

**Human Health Risk Assessment
Onondaga Lake
Wastebeds 1-8 Site: Bike Trail
Geddes, NY**

January 2009



**U.S. Environmental Protection Agency, Region II
Emergency and Remedial Response Division
290 Broadway – 18th Floor
New York, NY 10007**

TABLE OF CONTENTS

1. Introduction.....	3
1.1. Site Overview	3
2. Human Exposure Pathways	4
3. Hazard Identification	5
3.1. Data Collection and Evaluation.....	5
3.2. Criteria for Selecting COPCs	6
3.3. Calculation of the Exposure Point Concentration	7
4. Exposure Assessment	7
4.1. Exposure Assumptions.....	8
Child Rider.....	8
Adolescent Rider	9
Adult Rider.....	9
Construction Worker	10
Age-Dependent Adjustment Factors (ADAFs).....	10
4.2. Estimating Exposure	10
Dermal Exposure to Soil and Groundwater	10
Particulate Emission Factor	10
5. Toxicity Assessment.....	12
5.1. Health Effects Criteria for Non-carcinogens.....	12
5.2. Health Effects Criteria for Carcinogens.....	12
6. Risk Characterization	14
6.1. Carcinogenic Risk.....	14
Child Rider (0-12)	14
Adolescent Rider (12-16).....	14
Adult Rider (16-30)	14
Construction Worker	15
6.2. Non-carcinogenic Hazard.....	15
Child Rider (0-12)	16
Adolescent Rider (12-16).....	16
Adult Rider (16-30)	16
Construction Worker	17
6.3. Uncertainties.....	17
7.0. Risk Summary and Recommendations	19
Bibliography	20

1. Introduction

In order to determine the cancer risks and non-cancer hazards associated with exposure to surface soil contamination from the future use of the Wastebeds 1-8 site (Site) for a recreational bike trail, a human health risk assessment (HHRA) was performed using data collected during the Preliminary Site Investigation (2005) and Remedial Investigation (RI) (ongoing) for the Site, as well as speciated chromium data collected in May 2008. This HHRA identifies the potential exposure pathways by which populations may be exposed to site-related contamination, the toxicity of the chemicals that are present, and the potential for cancer risks and non-cancer health hazards from exposure to those chemicals.

A four-step process is utilized for assessing site-related human health risks for a reasonable maximum exposure (RME) scenario: Hazard Identification – identifies the contaminants of potential concern at the site based on several factors such as toxicity, frequency of occurrence and concentration. Exposure Assessment – estimates the magnitude of actual and/or potential human exposures, the frequency and duration of these exposures and the exposure pathways (*i.e.*, ingesting contaminated soil) under current and likely future land use scenarios. Toxicity Assessment – determines the types of adverse health effects associated with chemical exposures, and the relationship between magnitude of exposure (dose) and severity of adverse effects (response). Risk Characterization – summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site-related risks and hazards, and presents a discussion of the uncertainties of the process.

1.1. Site Overview

The Site is located along the southwestern shore of Onondaga Lake. The wastebeds extend into the lake at Lakeview Point and cover roughly 315 acres (O'Brien and Gere [OBG], 2006). The wastebeds are composed of a series of perimeter dikes that were filled in with waste materials (primarily Solvay waste) consisting largely of calcium carbonate, gypsum, sodium chloride, and calcium chloride. These wastes were generated at the former Main Plant as part of soda ash production. Solvay waste was hydraulically pumped into the wastebeds from approximately 1916 to 1943. Crucible landfill covers roughly 20 acres on the northwestern portion of the Site and contains both hazardous and nonhazardous waste. The landfill was capped in 1988 in accordance with a NYSDEC approved closure plan. Contaminants at the Site include benzene, toluene, ethylbenzene, xylene, (BTEX) naphthalene and assorted polycyclic aromatic hydrocarbons (PAHs) phenolic compounds, and inorganics. Surface soil contaminants in the Lakeshore Area include BTEX, PAHs, and inorganics. Surface soil contaminants in the Parking Lot and Upland Successional Areas include PAHs, dieldrin, 4,4'-DDT, inorganics and volatile organic compounds. (These areas are depicted in a figure in Appendix A.) Subsurface soil contaminants include BTEX, acetone, naphthalene and PAHs, phenolic compounds, and inorganics. Compounds associated with chlorinated benzene production may have also been disposed of in the wastebeds. Additionally, the City of Syracuse and Onondaga County disposed of sewage sludge on the southeastern portion (Biosolids Area) of the

Site from 1925 to 1978 (OBG, 2006). See Appendix A for a map showing the above-mentioned areas.

The Onondaga County Department of Transportation is proposing to extend the Lake Canalways Trail Section 1 roughly 1.5 miles along the lake shore over the wastebeds. The proposed trail will be approximately 14 feet wide, bordered by landscaping ranging from 8 to 32 feet on both sides. The area along the bike trail would be planted with grass, wetland, or wildflower mix (see Appendix A for a map of the proposed trail route).

The Site is currently owned by the State of New York and Onondaga County. The New York State Fairgrounds uses a portion of the Site for parking during the fair. Access to the Site is limited due to it being cut off from residential areas by highway I-690. However, the gates to the Site are not locked and it has been reported that all-terrain vehicle (ATV) riders use the Site on a regular basis. Evidence of their presence can be seen in the Lakeshore Area and along the well-worn trails present on the northwestern portion of the Site. The extension of the bike trail will facilitate access to the Site by connecting it to the residential communities on the northwestern portion of the lake.

2. Human Exposure Pathways

For the purposes of this risk assessment, the exposure pathways have been developed based on the assumption that the future use of a portion of the Site will be as a bike trail. Other receptors that may use the Site (e.g., trespassers, fair goers, etc) will be evaluated in the HHRA being developed by OBG for Honeywell. The following section describes the possible sources, receptors, and exposure pathways used in this HHRA. The exposure pathways are summarized in Table 1 of Appendix B.

The HHRA focused on the areas where the bike trail will be constructed and where there is clear evidence of ATV use: the Upland Successional Area, which includes the Biosolids Area, and the Lakeshore Area (see Appendix A for a figure showing these areas). There were no surface soil samples collected from the capped Crucible Landfill Area. The State Fair parking lots were excluded because they are either paved or have a gravel cover, so exposure to surface soils is more limited. Also, the HHRA assumed that bike trail users would not likely spend much time in these parking areas except to load and unload their cars.

The receptors that would be expected to use the bike trail would be children, older children, adolescents and adults. These receptors would have access to the bike trail from residential neighborhoods on the northwest portion of the Lake. They may also drive in by car from other neighborhoods and park at the trail head. Children (0 to 12 years old) would be expected to visit the bike trail primarily with their parents and to stay on the paved trail. Very young children (0 to 3 years) would be expected to ride on the back of a parent's bike or in a stroller. The older children (3 to 12 years) would likely ride their own bikes. The only exposure pathway for the child receptor that stays on the trail is inhalation of windborne contaminated dust from soil across the Site.

The adolescent receptor (12 to 16 years) would be expected to visit the bike trail mostly alone, although he or she could be accompanied by a parent. Because of the evidence of off-roading already occurring at the Site, the adolescent would be expected to spend a portion of his or her time exploring off-trail areas. Although the County has plans to restrict access by ATV riders and to limit off-trail use, EPA's standard approach does not assume that any engineering or institutional controls will be in place. While the adolescent is on the trail, the only exposure pathway for this receptor is inhalation of windborne contaminated dust. However, the adolescent off the trail would be exposed through inhalation of dust generated while riding an ATV as well as through incidental ingestion and dermal contact with contaminated surface soil. Similar to the adolescent, the adult (16 to 30 years) would be expected to spend a portion of his or her time off the trail and would be exposed through the same pathways.

Adolescent and adult bike trail users, which include ATV riders who stray off the trail, are assumed to utilize already existing, well-worn trails observed both in aerial photos and from site inspections. These receptors may also create new trails since the bike trail will provide access to areas that may be currently inaccessible due to dense vegetation. Pedestrians may also leave the trail to get a better view of the lake, take photos, gather rocks, observe deer or other wildlife, etc. However, exposure to pedestrians would be considered minimal relative to off-trail ATV riders since walking activities would not involve significant dust generation. Cyclists would generate dust emissions that are somewhere between the pedestrian and ATV rider levels. They were not specifically evaluated since ATV riders are assumed to be representative of the RME receptor. ATV riders, in addition to riding their vehicles, might also engage in some of the same walking off-trail activities described above.

An additional receptor that was evaluated in this HHRA was the construction worker who will be responsible for constructing the bike trail. Because the bike trail will be laid directly on top of existing land, the construction worker is not expected to be digging and would, therefore, only come in contact with surface contamination. The exposure pathways for this receptor are inhalation of windborne dust, incidental ingestion of and dermal contact with surface soil.

A trail maintenance worker may also be exposed to contaminants through regular trail upkeep, such as picking up garbage and performing periodic repairs. However, the exposure to the receptor is expected to be minimal and, therefore, was not evaluated quantitatively in the HHRA.

3. Hazard Identification

This section outlines the data used in the risk assessment, how it was collected, the criteria for selecting the chemicals of potential concern (COPCs), and the calculation of the Exposure Point Concentrations (EPCs).

3.1.1. Data Collection and Evaluation

For the purpose of characterizing the nature and extent of contamination at the Site, soil data were collected in 2004 and 2007 by OBG during two investigations, the Preliminary Site Investigation (2005) and the hot spot investigation (2007), which was part of the ongoing RI. These data were used in calculating EPCs for the HHRA. In addition, speciated chromium data (Appendix H) were collected in May 2008 by OBG, on behalf of Honeywell. These data are discussed below and were used to calculate the EPCs for chromium VI. As mentioned previously, only surface soil samples (from 0 to 0.5 feet) that were outside the parking lot area were included in this assessment. See Appendix D for the samples included in the HHRA.

All samples, except those collected for chromium speciation purposes, were analyzed for the Target Compound List volatile organic compounds and semi-volatile organic compounds, PCBs and pesticides, as well as the Target Analyte List for metals, including mercury and cyanide. The analytical methods used were approved by EPA and followed proper quality assurance/quality control procedures.

3.1.2. Speciated Chromium Data

In May 2008, OBG, on behalf of Honeywell, collected 41 surface soil samples (five were at seep locations and represent soils wetted by seep water) and twelve subsurface soil samples from various exposure areas at the Wastebeds 1-8 Site to evaluate the levels of hexavalent and total chromium. Only the surface soil samples (from 0 to 0.5 feet) were used to update the HHRA. Data from the State Fair Parking Area and the Site Ditches (seep soil) were excluded from the chromium dataset.

3.2. Criteria for Selecting COPCs

Tables 2.1 and 2.2 in Appendix B summarize the analytical data for the surface soil used to determine the COPCs for this risk assessment. Table 2.1 includes all the surface soil data from the bike trail area (Upland Successional, Biosolids, and Lakeshore Area), and does not include the samples that were taken in the State Fair parking lots. Table 2.2, which was used to determine COPCs for direct contact for the construction worker, only includes surface soil data from along the proposed bike trail route. Chemicals that were not detected in any of the surface soil samples were not evaluated in Table 2. Field duplicates were not included in the data set summarized in Table 2. Also, the essential nutrients calcium, magnesium, potassium, and sodium were not evaluated.

The maximum detected concentration for each chemical in surface soil was compared to the corresponding residential value, or in the case of the construction worker, the industrial value from the Region 9 Preliminary Remediation Goals (PRGs) table. The PRG values represent a cancer risk of one in a million (1×10^{-6}) or a hazard quotient of 1. The non-cancer hazard quotients from the PRG table were adjusted to 0.1 to account for potential exposures to multiple chemicals. If the concentration of a chemical was below its respective PRG value, that chemical was determined unlikely to cause adverse effects.

The PRG for methyl mercury was used to screen mercury in order to be health-protective. For lead, the screening values recommended by EPA of 400 mg/kg for residential and

800 mg/kg for industrial were used. Although the maximum detected concentration for lead exceeded these values in both datasets, the average concentration, which is appropriate to use for evaluating health effects from lead, did not. Therefore, lead was not further evaluated in this HHRA.

3.3. Calculation of the Exposure Point Concentration

EPCs for those chemicals that exceeded their screening values in Table 2.1 and 2.2 were calculated using ProUCL, version 4.0 (Lockheed Martin, 2006). The EPC is the 95 % Upper Confidence Limits (UCL) on the arithmetic mean of a chemical concentration. It is based upon the distribution of the data. The ProUCL program tests the normal, lognormal, and gamma distributions of each data set and recommends the appropriate statistic using parametric and non-parametric statistical methods. Consistent with EPA guidance, the mean concentration of lead, rather than the 95% UCL, was used as the EPC. If analytical data indicated a non-detect result for a chemical, a value of ½ of the detection limit was used in calculating the UCL.

The data set that included all surface soil samples exclusive of the parking lots was robust and ProUCL was able to calculate meaningful statistics for all chemicals. The data set that included only those samples collected along the bike trail, however, was more limited and, in some cases, the maximum detected concentration was used as the EPC because ProUCL could not recommend an appropriate statistic. The EPC values and the methods used to calculate them can be found in Tables 3.1 and 3.2 in Appendix B. ProUCL outputs can be found in Appendix C.

3.3.1. Chromium

The EPC for Chromium VI was calculated using both the data collected in May 2008 as well as data from the RI. Each sample collected in May 2008 was analyzed for total and hexavalent chromium. Statistical analysis done by Lockheed Martin for EPA (September 2008) suggested that concentrations of chromium VI in the Biosolids Area were different from the rest of the Site. Based on the ratio of hexavalent to total chromium from these samples, ratios were developed that could be applied to the historical chromium data collected during the RI. A separate ratio was developed for the Biosolids Area. The ratio was calculated using ordinary least square regression of chromium VI concentrations against co-located total chromium concentrations. It was determined that 11 percent of the chromium in the Biosolids Area was hexavalent. For the rest of the Site, only 1 percent of the total chromium was determined to be hexavalent. These percentages were applied to the RI data in order to derive concentrations of hexavalent and trivalent chromium which were then used in the screening process and, in the case of chromium VI, the development of an EPC.

4. Exposure Assessment

The exposure assessment evaluates pathways by which people are or can be exposed to the contaminants of concern in different media (e.g., soil, groundwater). The

quantification of exposure is based on factors including, but are not limited to, the concentrations that people are or can be exposed to, the potential frequency (number of days per year), and the duration of exposure (number of years). The exposure assessment is based on site-specific parameters that can reasonably be expected at the site. The goal of the risk assessment is to estimate the RME expected to occur under both current and future land-use conditions assuming no access or use controls and no remediation. In other words, the RME is the greatest exposure that is reasonably expected to occur. As a result, the risk assessment provides upper-bound estimates of the risks and hazards for users of the bike trail and the surrounding area, using health-protective assumptions so that these risks and hazards are not underestimated. The exposure assumptions for each receptor can be found in Tables 4.1-4.5 in Appendix B. Following is a description of the exposure parameters used for each receptor in this assessment.

4.1. Exposure Assumptions

Child Rider

Under future circumstances, the child (aged 0 to 12 years) could potentially be exposed to contaminated surface soil via inhalation of fugitive dust. In developing this scenario, best professional judgment and site-specific information was used to identify likely exposure parameters.

Child On-Trail Rider (0-6 years)

The exposure frequency of 94 days was used for all receptors in the HHRA. This value was developed by EPA and New York State, in conjunction with OBG, for the older child (6-12 years) receptor for the Wastebeds 1-8 HHRA. This value has been carried over to this younger age group as well. It assumes that the child would visit the bike trail with a parent two days per week during the fall and spring when the daily maximum temperature is at least 50° F, and five days per week in the summer (assuming 10 weeks of summer). Using data from the National Weather Service, there are roughly 22 weeks in the spring and fall when the temperature is above 50° F (see Appendix E). The exposure duration assumes the child would spend 4 hours per day on the bike trail, which is consistent with other EPA assessments for recreational receptors and was agreed upon in the HHRA for Wastebeds 1-8. In addition to cycling, bike trail users may also engage in walking or rollerblading. The exposure frequency and duration are designed to take other bike trail activities in to account. The inhalation rate of 1.2 m³/hr comes from Table 5-23 of the 1997 *Exposure Factors Handbook (EFH)* and assumes moderate activity. The body weight value represents a mean body weight for children ages 0-6 (male and female), and comes from the 1991 *Standard Default Exposure Factors*.

Child On-Trail Rider (6-12 years)

The exposure values mentioned above were also used for the older child. The body weight value represents a mean body weight for children ages 6-12 (male and female), and comes from Table 11-6 of the 2002 *Children's Exposure Factors Handbook EFH*.

Adolescent Rider

While on the trail, the adolescent (aged 12-16 years) could potentially be exposed to contaminated surface soil via inhalation of fugitive dust. However, the adolescent off the trail could be exposed through inhalation of dust generated while riding an ATV, as well as through incidental ingestion and dermal contact with contaminated surface soil. Two sets of exposure tables were developed for this receptor: on-trail and off-trail. The body weight value represents a mean body weight for adolescents ages 12-16 (male and female), and comes from Table 11-6 of the 2002 Children's *EFH*.

Adolescent On-Trail Rider

The exposure values for the child receptor were also used for the adolescent on-trail rider. This receptor is expected to spend 2 hours on the trail and 2 hours off the trail.

Adolescent Off-Trail Rider

The inhalation exposure parameters for the off-trail adolescent rider do not change. The soil ingestion rate is assumed to be 100 mg/day (EPA 1991). For the dermal pathway, the skin surface area is estimated to be 5098 cm², which is a mean value that assumes that head, forearms, hands, and lower legs are exposed. The soil to skin adherence factor of 0.7 mg/cm² is for the heavy equipment operator from Exhibit 3-5 of *RAGS E* (EPA 2004) and represents a high end (95th percentile) value for central tendency contact activity.

Adult Rider

While on the trail, the adult (aged 16-30 years) could potentially be exposed to contaminated surface soil via inhalation of fugitive dust. However, the adult off the trail could be exposed through inhalation of dust generated while riding an ATV, as well as through incidental ingestion and dermal contact with contaminated surface soil. Two sets of exposure tables were developed for this receptor: on-trail and off-trail. The body weight value represents a mean body weight for adults (male and female), and comes from Table 7-2 of the 1997 *EFH*. The EF of 94 days was used for this receptor as well since one portion of this age group (16-18 years) would have similar use patterns as the adolescent and the other portion (18-30 years) could be a parent accompanying the child aged 0-12 years.

Adult On-Trail Rider

The only exposure parameter that changes for the adult rider relative to the adolescent rider is the inhalation rate. The rate of 1.6 m³/hr comes from Table 5-23 of the *EFH* and is for moderate activity. This receptor is expected to spend 2 on the trail and 2 hours off the trail.

Adult Off-Trail Rider

The inhalation exposure parameters for the off-trail adult rider do not change. The soil ingestion rate is assumed to be 100 mg/day (EPA 1991). For the dermal

pathway, the skin surface area is estimated to be 5700 cm², which is a mean value that assumes that head, forearms, hands, and lower legs are exposed. The soil to skin adherence factor of 0.7 mg/cm² is for the heavy equipment operator from Exhibit 3-5 of *RAGS E* (EPA 2004) and represents a high end (95th percentile) value for central tendency contact activity

Although these age groupings were evaluated separately from an exposure standpoint, the HHRA assumes that the child, adolescent and adult receptors all belong to the same population (*i.e.*, the same rider uses the bike trail for the entire 30-year exposure duration). The cancer risks and non-cancer health hazards are presented in Section 6 for each age group and also for the 30-year user.

Construction Worker

This assessment assumes that construction of the bike trail would take 3 months (66 days of 8 hour work). Default exposure parameters for the construction worker, such as a soil ingestion rate of 330 mg/day (US EPA, 2002b) and a soil to skin adherence factor of 0.3 mg/cm² (US EPA, 2004) were also used. The inhalation rate of 1.5 m³/hr for outdoor workers performing moderate activities is from Table 5-23 in the *EFH*. The body weight value represents a mean body weight for adults (male and female), and comes from Table 7-2 of the 1997 *EFH*.

Age-Dependent Adjustment Factors (ADAFs)

To account for the COPCs that are considered carcinogenic by mutagenic mode of action, a supplemental set of Table 4s was created showing the age-adjusted exposure parameters used for the age bins requiring adjustment to the cancer risk calculations. They are labeled Supplement A and follow Table 4.1-4.5 in Appendix B. Supplement B in Appendix B provides the age-specific inputs used for the age-adjusted exposure parameters.

4.2. Estimating Exposure

Dermal Exposure to Soil

To calculate dermal exposure to soil, Exhibit 1-3 in *RAGS, Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA, 2004) was followed. Cancer risks and non-cancer hazards for arsenic, cadmium, benzo(a)pyrene and other PAHs, and PCBs were calculated using the dermal absorption factors in Exhibit 3-4 of *RAGS, Part E* (EPA, 2004).

Particulate Emission Factor

A particulate emission factor (PEF) relates the concentration of a contaminant in soil to the concentration of dust particles in the air. The PEF was used in the intake calculations

to estimate the amount of contaminated fugitive dust that could be inhaled by riders on and off the trail.

For the receptors that stay on the trail, the default PEF from Equation 4-5 in the 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* was modified using site-specific inputs (see Appendix E). A site-specific dispersion factor (Q/C_{wind}) was calculated based on meteorological data from Appendix D, Exhibit D-2, of the *Supplemental Guidance*. The constants selected for the dispersion factor were based on data from Chicago, IL. These values were considered representative because of the “lake effect” that would impact meteorological conditions at Onondaga Lake. Additionally, the contaminated area was assumed to be 142 acres. This value, which excludes the State Fair parking lots, represents roughly 45 percent of the total 315 acres of the Site. The Site was assumed to have 65 percent vegetative cover. This value was derived by viewing aerial photos and maps of the Site. The sparsely vegetated Lakeshore and trial areas balance out the more heavily vegetated Upland Successional area. (See Appendix E for the equations and calculations for the PEF factor)

For receptors that leave the trail, Equation E-18 from the *Supplemental Guidance* was used to generate a PEF based on dust generated while riding an ATV. This equation is designed to estimate dust generation from traffic on unpaved roads. The aerial extent of contamination input (A_s) to the wind dispersion factor (Q/C_{sr}) was adjusted from 0.5 acres (the default) to 1.8 acres. This value was calculated by assuming that the trail is 4,755 meters long (based on measurements of the existing trails shown on the May 2005 OBG Figure 16 from the PSA) and 1.5 meters wide (the average width of a car, which can fit down most of the trails).

The dispersion correction factor (F_D – Equation E-16) used a site-specific travel time of 188 hours, based on the assumption that an adolescent or adult receptor would use the Site for 2 hours per day, 94 days per year.

The inputs for surface material silt content (s) and surface material moisture content (M_{dry}) were obtained from OBG. They were 18 percent and 0.2 percent, respectively.

The number of days with at least 0.01 inches of precipitation for the expected months of off road use (April to November) was 69 days. This is based on National Weather Service data from Hancock Field in Syracuse (see Appendix F).

The vehicle weight (181 kg) was estimated based on information from the Powersports Network website, which has information on a wide variety of all-terrain vehicles. Although trail rules will prohibit ATV use, this receptor was evaluated based on historic evidence of ATV use at the Site.

To estimate the sum of kilometers traveled, it was assumed that 5 vehicles per day would travel the 4,755 meters of the trail, 5 times per day, for 94 days. More information on the inputs, as well as the calculations and equations used to estimate the PEF for the off trail rider can be found in Appendix E.

Inhalation of fugitive vapors was not evaluated since no volatile compounds were determined to be COPCs for the surface soil.

5. Toxicity Assessment

The toxicity assessment determines the types of adverse health effects potentially associated with exposures to contaminants at the site and the relationship between the magnitude of exposure (dose) and severity of adverse effects (response). In December 2003, the Office of Solid Waste and Emergency Response (OSWER) issued a directive outlining the hierarchy of toxicity values to be used for risk assessment purposes. Values that come from the Integrated Risk Information System (IRIS), which represents EPA's consensus database for cancer and non-cancer toxicity information, belong in Tier I of the hierarchy. Tier II is the Provisional Peer-Reviewed Toxicity Values (PPRTV). Tier III includes other sources of toxicity information such as California EPA, the Agency for Toxic Substances and Diseases (ATSDR), and the Health Effects Assessment Summary Table (HEAST). For this assessment, IRIS values were used when they were available. PPRTVs were used in the absence of IRIS values if they were available. All toxicity values from Tier III have been approved by the EPA Office of Research and Development, National Center for Environmental Assessment (NCEA), Superfund Technical Support Center.

5.1. Health Effects Criteria for Non-carcinogens

Tables 5.1 and 5.2 provide data on non-cancer health effects associated with the COPCs. The toxicity values presented are the oral reference dose (RfD), the absorbed RfD for dermal exposure, and the inhalation reference concentrations (RfC). The non-cancer health endpoint (*i.e.*, the target organ) associated with the chemical can also be found on these tables.

5.2. Health Effects Criteria for Carcinogens

Tables 6.1 and 6.2 provide dose-response information in the form of the cancer slope factor for the ingestion, dermal contact, and inhalation routes. The weight of evidence (WOE) for each chemical, which is used to characterize the extent to which the available human epidemiology and animal studies indicate that a chemical may cause cancer in humans, is also shown. The WOE is categorized into six groups: (A) Known Human Carcinogen; (B-1) Probable Human Carcinogen – based on limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals; (B-2) Probable Human Carcinogen – based on sufficient evidence of carcinogenicity in animals; (C) Possible Human Carcinogen; (D) Not classifiable as a human carcinogen; and (E) Evidence chemical is not a carcinogen in humans.

The EPA 2005 *Cancer Guidelines*, however, provide an update to the original 1986 *Cancer Guidelines* and subsequent updates. In summary, the 2005 *Cancer Guidelines* emphasize the value of understanding the biological changes that the chemical can cause

and how these changes might lead to the development of cancer. They also discuss methods to evaluate and use such information, including information about an agent's postulated *mode of action*, or the series of steps and processes that lead to cancer formation. Mode-of-action data, when available and of sufficient quality, may be useful in drawing conclusions about the potency of an agent, its potential effects at low doses, whether findings in animals are relevant to humans, and which populations or life stages may be particularly susceptible. In the absence of mode-of-action information, default options are available to allow the risk assessment to proceed.

The 2005 *Guidelines* recommend that an agent's human carcinogenic potential be described in a *weight-of-evidence narrative* rather than the previously identified letter categories. The narrative summarizes the full range of available evidence and describes any conditions associated with conclusions about an agent's hazard potential. The following are the five recommended standard hazard descriptors:

- carcinogenic to humans
- likely to be carcinogenic to humans
- suggestive evidence of carcinogenic potential
- inadequate information to assess carcinogenic potential
- not likely to be carcinogenic to humans

EPA is evaluating the carcinogenic weight of evidence of chemicals through the IRIS chemical process. The requirements for in-depth analysis of mode-of-action data and the review process does not allow the equating of a chemical evaluated under the old letter system classification with the 2005 Classification narrative, rather a full analysis of the data is required.

The 2005 *Cancer Guidelines* also include *Supplemental Guidance* on the evaluation of early lifetime exposures. For example, where data are available on mutagenic mode of action for carcinogenesis, the *Supplemental Guidance* provides procedures for developing chemical-specific potency factors that account for early life susceptibility. In most cases, these data do not exist and standard age-dependent adjustment factors can be applied to account for early life susceptibility.

Because chemical-specific toxicity data on early life susceptibility are not available for most chemicals (vinyl chloride being the exception), cancer risks from the COPCs in this HHRA that are known to be carcinogenic by mutagenic mode of action (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were calculated using the general age-dependent adjustment factors recommended in the Supplemental Guidance. They are: a 10-fold adjustment to the toxicity value for ages 0 – <2 years; a 3-fold adjustment to the toxicity value for ages 2 – <16 years; and no adjustment to the toxicity value for ages 16 years and older. See Section 6 for a discussion of where these adjustments are presented in the HHRA.

6. Risk Characterization

This final step in the HHRA combines the exposure and toxicity information to provide a quantitative assessment of site risks. Exposures are evaluated based on the potential risk for developing cancer and the potential for non-cancer health hazards. The methodology used to estimate the cancer risks and non-cancer hazards are described below. Risk and hazard calculations for the RME expected to occur in the bike trail area are shown in Tables 7.1 – 7.5 in Appendix B. They are organized by receptor and timeframe. See Supplement A to the Table 7 series in Appendix B for the intermediate calculations for the chemicals that are carcinogenic by mutagenic mode of action. The cancer risks and non-cancer hazards are summarized in the Table 9 series.

6.1. Carcinogenic Risk

For carcinogens, cancer risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation.

$$\text{Risk} = \text{CDI} * \text{CSF}$$

Where Risk = a unitless probability of an individual's developing cancer
 CDI = chronic daily intake averaged over 70 years (mg/kg-day)
 CSF = slope factor, expressed as (mg/kg-day)⁻¹

These risks are probabilities that usually are expressed in scientific notation. An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimated has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the regulation that implements the Superfund law, defines the acceptable risk range for site-related exposures as one in a million (1×10^{-6}) to one in 10,000 (1×10^{-4}).

Child Rider (0-12)

The total RME cancer risk from inhalation of fugitive dust from riding on the bike trail is 6×10^{-8} , which is below the NCP's acceptable risk range of 1×10^{-6} to 1×10^{-4} .

Adolescent Rider (12-16)

The total RME cancer risk from exposure to surface soil through inhalation, ingestion and dermal contact is 7×10^{-5} , which is within the NCP's acceptable risk range of 1×10^{-6} to 1×10^{-4} . This risk represents the combined exposure from both on- and off- trail riding.

Adult Rider (16-30)

The total RME cancer risk from exposure to surface soil through inhalation, ingestion and dermal contact is 1×10^{-4} , which is at the upper end of the NCP's acceptable risk range of 1×10^{-6} to 1×10^{-4} . This risk represents the combined exposure from both on- and off-

trail riding. The risk is primarily driven by inhalation of hexavalent chromium and cadmium while riding off the trail.

The cumulative excess lifetime cancer risk for an individual who uses the trail for 30 years is 2×10^{-4} , which is at the upper end of the NCP's acceptable risk range. As stated earlier, the risk is driven primarily by the inhalation of cadmium and hexavalent chromium, which is a Class A carcinogen by the inhalation route, as well as ingestion of benzo(a)pyrene. It should be noted that cancer risk from chromium VI is driven primarily by the results from samples WB18-SS-02 – WB18-SS-02D in the Biosolids Area. Concentrations of chromium VI, as well as total chromium, in this hotspot area tend to be higher than throughout the rest of the site, with a few exceptions (BT-SS-15 and WB18-SS-40).

Construction Worker

The total RME cancer risk from exposure to surface soil is 1.9×10^{-6} , which is within the NCP's acceptable risk range of 1×10^{-6} to 1×10^{-4} .

6.2. Non-carcinogenic Hazard

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (*i.e.*, lifetime) with a reference dose (RfD) derived for a similar exposure period. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. The estimated intake of chemicals identified in environmental media (*e.g.*, the amount of a chemical ingested from contaminated surface soil) is compared to the RfD or the RfC to derive the hazard quotient (HQ) for the contaminant in the particular medium. An $HQ \leq 1.0$ indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely.

The Hazard Index (HI) is generated by adding the HQs for all the chemicals of potential concern that affect the same target organ or act through the same mechanism of action within a medium or across all media to which an individual may reasonably be exposed. An $HI \leq 1.0$ indicates that based on the sum of all HQs from different contaminants and exposure routes, adverse toxic non-carcinogenic effects from all contaminants are unlikely. An $HI > 1.0$ indicates that a site related exposure may present a hazard to human health. The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI/RfD}$$

Where CDI = chronic daily intake (mg/kg-day)
 RfD = reference dose (mg/kg-day)

CDI and RfD are expressed in the same units and represent the same exposure period (*i.e.* chronic, subchronic or short term).

Child Rider (0-12)

The sum of the HQs from inhalation of fugitive dust from riding on the bike trail is 0.01. The HQ for each of COPC does not exceed the benchmark of an HQ of 1. The total HI based on individual health endpoints is below EPA's acceptable threshold of 1; therefore, adverse health effects are not expected for this receptor.

Adolescent Rider (12-16)

The sum of the HQs from exposure to surface soil through inhalation, ingestion and dermal contact is 4. The HQ of 2 from inhalation of manganese exceeds the benchmark of 1. This hazard represents the combined exposure from both on- and off- trail riding. The total HI based on individual health endpoints is above EPA's acceptable threshold of 1 and could possibly have adverse health effects on the nervous system under the RME scenario.

Adult Rider (16-30)

The sum of the HQs from exposure to surface soil through inhalation, ingestion and dermal contact is 5. The HQ of 3 from inhalation of manganese exceeds the benchmark of 1. This hazard represents the combined exposure from both on- and off- trail riding. The total HI based on individual health endpoints is above EPA's acceptable threshold of 1 and could possibly have adverse health effects on the nervous system under the RME scenario.

The total HI risk for an individual who uses the trail for 30 years is 8. As stated earlier, the hazard is driven primarily by the inhalation of manganese. In addition, when all the age groupings are combined, the HQ for dermal contact with aroclor 1260 is 1. The HQ for inhalation of aluminum is also 1.

The distribution of manganese is relatively homogenous across the Site. A cursory look at the subsurface concentrations (0.5 to 2 ft) suggests a similar distribution. The manganese could possibly be naturally occurring. However, since a background study was not performed it is not known whether this is the case. The Wastebeds 1-8 soils cannot be considered typical soils or assumed to have soil properties similar to other soils in New York State, or even in Onondaga County. The "soil" that exists at the Site is the result of many years of Solvay waste disposal. As presented in the draft Revised Wetland Delineation and Floodplain Assessment, October 2008, "observed soils were predominantly a mixture of weathered Solvay waste material. Varying proportions of brown silty loam and a thin surface layer of organic (decomposed vegetation) material were also observed." The waste is visible at the surface and appears white and chalky. Manganese could be a ubiquitous component of Solvay waste. A detailed analysis of the composition of Solvay waste at the Site would need to be performed to determine this. Because of the uniqueness of the soils at the Site, use of background data for New York State is not applicable.

Although the HQs for aroclor 1260 and aluminum are 1, because of the conservatism built into the dermal and inhalation exposure models, adverse health effects are not likely from exposure to these contaminants.

Construction Worker

The sum of the HQs from exposure to surface soil is 1, which is equal to EPA's non-cancer threshold. The HQ for each of COPC does not exceed the benchmark of an HQ of 1, however. Because of the conservative assumptions built into the construction worker exposure models, adverse health effects are not expected for this receptor.

6.3. Uncertainties

The process of evaluating human health cancer risks and non-cancer health hazards involves multiple steps. Inherent in each step of the process are uncertainties that ultimately affect the final calculated cancer risks and non-cancer health hazards. Uncertainties may exist in numerous areas, including the environmental data used to conduct the risk assessment, the exposure parameter assumptions, the toxicological information used in the assessment, and the risk characterization when there is a mixture of chemicals present at a site. In general, the main sources of uncertainty include:

- environmental chemistry sampling and analysis
- environmental parameter measurement
- fate and transport modeling
- exposure parameter estimation
- toxicological data.

Uncertainty in environmental sampling arises in part from the potentially uneven distribution of chemicals in the media sampled. Consequently, there is significant uncertainty as to the actual levels present. Environmental chemistry-analysis error can stem from several sources including the errors inherent in the analytical methods and characteristics of the matrix being sampled.

Uncertainties in the exposure assessment are related to estimates of how often an individual would actually come in contact with the chemicals of concern, the period of time over which such exposure would occur, and in the models used to estimate the concentrations of the chemicals of concern at the point of exposure. Additionally, the risk assessment assumes that concentrations of contaminants remain constant for the duration of exposure, which is most likely not the case.

Uncertainties in toxicological data occur in extrapolating both from animals to humans and from high to low doses of exposure, as well as from the difficulties in assessing the toxicity of a mixture of chemicals. These uncertainties are addressed by making conservative assumptions concerning risk and exposure parameters throughout the assessment. As a result, the risk assessment provides upper-bound estimates of the risks to populations near the site, and is highly unlikely to underestimate actual risks related to the site.

Important sources of uncertainty in this HHRA are as follows:

For several chemicals – dibenzo(a,h)anthracene, dieldrin, hexachlorobenzene, silver, and thallium – a majority of the sample results were non-detect. Substituting one-half the detection limit therefore significantly affected the distribution of the dataset. However, since these chemicals were not determined to be risk drivers, the overall impact of these biased statistics is minor. For chromium VI, 75 percent of the samples were non-detect, which skews the dataset. As mentioned previously, the hotspot area around sample WB18-SS-02 had the highest chromium concentrations on site. Additionally, because the dataset for the construction worker’s exposure was small, statistics could not be calculated for many of the compounds and the EPC defaulted to the maximum detected concentration.

For the dermal exposure to soil pathway, there are also uncertainties, such as a) not all chemicals have scientifically established dermal absorption values for soil and therefore may be left out of the quantitative assessment, b) sometimes soil to skin adherence factors do not match exactly with site conditions, and c) exposed skin surface area and exposure frequency may change seasonally, which may not be adequately accounted for in the exposure parameters used to represent the RME scenario.

The cancer slope factor for nickel refinery dust was used to evaluate nickel in order to be health-protective. This may overestimate the risk from inhalation of nickel. However, because inhalation of nickel does not pose an unacceptable risk in the assessment, there can be assurance that the risks from exposure to this compound are not underestimated and that no further evaluation is necessary.

The RfC is an estimate “(with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime.” The RfC uncertainty factors, combined with health-protective exposure assumptions, ensure that non-cancer hazard is not underestimated. Although the hazard quotient for manganese exceeded EPA’s non-carcinogenic hazard threshold of 1, the exceedence was slight and was only for those individuals who leave the trail.

Another factor that puts the manganese hazard quotient in perspective is dust particle size. As noted in the 2007 *Framework for Metals Risk Assessment*, particle size of the inhaled compound is important when considering dosimetry and bioavailability. Larger, coarser particles are often the result of mechanical disruption (e.g., construction activities) which the PEF equation models. These larger particles are less likely to stay suspended in the air for long periods of time and get deep in to the respiratory tract. Most likely, the manganese disturbed by ATV riding would be in the form of larger particles. However, because it is Solvay waste, rather than typical soil across the Wastebeds 1-8 Site, it cannot be known with certainty if this is the case.

Finally, there is uncertainty associated with modeling dust generation. In addition to the inherent uncertainty in modeling dust emissions over a large area, a number of assumptions had to be made concerning hypothetical use of the bike trail area by ATVs. However, the input parameters to the dust model are conservative and therefore it is

unlikely that the cancer risks and non-cancer health hazards from inhalation for the individual receptors are underestimated. One deficiency of the model is that it does not allow the user to estimate of exposure to on-trail riders from ATV-generated dust. Nevertheless, the risks and hazards for the on-trail rider were low enough that incorporating additional risks and hazards that may result from inhalation of ATV-generated dust would be unlikely to change the conclusions of this assessment.

7.0. Risk Summary and Recommendations

The risk and hazard calculations for those receptors that use the bike trail as intended (*i.e.*, they abide by posted rules and signage and do not leave the bike trail) are below EPA's levels of concern. However, this risk assessment also considered the possibility that users may leave the bike trail. This assumption was justified based on evidence of ATV use at the Site and the fact that the new bike trail will provide greater access to the Site by residents living on the northwestern shore of the Lake. Risk and hazard calculations for the receptor that spends a portion of his or her time off the trail indicate that the cancer risks are at the upper bound of EPA's acceptable risk range and non-cancer health hazards are above EPA's threshold of 1. These risks and hazards are based on 30 years of exposure using the RME assumptions outlined in Section 4 of this HHRA. The non-cancer hazard comes primarily from inhalation of manganese. Because the source of manganese is unknown, EPA recommends ensuring off-trail use of the Site is effectively prohibited by fencing or other means. Demonstrated hazard from off-trail riding also suggests that ATV access to the Site should also be prohibited. Currently, the gates are often unlocked and fencing is inadequate to effectively keep trespassers from using the Site.

For several chemicals (*i.e.*, aroclor 1260, arsenic, barium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, cadmium, copper, and mercury) the maximum detected concentration, as well as the calculated EPC, exceed both the restricted-residential and commercial New York State Soil Cleanup Objectives (see Appendix G). This information lends further weight to the need to prohibit off-trail usage of the Site.

The risk and hazard calculations for the future construction worker are below EPA's levels of concern.

Bibliography

Lockheed Martin. September 2008. Statistical Review of Chromium Speciation. Wastebeds 1-8.

National Weather Service – Historical Climatological Data for Syracuse. Accessed March 30, 2007 at <http://www.erh.noaa.gov/bgm/climate/syr.shtml>

New York State, State Environmental Board. 2006. 6 NYCRR Subparts 375-1 through 375-4 and Subpart 375-6. Available at <http://www.dec.ny.gov/chemical/34189.html>. Accessed on November 21, 2007.

O'Brien & Gere. September 2005. Preliminary Site Assessment Wastebeds 1 through 8.

O'Brien & Gere. November 2006. RI/FS Workplan: Wastebeds 1-8.

O'Brien & Gere. July 2008. Human Health Risk Assessment Interim Deliverable. Wastebeds 1-8.

O'Brien & Gere. September 2008. Data Validation Report. RI: Chromium Speciation Study: Wastebeds 1-8.

O'Brien & Gere. October 2008. Wetland Delineation and Floodplain Assessment – Wastebeds 1-8.

US EPA. 1989. Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual, Part A. US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

US EPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: “Standard Default Exposure Factors.” OSWER Directive 9285.6-03.

US EPA. 1991b. RAGS Volume 1, Human Health Evaluation Manual, Part B, Development of Risk-based Preliminary Remediation Goals. US EPA, OSWER, Washington, DC. 9285.7-01B.

US EPA. 1991c. Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER Directive 9355.0-30.

US EPA. 1995. Land Use in the CERCLA Remedy Selection Process. OSWER Directive 9355.7-04.

US EPA. 1997. Exposure Factors Handbook: Volume I (General Factors) & III (Activity Factors). EPA/600/P-95/002Fa

US EPA. 1998. Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA sites and RCR Corrective Action Facilities. OSWER Directive 9200.4-27P.

US EPA. 2001. RAGS Volume 1, Human Health Evaluation Manual, Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments. US EPA, OSWER, Washington, DC. OSWER 9285.7-47.

US EPA 2002a. Child-Specific Exposure Factors Handbook (Interim Report) 2002. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA-600-P-00-002B, 2002

US EPA. 2002b. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

US EPA. 2002c. Calculating the Upper Confidences Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

US EPA. 2003a. Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53.

US EPA. 2003b. Recommendations of the Technical Review Workgroup for Lead for and Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil. EPA 540-R-03-001.

US EPA. 2004a. RAGS Volume 1, Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment. US EPA, OSWER, Washington, DC. OSWER 9285.7-02EP.

US EPA. 2004b. Region 9 Preliminary Remediation Goals. <http://www.epa.gov/region09/waste/sfund/prg/index.htm>

US EPA. 2004c. Integrated Risk Information System. www.epa.gov/iris.

US EPA. March 2005. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F.

US EPA. March 2005b. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.

US EPA. March 2007. Framework for Metals Risk Assessment.

US EPA. April 2007. ProUCL User's Guide Version 4.0. Prepared for US EPA by Lockheed Martin. EPA/600/R-07/038.