Health Consultation

Evaluation of Environmental Data

RARITAN BAY SLAG

OLD BRIDGE AND SAYREVILLE, MIDDLESEX COUNTY, NEW JERSEY

EPA FACILITY ID: NJN000206276

FEBRUARY 23, 2009

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

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Public Health Services Branch
Consumer and Environmental Health Services
Hazardous Site Health Evaluation Program
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Summary

In November 2008, the United States Environmental Protection Agency requested the Agency for Toxic Substances and Disease Registry and the New Jersey Department of Health and Senior Services to evaluate sampling data collected at six areas at the Raritan Bay Slag site, located at Old Bridge and Sayreville, New Jersey. Samples included the collection of surface and subsurface soil, surface water and sediment samples from a slag area at the base of the park on the waterfront (Area 1), three beach areas (designated as Areas 2, 3 and 4), one jetty (Area 5) and a park and playground area (Area 6).

The primary contaminants of concern were antimony, arsenic and lead. Based on observed uses of these areas and evaluation of environmental contamination, New Jersey Department of Health and Senior Services and Agency for Toxic Substances and Disease Registry determined that children and adults could be exposed to lead at three of the areas at levels that could be harmful to health. The New Jersey Department of Health and Senior Services and Agency for Toxic Substances and Disease Registry consider Areas 1, 2 and 5 to be a **Public Health Hazard** based on data provided to New Jersey Department of Health and Senior Services as of November 2008. High lead levels in surface and subsurface soil and in surface water could result in lead exposures of health concern from recreational activities such as sitting on slag and eating and drinking, playing on sand and/or swimming. The New Jersey Department of Health and Senior Services recommend that the United States Environmental Protection Agency should restrict access to the slag area at the base of the park on the waterfront (Area 1), the beach area between the Seawall and the first jetty (Area 2), and the Cheesequake Creek Inlet Western Slag Jetty (Area 5).

Statement of Issues

This health consultation is in response to the United States Environmental Protection Agency (USEPA) request to evaluate results from environmental sampling at the Raritan Bay Slag site and assess the public health implications of the results. This consultation provides an evaluation of surface soil, sediment and surface water samples collected by the USEPA in September 2008 from the Laurence Harbor Seawall and the Cheesequake Creek inlet areas, collectively comprising the Raritan Bay Slag site. The health consultation was prepared by the New Jersey Department of Health and Senior Services (NJDHSS) through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

Background

The Raritan Bay Slag site is located in the Laurence Harbor section of Old Bridge and in Sayreville along the Raritan Bay. The portion of the site that is in Laurence Harbor is part of what is now called Old Bridge Waterfront Park. For the purposes of this health consultation, the site consists of six areas (see Figure 1):

1. Laurence Harbor Seawall: Slag area at the base of the park on the waterfront (including along Margaret's Creek)
2. Laurence Harbor Beach: Area between Seawall and first jetty
3. Laurence Harbor Beach: Area between first and second jetty
4. Laurence Harbor Beach: Area between third jetty and Cheesequake Creek Inlet eastern jetty
5. Cheesequake Creek Inlet Western Slag Jetty in Sayreville
6. Laurence Harbor park and playground area

Lead slag was deposited along the beachfront in the late 1960s and early 1970s. The New Jersey Department of Environmental Protection (NJDEP) sampling conducted at the beach area near the Seawall and a nearby park identified an area of concern in the beach area in 2007, based on high lead concentrations in the soil. Based on NJDHSS recommendations (ATSDR 2007), temporary "snow" fencing was placed in this area and "Keep Off" signs were posted in the park along the fence-line area (consisting of a split rail fence) bordering the edge of the Seawall.

The NJDEP requested that the USEPA perform a removal action on the Laurence Harbor Seawall. Subsequently, the USEPA identified another potential area of concern, a jetty on the Sayreville waterfront, adjacent to the Laurence Harbor beaches. Both lead slag and crushed battery casings were also present on the jetty.

The USEPA removal assessment is ongoing, and includes the collection of soil, sediment, surface water, biological and slag samples along the Seawall, jetty and the beaches.

Site Visit

Somia Aluwalia and Sharon Kubiak, NJDHSS, and Nick Magriples, USEPA, conducted a site visit on December 9, 2008. The purpose was to visually inspect the areas of concern that are the subject of this health consultation. The snow fencing around the beach area "hot spot" was largely missing and it was noted that at low tide the fencing was easily circumvented. Staff noticed the presence of slag along the Laurence Harbor Seawall and on the adjacent sediment areas, as well as in less accessible areas of the Margaret Creek. During the course of about a half hour, staff observed approximately 10 individuals utilizing the park area and walking path. Additionally, an individual was seen using a metal detector on the beach area on the Laurence Harbor side of Cheesequake Creek. Photographs of persons engaged in recreational activities are shown in the Appendix; these photographs were taken over the last several months by the USEPA and NJDHSS.

Environmental Contamination

On September 10-16, 2008, the USEPA collected samples from Areas 1-6, as shown in Figure 1. Tables 1a through 6a provide summary statistics for the results obtained by USEPA from surface soil, surface water and sediment sampling in the six areas. The total numbers of samples collected are not equal within each set for a contaminant as data validation review resulted in rejection of some individual data results. The surface water samples from Areas 2 and 4 were collected by stirring up sediment and collecting the water and sediment entrained in the water column, known as activity-based sampling. The results of surface water samples (in Tables 1a through 6a) are presented as the compilation of total metal and dissolved metal results for each sample. Per USEPA's request, this evaluation focuses on the following metals: antimony, arsenic, copper and lead. Data from NJDEP sampling is also provided in Tables 1b through 3b and Table 6b.

There are a number of comparison values (CVs) available for screening environmental contaminants to identify contaminants of concern. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse non-carcinogenic effects. For lead in soil and sediment, another CV includes the USEPA Screening Guidance value of 400 mg/kg. For lead in surface water, the USEPA drinking water action level of 15 micrograms per liter (μg/L) was used as a comparison value. Both these CVs are considered to be conservative values used in screening potential contaminants of concern as these are based on residential soil standards and drinking water standards.

<u>Area 1</u>: The Laurence Harbor Seawall area is the slag area at the base of the park on the waterfront (including along Margaret's Creek). Results from Area 1 indicated that

antimony, arsenic and lead were elevated in some samples in surface soil, surface water and sediment (see Table 1a). Copper was not elevated above the comparison value in any sample. The average lead concentration in surface soil was 1,474 mg/kg; this average was driven by one very elevated sample of 10,200 mg/kg which was collected from soil that was located in a runoff migration pathway between the slag and Margaret's Creek area. Approximately one-half of the surface soil samples contained arsenic, antimony and lead at levels that exceeded the CVs. With regard to soils below the surface, samples taken at various depth intervals indicated lead levels exceeding the CV. Half of the subsurface soil samples had lead levels exceeding the USEPA Screening Guidance value. The majority of the surface water samples were elevated above the comparison values for all metals.

Table 1b shows the results of the sampling that NJDEP conducted between May and July 2007. In Area 1, all the levels detected for antimony, arsenic, copper and lead were higher than the USEPA results. Of the 24 samples collected, 22 samples were elevated above the lead USEPA Screening Guidance value. The average lead level was 18,503 mg/kg and the maximum lead concentration detected was 142,000 mg/kg.

Area 2: The Laurence Harbor beach area between the Seawall and the first jetty (Area 2) is of particular interest as it had been previously sampled by the NJDEP and the area is easily accessible for recreational activities. Surface soil sampling results indicated a hot spot on the beach where lead levels were elevated, with an average concentration was 526 mg/kg and a maximum hotspot concentration of 1,630 mg/kg (Table 2a). Seven out of 12 samples were elevated above the USEPA Screening Guidance value for lead. Arsenic and antimony were also elevated in the surface soil samples. These elevated levels appear to be scattered throughout the sampled beach area.

In addition to surface soil sampling in the hotspot in Area 2, the USEPA also collected subsurface samples. The results from limited subsurface lead levels, collected at a depth of 6-12 inches and 12-18 inches, were very high (649-23,800 mg/kg). Arsenic and antimony were also elevated in the subsurface soil samples. Surface water results show that antimony, arsenic and lead were elevated above CVs for all samples tested (Table 2a).

As shown in Table 2b, the NJDEP sampling results indicated comparable levels to the USEPA results. The maximum lead level was 1,090 mg/kg, close to the USEPA maximum lead level of 1,630 mg/kg in surface soil.

Area 3: The area between the first and second jetty in Laurence Harbor has results only for surface soil sampling and this area had two samples that were elevated above the lead CV (Table 3a). The results for antimony and arsenic in surface soil were all rejected on the basis of laboratory quality assurance/control. The NJDEP sampling results, as shown in Table 3b, are similar to the results obtained from USEPA sampling with regard to the average concentration for lead.

Area 4: The beach area between the third jetty and the Cheesequake Creek eastern inlet had the lowest contaminant levels for the metals of concern in soil and sediment; there were no exceedances above the CVs (Table 4). The metals in surface water were elevated above the CVs in all samples.

Area 5: Another area of potential concern is the Cheesequake Creek Inlet Western Slag Jetty (Area 5) where activities such as walking, fishing, clamming, crabbing, sitting on slag and eating and drinking have been observed. The surface soil results (see Table 5) from this area show an extremely high concentration of lead (maximum concentration was 198,000 mg/kg). Seven out of eight surface soil samples were elevated above the CVs for antimony, arsenic and lead. The sub-surface samples were elevated as well, and the maximum lead level was 21,500 mg/kg. Surface water samples were also elevated for antimony, arsenic and lead in a majority of the samples.

Area 6: Only surface soil samples were collected in this area. The majority of the park and playground area soil samples were not elevated; the average soil levels were below the CVs (see Table 6a). Two samples were elevated for arsenic (34 and 114 mg/kg) and these samples were in the park area. Approximately one fourth of the samples were above the CV for antimony. The NJDEP had collected three samples from this area (see Table 6b) and none of the samples were elevated above the CVs.

In summary, the contaminants of concern selected for further evaluation in the various areas are as follows:

<table>
<tr><th>Media</th><th>Area 1</th><th>Area 2</th><th>Area 3</th><th>Area 4</th><th>Area 5</th><th>Area 6</th></tr>
<tr><td>Soil</td><td rowspan="3">Antimony, Arsenic, Lead</td><td rowspan="3">Antimony, Arsenic, Lead</td><td>Lead</td><td></td><td rowspan="3">Antimony, Arsenic, Copper, Lead</td><td>Antimony, Arsenic</td></tr>
<tr><td>Surface water</td><td></td><td>Antimony, Arsenic, Lead</td><td></td></tr>
<tr><td>Sediment</td><td></td><td></td><td></td></tr>
</table>

Discussion

The method for assessing whether a health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminant source to a receptor population and then whether exposures to contamination are high enough to be of health concern.

Exposure Pathway Analysis

An exposure pathway is a series of steps starting with the release of a contaminant in a media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. a receptor population.

Generally, the ATSDR considers three exposure pathway categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent.

To evaluate potential exposures to contaminants in the soil, sediment and surface water at the Raritan Bay Slag site, NJDHSS evaluated the environmental data and considered how people might come into contact with contaminants in soil. The possible pathways of exposure are incidental ingestion of contaminated soil, sediment and surface water. In other words, in order to be exposed to contaminants in soil and sediment, one must come into contact with the soil by eating soil/sediment adhered to fingers or food items. For surface water, one must drink water while swimming in order to be exposed to contaminants in surface water. Dermal contact with contaminated soil, sediment and surface water is also possible during recreational activities. The extent of dermal absorption of contaminants depends on the area and duration of contact, chemical and physical attraction between the contaminant and the media (loosely or tightly bound), and the ability of the contaminant to penetrate the skin. Although the potential for exposure by dermal absorption of chemicals exists, ATSDR generally considers dermal exposure to be a minor contributor to the overall exposure dose relative to contributions from ingestion and inhalation for most exposure scenarios (ATSDR 2005).

<u>Surface and sub-surface soils</u>: In Areas 1, 2, 3, 5 and 6, adults and children have been observed engaging in activities such as fishing, clamming, walking, dog walking, sitting on slag, running, playing, lying on a blanket, digging, shell/rock collecting, ATV use, and eating and drinking (see photographs in the Appendix). Individuals accessing these areas were likely to be exposed to surface soil contaminated with antimony, arsenic, copper and lead during the observed recreational activities. Small children may have been more exposed than older children and adults because they have more hand-to-mouth contact with soil.

<u>Surface water</u>: Activity-based surface water samples were collected in Areas 2 and 4; routine water samples were collected from Area 1 and 5. Results indicate that adults and children swimming in the water in these areas could be exposed to antimony, arsenic and lead. Observed uses of these areas also include fishing, clamming, and crabbing which would result in contact with surface water resulting in incidental ingestion, but is considered to be minor when compared to the ingestion of surface water while swimming.

<u>Sediment</u>: As soil results are similar to sediment results, this media will not be considered in further evaluation. It is thought that exposures from contacting soil and

surface water would represent a comprehensive evaluation, as contact with sediment would constitute a minor portion of the exposure assessment.

To summarize, these are the completed exposure pathways for the site:

- Areas 1, 2, 3, 5 and 6: Incidental ingestion of soil contaminated with antimony, arsenic, lead and copper.

- Areas 1, 2, 4 and 5: Incidental ingestion of surface water contaminated with antimony, arsenic, lead and copper while swimming.

Public Health Implications

When determining the public health implications of exposure to hazardous contaminants, NJDHSS considers how much of the contaminant people might come into contact with and compares these contaminant exposure doses with health protective comparison values. When contaminant exposure dose levels are below health-based comparison values, health impacts from exposure to those levels are unlikely. Contaminant levels exceeding comparison values do not indicate that health impacts are likely but instead warrant further evaluation.

Non-Cancer Health Effects

To assess non-cancer health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, non-cancer health effects. MRLs are developed for a route of exposure, i.e., ingestion or inhalation, over a specified time period, e.g., acute (less than 14 days); intermediate (15 - 364 days); and chronic (365 days or more). MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies, and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, observed effect levels include:

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. In order to provide additional perspective on these health effects, the calculated exposure doses were then compared to observed effect levels (e.g., NOAEL, LOAEL). As the exposure dose increases beyond the MRL to the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

To ensure that MRLs are sufficiently protective, the extrapolated values can be several hundred times lower than the observed effect levels in experimental studies. When MRLs for specific contaminants are unavailable, other health based comparison values such as USEPA Reference Dose (RfD). The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

NJDHSS evaluated non-cancer health risks based on realistic recreational exposure scenarios for children and adults who may come into contact with soils in all areas and surface water at Areas 1, 2, 4 and 5. The recreational exposure scenario assumes a seasonal exposure over the period of three summer months. While it is noted and observed that some of the mentioned recreational activities occur at times outside of the summer months, it is assumed the summer month exposure duration would result in maximum contact with contaminated beach soil and surface water (particularly for children).

Exposures are based on ingestion of contaminated media; non-cancer exposure doses were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{\mathrm{C \times IR \times EF}}{\mathrm{BW}} \times \frac{\mathrm{ED}}{\mathrm{AT}}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in soil (mg/kg) or concentration of contaminant in water (μg/L);
IR = soil ingestion rate (mg/day) or water ingestion rate (L/day);
EF = exposure factor representing the site-specific exposure scenario;
ED = exposure duration (years);
AT = averaging time (years); and
BW = body weight (kg)

Based on the USEPA Exposure Factors (USEPA 1997, USEPA 2008) and site-specific conditions, the following assumptions were used to calculate exposure doses for children and adults:

Media	Receptor Population	Ingestion Rate	No. of Days of Exposure Per Year	Body Weight (kg)
Soil	Child	100 mg/day	60 days (5 days per week, 3 months per year)	17
	Adult	50 mg/day		70
Surface Water	Child	0.05 L/day		17
	Adult	0.07 L/day		70

The following section describes the calculated doses and public health implications for non-cancer health effects for each exposure pathway on an area-by-area basis. Results are presented and compared to MRLs in Tables 7 through 11 for all contaminants of concern except lead.

Lead is considered separately using the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model for children and the Adult Lead Methodology (ALM) model for adults. These models predict total human exposure as measured by the amount of lead in blood, based on contaminant levels in the environment. In this health consultation, the IEUBK model was used to calculate the geometric mean of lead in blood in children, aged up to 84 months (USEPA 1994a). Each age group was modeled separately because the exposures at the site are intermittent in nature. The model also provides the probability estimate (expressed as P_{10}) that a typical child will have a blood lead level greater or equal to the level of concern established by the U.S. Centers for Disease Control and Prevention (10 µg/dL). This P_{10} estimate should be at or below a protection level of five percent, i.e., $P_{10} \leq 5$ percent, as recommended by the USEPA Office of Solid Waste and Emergency Response (USEPA 1994b). The Adult Lead Model describes a methodology for assessing risks associated with non-residential exposures to lead in soil. It provides similar outputs as the IEUBK lead model [USEPA 2003a].

Area 1: Laurence Harbor Seawall: Slag area at the base of the park on the waterfront (including along Margaret's Creek)

<u>Antimony and Arsenic:</u>

Incidental ingestion from soil**:** Given the above described assumptions about exposure frequency and duration and an average concentration of 35 mg/kg for antimony, the average daily dose from ingestion was estimated to be 3.7E-05 mg/kg/day and 4.5E-06 mg/kg/day for children and adults, respectively (see Table 7). This dose is below the USEPA's RfD for chronic oral exposure of 4E-04 mg/kg/day (USEPA 1992). Therefore, non-cancer effects from antimony in soil at this area are very unlikely. For arsenic, the average daily dose from ingestion was estimated to be 2.1E-05 mg/kg/day and 2.6E-06 mg/kg/day for children and adults, respectively. This dose is below the ATSDR MRL for chronic oral exposure of 3E-04 mg/kg/day (ATSDR 2007). Non-cancer effects from arsenic in soil at this area are very unlikely.

Incidental ingestion from surface water when swimming: The average daily dose from ingestion of surface water for antimony was calculated to be 1.6E-05 mg/kg/day and 5.4E-06 mg/kg/day for children and adults, respectively (see Table 7). This is below the USEPA's RfD of 4E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. The average daily dose from ingestion of surface water for arsenic was calculated to be 5.8E-06 mg/kg/day and 2E-06 mg/kg/day for children and adults, respectively. This is below the ATSDR MRL of 3E-04 mg/kg/day and therefore non-cancer health effects are very unlikely.

Total Ingestion Dose*:* When the ingestion doses for both pathways are combined, the total antimony dose is calculated to be 5.3E-05 and 9.9E-06 for children and adults, respectively (see Table 7). This is also below the USEPA's RfD for chronic oral exposure of 4E-04 mg/kg/day. For arsenic, the total dose was calculated to be 2.7E-05 and 4.6E-06 for children and adults, respectively (see Table 7). This dose is also below the ATSDR's MRL for chronic oral exposure of 3E-04 mg/kg/day. Therefore, in the exposure scenario of combined ingestion dose from ingestion of soil and ingestion of water while swimming, non-cancer effects from antimony and arsenic present in this area are very unlikely.

Lead:

Lead exposures to children accessing the site using realistic scenarios were evaluated using the USEPA IEUBK lead model and are presented below:

Incidental ingestion from soil and surface water when swimming: For this area, the IEUBK model for assessing intermittent or variable exposures at sites was used to estimate the contribution from ingestion of lead contaminated soil and surface water (USEPA 2003b). Since it is more plausible that children aged 12-84 months actively play with the sand and swim at the site, the blood lead level as contributed by lead contaminated soil and surface water ingestion was evaluated for this age interval.

The assumptions for the lead exposure scenario for children aged 12 to 84 months are as follows:

1. Children were exposed to soil and surface water containing lead each time the area was visited over the three month period. The visit frequency was assumed to be five days per week over three months of the year. It was assumed that the child does not return to the site for the remainder of that year but continues to return every year from age of 12 months through 84 months for three summer months of the year (intermittent exposures). This scenario considers a lead

"wash-out[1]" period in between the annual cycles of intermittent exposures over the course of a child life from 12 – 84 months.

2. The swimming was assumed to last one hour per visit.

3. The lead concentration of residential soil was assumed to be 50 mg/kg (ATSDR 2002). The daily site soil and water exposures were added to the IEUBK model alternate source parameter. IEUBK model default values were used for all other variables (USEPA 2002).

4. The daily lead intake for use in the model was calculated using the average soil lead concentration (1,474 mg/kg) and average surface water lead concentration (62 µg/L). Since the average soil lead in this area was driven by one very elevated sample, an alternate analysis was also done excluding this value and using an average soil lead of 602 mg/kg. The IEUBK model assumes lead bioavailability of 30% and 50% for soil lead and water lead, respectively. The calculation for the average soil lead concentration of 1,474 mg/kg is shown below:

   Soil: 1,474 mg/kg*45[2]mg/day*(1/1000)*(5 days/7 days)*(30%) = 14.2 µg/day
   Water: 62 µg/L*0.05 L/day*(5 days/7 days)*(50%)= 1.1 µg/day
   Total lead intake: 14.2 µg/day + 1.1 µg/day = 15.3 µg/day

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 10 µg/dL (P_{10}) for children are shown in the following table. The exposure estimate characterizes children who return to the site for a period of three months each year, and whose added blood lead burden is eliminated during the intervening months between successive annual exposures.

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[1] For seasonal exposures that are restricted to only a fraction of a year (e.g., summer months), some of the lead burden accumulated during the exposure season will be eliminated during the intervening months between seasonal exposures. However, the IEUBK model cannot simulate this loss of lead; model predictions correspond to a full year of exposure to a contact exposure level regardless of the actual exposure period. For seasonal exposures that occur in successive years, the TRW recommends that exposures be simulated for individual age-years and predicted blood lead concentrations for each age-year of exposure be averaged (USEPA-540-R-03-008) OSWER # 9285.7-76 page 30.

[2] Daily soil-dust ingestion rate is an age-specific range in the IEUBK model (85-135 mg/day). The USEPA default child ingestion rate of 100 mg/day represents a reasonable central value for the age-specific range. The soil-dust ingestion rate is a composite of soil ingestion (45%) and dust ingestion (55%); hence 45 mg/day is a reasonable ingestion rate for assessing exposure to outdoor soil sources.

Age (months)	Column A		Column B	
	Based on mean soil conc. of 1,474 mg/kg and water conc. of 62 µg/L		Based on mean soil conc. of 602 mg/kg and water conc. of 62 µg/L	
	Blood Lead Level[a] (µg/dL)	P_{10} (%)[b]	Blood Lead Level (µg/dL)	P_{10} (%)
12 - 24	6.0	14	3.7	1.8
24 - 36	5.3	8.5	3.3	0.9
36 - 48	4.8	5.9	3.0	0.53
48 - 60	4.3	3.6	2.7	0.24
60 - 72	3.8	2	2.4	0.11
72 - 84	3.4	1.1	2.1	0.05
12-84 Intermittant.	4.6	5.9	2.9	0.61

[a]Geometric Mean lead levels in blood; [b]probability of blood lead level > 10 µg/dL

The above table presents a range of possible risks for children who access the site for three months of the year. The blood lead levels for all the age groups are below the action level of 10 µg/dL for Column A and Column B. The P_{10} value for the individual age-years (from one to seven years) ranged from one to 14 percent for Column A and from 0.05 to two percent for Column B. For the exposure scenario based on Column A, it can be concluded that if a group of one to four year olds were to visit the site five days a week for a period of three months, more than 5 percent of them will have blood lead levels above 10 µg/dL. For seasonal exposures that occur in successive years for a period of seven years (one to seven years) for a child accessing the site, the predicted blood lead concentrations for each age-year of exposure were averaged and the mean blood level was predicted to be 4.6 µg/dL with an associated P_{10} value of 5.9 percent. It is more likely that the exposure scenario will be the one that is presented in Column B, based on the mean level that excludes the one elevated sample of 10,200 mg/kg. That particular sample was collected from a piece of soil in an area infrequently accessed by individuals (i.e., is not on the beach or on the shore-front). Accumulation of lead in the body can cause damage to the nervous or gastrointestinal system, kidneys, or red blood cells (ATSDR 2006). Children, infants, and fetuses are the most sensitive populations. Lead may cause learning difficulties and stunted growth, or may endanger fetal development. Health effects associated with lead exposure, particularly changes in children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (i.e., no NOAEL or LOAEL is available).

An adult blood lead model estimated a geometric mean blood lead level of 4.4 µg/dL for adult workers based on the high soil lead mean of 1,424 mg/kg and a surface water concentration of 62 µg/L (see Table 12). As such, adverse health effects to adults associated with lead exposures from this area are not expected.

Area 2: Laurence Harbor Beach: Area between Seawall and first jetty

Antimony and Arsenic:

Incidental ingestion from soil: Antimony and arsenic both had an average soil concentration of 20 mg/kg. Using this concentration, the average daily dose from ingestion was estimated to be 2.1E-05 mg/kg/day and 2.6E-06 mg/kg/day for children and adults, respectively for both metals (see Table 8). This dose is below the USEPA's RfD for chronic oral exposure of 4E-04 mg/kg/day for antimony and the ATSDR's MRL of 3E-04 mg/kg/day for arsenic. Therefore, non-cancer effects from antimony and arsenic in soil at this area are very unlikely.

Incidental ingestion from surface water when swimming: The average daily dose from ingestion of surface water for antimony was calculated to be 1.0E-05 mg/kg/day and 3.4E-06 mg/kg/day for children and adults, respectively (see Table 8). This is below the USEPA's RfD of 4E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. The average daily dose from ingestion of surface water for arsenic was calculated to be 1.6E-05 mg/kg/day and 5.4E-06 mg/kg/day for children and adults, respectively. This is below the ATSDR's MRL of 3E-04 mg/kg/day and therefore non-cancer health effects are very unlikely.

Total Ingestion Dose: When the ingestion doses for both pathways are combined, the total antimony dose is calculated to be 3.1E-05 and 6.0E-06 for children and adults, respectively (see Table 8). This is also below the USEPA's RfD for chronic oral exposure of 4E-04 mg/kg/day. For arsenic, the total dose was calculated to be 3.7E-05 and 8.0E-06 for children and adults, respectively (see Table 8). This dose is also below the ATSDR's MRL for chronic oral exposure of 3E-04 mg/kg/day. Therefore, in the exposure scenario of combined ingestion dose from ingestion of soil and ingestion of water while swimming, non-cancer effects from antimony and arsenic present in this area are very unlikely.

Lead:

Incidental ingestion from soil and surface water when swimming: For this area, the IEUBK model for assessing intermittent or variable exposures at sites was used to estimate the contribution from ingestion of lead contaminated soil and surface water (USEPA 2003b).

The assumptions for the lead exposure scenario for children aged 12 to 84 months are as follows:

1. Children were exposed to soil and surface water containing lead each time the area was visited over the three month period. The visit frequency was assumed to be five days per week over three months of the year. It was assumed that the child does not return to the site for the remainder of that year but continues to return every year from age of 12 months through 84 months for three summer

months of the year (intermittent exposures). This scenario considers a lead "wash-out" period in between the annual cycles of intermittent exposures over the course of a child life from 12 – 84 months.

2. The swimming was assumed to last one hour per visit.

3. The lead concentration of residential soil was assumed to be 50 mg/kg (ATSDR 2002). The daily site soil and water exposures were added to the IEUBK model alternate source parameter. IEUBK model default values were used for all other variables (USEPA 2002).

4. The daily lead intake for use in the model was calculated using the average soil lead concentration (526 mg/kg) and average surface water lead concentration (1,124 µg/L). The IEUBK model assumes lead bioavailability of 30% and 50% for soil lead and water lead, respectively. The calculation is shown below:

   Soil: 526 mg/kg*45mg/day*(1/1000)*(5 days/7 days)*(30%) = 5.1 µg/day
   Water: 1,124 µg/L*0.05 L/day*(5 days/7 days)*(50%) = 20.1 µg/day
   Total lead intake: 5.1 µg/day + 20.1 µg/day = 25.2 µg/day

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 10 µg/dL (P_{10}) for children are shown in the following table:

Age (months)	Based on mean soil conc. of 526 mg/kg and water conc. of 1,124 µg/L	
	Blood Lead Level[a] (µg/dL)	P_{10} (%)[b]
12 - 24	8.4	36
24 - 36	7.3	25
36 - 48	6.7	20
48 - 60	6.0	14
60 - 72	5.4	9.3
72 - 84	4.8	5.9
12 - 84	6.4	18

[a]Geometric Mean lead levels in blood; [b]probability of blood lead level > 10 µg/dL

The geometric mean blood lead levels for all the age groups are below the action level of 10 µg/dL. The P_{10} value ranged from approximately six to 36 percent for the 12-84 months age groups. It can be concluded that if a group of one to seven year olds were to visit the site five days a week for a period of three months, more than 5 percent of them will have blood lead levels above 10 µg/dL. The predicted mean blood level for a child who accessed the site for three months of the years each successive year over a seven year period (1 – 7 years) was calculated to be 6.4 µg/dL with an associated P_{10} value of 18 percent. Overall, this area does pose a lead hazard to children.

An adult blood lead model estimated a geometric mean blood lead level of 4.7 µg/dL for adult workers based on the mean soil lead of 526 mg/kg and a surface water concentration of 1,124 µg/L (see Table 12). As such, adverse health effects to adults associated with lead exposures from this area are not expected.

Area 3: Laurence Harbor Beach: Area between first and second jetty

Lead:

Incidental ingestion from soil: For this area, the IEUBK model for assessing intermittent or variable exposures at sites was used to estimate the contribution from ingestion of lead contaminated soil (USEPA 2003b).

The assumptions for the lead exposure scenario for children aged 12 to 84 months are as follows:

1. Children were exposed to soil containing lead each time the area was visited over the three month period. The visit frequency was assumed to be five days per week over three months of the year. It was assumed that the child does not return to the site for the remainder of that year but continues to return every year from age of 12 months through 84 months for three summer months of the year (intermittent exposures). This scenario considers a lead "wash-out" period in between the annual cycles of intermittent exposures over the course of a child life from 12 – 84 months.

2. The lead concentration of residential soil was assumed to be 50 mg/kg (ATSDR 2002). The daily site soil exposure was added to the IEUBK model alternate source parameter. IEUBK model default values were used for all other variables (USEPA 2002).

3. The daily lead intake for use in the model was calculated using the average soil lead concentration (321 mg/kg). The IEUBK model assumes lead bioavailability of 30% for soil lead. The calculation is shown below:

   Soil: 321 mg/kg*45mg/day*(1/1000)*(5 days/7 days)*(30%) = 3.1 µg/day

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 10 µg/dL (P_{10}) for children are shown in the following table:

Age (months)	**Based on mean soil conc. of 321 mg/kg**	
	Blood Lead Level[a] (µg/dL)	**P_{10} (%)[b]**
12 - 24	2.6	0.2
24 - 36	2.3	0.09
36 - 48	2.1	0.05
48 - 60	1.9	0.02
60 - 72	1.7	0.01
72 - 84	1.5	0

[a]Geometric Mean lead levels in blood; [b]probability of blood lead level > 10 µg/dL

The blood lead levels for children aged 12-84 months are below the action level (10 µg/dL). The P_{10} values are below the recommended protection level of five percent. There is no lead associated health risk for these age groups from ingesting soil in this area.

An adult blood lead model estimated a geometric mean blood lead level of 2.5 µg/dL for adult workers based on the mean soil lead of 321 mg/kg (see Table 12). As such, adverse health effects to adults associated with lead exposures from this area are not expected.

Area 4: Laurence Harbor Beach: Area between third jetty and Cheesequake Creek Inlet eastern jetty

<u>Antimony and Arsenic</u>:

Incidental ingestion from surface water when swimming: The average daily dose from ingestion of surface water for antimony was calculated to be 3.2E-05 mg/kg/day and 1.1E-05 mg/kg/day for children and adults, respectively (see Table 9). This is below the USEPA's RfD of 4E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. The average daily dose from ingestion of surface water for arsenic was calculated to be 7.9E-06 mg/kg/day and 2.7E-06 mg/kg/day for children and adults, respectively (see Table 9). This is below the ATSDR's MRL of 3E-04 mg/kg/day and therefore non-cancer health effects are very unlikely.

<u>Lead</u>:

Incidental ingestion from surface water when swimming: For this area, the IEUBK model was used estimate the contribution from ingestion of lead contaminated surface water when swimming.

The assumptions for the lead exposure scenario for children aged 12 to 84 months are as follows:

1. Children were exposed to water containing lead each time the area was visited. The visit frequency was assumed to be five days per week over three months of the year. It was assumed that the child does not return to the site for the remainder of that year but continues to return every year from age of 12 months through 84 months for three summer months of the year (intermittent exposures). This scenario considers a lead "wash-out" period in between the annual cycles of intermittent exposures over the course of a child life from 12 - 84 months.

2. The swimming was assumed to last one hour per visit.

3. The daily lead intake for use in the model was calculated using the average surface water lead concentration (70 µg/L). The calculation is shown below:

   Water: 70 µg/L * 0.05 L/day * (5 days/7 days) * (50%) = 1.25 µg/day

4. The lead concentration of residential soil was assumed to be 50 mg/kg (ATSDR 2002). The daily site water exposure was added to the IEUBK model alternate source parameter. IEUBK model default values were used for all other variables (USEPA 2002).

The predicted geometric mean blood lead levels and the probability of blood lead levels exceeding 10 µg/dL (P_{10}) for children are shown in the following table:

Age (months)	Based on mean water conc. of 70 µg/L	
	Blood Lead Level[a] (µg/dL)	P_{10} (%)[b]
12 - 24	2.0	0.03
24 - 36	1.8	0.02
36 - 48	1.7	0.01
48 - 60	1.5	0
60 - 72	1.3	0
72 - 84	1.2	0

[a]Geometric Mean lead levels in blood; [b]probability of blood lead level > 10 µg/dL

The blood lead levels for children aged 12 - 84 months are below the action level (10 µg/dL). The P_{10} values are below the recommended protection level of five percent. There is no lead associated health risk for these age groups from ingesting surface water in this area.

An adult blood lead model estimated a geometric mean blood lead level of 2.1µg/dL for adult workers based on the mean surface water lead of 70 µg/L (see Table

12). As such, adverse health effects to adults associated with lead exposures from this area are not expected.

Area 5: Cheesequake Creek Inlet Western Slag Jetty in Sayreville

Antimony, Arsenic and Copper:

Incidental ingestion from soil: Based on an average concentration of 1,054 mg/kg for antimony, the average daily dose from ingestion was estimated to be 1.1E-03 mg/kg/day and 1.3E-04 mg/kg/day for children and adults, respectively (see Table 10). The adult dose is below the USEPA's RfD for chronic oral exposure of 4E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. The child dose is above the USEPA's RfD. The chronic oral RfD for antimony is based on reduced longevity, blood glucose, and altered cholesterol levels of a group of rats in an oral bioassay study. A lowest-observed-adverse-effect level (LOAEL) of 0.35 mg/kg/day and an uncertainty factor of 1,000 were used to calculate the oral RfD. The average daily dose for children is lower than the LOAEL by a factor of approximately 320. For children who access the jetty on a regular basis such as the assumptions used (5 days a week, 3 months a year), there is a potential for non-cancer health effects from this exposure pathway, although this is expected to be unlikely based on the LOAEL comparison.

For arsenic, the average daily dose from ingestion based on an average concentration of 786 mg/kg was estimated to be 8.3E-04 mg/kg/day and 1.1E-04 mg/kg/day for children and adults, respectively (see Table 10). The adult dose is below the ATSDR's MRL for chronic oral exposure of 3E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. The child dose is slightly above the ATSDR's MRL for chronic oral exposure of 3E-04 mg/kg/day. The MRL is based on hyperpigmentation, keratosis and possible vascular complications observed in humans (ATSDR 2007). A no-observed-adverse-effect-level (NOAEL) of 8.0E-04 mg/kg/day and an uncertainty factor of 3 was used to calculate the MRL. The average daily dose for a child is approximately the same as the NOAEL. Although there is a potential for non-cancer health effects for children from this exposure pathway, it should be noted that the calculated dose is approximately the same as the NOAEL, i.e., a level at which no effects were seen in a human study. Additionally, the MRL in based on what is termed as less serious health effects such as hyperpigmentation and keratosis. Therefore, the likelihood of any potential health effects from this pathway is low.

The average daily dose from ingestion of copper was estimated to be 1.6E-03 mg/kg/day and 1.9E-04 mg/kg/day for children and adults, respectively (see Table 10). This dose is below the EPA's RfD for chronic oral exposure of 1E-02mg/kg/day; therefore, non-cancer health effects are very unlikely.

Incidental ingestion from surface water when swimming: The average daily dose from ingestion of surface water for antimony was calculated to be 2.8E-05 mg/kg/day and 9.6E-06 mg/kg/day for children and adults, respectively (see Table 10). This is below the USEPA RfD of 4E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. The average daily dose from ingestion of surface water for arsenic was calculated to be 1E-05 mg/kg/day and 3.4E-06 mg/kg/day for children and adults, respectively (see Table 10). This is below the ATSDR MRL of 3E-04 mg/kg/day and therefore non-cancer health effects are very unlikely. For copper, the average daily dose from ingestion was estimated to be 2.7E-05 mg/kg/day and 9.3E-06 mg/kg/day, which are well below the ARSDR MRL of 1E-02 mg/kg/day (see Table 10). Non-cancer effects from copper in surface water at this area are very unlikely.

Total Ingestion Dose: When the ingestion doses for both pathways are combined, the total antimony dose is calculated to be 1.1E-03 and 1.4E-04 for children and adults, respectively (see Table 10). The child dose is above the USEPA's RfD for chronic oral exposure of 4E-04 mg/kg/day. For arsenic, the total dose was calculated to be 8.4E-04 and 1.1E-04 for children and adults, respectively (see Table 10). The child dose is above the ATSDR's MRL for chronic oral exposure of 3E-04 mg/kg/day. Therefore the combined ingestion dose from ingestion of soil and ingestion of water while swimming has the potential to cause non-cancer health effects in children for both metals. As illustrated in the ingestion from soil section above, the likelihood is considered to be low.

Lead: Since the average soil lead concentration (52,499 mg/kg) is so high, the IEUBK model can not used for evaluating this as this would yield blood lead levels above 30 μg/dL. The model is not empirically validated for blood levels above this value. Based on comparison to the USEPA screening guidance value of 400 mg/kg and observed activities such as walking, fishing, clamming, crabbing, sitting on slag, eating/drinking noted in this area, it can be concluded that lead-related health effects could result from exposure to adults and children who recreate in this area.

Area 6: Laurence Harbor park and playground area

Antimony and Arsenic:

Incidental ingestion from soil: Given the described assumptions about exposure frequency and duration and an average concentration of 11 mg/kg for antimony, the average daily dose from ingestion was estimated to be 1.2E-05 mg/kg/day and 1.4E-06 mg/kg/day for children and adults, respectively (see Table 11). This dose is below the EPA's RfD for chronic oral exposure of 4E-04 mg/kg/day. Therefore, non-cancer health effects from antimony in soil at this area are very unlikely. For arsenic, the average daily dose from ingestion was estimated to be 1.3E-05 mg/kg/day and 1.5E-06 mg/kg/day for children and adults, respectively (see Table 11). This dose is below the ATSDR MRL and EPA's RfD for chronic oral exposure of 3E-04 mg/kg/day. Non-cancer effects from arsenic in soil at this area are very unlikely.

Cancer Health Effects

The site-specific lifetime excess cancer risk (LECR) indicates the cancer potential of contaminants. LECR estimates are usually expressed in terms of excess cancer cases in an exposed population in addition to the background rate of cancer. For perspective, the lifetime risk of being diagnosed with cancer in the United States is 46 per 100 individuals for males, and 38 per 100 for females; the lifetime risk of being diagnosed with any of several common types of cancer ranges approximately between 1 in 100 and 10 in 100 (SEER 2005). Typically, health guideline CVs developed for carcinogens are based on a lifetime risk of one excess cancer case per 1,000,000 individuals. ATSDR considers estimated cancer risks of less than one additional cancer case among one million persons exposed as insignificant or no increased risk (expressed exponentially as 10^{-6}).

According to the United States Department of Health and Human Services (USDHHS), the cancer class of contaminants detected at a site is as follows:

1 = Known human carcinogen
2 = Reasonably anticipated to be a carcinogen
3 = Not classified

Exposure doses for cancer risk assessment were calculated using the following formula:

$$\textit{Cancer Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF}{BW} \times \frac{ED}{AT}$$

Where C = concentration of contaminant in soil (mg/kg) or concentration of contaminant in water (µg/L);
IR = soil ingestion rate (mg/day) or water ingestion rate (L/day);
EF = exposure factor representing the site-specific exposure scenario;
ED = exposure duration (year);
BW = body weight (kg); and,
AT = averaging time (year).

The LECR was calculated by multiplying the cancer exposure dose by the cancer slope factor.

Antimony and copper are not classified as carcinogens. Lead has been classified as a carcinogen by the USDHHS[3] and the USEPA[4]. The carcinogenicity of inorganic lead and lead compounds has been evaluated by the USEPA (USEPA 1986, 1989). The USEPA has determined that data from human studies are inadequate for evaluating the carcinogenicity of lead, but there are sufficient data from animal studies which demonstrate that lead induces renal tumors in experimental animals. In addition, there are some animal studies which have shown evidence of tumor induction at other sites (i.e., cerebral gliomas; testicular, adrenal, prostate, pituitary, and thyroid tumors). A cancer slope factor has not been derived for inorganic lead or lead compounds, so no

[3]Lead and Lead Compounds are listed in the Eleventh Edition of the Report on Carcinogens as "reasonably anticipated to be human carcinogens" (NTP 2006)
[4]Probable human carcinogen (B2)

estimation of LECR can be made for lead exposure. Arsenic has been classified by the USEPA and USDHSS as a known human carcinogen based on sufficient evidence of carcinogenicity from human data (ATSDR 2007). Ingestion of elevated levels of inorganic arsenic has been associated with increased risk for cancer of the liver, bladder, kidneys, prostate and lungs.

Based on the USEPA Exposure Factors (USEPA 1997, USEPA 2008) and site-specific conditions, the following assumptions were used to calculate the exposure doses and the corresponding LECRs for adults from exposure to arsenic in surface soil and surface water:

Media	Receptor Population	Ingestion Rate	No. of Days of Exposure Per Year	Years Exposed	Body Weight (kg)
Soil	Adult	50 mg/day	60 days (5 days per week, 3 months per year)	30	70
Surface water		0.07 L/day			

The theoretical cancer risks from long-term exposure to arsenic in the six areas are presented in Table 13.

Area 1: Exposure to an average soil arsenic concentration of 20 mg/kg represents a slight increased theoretical cancer risk (the potential for two excess cancers per 1,000,000 individuals exposed) for adults who may contact contaminated soil in this area. This theoretical excess cancer risk is not considered to be significant. The LECR was estimated to be one excess cancer per 1,000,000 individuals exposed for the swimming exposure scenario. This theoretical excess cancer risk is not considered to be significant.

Area 2: The theoretical cancer risk from exposure to an average soil arsenic concentration of 20 mg/kg and an average surface water concentration of 30 µg/L was estimated to be two and three excess cancers per 1,000,000 individuals exposed, respectively. This represents a slight increased theoretical cancer risk for individuals who access this area five days per week for three months of the year. This theoretical excess cancer risk is not considered to be significant.

Area 5: At the mean soil arsenic concentration of 786 mg/kg, an excess cancer risk of approximately six cancer cases per 100,000 individuals was determined. This calculated LECR is considered to be a low increased risk when compared to the background risk for all or specific cancers. The theoretical cancer risk from exposure to an average surface water arsenic concentration of 19 µg/L was estimated to be two excess cancers per 1,000,000 individuals exposed. This represents a slight increased theoretical cancer risk for individuals who access this area five days per week for three months of the year. This theoretical excess cancer risk is not considered to be significant.

Area 6: Based on average arsenic concentration in soil (12 mg/kg), the calculated LECR was determined to be approximately one excess cancer per 1,000,000 individuals. This theoretical excess cancer risk is not considered to be significant.

Conclusions

The completed exposure pathways, including ingestion of soil and surface water when swimming or engaging in recreational activities to adults and children, were evaluated for six areas as specified by the USEPA comprising the Raritan Bay Slag site. Non-cancer and cancer health effects of the contaminants of concern, which are antimony, arsenic, copper and lead, were assessed in the previous section. Based on observed activity patterns at the site and the results of NJDHSS evaluation of the USEPA sampling results, the following conclusions can be made for the six areas reviewed:

Area 1: This is the Laurence Harbor Seawall area that includes the slag area at the base of the park on the waterfront (including along Margaret's Creek). Observed uses of this area are fishing, clamming, walking, dog walking, sitting on slag, and eating/drinking. Non-cancer health effects are not expected to result from exposures to antimony and arsenic in surface soil and water for children and adults accessing this area, based on the assumptions used. The theoretical excess cancer risk from arsenic present in soil and surface water was not considered to be significant. The potential for adverse health effects to adults associated with lead exposures from this area are not expected. Child lead exposures were evaluated using the USEPA IEUBK lead model. It can be concluded from the model results that if a group of one to four year olds were to visit the site five days a week for a period of three months, more than 5 percent of them will have blood lead levels above 10 µg/dL which is the blood lead level of concern established by the U.S. Centers for Disease Control and Prevention. Previous NJDEP sampling indicated elevated levels of antimony, arsenic, copper and lead in this area. Although the USEPA data results were not as consistently elevated as the NJDEP results, it may be that different areas were selected for sampling being that Area 1 encompasses a large area. Based on previously detected elevated lead result and conclusions drawn from USEPA data, NJDHSS concludes that this area represents a **Public Health Hazard** based on lead exposures to children. Actions should be taken to restrict access to this area.

Area 2: This area comprises the Laurence Harbor beach area between the Seawall and the first jetty. Observed uses of this area are walking, running, playing, sitting, lying on blanket, digging, shell/rock collecting, swimming, eating/drinking, ATV use, and fishing from first jetty. Non-cancer health effects are not expected to result from exposures to antimony and arsenic in surface soil and water for children and adults accessing this area, based on the assumptions used. The theoretical excess cancer risk from arsenic present in soil and surface water was not considered to be significant. It can be concluded that if a group of one to seven year olds were to visit the site five days a week for a period of three months, more than 5 percent of them will have blood lead levels above 10 µg/dL. The potential for adverse health effects to adults associated with lead exposures from this area are not expected.

This area is readily accessible to individuals as it is located near the main parking area for the Laurence Harbor beach area. Previously, based on an elevated lead hot-spot, NJDHSS had made recommendations to restrict access to a part of the beachfront in this area. Snow fencing was erected earlier in 2007, but a site visit in December 2008 revealed that the fence was in disrepair. The site visit also revealed that the fence was easily circumvented at low tide. The majority of the surface samples in Area 2 were elevated above the USEPA Screening Guidance value for lead (400 mg/kg); these elevated samples were dispersed throughout this area. Furthermore, limited subsurface samples focused mostly on the previously sampled lead hot-spot area behind the snow fencing. It is unclear how much subsurface soil in the main beach area has been impacted by lead contamination. This is important to note as young children frequently dig deep into the sand or bury themselves in sand as part of their playing activities. NJDHSS concludes that this area represents a **Public Health Hazard** based on lead exposures to children. Actions should be taken to restrict access to this area.

Area 3: This is the Laurence Harbor beach area between the first and second jetty. Observed uses of this area are walking, shell/rock collecting, and ATV use. The results for antimony and arsenic in surface soil were all rejected on the basis on laboratory quality assurance/control; therefore exposures to these metals could not be evaluated. There were two soil lead samples that were elevated above the USEPA Screening Guidance value. The IEUBK model results show that the blood lead levels for children aged 12-84 months are below the action level (10 µg/dL). The P_{10} values are below the recommended protection level of five percent. There is no lead-associated health risk for these age groups from ingesting soil in this area. The potential for adverse health effects to adults associated with lead exposures from this area are not expected. NJDHSS concludes that this area represents an **Indeterminate Public Health Hazard** based on unavailability of data for antimony and arsenic.

Area 4: This beach area is between the third jetty and Cheesequake Creek Inlet eastern jetty. Observed uses are walking, running, playing, lying on blanket, swimming, fishing, sitting, and eating/drinking. The soil samples were below the comparison level; therefore health effects associated with soil exposures are not expected for this area. Non-cancer health effects are very unlikely for the swimming exposure scenario. Additionally, there is no lead associated health risk for children and adults ingesting surface water in this area. NJDHSS concludes that this area represents a **No Apparent Public Health Hazard** based on the evaluation of data.

Area 5: This area of concern based on sampling results is the Cheesequake Creek Inlet Western Slag Jetty (where activities such as walking, fishing, clamming, crabbing, sitting on slag and eating and drinking have been noted). For children and adults who access the jetty on a regular basis such as the assumptions used (five days a week, three months a year), there is a potential for non-cancer health effects from ingesting soil in this area, based on antimony, arsenic and lead levels present in the soil. Non-cancer health effects are very unlikely based on the swimming exposure scenario with regard to antimony and arsenic. At the mean soil arsenic concentration of 786 mg/kg, an excess cancer risk of approximately six cancer cases per 100,000 individuals was determined. This calculated LECR is considered to be a low increased risk when compared to the background risk for all or specific cancers.

The surface soil results (see Table 5) from this area show an extremely high concentration of lead, present at levels hazardous to both adults and children (maximum lead concentration of 198,000 mg/kg). Seven out of eight samples were elevated above the USEPA Screening Guidance value. Based on comparison to the USEPA Screening Guidance value of 400 mg/kg and observed activities such as walking, fishing, clamming, crabbing, sitting on slag, eating/drinking noted in this area, it can be concluded that there is a potential for health effects associated with this area for adults and children. No one should be accessing this area and engaging in the above mentioned activities. NJDHSS concludes that this area represents a **Public Health Hazard** based on potential health effect associated with elevated levels of antimony, arsenic and lead in soil.

Area 6: This is the Laurence Harbor park and playground area where activities such as walking, running, playing, sitting and eating/drinking have been observed. Antimony and arsenic were elevated in some samples; however, it was determined that non-cancer health effects from antimony and arsenic in soil at this area are very unlikely. The theoretical excess cancer risk from arsenic present in soil was not considered to be significant. NJDHSS concludes that this area represents a **No Apparent Public Health Hazard** based on evaluation of data. Pica behavior was not specifically evaluated for Area 6. Because the contaminant levels are low, even if a pica child were to ingest soil contaminated with antimony and arsenic, it would not likely result in harmful health effects.

In summary, the NJDHSS and ATSDR consider Areas 1, 2 and 5 to be a **Public Health Hazard** based on data provided to NJDHSS as of November 2008. High lead levels in surface and subsurface soil and in surface water could result in lead exposures of health concern from recreational activities as mentioned in detail above. Although NJDHSS and ATSDR are aware that such activities are less likely to be occurring at the present time (winter), it is strongly recommended that appropriate actions be taken to restrict access before the summer season commences.

Recommendations

1. The USEPA should restrict access to the following areas: the slag area at the base of the park on the waterfront (Area 1), the beach area between the Seawall and the first jetty (Area 2), and the Cheesequake Creek Inlet Western Slag Jetty (Area 5).

2. The USEPA should consider re-sampling areas for which laboratory samples were rejected.

Public Health Action Plan (PHAP)

The purpose of a PHAP is to ensure that this health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and NJDHSS to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDHSS and the ATSDR are as follows:

Public Health Actions Undertaken by NJDHSS and ATSDR

1. The NJDHSS and ATSDR reviewed available environmental data and other relevant information for the Raritan Bay Slag site to determine human exposure pathways and public health issues.

2. In 2008, a Letter of Technical Assistance was prepared and issued by the NJDHSS recommending the installation of snow fencing around a lead hot-spot in the beach area in Area 2,

3. The NJDHSS and ATSDR conducted two site visits and met with USEPA staff to identify community concerns.

Public Health Actions Planned by NJDHSS and ATSDR

1. Copies of this health consultation will be provided to concerned residents in the vicinity of the site via the township libraries and the Internet.

2. In cooperation with the USEPA, public meetings can be scheduled, if needed, to discuss the findings of this report and to determine and address any additional community concerns.

3. As additional site-related contamination data (e.g., from biota and slag) become available, the NJDHSS and ATSDR will prepare health consultation(s) in order to evaluate the public health implications of potential contamination.

4. New environmental, toxicological, or health outcome data, or the results of implementing the recommendation and proposed actions, may determine the need for additional actions at this site. The ATSDR and the NJDHSS will reevaluate and expand the PHAP as warranted.

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CERTIFICATION

The health consultation for the Raritan Bay Slag site, Middlesex County, New Jersey was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures' existing at the time the public health assessment was initiated.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

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Team Leader, CAT, CAPEB, DHAC
Agency for Toxic Substances and Disease Registry

Table 1a: <u>Area 1: Laurence Harbor Seawall: Slag area at the base of the park</u>

Surface Soil

Contaminant	**Range (mg/kg)**	**Average (mg/kg)**	**Comparison Value (CV) (mg/kg)**	**Number of Exceedances of CV/No. of Samples Taken**
Surface (0-2")				
Antimony	6.9 – 120	35	20 (RMEG)	3/6
Arsenic	0.76 – 48	20	19 (NJRDCSRS)	3/6
Copper	1.3 – 315	75	500 (EMEG)	0/11
Lead	11 – 10,200	1,474	400 (USEPA)	6/11
Sub-surface (6-12")				
Antimony	NA*	NA	20 (RMEG)	NA
Arsenic	NA	NA	19 (NJRDCSRS)	NA
Copper	2.7 - 51	22	500 (EMEG)	0/4
Lead	23 – 1,100	525	400 (USEPA)	2/4

* Not Available

Surface Water

Contaminant	**Range (µg/L)**	**Average (µg/L)**	**Comparison Value (CV) (µg/L)**	**Number of Exceedances of CV/No. of Samples Taken**
Antimony	1.4 – 60	30	4 (RMEG)	16/24
Arsenic	10 – 25	11	3 (EMEG)	24/24
Copper	2.2 – 53	21	100 (EMEG)	0/24
Lead	10 - 298	62	15 (MCL Action Level)	17/24

Sediment

Contaminant	**Range (mg/kg)**	**Average (mg/kg)**	**Comparison Value (CV) (mg/kg)**	**Number of Exceedances of CV/No. of Samples Taken**
Antimony	0.63 – 33	9.7	20 (RMEG)	3/21
Arsenic	1.3 – 23	7.9	19 (NJRDCSRS)	1/21
Copper	1.4 – 117	22	500 (EMEG)	0/21
Lead	7.3 – 5,860	433	400 (USEPA)	9/32

Table 1b: NJDEP May – July 2007 surface soil (0-3”) sampling results

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	4.6 - 12,900	1,337	20 (RMEG)	20/23
Arsenic	24 - 3,350	365	19 (NJRDCSRS)	22/22
Copper	43 – 3,590	668	500 (EMEG)	7/15
Lead	155 - 142,000	18,503	400 (USEPA)	22/24

Table 2a: Area 2: Laurence Harbor Beach: Area between Seawall and first jetty

Surface Soil

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Surface (0-2”)				
Antimony	0.8 - 74	20	20 (RMEG)	6/16
Arsenic	3.2 - 91	20	19 (NJRDCSRS)	6/16
Copper	2.8 - 114	29	500 (EMEG)	0/17
Lead	58 - 1,630	526	400 (USEPA)	7/12
Sub-surface (6-18”)				
Antimony	18 - 832	332	20 (RMEG)	3/4
Arsenic	20 - 602	238	19 (NJRDCSRS)	4/4
Copper	27 - 704	338	500 (EMEG)	4/4
Lead	649 - 23,800	11,025	400 (USEPA)	4/4

Surface Water

Contaminant	Range (µg/L)	Average (µg/L)	Comparison Value (CV) (µg/L)	Number of Exceedances of CV/No. of Samples Taken
Antimony	12 - 29	19	4 (RMEG)	6/6
Arsenic	25 - 36	30	3 (EMEG)	6/6
Copper	22 - 83	53	100 (EMEG)	0/6
Lead	686 - 1,780	1,124	15 (MCL Action Level)	6/6

- *cont* -

Table 2a: <u>Area 2: Laurence Harbor Beach: Area between Seawall and first jetty</u>

Sediment

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	4.6 - 33	13	20 (RMEG)	2/12
Arsenic	5.1 - 56	17	19 (NJRDCSRS)	3/12
Copper	13 - 47	0.42	500 (EMEG)	0/12
Lead	200 - 533	22	400 (USEPA)	4/12

Table 2b: NJDEP May – July 2007 surface soil (0-3”) sampling results

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	18 - 68	51	20 (RMEG)	2/3
Arsenic	26 - 55	40	19 (NJRDCSRS)	3/3
Lead	334 - 1,090	690	400 (USEPA)	2/3

Table 3a: Area 3: Laurence Harbor Beach: Area between first and second jetty

Surface Soil (0 – 2”)

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	NA	NA	20 (RMEG)	NA
Arsenic	NA	NA	19 (NJRDCSRS)	NA
Copper	4.2- 76	20	500 (EMEG)	0/10
Lead	109 - 935	321	400 (USEPA)	2/10

NA: Not Available as all sample results were rejected

Table 3b: NJDEP May – July 2007 surface soil (0-3”) sampling results

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	9.3 – 18	14	20 (RMEG)	0/2
Arsenic	15 - 24	20	19 (NJRDCSRS)	1/2
Lead	245 - 260	253	400 (USEPA)	0/2

Table 4. **<u>Area 4: Laurence Harbor Beach: Area between third jetty and Cheesequake Creek inlet eastern jetty</u>**

Surface Soil (0 – 2")

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	6 - 7	6.2	20 (RMEG)	0/25
Arsenic	1.9 - 9.2	3.1	19 (NJRDCSRS)	0/19
Copper	0.7 - 15	2.8	500 (EMEG)	0/19
Lead	1.7 - 94	14	400 (USEPA)	0/25

Surface Water

Contaminant	Range (µg/L)	Average (µg/L)	Comparison Value (CV) (µg/L)	Number of Exceedances of CV/No. of Samples Taken
Antimony	60 - 60	60	4 (RMEG)	6/6
Arsenic	12 - 16	15	3 (EMEG)	6/6
Copper	4 - 25	16	100 (EMEG)	0/6
Lead	39 - 99	70	15 (MCL Action Level)	4/4

Sediment

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	6.1 - 8.5	6.9	20 (RMEG)	0/20
Arsenic	1.1 - 3.7	2.2	19 (NJRDCSRS)	0/19
Copper	0.44 - 4.3	1.1	500 (EMEG)	0/19
Lead	1.2 - 11	3.3	400 (USEPA)	0/19

Table 5: **Area 5: Cheesequake Creek inlet western slag jetty in Sayreville**

Surface Soil

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Surface (0-2")				
Antimony	11 - 3,120	1,054	20 (RMEG)	7/8
Arsenic	19 - 2,470	786	19 (NJRDCSRS)	7/8
Copper	175 - 4,630	1,485	500 (EMEG)	4/8
Lead	231 - 198,000	52,499	400 (USEPA)	7/8
Sub-surface (6-18")				
Antimony	7 - 419	144	20 (RMEG)	1/3
Arsenic	8 - 228	84	19 (NJRDCSRS)	1/3
Copper	34 - 489	200	500 (EMEG)	0/3
Lead	172 - 21,500	7,468	400 (USEPA)	2/3

Surface Water

Contaminant	Range (μg/L)	Average (μg/L)	Comparison Value (CV) (μg/L)	Number of Exceedances of CV/No. of Samples Taken
Antimony	21 - 62	54	4 (RMEG)	12/12
Arsenic	2.5 - 80	19	3 (EMEG)	9/12
Copper	25 - 197	52	100 (EMEG)	2/12
Lead	3.4 - 1,810	378	15 (MCL Action Level)	4/12

Sediment

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	1 - 3,270	369	20 (RMEG)	6/14
Arsenic	3 - 2,100	234	19 (NJRDCSRS)	6/14
Copper	11 - 2,050	282	500 (EMEG)	2/14
Lead	30 - 2,150	572	400 (USEPA)	3/9

Table 6a: Area 6: Laurence Harbor park and playground area

Surface Soil (0 – 2”)

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	0.36 - 31	11	20 (RMEG)	6/25
Arsenic	0.84 - 144	12	19 (NJRDCSRS)	2/25
Copper	3.9 - 131	21	500 (EMEG)	0/25
Lead	8.9 - 98	31	400 (USEPA)	0/25

Table 6b: NJDEP May – July 2007 surface soil (0-3”) sampling results

Contaminant	Range (mg/kg)	Average (mg/kg)	Comparison Value (CV) (mg/kg)	Number of Exceedances of CV/No. of Samples Taken
Antimony	0.86 - 2.8	1.7	20 (RMEG)	0/3
Arsenic	2 - 13	7	19 (NJRDCSRS)	0/3
Lead	8.1 - 71	35	400 (USEPA)	0/3

Table 7: Area 1 – Comparison of calculated exposure doses with the Health Guideline CVs

Contaminants of Concern	Maximum	Mean	Average Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)	Potential for Non-cancer Health Effects
			Child	Adult		
Soil (mg/kg)						
Antimony	120	35	3.7E-05[a]	4.5E-06[b]	4E-04 (RfD)	No
Arsenic	48	20	2.1E-05	2.6E-06	3E-04 (MRL)	No
Surface water (µg/L)						
Antimony	60	30	1.6E-05[c]	5.4E-06[d]	4E-04 (RfD)	No
Arsenic	25	11	5.8E-06	2.0E-06	3E-04 (MRL)	No
Total dose from ingestion						
Antimony			5.3E-05	9.9E-06	4E-04 (RfD)	No
Arsenic			2.7E-05	4.6E-06	3E-04 (MRL)	No

[a]Child soil ingestion exposure scenario: 5 days/week, 3 month/year, 100 mg/day ingestion rate and 17 kg body weight; [b]Adult soil ingestion exposure scenario: 5 days/week, 3 month/year, 50 mg/day ingestion rate and 70 kg body weight; [c]Child water ingestion exposure scenario: 5 days/week, 3 month/year, 0.05 L/day ingestion rate and 17 kg body weight; [d]Adult water ingestion exposure scenario: 5 days/week, 3 month/year, 0.07 L/day ingestion rate and 70 kg body weight

Table 8: Area 2 - Comparison of calculated exposure doses with the Health Guideline CVs

Contaminants of Concern	Maximum	Mean	Average Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)	Potential for Non-cancer Health Effects
			Child	Adult		
Soil (mg/kg)						
Antimony	74	20	2.1E-05	2.6E-06	4E-04 (RfD)	No
Arsenic	91	20	2.1E-05	2.6E-06	3E-04 (MRL)	No
Surface water (µg/L)						
Antimony	29	19	1.0E-05	3.4E-06	4E-04 (RfD)	No
Arsenic	36	30	1.6E-05	5.4E-06	3E-04 (MRL)	No
Total dose from ingestion						
Antimony			3.1E-05	6.0E-06	4E-04 (RfD)	No
Arsenic			3.7E-05	8.0E-06	3E-04 (MRL)	No

[a]Child soil ingestion exposure scenario: 5 days/week, 3 month/year, 100 mg/day ingestion rate and 17 kg body weight; [b]Adult soil ingestion exposure scenario: 5 days/week, 3 month/year, 50 mg/day ingestion rate and 70 kg body weight; [c]Child water ingestion exposure scenario: 5 days/week, 3 month/year, 0.05 L/day ingestion rate and 17 kg body weight; [d]Adult water ingestion exposure scenario: 5 days/week, 3 month/year, 0.07 L/day ingestion rate and 70 kg body weight

Table 9: Area 4 - Comparison of calculated exposure doses with the Health Guideline CVs

Contaminants of Concern	Maximum	Mean	Average Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)	Potential for Non-cancer Health Effects
			Child	Adult		
Surface water (µg/L)						
Antimony	60	60	3.2E-05[a]	1.1E-05[b]	4E-04 (RfD)	No
Arsenic	16	15	7.9E-06	2.7E-06	3E-04 (MRL)	No

[a]Child water ingestion exposure scenario: 5 days/week, 3 month/year, 0.05 L/day ingestion rate and 17 kg body weight; [b]Adult water ingestion exposure scenario: 5 days/week, 3 month/year, 0.07 L/day ingestion rate and 70 kg body weight; [c]Child soil ingestion exposure scenario: 5 days/week, 3 month/year, 100 mg/day ingestion rate and 17 kg body weight; [d]Adult soil ingestion exposure scenario: 5 days/week, 3 month/year, 50 mg/day ingestion rate and 70 kg body weight

Table 10: Area 5 - Comparison of calculated exposure doses with the Health Guideline CVs

Contaminants of Concern	Maximum	Mean	Average Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)	Potential for Non-cancer Health Effects
			Child	Adult		
Soil (mg/kg)						
Antimony	3,120	1,054	1.1E-03[c]	1.3E-04[d]	4E-04 (RfD)	**Yes**
Arsenic	2,470	786	8.3E-04	1.1E-04	3E-04 (MRL)	**Yes**
Copper	4,630	1,485	1.6E-03	1.9E-04	1E-02 (MRL)	No
Surface water (µg/L)						
Antimony	62	54	2.8E-05	9.6E-06	4E-04 (RfD)	No
Arsenic	80	19	1.0E-05	3.4E-06	3E-04 (MRL)	No
Copper	197	52	2.7E-05	9.3E-06	1E-02 (MRL)	No
Total dose from ingestion						
Antimony			1.1E-03	1.4E-04	4E-04 (RfD)	**Yes**
Arsenic			8.4E-04	1.1E-04	3E-04 (MRL)	**Yes**
Copper			1.6E-03	2.0E-04	1E-02 (MRL)	No

[a]Child water ingestion exposure scenario: 5 days/week, 3 month/year, 0.05 L/day ingestion rate and 17 kg body weight; [b]Adult water ingestion exposure scenario: 5 days/week, 3 month/year, 0.07 L/day ingestion rate and 70 kg body weight; [c]Child soil ingestion exposure scenario: 5 days/week, 3 month/year, 100 mg/day ingestion rate and 17 kg body weight; [d]Adult soil ingestion exposure scenario: 5 days/week, 3 month/year, 50 mg/day ingestion rate and 70 kg body weight

Table 11: Area 6 - Comparison of calculated exposure doses with the Health Guideline CVs

Contaminants of Concern	Maximum	Mean	Average Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)	Potential for Non-cancer Health Effects
			Child	Adult		
Soil (mg/kg)						
Antimony	31	11	1.2E-05[a]	1.4E-06[b]	4E-04 (RfD)	No
Arsenic	144	12	1.3E-05	1.5E-06	3E-04 (MRL)	No

[a]Child soil ingestion exposure scenario: 5 days/week, 3 month/year, 100 mg/day ingestion rate and 17 kg body weight; [b]Adult soil ingestion exposure scenario: 5 days/week, 3 month/year, 50 mg/day ingestion rate and 70 kg body weight

Table 12: Adult Lead Model Results

Description of Exposure Variable	Units	Area 1	Area 2	Area 3	Area 4
Lead concentration in water	ug/L	62	1124	--	70
Water ingestion rate	L/day	0.07	0.07	--	0.07
Absorption Fraction from water	--	0.09	0.09	--	0.09
Soil lead concentration	ug/g	1474	526	321	
Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
Geometric standard deviation PbB	--	2.0	2.0	2.0	2.0
Baseline PbB	ug/dL	2.0	2.0	2.0	2.0
Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	0.050	0.050
Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--
Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--
Mass fraction of soil in dust	--	--	--	--	--
Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
Exposure frequency (same for soil and dust)	days/yr	240	240	240	240
Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB of adult worker, geometric mean	**ug/dL**	**4.4**	**4.7**	**2.5**	**2.1**
Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0	10.0	10.0

Table 13: **Calculated LECRs associated with Arsenic in surface soil and surface water**

Arsenic	Average Conc.	Exposure Dose (mg/kg/day)	Cancer Slope Factor (CSF) $(mg/kg/d)^{-1}$	LECR[a]
Soil (mg/kg)				
Area 1	20	1.1E-06[b]	1.5	2E-06
Area 2	20	1.1E-06		2E-06
Area 5	786	4.3E-05		6E-05
Area 6	12	6.6E-07		1E-06
Surface Water (µg/L)				
Area 1	11	8.4E-07[c]	1.5	1E-06
Area 2	30	2.3E-06		3E-06
Area 5	19	1.5E-06		2E-06

[a]Lifetime Excess Cancer Risk; [b]Adult exposure scenario: 5 days/week, 3 months/year, 50 mg/day ingestion rate, 70 kg body weight and 30 year exposure duration; [c]Adult exposure scenario: 5 days/week, 3 months/year, 0.07 L/day ingestion rate, 70 kg body weight and 30 year exposure duration

Figure 1: Location of the Raritan Bay Slag Site

Appendix

1) Area 2 – Area 2 as viewed from main parking lot

2) Area 2 – Beach area in Area 2

3) Area 2 – Day camp as viewed from Area 2

4) Area 2 – The playground (Area 6)
as viewed from Area 2

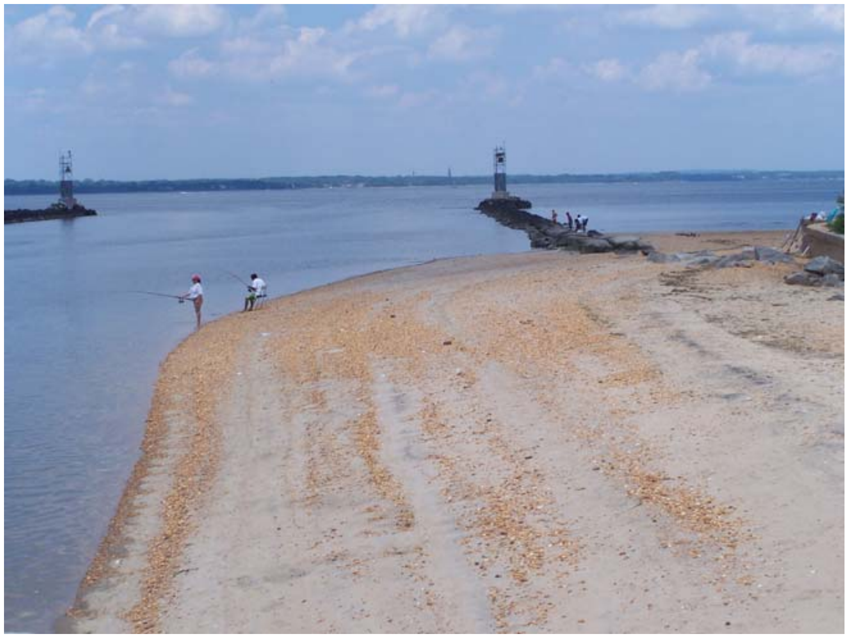
5) Area 2 Beach area

6) Area 2 – The fenced in hotspot area
in summer 2008

7) and 8) Examples of individuals walking and sitting on slag

9) and 10) Examples of recreational activities

11) and 12) Area 1 – Paved walkway viewing Area 1



13) Area 4 – Beach area at the Cheesequake Creek Inlet

14) Area 5 – Cheesequake Creek Inlet Western Slag Jetty