 0.50	< 5.0	< 0.050	< 0.050	< 0.050	< 5.0	< 5.0	< 5.0	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 5.0
Chloramben	9,200	920	< 1.0	< 0.10	< 1.0	< 0.10	< 0.010	< 0.10	< 0.10	< 0.010	< 0.010	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dacthal	6,200	620	< 2.0	< 0.20	< 0.20	< 0.20	< 0.020	< 0.020	< 0.020	< 2.0	< 0.020	< 0.020	< 2.0	< 2.0	< 0.020	< 0.020	< 0.020	< 2.0
Dalapon	18,000	1,800	< 5.0	< 0.50	< 0.50	< 0.50	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Dicamba	18,000	1,800	**3.4**	**0.22 J**	**2.0**	**2.4**	**0.034**	**1.0**	**1.1**	**1.3**	**0.78**	**0.69**	**2.8**	**2.7**	**2.9**	**3.3**	**0.80**	**0.63**
Dichloroprop	---	---	**136**	**7.7 J**	**21**	**26**	< 0.20	**2.8**	**3.0**	**4.1**	**3.2**	**4.5**	**5.8**	**9.1**	**7.2**	**7.0**	**13**	**20**
Dinoseb	620	62	< 2.0	< 0.20	< 0.20	< 2.0	< 0.020	< 0.20	< 0.20	< 2.0	< 0.020	< 0.020	< 0.020	< 2.0	< 0.020	< 0.020	< 2.0	< 2.0
MCPA*	310	31	< 400	< 400	< 400	< 400	< 40 UJ	< 40 UJ	< 40 UJ	**25**	**12**	**26**	**31**	**40**	**24**	**14**	< 400	< 400
MCPP*	620	62	< 400	< 400	< 400	< 400	< 4.0	< 40	< 40	< 400	< 400	< 400	< 400	< 400	< 400	< 400	< 400	< 400
Pentachlorophenol	2.7	2.7	< 0.20	< 0.20	< 0.20	< 0.20	< 0.0020	< 0.20	< 0.20	< 2.0	< 0.20	< 2.0	< 0.20	< 2.0	< 2.0	< 2.0	< 10	< 1.0
Picloram	43,000	4,300	< 1.0	< 0.10	< 0.10	< 0.10	< 0.010	< 0.010	< 0.010	< 1.0	< 1.0	< 0.010	< 1.0	< 0.010	< 0.010	< 0.010	< 0.010	< 1.0
SVOCS, Method 8270C																		
1-Methylnaphthalene	53	53	**3.9**	< 0.33	**0.38**	**0.40**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	**0.23 J**	< 0.33	**0.27 J**	< 0.33	< 0.33	**1.5**	**2.2**
2,2'-Oxybis (1-Chloropropane) [bis(2-chloroisopropyl)ether]	22	22	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
2,4,5-Trichlorophenol	62,000	6,200	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
2,4,6-Trichlorophenol	160	160	**3.4**	**0.62**	**0.97**	**0.76**	< 0.33	**0.12 J**	**0.15 J**	**0.22 J**	**0.31 J**	**0.23 J**	**0.26 J**	**0.26 J**	**0.63**	**0.22 J**	**0.68**	**0.69**
2,4-Dichlorophenol	1,800	180	**74**	**8.6**	**23**	**18**	< 0.33	**8.8**	**9.6**	**6.2**	**15**	**17**	**8.2**	**14**	**34**	**13**	**35**	**29**
2,4-Dimethylphenol	12,000	1,200	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
2,4-Dinitrophenol	1,200	120	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7 UJ	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2,4-Dinitrotoluene	5.5	5.5	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
2,6-Dinitrotoluene	620	62	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
2-Chloronaphthalene	82,000	8,200	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
2-Chlorophenol	5,100	510	< 0.33	< 0.33	**0.30 J**	**0.28 J**	< 0.33	< 0.33	< 0.33	**0.088 J**	**0.13 J**	**0.10 J**	**0.17 J**	< 0.33	**0.22 J**	**0.23 J**	**0.41**	**0.11 J**
2-Methylnaphthalene	2,200	220	**7.2**	**0.24 J**	**0.62**	**0.62**	< 0.33	< 0.33	< 0.33	< 0.33	**0.067 J**	**0.36**	< 0.33	**0.37**	**0.067 J**	< 0.33	**2.5**	**3.6**
2-Methylphenol (o-cresol)	31,000	3,100	< 0.33	< 0.33	< 0.33	< 0.33	**0.14 J**	**2.9**	**2.6**	**0.37**	**0.082 J**	**0.058 J**	< 0.33	< 0.33	**0.070 J**	**0.12 J**	**0.22 J**	< 0.33
2-Nitrophenol	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
3,3'-Dichlorobenzidine	3.8	3.8	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
3,4-Methylphenol (m+p cresols)	62,000	6,200	< 0.33	< 0.33	**0.097 J**	< 0.33	< 0.33	**0.13 J**	**0.078 J**	< 0.33	**0.28 J**	**0.17 J**	< 0.33	< 0.33	**0.16 J**	**0.12 J**	**0.12 J**	< 0.33
4,6-Dinitro-2-methylphenol	49	5	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
4-Bromophenyl-phenylether	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
4-Chloro-2-methylphenol	---	---	**4.6**	**1.8**	**1.8**	**1.7**	**2.7**	**4.8**	**5.4**	**0.56**	**6.1**	**1.2**	**3.3**	**0.89**	**8.1**	**15**	**4.4**	**2.4**
4-Chloro-3-methylphenol	62,000	6,200	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	**0.65**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
4-Chloroaniline (p-chloroaniline)	8.6	8.6	**1.3**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
4-Chlorophenol	---	---	**4.8**	**5.0**	**5.6**	**3.9**	**0.19 J**	**7.8**	**9.0**	**6.4**	**33**	**22**	**7.1**	**4.0**	**35**	**29**	**29**	**18**
4-Chlorophenyl-phenylether	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
4-Nitroaniline	86	86	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Acenaphthene	33,000	3,300	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Acenaphthylene	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Anthracene	170,000	17,000	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Azobenzene	23	23	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzidine*	0.0075	0.0075	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzo(a)anthracene	2.1	2.1	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzo(a)pyrene*	0.21	0.21	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzo(b)fluoranthene	2.1	2.1	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzo(g,h,i)perylene	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzo(k)fluoranthene	21	21	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Benzoic acid	2,500,000	250,000	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33 UJ	**0.42**	**0.39**	< 0.33 UJ	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
bis(2-Chloroethoxy)methane	1,800	180	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
bis(2-Chloroethyl)ether	1	1	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33

Table 1. Analytical Results for SWMU-6 Soil Samples and Regional Screening Levels

Loveland Products, Inc.
Billings, MT

	RSL - Direct Contact, Industrial (mg/kg)		Sample Locations and Dates. Samples collected from 4 to 6 feet bgs. Concentrations are in mg/kg.															
	HQ =1	HQ = 0.1[a]	Pond A (8/31/12)				Pond B (9/25/12)			Pond C (10/24/12)								
Chemical	**ECR = 1E-06**	**ECR = 1E-06**	**SI A-1A**	**SI A-2A**	**SI A-3A**	**SI A-3A Dup**	**SI B-1A**	**SI B-2A**	**SI B-2A Dup**	**SI C-1A**	**SI C-2A**	**SI C-3A**	**SI C-4A**	**SI C-5A**	**SI C-6A**	**SI C-7A**	**SI C-8A**	**SI C-9A**
bis(2-Ethylhexyl)phthalate	120	120	**0.73**	< 0.33	**0.45**	**0.44**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	**0.35**	< 0.33	< 0.33	< 0.33	< 0.33	**0.75**	**0.84**
Butylbenzylphthalate	910	910	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Chrysene	210	210	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Diallate	28	28	**36**	**1.3**	**17**	**16**	**0.70**	**0.88**	**0.99**	< 0.33	**0.91**	**0.24 J**	< 0.33	**0.21 J**	**0.61**	< 0.33	**0.54**	**0.57**
Dibenz(a,h)anthracene*	0.21	0.21	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Dibenzofuran	1,000	100	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Diethylphthalate	490,000	49,000	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Dimethylphthalate	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Di-n-butylphthalate	62,000	6,200	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Di-n-octylphthalate	---	---	**2.1**	< 0.33	**0.40**	**0.36**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	**0.16 J**	< 0.33	< 0.33	**1.4**	**2.2**
Fluoranthene	22,000	2,200	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Fluorene	22,000	2,200	**0.10 J**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Hexachlorobenzene	1.1	1.1	**0.13 J**	**0.068 J**	**0.079 J**	**0.072 J**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Hexachlorocyclopentadiene	3,700	370	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Hexachloroethane	43	43	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Indeno(1,2,3-cd)pyrene	2.1	2.1	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Isophorone	1,800	1,800	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Nitrobenzene	24	24	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
N-Nitrosodimethylamine*	0.034	0.034	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
N-Nitroso-di-n-propylamine*	0.25	0.25	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
N-Nitrosodiphenylamine	350	350	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Phenanthrene	---	---	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Phenol	180,000	18,000	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	**1.3**	**0.48**	**0.29 J**	**0.16 J**	**0.098 J**	**0.27 J**	**0.20 J**	**1.2**	< 0.33
Pyrene	17,000	1,700	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Pyridine	1,000	100	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
Triallate	8,000	800	**767**	**37**	**217**	**233**	**14 J**	**0.68**	**0.83**	**3.9 J**	**10**	**63**	**12**	**100**	**17**	**6.4**	**221**	**219**
VOCs, Method 8260B																		
1,1,1,2-Tetrachloroethane	9.3	9.3	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,1,1-Trichloroethane	38,000	3,800	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,1,2,2-Tetrachloroethane	2.8	2.8	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,1,2-Trichloroethane	5.3	5.3	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,1-Dichloroethane	17	17	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,1-Dichloroethene	1,100	110	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,1-Dichloropropene	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2,3-Trichlorobenzene	490	49	---	---	---	< 0.20	---	---	---	---	---	---	---	---	---	---	---	---
1,2,3-Trichloropropane (1,2,3-TCP)*	0.095	0.095	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2,4-Trichlorobenzene	99	99	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2,4-Trimethylbenzene	260	260	**123**	**1.9**	**5.9**	**7.5**	**0.055 J**	**0.11 J**	**0.095 J**	**0.77 J**	**0.15 J**	**2.9**	**0.13 J**	**2.1**	**0.47**	< 0.20	**5.4**	**11**
1,2-Dibromo-3-chloropropane (DBCP)*	0.069	0.069	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2-Dibromoethane (EDB)*	0.17	0.17	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2-Dichlorobenzene	9,800	980	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2-Dichloroethane	2.2	2.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,2-Dichloropropane	4.7	4.7	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,3,5-Trimethylbenzene	10,000	1,000	**38**	**0.56**	**2.0**	**2.3**	< 0.20	< 0.20	**0.026 J**	**0.35**	**0.058 J**	**1.2**	**0.047 J**	**0.86**	**0.19 J**	< 0.20	**2.0**	**3.9**
1,3-Dichlorobenzene	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,3-Dichloropropane	20,000	20,000	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
1,4-Dichlorobenzene	12	12	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
2,2-Dichloropropane	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
2-Butanone (Methyl ethyl ketone)	200,000	20,000	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
2-Chloroethylvinyl ether	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
2-Chlorotoluene	20,000	2,000	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
2-Hexanone	1,400	140	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
4-Chlorotoluene	20,000	2,000	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
4-Isopropyl toluene	---	---	< 0.20	< 0.20	**0.059 J**	**0.066 J**	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.064 J**	< 0.20	< 0.20	< 0.20	< 0.20
4-Methyl-2-pentanone (Methyl isobutyl ketone)	53,000	5,300	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Acetone	630,000	63,000	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	**0.98 J**	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Acrolein*	0.65	0.065	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Benzene	5.4	5.4	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20

Table 1. Analytical Results for SWMU-6 Soil Samples and Regional Screening Levels

Loveland Products, Inc.
Billings, MT

Chemical	RSL - Direct Contact, Industrial (mg/kg)		Sample Locations and Dates. Samples collected from 4 to 6 feet bgs. Concentrations are in mg/kg.															
	HQ =1	HQ = 0.1[a]	Pond A (8/31/12)				Pond B (9/25/12)			Pond C (10/24/12)								
	ECR = 1E-06	ECR = 1E-06	SI A-1A	SI A-2A	SI A-3A	SI A-3A Dup	SI B-1A	SI B-2A	SI B-2A Dup	SI C-1A	SI C-2A	SI C-3A	SI C-4A	SI C-5A	SI C-6A	SI C-7A	SI C-8A	SI C-9A
Bromobenzene	1,800	180	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Bromochloromethane	680	68	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Bromodichloromethane	1.4	0.14	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Bromoform	220	220	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Bromomethane	32	3.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Carbon disulfide	3,700	370	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Carbon tetrachloride	3	3	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chlorobenzene	1,400	140	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chloroethane	61,000	6100	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chloroform	1.5	1.5	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chloromethane	500	50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
cis-1,2-Dichloroethene	2,000	200	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
cis-1,3-Dichloropropene	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Dibromochloromethane (Chlorodibromomethane)	3.3	3.3	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Dibromomethane	110	11	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Dichlorodifluoromethane	400	40	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Ethylbenzene	27	27	**0.96**	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.040 J**	**0.41**
Hexachlorobutadiene	22	22	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Isopropylbenzene (Cumene)	11,000	1100	**2.2**	**0.033 J**	**0.12 J**	**0.14 J**	< 0.20	< 0.20	< 0.20	**0.028 J**	< 0.20	**0.098 J**	< 0.20	**0.075 J**	< 0.20	< 0.20	**0.20**	**0.58**
m,p-Xylene	2,500	250	**4.3**	< 0.20	**0.087 J**	**0.096 J**	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.11 J**	< 0.20	**0.063 J**	< 0.20	< 0.20	**0.23**	**1.8**
Methylene chloride	960	960	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.042 J**	< 0.20
Methyl tert-Butyl ether	220	220	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Naphthalene	18	18	**4.0**	**0.64**	**0.82**	**0.85**	< 0.20	< 0.20	< 0.20	**0.083 J**	< 0.20	**0.21**	< 0.20	**0.13 J**	< 0.20	< 0.20	**0.48**	**0.67**
n-Butylbenzene	51,000	5100	< 0.20 UJ	< 0.20 UJ	< 0.20 UJ	< 0.20 UJ	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
n-Propylbenzene	21,000	2100	**15**	**0.14 J**	**0.40**	**0.47**	< 0.20	< 0.20	< 0.20	**0.080 J**	< 0.20	**0.32**	< 0.20	**0.27**	**0.079 J**	< 0.20	**0.70**	**1.7**
o-Xylene	3,000	300	**18**	**0.055 J**	**0.15 J**	**0.16 J**	< 0.20	< 0.20	< 0.20	**0.067 J**	< 0.20	**0.27**	< 0.20	**0.16 J**	**0.046 J**	< 0.20	**0.55**	**2.6**
sec-Butylbenzene	---	---	**0.62**	< 0.20	**0.075 J**	**0.088 J**	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.037 J**	< 0.20	< 0.20	**0.090 J**	< 0.20
Styrene	36,000	3600	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
tert-Butylbenzene	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Tetrachloroethene	110	110	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Toluene	45,000	4500	**13**	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.11 J**	< 0.20	**0.044 J**	< 0.20	< 0.20	**0.097 J**	**4.5**
trans-1,2-Dichloroethene	690	69	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
trans-1,3-Dichloropropene	---	---	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Trichloroethene	6.4	6.4	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Trichlorofluoromethane	3,400	340	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Vinyl Acetate	4,100	410	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Vinyl chloride	1.7	1.7	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Xylene, total	2,700	270	**22**	< 0.20	**0.087 J**	**0.096 J**	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**0.11 J**	< 0.20	**0.063 J**	< 0.20	< 0.20	**0.23**	**1.8**

Notes:
Shading indicates concentration or reporting limit in excess of applicable screening level
Bold font indicates concentration above detection limit
* = Reporting limit exceeded RSL
RSL = The November 2012 USEPA Industrial Soil Regional Screening Level
HQ = Hazard quotient
ECR = Lifetime Excess cancer risk
Dup = Designates field Duplicate
mg/kg = Milligrams per kilogram
J = Estimated concentration: Analyte detected below quantitation limits
U = Evaluated to be undetected at the reporting limit/concentration,
[a]=non -carcinogenic RSL divided by 10 per MDEQ Soil Screening Process: Part 1 - Direct Exposure

Table 2. Summary Statistics for the COPCs
Loveland Products, Inc.
Billings, MT

Analyte	# of Samples	# of Detections	Detection Frequency	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Reporting Limit (mg/kg)	Maximum Reporting Limit (mg/kg)	Outliers (mg/kg)	EPC- No Outliers[b] (mg/kg)	EPC -with Outliers[a] (mg/kg)
Detected COPCs										
2,4-D	14	14	100%	0.069	7100			Yes Max Conc.	1,622	3,038
MCPA	14	7	50%	12	40	40	400	No	29.92	29.22
Diallate	14	13	93%	0.21	36	0.33	0.33	Yes Max Conc.	9.83	31.51
Non-Detected COPCs										
Benzidine	14	0	0%			0.33	0.33			
Benzo(a)pyrene	14	0	0%			0.33	0.33			
Dibenz(a,h)anthracene	14	0	0%			0.33	0.33			
1,2-Dibromo-3-chloropropane	14	0	0%			0.2	0.2			
1,2-Dibromoethane	14	0	0%			0.2	0.2			
MCPP	14	0	0%			4	400			
N-Nitroso-di-n-propylamine	14	0	0%			0.33	0.33			
N-Nitrosodimethylamine	14	0	0%			0.33	0.33			
1,2,3-Trichloropropane	14	0	0%			0.2	0.2			

Notes:
mg/kg = milligrams per kilogram
EPC = Reasonable maximum exposure point concentration. Calculated with US EPA ProUCL software. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate.
[a]Maximum concentrations for 2,4-D and diallate were identified as outliers by ProUCL and the soil where the maximum concentration was detected has been removed. The outlier were not included in the data used to calculate the EPC to provide a realistic, site-specific evaluation or risk.. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate. See Table 5
[b]Maximum concentrations for 2,4-D and diallate were identified as outliers by ProUCL and the soil where the maximum concentration was detected has been removed. The outliers were included in the data used to calculate this EPC for reference. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate.
RSL= regional screening level
COPC = chemical of potential concern
Includes soil data available from 4-6 fee
Shading indicates a detected COPC
ND = not detected
MDC = maximum detected concentration
MRL = maximum reporting limit

Table 3. Exposure Factors for Site-Specific Screening Levels

Loveland Products, Inc.
Billings, MT

Variable	Definition	Units	Exposure Factor		Reference* Industrial / Excavation
			Industrial Workers	Excavation Workers	
TR	Target Risk	unitless	1.00E-05	1.00E-05	MDEQ, 2013
THQ	Target Hazard Quotient	unitless	1.00E+00	1.00E+00	MDEQ, 2013
AT_{ow}	Averaging Time - Outdoor Worker	days per year	3.65E+02	3.65E+02	MDEQ, 2013
EF_{ow}	Outdoor Worker Exposure Frequency	days per year	1.87E+02	3.00E+01	MDEQ, 2013 / Site Specific Value
ED_{ow}	Outdoor Worker Exposure Duration	year	1.00E+00	1.00E+00	MDEQ, 2013
Etow	Outdoor Worker Exposure Duration	hours per day	8.00E+00	8.00E+00	USEPA, 2013
LT	Lifetime	year	7.80E+01	7.80E+01	MDEQ, 2013
Bwow	Body Weight	k	8.00E+01	7.00E+01	MDEQ, 2013 / USEPA, 2013
IR_{ow}	Soil Ingestion Rate	mg per day	3.30E+02	3.30E+02	USEPA, 2013
Saow	Surface Area Outdoor Worker	cm^2	3.30E+03	3.30E+03	USEPA, 2013
AF_{ow}	Adherence Factor Outdoor Worker	mg per cm^2 per day	2.00E-01	2.00E-01	USEPA, 2013
City	Climate Zone	unitless	Casper, WY (4)	Casper, WY (4)	USEPA, 2013
A_s	Acres	$acres^2$	0.5	0.5	USEPA, 2013
Q/C_{wp}	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source	g/m^2-s per kg/m^3	1.02E+02	1.02E+02	USEPA, 2013
PEF	Particulate Emission Factor`	m^3/kg	2.69E+08	2.69E+08	USEPA, 2013
VF	Volatilization Factor - DBCP	m^3/kg	5.14E+04	5.14E+04	USEPA, 2013
	EDB	m^3/kg	1.39E+04	1.39E+04	USEPA, 2013
	1,2,3-TCP	m^3/kg	2.52E+04	2.52E+04	USEPA, 2013
SSF	Soil Saturation Factor - DBCP	mg/kg	9.80E+02	9.80E+02	USEPA, 2013
	EDB	mg/kg	1.34E+03	1.34E+03	USEPA, 2013
	1,2,3-TCP	mg/kg	2.52E+04	2.52E+04	USEPA, 2013
A	Dispersion Constant	unitless	7.1414	7.14E+00	USEPA, 2013
B	Dispersion Constant	unitless	3.12E+01	3.12E+01	USEPA, 2013
C	Dispersion Constant	unitless	3.83E+02	3.83E+02	USEPA, 2013
V	Fraction of Vegetative Cover	unitless	5.00E-01	5.00E-01	USEPA, 2013
U_m	Mean Annual Wind Speed	m/s	5.77E+00	5.77E+00	USEPA, 2013
U_t	Equivalent Threshold Value of Wind Spee	m/s	1.13E+01	1.13E+01	USEPA, 2013
F(x)	Function Dependent on U_m / U_t	unitless	5.70E-01	5.70E-01	USEPA, 2013
City	Climate Zone	unitless	Casper, WY (4)	Casper, WY (4)	USEPA, 2013
A_s	Acres	$acres^2$	0.5	0.5	USEPA, 2013
Q/C_{wp}	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source	g/m^2-s per kg/m^3	1.02E+02	1.02E+02	USEPA, 2013
foc	Organic Carbon Content of Soil	g/g	6.00E-03	6.00E-03	USEPA, 2013
ρb	Dry Soil Bulk Density	g/cm3	1.50E+00	1.50E+00	USEPA, 2013
ρs	Soil Particle Density	g/cm3	2.65E+00	2.65E+00	USEPA, 2013
θw	Water Filled Soil Porosity	L_{water}/L_{soil}	1.50E-01	1.50E-01	USEPA, 2013
T	Exposure Interval	s	9.50E+08	9.50E+08	USEPA, 2013
A	Dispersion Constant	unitless	7.14E+00	7.14E+00	USEPA, 2013
B	Dispersion Constant	unitless	3.12E+01	3.12E+01	USEPA, 2013
C	Dispersion Constant	unitless	3.83E+02	3.83E+02	USEPA, 2013

Notes:
*See Section 10 of SWMU-6 Risk Assement (Rubik, 2013)
cm = Centimeter
g = Gram
k = Kilogram
L = Liter
m = Meter
mg = Milligram
s = Second

Table 4. Reasonable Maximum Exposure Point Concentrations

Loveland Products, Inc.
Billings, MT

COPC	Maximum Concentration or RL (mg/kg)	EPC Outliers Removed[a] (mg/kg)	EPC w/ Outliers[b] (mg/kg)
2,4-D	**7100**	1,622	3,038
MCPA	400	29.92	29.92
Diallate	**36**	9.83	31.51
Benzidine	0.33	0.33	0.33
Benzo(a)pyrene	0.33	0.33	0.33
Dibenz(a,h)anthracene	0.33	0.33	0.33
1,2-Dibromo-3-chloropropane	0.2	0.2	0.2
1,2-Dibromoethane	0.2	0.2	0.2
MCPP	400	400	400
N-Nitroso-di-n-propylamine	0.33	0.33	0.33
N-Nitrosodimethylamine	0.33	0.33	0.33
1,2,3-Trichloropropane	0.2	0.2	0.2

Notes:

COPC = Chemical of potential concern

RL = Laboratory reporting limit. The RL was provided the no concentration of a COPC was detected

mg/kg = milligrams per kilogram

EPC = Reasonable maximum exposure point concentration. Calculated with US EPA ProUCL software. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate.

[a]Maximum concentrations for 2,4-D and diallate were identified as outliers by ProUCL and the soil where the maximum concentration was detected has been removed. The outliers were not included in the data used to calculate the EPC to provide a realistic, site-specific evaluation or risk. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate. See Table 4

[b]Maximum concentrations for 2,4-D and diallate were identified as outliers by ProUCL and the soil where the maximum concentration was detected has been removed. The outliers were included in the data used to calculate this EPC for reference. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate.

Shading and bold indicates a detected COPC. All other concentrations are based on analtyical reporting limits.

Table 5. Toxicity Values used for Site-Specific Screening Levels

Loveland Products, Inc.
Billings, MT

Chemical	CAS Number	Carcinogen	VOC	Ingestion Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Reference	Chronic RfDo (mg/kg-day)	Reference	Chronic RfCi (mg/m^3)	Reference	GIABS*	ABS*	rba*	Volatilization Factor* (m^3/kg)	Soil Saturation Concentration* (mg/kg)	Particulate Emission Factor* (m^3/kg)
Benzidine	92-87-5	Yes	No	2.30E+02	IRIS	6.70E-02	IRIS	3.00E-03	IRIS	-		1	0.1	1	-	-	2.69E+08
Benzo[a]pyrene	50-32-8	Yes	No	7.30E+00	IRIS	1.10E-03	CALEPA	-		-		1	0.13	1	-	-	2.69E+08
Diallate	2303-16-4	Yes	No	6.10E-02	HEAST	-		-		-		1	0.1	1	-	-	2.69E+08
Dibenz[a,h]anthracene	53-70-3	Yes	No	7.30E+00	WHO/TEF	1.20E-03	CALEPA	-		-		1	0.13	1	-	-	2.69E+08
Dibromo-3-chloropropane, 1,2-	96-12-8	Yes	Yes	8.00E-01	PPRTV	6.00E-03	PPRTV	2.00E-04	PPRTV	2.00E-04	IRIS	1	-	1	5.14E+04	9.80E+02	2.69E+08
Dibromoethane, 1,2-	106-93-4	Yes	Yes	2.00E+00	IRIS	6.00E-04	IRIS	9.00E-03	IRIS	9.00E-03	IRIS	1	-	1	1.39E+04	1.34E+03	2.69E+08
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	No	No	-		-		1.00E-02	IRIS	-		1	0.05	1	-	-	2.69E+08
MCPA	94-74-6	No	No	-		-		5.00E-04	IRIS	-		1	0.1	1	-	-	2.69E+08
MCPP	93-65-2	No	No	-		-		1.00E-03	IRIS	-		1	0.1	1	-	-	2.69E+08
Nitroso-di-N-propylamine, N-	621-64-7	Yes	No	7.00E+00	IRIS	2.00E-03	CALEPA	-		-		1	0.1	1	-	-	2.69E+08
Nitrosodimethylamine, N-	62-75-9	Yes	No	5.10E+01	IRIS	1.40E-02	IRIS	8.00E-06	PPRTV	4.00E-05	PPRTV	1	0.1	1	-	-	2.69E+08
Trichloropropane, 1,2,3-	96-18-4	Yes	Yes	3.00E+01	IRIS	2.00E-03	CALEPA	4.00E-03	IRIS	3.00E-04	IRIS	1	-	1	2.52E+04	1.40E+03	2.69E+08

Notes:
CAS = Chemical Abstracts Service
VOC = Volatile Organic Compound
mg = Milligrams
kg = Kilograms
µg = Micrograms
m = Meter
RfDo = Reference dose - Oral
RfCi = Reference concentration - Inhalation
GIABS = Gastrointestinal Absorbtion Factor
ABS = Absorbtion Factor
RBA = Relative Bioavailability
IRIS = USEPA Integrated Risk Information System
PPRTV = USEPA's Provisional Peer Reviewed Toxicity Values
HEAST = USEPA Health Effects Assessment Summary Tables
WHO = World Health Organization Toxicity Equivalent Factors
*Values based onUSEPA Regional Screening Level (RSL) Industrial Soil November 2012 and USEPA Online RSL Calculator

Table 6. Site-Specific Screening Levels and Risk Estimates for Excavation Workers

Loveland Products, Inc.
Billings, MT

Chemical Name	EPC No Outliers (mg/kg)	EPC - with Outliers (mg/kg)	Max Conc. or RL (mg/kg)	Site-Specific Screening Level (ECR = 1E-05)	Site-Specific Screening Level (HQ = 1)	Excess Cancer Risk: EPC No Outliers (mg/kg)	Excess Cancer Risk: EPC - w/ Outliers (mg/kg)	Excess Cancer Risk: Max Conc. or RL (mg/kg)	Hazard Quotient: EPC No Outliers (mg/kg)	Hazard Quotient: EPC - All Data (mg/kg)	Hazard Quotient: Maximum Concentration or RL (mg/kg)
2,4-D	**1,622**	**3,038**	**7,100**	NA	2.35E+04	NA	NA	NA	0.07	0.13	0.30
Diallate	**9.83**	**31.51**	**36.00**	2.75E+04	NA	3.6E-09	1.1E-08	1.3E-08	NA	NA	NA
MCPA*	**29.92**	**29.92**	400.00	NA	1.08E+03	NA	NA	NA	0.03	0.03	0.37
MCPP*	400.00	400.00	400.00	NA	2.15E+03	NA	NA	NA	0.19	0.19	0.19
Benzidine*	0.33	0.33	0.33	7.29E+00	6.45E+03	4.5E-07	4.5E-07	4.5E-07	0.0001	0.0001	0.0001
Benzo(a)pyrene*	0.33	0.33	0.33	2.19E+02	NA	1.5E-08	1.5E-08	1.5E-08	NA	NA	NA
Dibenz(a,h)anthracene*	0.33	0.33	0.33	2.19E+02	NA	1.5E-08	1.5E-08	1.5E-08	NA	NA	NA
N-Nitroso-di-n-propylamine*	0.33	0.33	0.33	2.40E+02	NA	1.4E-08	1.4E-08	1.4E-08	NA	NA	NA
N-Nitrosodimethylamine*	0.33	0.33	0.33	3.29E+01	1.72E+01	1.0E-07	1.0E-07	1.0E-07	1.9E-02	1.9E-02	1.9E-02
1,2,3-Trichloropropane*	0.20	0.20	0.20	5.65E+01	2.69E+02	3.5E-08	3.5E-08	3.5E-08	0.001	0.001	0.001
1,2-Dibromo-3-chloropropane*	0.20	0.20	0.20	2.22E+02	2.17E+02	9.0E-09	9.0E-09	9.0E-09	0.001	0.001	0.001
1,2-Dibromoethane*	0.20	0.20	0.20	3.98E+02	3.08E+03	5.0E-09	5.0E-09	5.0E-09	0.0001	0.0001	0.0001
					TOTAL	**6.5E-07**	**6.6E-07**	**6.6E-07**	**0.30**	**0.36**	**0.88**

Notes:
EPC = Reasonable maximum exposure point concentration. Calculated with US EPA ProUCL software. 95% UCL used for 2,4-D and MCPA and 97.5% UCL used for diallate. EPCs calculated with and without outliers for 2,4-D and Diallate. Bold values a= EPC calculate from detected concentrations or detected concentrations and reporting limits. Non-bold values indicate reporting limit use for the EPC.
Bold values a= EPC calculate from detected concentrations or detected concentrations and reporting limits. Non-bold values indicate reporting limit use for the EPC.
UCL = Upper confidence limit on the arithmetic mean
RL = Laboratory reporting limit
TRL = Target risk level is the accepable lifetime excess cancer risk. Per USEPA, the TRL range can from 1E-04 to 1E-06. The MDEQ
Bold and Shaded = MEPC calculate from detected concentrations or detected concentrations and reporting limits. Non-bold values are maximum reporting limit.
* = Reporting limit exceeded RSL and/or maximum concentration detected. Reporting Limit used EPC. 95% UCL calculated for MCPA EPC. Max RL
ECR = Excess cancer risk (EPC/SSL)*1E-06
HQ = Hazard Quotient (EPC/SSL)
NA = Not applicable or not available
-- 95% UCL Calculated so screening level based on reporting limit isn't necessary.

Table 7. Risk Characterization for Current and Future Industrial Workers

Loveland Products, Inc.
Bilings, MT

Chemical Name	EPC Based RL (mg/kg)	Current Potential Receptor				Future Potential Receptor			
		Outdoor Worker Site-Specific SSLs		Outdoor Worker Inhalation Risk Estimates		Indoor Worker Site-Specific SSLs		Indoor Worker Inhalation Risk Estimates	
		Site-Specific SL ECR = 1E-05	Site-Specific SL HQ = 1	ECR*	HQ	ECR = 1E-05	HQ = 1	ECR	HQ
1,2-Dibromo-3-chloropropane	0.20	1.56	60.1	1.3E-06	0.003	1.56	60.1	1.3E-06	0.003
1,2-Dibromoethane	0.20	4.22	730	4.7E-07	0.000	4.22	730	4.7E-07	0.000
1,2,3-Trichloropropane*	0.20	2.30	44.30	8.7E-07	0.005	2.30	44.30	8.7E-07	0.005
			CUMULATIVE RISK	**2.6E-06**	**0.01**		**CUMULATIVE RISK**	**2.6E-06**	**0.01**

Notes:
EPC = Reasonable maximum exposure point concentration. No concentration detected. RMEPC is the reporting limit.
RL = Analytical Reporting Limit
SSL = Soil screening level
ECR = Lifetime excess cancer risk. MDEQ acceptable level for cumualtive risk is 1E-05 (MDEQ, 2013).
*ECR = (RMEPC/SSL)*1E-05
HQ = Hazard Quotient (RMEPC/SSL). MDEQ acceptable level for cumualtive risk is 1 (MDEQ, 2013).

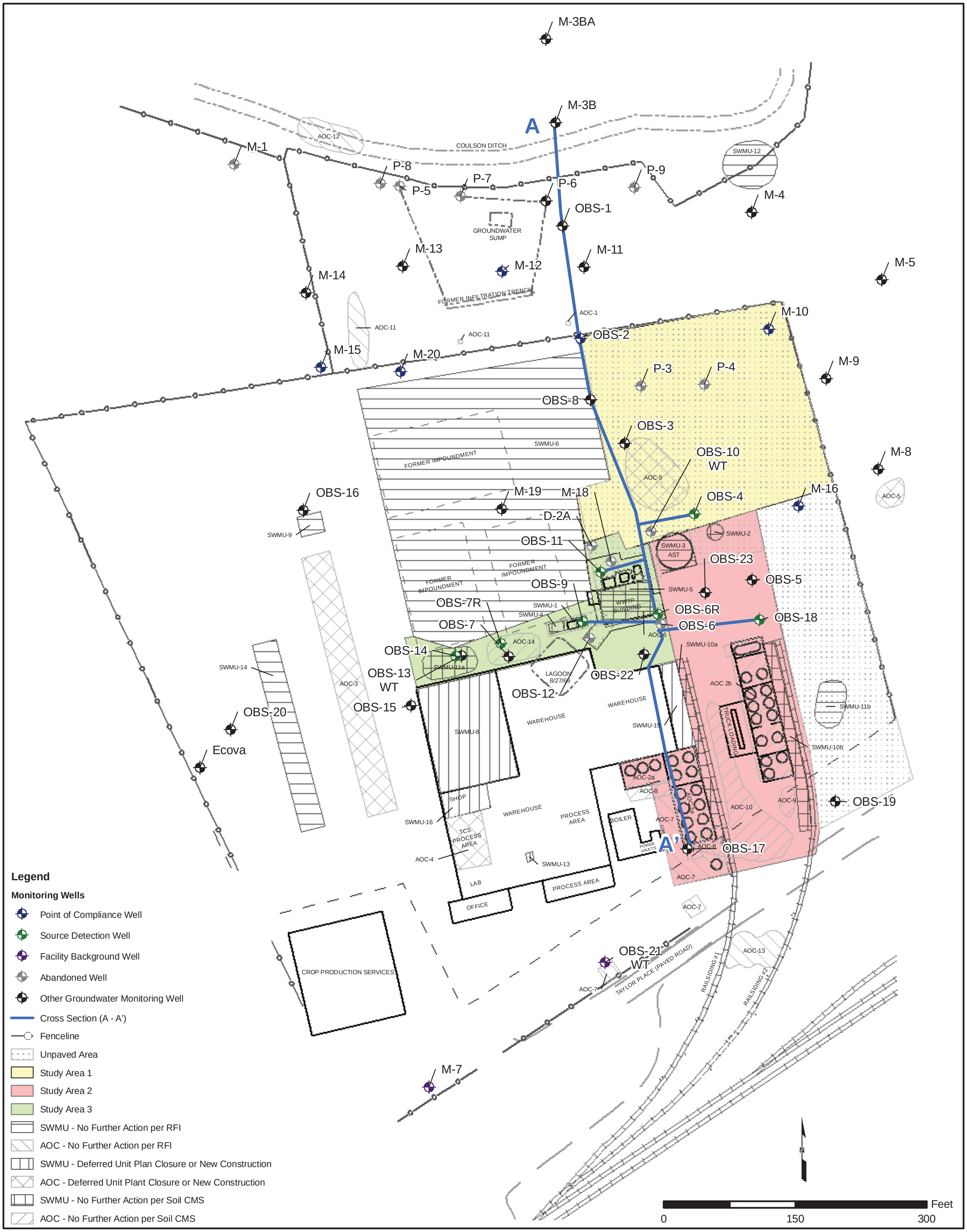
APPENDIX A

GEOLOGIC CROSS SECTION FROM 2010 GROUNDWATER CMS

DRAFT SWMU-6 RISK ASSESSMENT

LOVELAND PRODUCTS, INC.
BILLINGS, MT

August, 2013



Notes:
1."WT" Denotes Water Table Monitoring Well

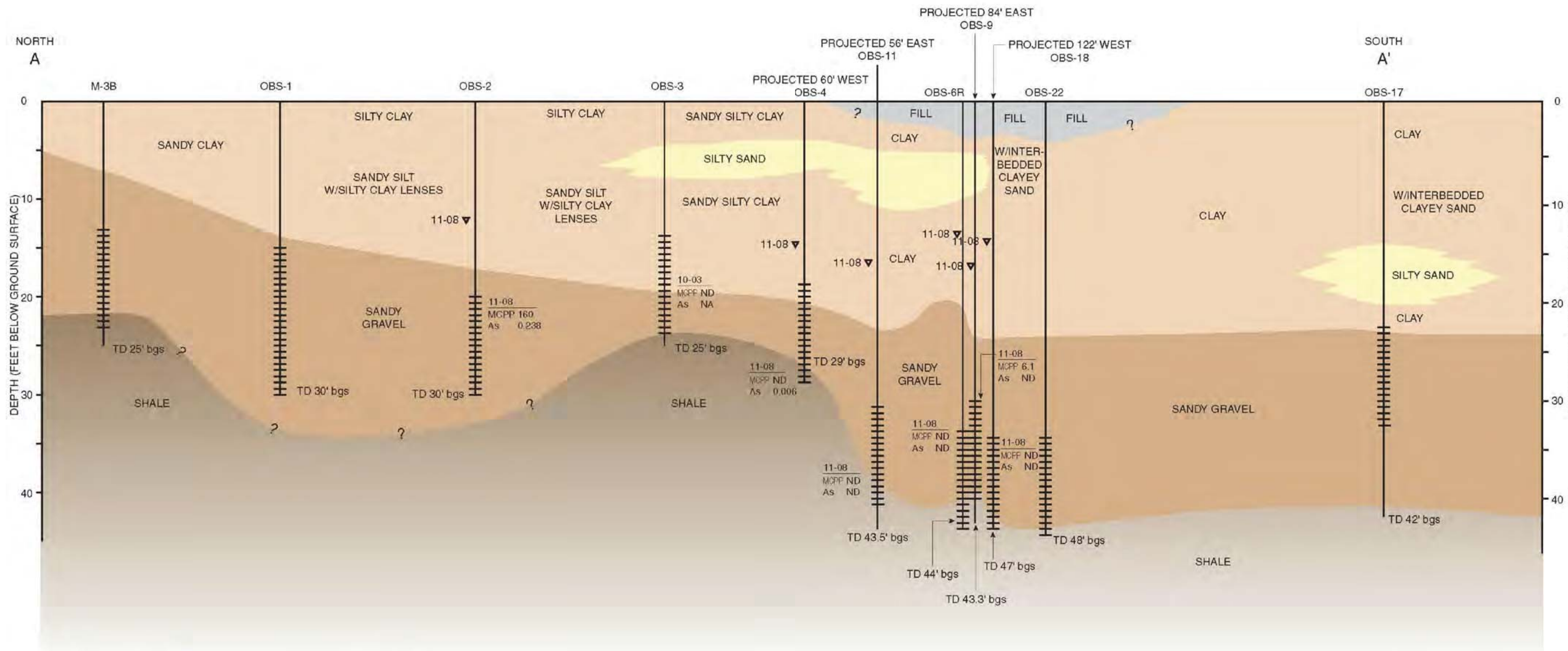
AECOM

LOVELAND PRODUCTS, INC.
BILLINGS, MONTANA
60150212-03006

SITE LAYOUT PLAN

DATE:03/25/2010	DRWN: LjP	Revision: 0	FIGURE 3-1

T:\UAP_TRANSBAS_NAD83\Projects\Working\GroundwaterCMS\3-1_SiteLayout.mxd



LEGEND

Well showing screened interval

11-08 ▼ Water level measured in November 2008

11-08 ← Sample Date
MCPP 160
As 0.238

Analyte — Concentration in Mg/L (MCPP) or mg/L (As)

NOTES

1. Cross-section transect shown on Figure 3-1.
2. As = arsenic
   bgs = below ground surface
   MCPP = chlorophenoxy herbicide
   mg/L = milligrams per liter
   ug/L = micrograms per liter
   NA = not analyzed
   ND = not detected
   TD = total depth
3. Well OBS-3 was not sampled after October 2003.

0 50 100 feet

AECOM

LOVELAND PRODUCTS, INC.
BILLINGS, MONTANA
60150212-03006

CROSS SECTION A-A'

DATE: 05/07/10 | DRWN: LP/FTC

FIGURE 3-2

APPENDIX B

HUMAN HEALTH CONCEPTUAL SITE MODEL

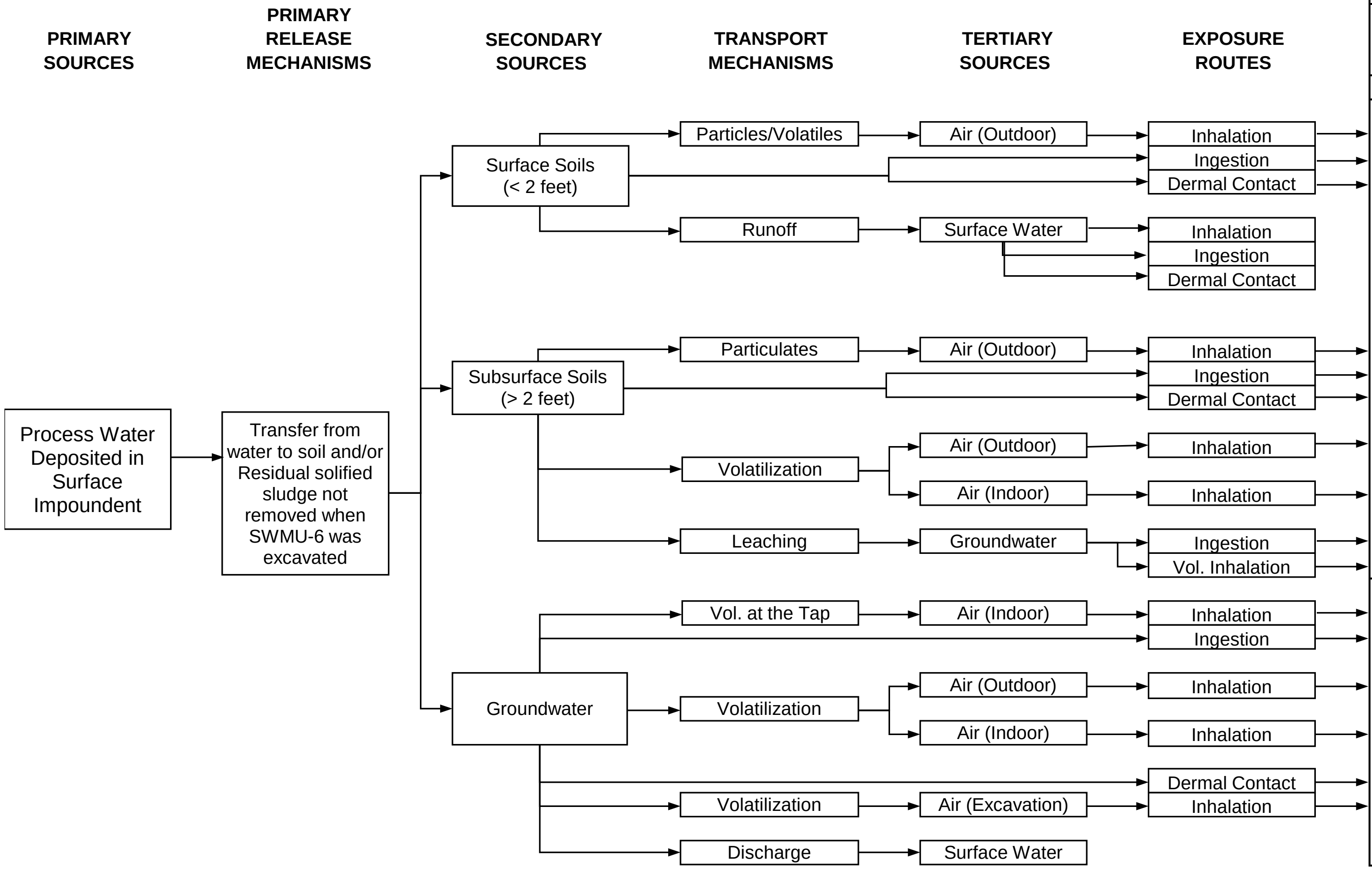
DRAFT SWMU-6 RISK ASSESSMENT

LOVELAND PRODUCTS, INC.
BILLINGS, MT

August, 2013

HUMAN HEALTH CONCEPTUAL SITE MODEL

Loveland Products, Inc.
Billings, Montana



Secondary Source	Transport Mechanism	Tertiary Source	Exposure Route	Residential Current	Residential Future	Occupational (Outdoor Industrial Worker) Current	Occupational (Outdoor Industrial Worker) Future	Excavation Current	Excavation Future
Surface Soils (< 2 feet)	Particles/Volatiles	Air (Outdoor)	Inhalation	O	O	O	O	O	O
Surface Soils (< 2 feet)			Ingestion	O	O	O	O	O	O
Surface Soils (< 2 feet)			Dermal Contact	O	O	O	O	O	O
Surface Soils (< 2 feet)	Runoff	Surface Water	Inhalation	O	O	O	O	O	O
Surface Soils (< 2 feet)	Runoff	Surface Water	Ingestion	O	O	O	O	O	O
Surface Soils (< 2 feet)	Runoff	Surface Water	Dermal Contact	O	O	O	O	O	O
Subsurface Soils (> 2 feet)	Particulates	Air (Outdoor)	Inhalation	O	O	O	O	X	X
Subsurface Soils (> 2 feet)			Ingestion	O	O	O	O	X	X
Subsurface Soils (> 2 feet)			Dermal Contact	O	O	O	O	X	X
Subsurface Soils (> 2 feet)	Volatilization	Air (Outdoor)	Inhalation	O	O	X	X	X	X
Subsurface Soils (> 2 feet)	Volatilization	Air (Indoor)	Inhalation	O	O	O	O	O	O
Subsurface Soils (> 2 feet)	Leaching	Groundwater	Ingestion	O	O	O	O	O	O
Subsurface Soils (> 2 feet)	Leaching	Groundwater	Vol. Inhalation	O	O	O	O	O	O
Groundwater	Vol. at the Tap	Air (Indoor)	Inhalation	O	O	O	O	O	O
Groundwater			Ingestion	O	O	O	O	O	O
Groundwater	Volatilization	Air (Outdoor)	Inhalation	O	O	O	O	O	O
Groundwater	Volatilization	Air (Indoor)	Inhalation	O	O	O	O	O	O
Groundwater			Dermal Contact	O	O	O	O	O	O
Groundwater	Volatilization	Air (Excavation)	Inhalation	O	O	O	O	O	O
Groundwater	Discharge	Surface Water							

Notes:

X Potentially Complete Exposure Pathway

O Incomplete Exposure Pathway

APPENDIX C

PRO UCL OUTLIER AND RMEPC DATA

DRAFT SWMU-6 RISK ASSESSMENT

LOVELAND PRODUCTS, INC.
BILLINGS, MT

August, 2013

	Outlier Tests for Selected Variables
User Selected Options	
From File	L:\Rubik Environmental\Projects\CPS\Billings, MT\2013 SWMU-6 Risk Assessment\2013 Rubik RA
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	1

Dixon's Outlier Test for 2,4-D

Number of data = 14
10% critical value: 0.492
5% critical value: 0.546
1% critical value: 0.641

1. Data Value 7100 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.820

For 10% significance level, 7100 is an outlier.
For 5% significance level, 7100 is an outlier.
For 1% significance level, 7100 is an outlier.

2. Data Value 0.069 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.064

For 10% significance level, 0.069 is not an outlier.
For 5% significance level, 0.069 is not an outlier.
For 1% significance level, 0.069 is not an outlier.

Dixon's Outlier Test for Diallate

Number of data = 11
10% critical value: 0.517
5% critical value: 0.576
1% critical value: 0.679

1. Data Value 36 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.970

For 10% significance level, 36 is an outlier.
For 5% significance level, 36 is an outlier.
For 1% significance level, 36 is an outlier.

2. Data Value 0.21 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.020

For 10% significance level, 0.21 is not an outlier.
For 5% significance level, 0.21 is not an outlier.
For 1% significance level, 0.21 is not an outlier.

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
From File	L:\Rubik Environmental\Projects\CPS\Billings, MT\2013 SWMU-6 Risk Assessment\2013 Rubik RA\Statistics\20
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

2,4-D

General Statistics			
Number of Valid Observations	13	Number of Distinct Observations	13
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.069	Minimum of Log Data	-2.674
Maximum	3740	Maximum of Log Data	8.227
Mean	579.3	Mean of log Data	4.989
Geometric Mean	146.8	SD of log Data	2.583
Median	216		
SD	1021		
Std. Error of Mean	283.2		
Coefficient of Variation	1.763		
Skewness	2.885		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.568	Shapiro Wilk Test Statistic	0.747
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
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	1084	95% H-UCL	374030
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8633
95% Adjusted-CLT UCL (Chen-1995)	1287	97.5% Chebyshev (MVUE) UCL	11500
95% Modified-t UCL (Johnson-1978)	1122	99% Chebyshev (MVUE) UCL	17131
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.411	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	1410		
MLE of Mean	579.3		
MLE of Standard Deviation	903.7		
nu star	10.68		
Approximate Chi Square Value (.05)	4.374	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	1045
Adjusted Chi Square Value	3.815	95% Jackknife UCL	1084
		95% Standard Bootstrap UCL	1016
Anderson-Darling Test Statistic	0.681	95% Bootstrap-t UCL	2350
Anderson-Darling 5% Critical Value	0.796	95% Hall's Bootstrap UCL	2566
Kolmogorov-Smirnov Test Statistic	0.253	95% Percentile Bootstrap UCL	1070
Kolmogorov-Smirnov 5% Critical Value	0.251	95% BCA Bootstrap UCL	1377
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1814

		97.5% Chebyshev(Mean, Sd) UCL	2348
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3398
95% Approximate Gamma UCL (Use when n >= 40)	1415		
95% Adjusted Gamma UCL (Use when n < 40)	1622		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	1622

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.

MCPA

General Statistics

Number of Valid Data	14	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	7
		Percent Non-Detects	50.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	12	Minimum Detected	2.485
Maximum Detected	40	Maximum Detected	3.689
Mean of Detected	24.57	Mean of Detected	3.129
SD of Detected	9.589	SD of Detected	0.426
Minimum Non-Detect	40	Minimum Non-Detect	3.689
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	14
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	86.57	Mean	3.885
SD	87.99	SD	1.132
95% DL/2 (t) UCL	128.2	95% H-Stat (DL/2) UCL	238
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	

MLE method failed to converge properly		Mean in Log Scale	3.101
		SD in Log Scale	0.352
		Mean in Original Scale	23.5
		SD in Original Scale	7.991
		95% t UCL	27.28
		95% Percentile Bootstrap UCL	26.98
		95% BCA Bootstrap UCL	27.03
		95% H-UCL	28.57
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	4.116	**Data appear Normal at 5% Significance Level**	
Theta Star	5.97		
nu star	57.62		
A-D Test Statistic	0.336	**Nonparametric Statistics**	
5% A-D Critical Value	0.709	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.709	Mean	24
5% K-S Critical Value	0.313	SD	8.52
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	3.341
		95% KM (t) UCL	29.92
Assuming Gamma Distribution		95% KM (z) UCL	29.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	30.13
Minimum	12	95% KM (bootstrap t) UCL	29.94
Maximum	40	95% KM (BCA) UCL	29.15
Mean	24.33	95% KM (Percentile Bootstrap) UCL	29.36
Median	25.26	95% KM (Chebyshev) UCL	38.56
SD	8.268	97.5% KM (Chebyshev) UCL	44.87
k star	6.686	99% KM (Chebyshev) UCL	57.25
Theta star	3.639		
Nu star	187.2	**Potential UCLs to Use**	
AppChi2	156.5	95% KM (t) UCL	29.92
95% Gamma Approximate UCL (Use when n >= 40)	29.09	95% KM (Percentile Bootstrap) UCL	29.36
95% Adjusted Gamma UCL (Use when n < 40)	29.8		
Note: DL/2 is not a recommended method.			
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, Maichle, and Lee (2006).			
For additional insight, the user may want to consult a statistician.			
Diallate			
General Statistics			
Number of Valid Data	13	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	3
		Percent Non-Detects	23.08%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.21	Minimum Detected	-1.561
Maximum Detected	17	Maximum Detected	2.833
Mean of Detected	2.307	Mean of Detected	-0.203

SD of Detected	5.173	SD of Detected	1.213
Minimum Non-Detect	0.33	Minimum Non-Detect	-1.109
Maximum Non-Detect	0.33	Maximum Non-Detect	-1.109
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.426	Shapiro Wilk Test Statistic	0.808
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.813	Mean	-0.572
SD	4.578	SD	1.263
95% DL/2 (t) UCL	4.075	95% H-Stat (DL/2) UCL	4.21
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.568
		SD in Log Scale	1.275
		Mean in Original Scale	1.816
		SD in Original Scale	4.576
		95% t UCL	4.079
		95% Percentile Bootstrap UCL	4.315
		95% BCA Bootstrap UCL	5.62
		95% H-UCL	4.384
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.484	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	4.771		
nu star	9.672		
A-D Test Statistic	1.669	**Nonparametric Statistics**	
5% A-D Critical Value	0.769	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.769	Mean	1.827
5% K-S Critical Value	0.279	SD	4.393
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.284
		95% KM (t) UCL	4.115
Assuming Gamma Distribution		95% KM (z) UCL	3.939
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	4.087
Minimum	0.000001	95% KM (bootstrap t) UCL	24.16
Maximum	17	95% KM (BCA) UCL	4.444
Mean	1.775	95% KM (Percentile Bootstrap) UCL	4.331
Median	0.57	95% KM (Chebyshev) UCL	7.424
SD	4.593	97.5% KM (Chebyshev) UCL	9.847
k star	0.197	99% KM (Chebyshev) UCL	14.6
Theta star	9.008		
Nu star	5.122	**Potential UCLs to Use**	
AppChi2	1.209	97.5% KM (Chebyshev) UCL	9.847
95% Gamma Approximate UCL (Use when n >= 40)	7.518		
95% Adjusted Gamma UCL (Use when n < 40)	9.441		

Note: DL/2 is not a recommended method.						
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, Maichle, and Lee (2006).						
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	L:\Rubik Environmental\Projects\CPS\Billings, MT\2013 SWMU-6 Risk Assessment\2013 Rubik RA\Statistics\Pr		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
2,4-D			
General Statistics			
Number of Valid Observations	14	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.069	Minimum of Log Data	-2.674
Maximum	7100	Maximum of Log Data	8.868
Mean	1045	Mean of log Data	5.266
Geometric Mean	193.6	SD of log Data	2.69
Median	234		
SD	2000		
Std. Error of Mean	534.5		
Coefficient of Variation	1.914		
Skewness	2.629		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.565	Shapiro Wilk Test Statistic	0.796
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
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	1992	95% H-UCL	678015
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	14558
95% Adjusted-CLT UCL (Chen-1995)	2326	97.5% Chebyshev (MVUE) UCL	19412
95% Modified-t UCL (Johnson-1978)	2054	99% Chebyshev (MVUE) UCL	28947
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.355	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	2941		
MLE of Mean	1045		
MLE of Standard Deviation	1753		
nu star	9.95		
Approximate Chi Square Value (.05)	3.91	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	1924
Adjusted Chi Square Value	3.423	95% Jackknife UCL	1992
		95% Standard Bootstrap UCL	1897
Anderson-Darling Test Statistic	0.763	95% Bootstrap-t UCL	5174
Anderson-Darling 5% Critical Value	0.814	95% Hall's Bootstrap UCL	5588
Kolmogorov-Smirnov Test Statistic	0.269	95% Percentile Bootstrap UCL	2003
Kolmogorov-Smirnov 5% Critical Value	0.245	95% BCA Bootstrap UCL	2496
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3375

		97.5% Chebyshev(Mean, Sd) UCL	4383
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6363
95% Approximate Gamma UCL (Use when n >= 40)	2659		
95% Adjusted Gamma UCL (Use when n < 40)	3038		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	3038

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.

MCPA

General Statistics

Number of Valid Data	14	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	7
		Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	12	Minimum Detected	2.485
Maximum Detected	40	Maximum Detected	3.689
Mean of Detected	24.57	Mean of Detected	3.129
SD of Detected	9.589	SD of Detected	0.426
Minimum Non-Detect	40	Minimum Non-Detect	3.689
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	14
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	86.57	Mean	3.885
SD	87.99	SD	1.132
95% DL/2 (t) UCL	128.2	95% H-Stat (DL/2) UCL	238
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	

MLE method failed to converge properly		Mean in Log Scale	3.101
		SD in Log Scale	0.352
		Mean in Original Scale	23.5
		SD in Original Scale	7.991
		95% t UCL	27.28
		95% Percentile Bootstrap UCL	27.04
		95% BCA Bootstrap UCL	27.05
		95% H-UCL	28.57
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	4.116	**Data appear Normal at 5% Significance Level**	
Theta Star	5.97		
nu star	57.62		
A-D Test Statistic	0.336	**Nonparametric Statistics**	
5% A-D Critical Value	0.709	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.709	Mean	24
5% K-S Critical Value	0.313	SD	8.52
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	3.341
		95% KM (t) UCL	29.92
Assuming Gamma Distribution		95% KM (z) UCL	29.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	30.13
Minimum	12	95% KM (bootstrap t) UCL	30.19
Maximum	40	95% KM (BCA) UCL	28.86
Mean	24.33	95% KM (Percentile Bootstrap) UCL	29.44
Median	25.26	95% KM (Chebyshev) UCL	38.56
SD	8.268	97.5% KM (Chebyshev) UCL	44.87
k star	6.686	99% KM (Chebyshev) UCL	57.25
Theta star	3.639		
Nu star	187.2	**Potential UCLs to Use**	
AppChi2	156.5	95% KM (t) UCL	29.92
95% Gamma Approximate UCL (Use when n >= 40)	29.09	95% KM (Percentile Bootstrap) UCL	29.44
95% Adjusted Gamma UCL (Use when n < 40)	29.8		
Note: DL/2 is not a recommended method.			

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, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Diallate

General Statistics

Number of Valid Data	14	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	3
		Percent Non-Detects	21.43%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.21	Minimum Detected	-1.561
Maximum Detected	36	Maximum Detected	3.584
Mean of Detected	5.37	Mean of Detected	0.142

SD of Detected	11.28	SD of Detected	1.621
Minimum Non-Detect	0.33	Minimum Non-Detect	-1.109
Maximum Non-Detect	0.33	Maximum Non-Detect	-1.109
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.525	Shapiro Wilk Test Statistic	0.805
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.255	Mean	-0.275
SD	10.14	SD	1.645
95% DL/2 (t) UCL	9.054	95% H-Stat (DL/2) UCL	17.97
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.619	Mean in Log Scale	-0.332
SD	13.06	SD in Log Scale	1.724
95% MLE (t) UCL	6.803	Mean in Original Scale	4.25
95% MLE (Tiku) UCL	7.332	SD in Original Scale	10.14
		95% t UCL	9.051
		95% Percentile Bootstrap UCL	9.138
		95% BCA Bootstrap UCL	10.78
		95% H UCL	22.82
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.369	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	14.57		
nu star	8.111		
A-D Test Statistic	1.714	**Nonparametric Statistics**	
5% A-D Critical Value	0.796	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.796	Mean	4.268
5% K-S Critical Value	0.272	SD	9.766
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2.737
		95% KM (t) UCL	9.115
Assuming Gamma Distribution		95% KM (z) UCL	8.77
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	9.064
Minimum	0.000001	95% KM (bootstrap t) UCL	121.1
Maximum	36	95% KM (BCA) UCL	9.234
Mean	4.219	95% KM (Percentile Bootstrap) UCL	8.293
Median	0.59	95% KM (Chebyshev) UCL	16.2
SD	10.16	97.5% KM (Chebyshev) UCL	21.36
k star	0.185	99% KM (Chebyshev) UCL	31.51
Theta star	22.78		
Nu star	5.186	**Potential UCLs to Use**	
AppChi2	1.239	99% KM (Chebyshev) UCL	31.51
95% Gamma Approximate UCL (Use when n >= 40)	17.66		
95% Adjusted Gamma UCL (Use when n < 40)	21.78		

Note: DL/2 is not a recommended method.						
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, Maichle, and Lee (2006).						
For additional insight, the user may want to consult a statistician.						