7 SUMMARY AND CONCLUSIONS

7.1 Introduction

The SRA represents the fulfillment of the agreement by USEPA in 2001 to perform additional risk assessment analyses to supplement the risk assessment completed by the Agency in 1995 and incorporated into the EIS. As noted in Section 1.3 (Scope), the purpose of the SRA was to address the following concerns:

- Additional exposure routes beyond inhalation
- Additional contaminants
- Potential exposures and health impacts to children
- Potential exposures and health impacts from dredging and sediment transport
- Use of additional site-specific information

As discussed, all of these concerns have been evaluated and addressed by the SRA. In addition to inhalation, the SRA includes an analysis of the potential risks associated with dermal absorption, soil ingestion, fish consumption from local water bodies and the consumption of home-grown produce, as well as, the potential impacts of exposures to children and students. While the 1995 risk assessment appraised the potential inhalation risk at the boundaries of the ECI site, the SRA assessed the potential impacts of the CDF on six nearby residential areas surrounding the CDF, and the middle school and high school to the south of the ECI site. Although the 1995 risk assessment considered 19 COPCs, the SRA addressed the potential risks associated with 53 COPCs. In addition to the use of the *in situ* sediment COPC concentration data to determine the particle-bound concentrations for the particle emissions, the SRA CDF emission scenarios reflects northwest Indiana's climatic seasonality and the annual dredging schedule as described by USACE. Furthermore, the atmospheric dispersion model used to model transport of the projected emissions from the CDF used five years of local hourly meteorological data. Lastly, the SRA's regulatory emission scenario incorporates the potential risk implications associated with sediment dredging and transport to the CDF through inclusion in the regulatory emission scenario discussed previously and summarized below.

In contrast to the 1995 risk assessment, the SRA used regulatory-based emission limits with modeling predictions for particle and particle-bound COPCs. These CDF emission limits are stipulated under the Indiana Administrative Code (IAC) to not exceed 25 TPY for volatile substances and 25 TPY for particles. Consequently, the SRA risk projections conservatively assumed that the yearly emissions from the CDF for both volatile substances and particles would equal the 25 ton regulatory limit. Despite the fact that the volatile materials potentially emitted from the CDF will consist of multiple volatile substances associated with the project sediments, the SRA assumed that the entire 25 tons of volatile material emitted each year would consist of naphthalene. Naphthalene has the highest carcinogenic and noncarcinogenic toxicity values of all of the volatile COPCs known to be associated with the project sediments.

The SRA is premised on a CDF emission scenario that is both conservative and differs notably from the approach used in the 1995 risk assessment. Consequently, the SRA provides an alternative perspective upon the potential risks associated with the operation of the CDF. However, despite the differences in the approaches used to model CDF emissions, it should also be noted that the inhalation risk predictions of the SRA do not differ significantly from the

1995 risk assessment results. The characteristics of the SRA and the 1995 risk assessment are summarized in the table below.

	1995 Risk Assessment	SRA
Emission Estimate (flux rate)	• Modeled • Constant mass emission rate	• Regulatory limits • Wind erosion modeling • Consideration of operating schedule and seasonal changes
Chemicals of Potential Concern (COPCs)	• 19 COPCs – 2 metals – 10 PAHs – Total PCBs – 6 VOCs	• 53 COPCs – 11 metals – 12 PAHs – Total PCBs – 17 dioxin/furan congeners – 6 pesticides and phenols – 5 VOCs – Particulate matter
Exposure Pathways	• Inhalation	• Inhalation • Soil ingestion • Homegrown produce ingestion • Fish consumption • Dermal absorption
Receptor Locations	• 400 and 800 meters from CDF boundary	• 6 neighborhoods • 2 schools
Exposure Scenarios	• Adult	• Adult resident • Adult fisher • Child resident • Child fisher • Student • Acute exposure • Age dependent
Air Dispersion Modeling	• One year (1986) of meteorological data (from 5 available years) at Hammond & Whiting • Average temperature and mixing height	• Five years (1987-1991) of local meteorological data from Amoco, Hammond & Whiting • Hourly wind speed, wind direction, and temperature

7.2 Expression of Chronic Health Risks

The risk assessment model used in this analysis provides quantitative estimates of two types of chronic (long-term) human health risks. First, the risk of developing cancer is expressed as the probability that an individual will develop cancer during that individual's lifetime. The probability results from estimating chemical exposures due to a combination of exposure pathways that define a reasonable exposure scenario. Cancer risk is determined separately for exposure to each chemical through each exposure pathway. The total cancer risk is determined by summing together the pathway risks in each scenario.

Second, the risk of developing noncarcinogenic adverse health effects from a particular chemical is called the hazard quotient. A hazard quotient indicates the extent to which an estimated level of chemical exposure is expected to cause adverse health effects. The hazard quotient is a ratio obtained by comparing the estimated chemical exposure level to a standard exposure level that should not pose significant adverse health effects even with long-term exposure. A hazard quotient is determined for each chemical through each exposure pathway that applies to reasonable exposure scenario. For a screening level evaluation, the hazard quotients for all chemicals in a given exposure pathway are assumed to be additive, and the combined hazard quotients are called the hazard index for that pathway. Likewise, the total hazard index for an exposed individual is expressed as the sum of hazard indices from each exposure pathway in the scenario.

The concepts of cancer risk and HI are discussed in more detail in Sections 6.4.2 and 6.4.3.

7.3 Criteria for Determining the Significance of Chronic Health Risks

There are a variety of different benchmarks or criteria that USEPA could use when determining the significance of an estimated cancer risk or a hazard index, depending on the context and purpose of the risk assessment and the risk management decision(s). At the outset, it should be stated that USEPA Region 5 is not aware of any specific risk assessment benchmarks or criteria that apply directly to ambient air emissions from land disposed sediments. Consequently, this section reviews and discusses several criteria that may be helpful in interpreting the results of this SRA based on relevant USEPA environmental programs and facility types.

Region 5 does not believe that a single set of criteria can be cited as conclusive in determining the significance of the identified risks, because each set of criteria discussed below was developed in a different statutory or programmatic context than the one presented by the Indiana Harbor CDF. The criteria also integrate varying margins of safety, reflecting in part the varying degree of uncertainty associated with risk characterization in these different contexts.

The following USEPA sources of policy and regulatory information were reviewed by Region 5 to obtain criteria for evaluating the significance of estimated risks of emissions from the CDF:

1) The criteria used by the Office of Air Quality Planning and Standards in its “residual risk analysis” are considered relevant because those criteria were developed to characterize risks resulting from ambient air emissions, which is also the goal of the analysis in this SRA. The document *Residual Risk Report to Congress* (USEPA 1999c) was developed to respond to requirements set out in the *Clean Air Act* at Section 112(f)(1). The Report contains USEPA’s general framework for assessing risks to public health and the environment from ambient air emissions of HAPs that could continue to occur after implementation of emissions standards under the Act.

2) USEPA-OSW has issued a set of “Acceptable Target Levels” that are intended to be protective for potential risks posed by ambient air emissions from hazardous waste combustion units. These target levels are found in the *Implementation Guidance for Conducting Indirect Exposure Analysis at RCRA Combustion Units* (USEPA 1994f). The target levels are used to evaluate the results of risk assessments conducted for combustion stack emissions. They also provide a basis for recommending additional permit conditions and emission limits, if necessary, to ensure the protection of human health.

3) Risk management goals under USEPA’s Superfund program for addressing industrial and chemical waste sites. These goals are intended for evaluating cumulative risks from multiple pollutants through multiple pathways. The goals are needed to identify levels of

health risk that require remediation, and levels of residual health risk considered acceptable after completion of remedial actions. USEPA uses a risk assessment approach to characterize the current and potential threats to human health that may be posed by contaminants which are found in soil, migrate to groundwater or surface water, release to air, and bioaccumulate in the food chain. USEPA's Office of Solid Waste and Emergency Response (OSWER) discusses the use of risk assessment to develop remedial alternatives and to support risk management decisions in OSWER Directive 9355.0-30, "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" (USEPA 1991).

The criteria reviewed by Region 5 indicate that USEPA addresses estimated cancer risks in the following manner: (1) for an exposure scenario displaying an estimated cancer risk of less than 1 case in 1,000,000 exposed individuals (1×10^{-6}; 1E-06), USEPA will generally recommend no further concern or action; (2) for an exposure scenario displaying an estimated cancer risk of greater than 1 in 10,000 (1×10^{-4}; 1E-04), USEPA will recommend further action, including recommendations to reduce risk through placing limits/controls on the source of chemical emission; (3) for an exposure scenario displaying estimated cancer risk between 1×10^{-6} and 1×10^{-4}, USEPA may determine that the risk is acceptable without further action or may decide that further action is warranted, including further analysis of risk and/or recommendations to ensure that the emission source is subject to appropriate monitoring and controls.

USEPA addresses estimated noncancer hazards as follows: (1) for an exposure scenario displaying an estimated HI of less than 1, USEPA will generally recommend no further action; (2) for an exposure scenario displaying an estimated HI greater than 1, USEPA will generally recommend further action. The further action could include additional hazard analysis such as re-evaluating the HI results according to chemicals which display a similar toxicological endpoint (i.e., target the same body organ or act by similar biological modes of action). Depending on the size of the HI, the further actions could also include recommendations to reduce the estimated hazard through placing limits/controls on the source of chemical emission.

The criteria summarized above are used as a starting point for evaluating the significance of the estimated cancer risk and HI results found in this SRA and displayed in detail in Section 6.4.

7.4 Summary and Significance of Estimated Cancer Risks

7.4.1 Local Area Resident

Local area residents living in the vicinity of the CDF are assumed to be potentially exposed to chemical contaminants through a combination of five modeled exposure pathways. Estimated cancer risks summarized by individual exposure pathway are listed in the following Tables: 6-13, 6-14, 6-17, and 6-18.

For local adult residents, the highest estimate of cancer risks are for those assumed to consume fish obtained from Powderhorn Lake (Table 6-17). For those individuals, the total (additive) cancer risk exceeds the "no further concern" level (i.e., 1E-06) in each neighborhood zone. No zone exhibits a total cancer risk at the "requires further action" level (i.e., 1E-04). Three zones exhibit estimated total cancer risk at a level of 1E-05 or above. These zones are: Marktown, Northside/Southside, and Robertsdale.

For local child residents, the highest estimate of cancer risks are for those assumed to consume fish obtained from Powderhorn Lake (Table 6-18). For those individuals, the total (additive) cancer risk exceeds the "no further concern" level (i.e., 1E-06) in four neighborhood zones (Hammond, Marktown, Northside/Southside, and Robertsdale). No zone exhibits an estimated total cancer risk at the "requires further action" level (i.e., 1E-04). No zone exhibits an estimated total cancer risk above a level of 4.5E-06.

Because estimated total cancer risks were found to be highest in the Northside/Southside zone for both adult and child residents, the estimated cancer risks for this zone are described further below in terms of the individual exposure pathways and the chemical contaminants predicted to contribute most significantly to a given pathway.

7.4.1.1 Inhalation

The estimated inhalation cancer risks for the adult and child resident at Northside/Southside are 4.2E-06 and 8.4E-07, respectively (Table 6-17; Table 6-18). The contribution of specific chemicals to these risks is summarized in detail in Appendix 7-1.

For both the adult and child, essentially all estimated risk is contributed by the sum of two contaminants: (1) naphthalene, which contributes the risk due to volatile emissions; and hexavalent chromium (Cr+6), which contributes risk as a contaminant carried in particle matter.

For the estimated adult inhalation cancer risk of 4.2E-06: 3.3E-06 (78.6 percent) is contributed by naphthalene and 8.8E-07 (21.0 percent) is contributed by hexavalent chromium.

For the estimated child inhalation cancer risk of 8.4E-07: 6.6E-07 (78.6 percent) is contributed by naphthalene and 1.8E-07 (21.4 percent) is contributed by hexavalent chromium.

Because of the assumptions used for modeling contaminant emissions, the estimated inhalation risks can be regarded as conservative estimates. They are likely to overestimate actual exposure risk to individuals in the neighborhood zone for the following reasons:

1) For modeling inhalation exposure due to volatile contaminants, all volatile contaminants were assumed to be composed only of naphthalene. Naphthalene is the chemical assigned the highest potency factor (i.e., CSF) compared to other known contaminants in Harbor sediments which could be expected to have a significant release as volatile constituents. For actual volatile releases from the CDF, other volatile constituents in addition to naphthalene are expected to be present.

2) For modeling inhalation exposure due to chromium, all chromium present in IHSC sediments and in particulate matter emitted from the CDF was assumed to be hexavalent chromium to prevent underestimation of chromium inhalation risk. In harbor sediments, the chromium content will not actually be 100 percent hexavalent chromium, and may be significantly lower, likely not exceeding 10-20 percent of the total chromium content.

7.4.1.2 Soil Ingestion

The estimated cancer risks due to soil ingestion for the adult and child resident at Northside/Southside are 8.4E-07 and 1.6E-06, respectively (Table 6-17; Table 6-18). The contribution of specific chemicals to these risks is summarized in Appendix 7-1.

For the estimated adult soil ingestion cancer risk of 8.4E-07, the chemical-specific contributions are:

Arsenic – 17.9%

BaP – 35.2%
Indeno[1,2,3cd]pyrene – 13.6%
Benzo[a]anthracene – 5.4%
Benzo[b]fluoranthene – 4.0%
Other PAHs – 0.6%

PCBs – 0.4%

Dioxin/Furan Congeners – 22.4%

Pesticides – 0.1%

For the estimated child soil ingestion cancer risk of 1.6E-06, the chemical-specific contributions are:

Arsenic – 18.0%

BaP – 35.3%
Indeno[1,2,3cd]pyrene – 13.7%
Benzo[a]anthracene – 5.4%
Benzo[b]fluoranthene – 4.0%
Other PAHs – 0.7%

PCBs – 0.4%

Dioxin/Furan Congeners – 22.6%

Pesticides – 0.1%

7.4.1.3 Home Garden Consumption

The estimated cancer risks due to consumption of garden grown produce for the adult and child resident at Northside/Southside are 4.0E-06 and 1.1E-06, respectively (Table 6-17; Table 6-18). The contribution of specific chemicals to these risks is summarized in Appendix 7-1.

For the estimated adult garden produce ingestion cancer risk of 4.0E-06, the chemical-specific contributions are:

Arsenic – 17.5%

BaP – 42.7%
Indeno[1,2,3cd]pyrene – 10.6%
Benzo[a]anthracene – 7.6%
Benzo[b]fluoranthene – 4.5%
Other PAHs – 0.5%

PCBs – 8.2%

Dioxin/Furan Congeners – 8.5%

Pesticides – 0.02%

For the estimated child garden produce ingestion cancer risk of 1.1E-06, the chemical-specific contributions are:

Arsenic – 17.5%

BaP – 42.7%
Indeno[1,2,3cd]pyrene – 10.6%
Benzo[a]anthracene – 7.6%
Benzo[b]fluoranthene – 4.5%
Other Polycyclic Aromatic Hydrocarbons – 0.5%

PCBs – 8.2%

Dioxin/Furan Congeners – 8.1%

Pesticides – 0.3%

7.4.1.4 Fish Consumption

The estimated cancer risks due to consumption of fish harvested from Powderhorn Lake for the adult and child resident at Northside/Southside are 5.3E-06 and 6.8E-07, respectively (Table 6-17; Table 6-18). The contribution of specific chemicals to these risks is summarized in Appendix 7-1.

Since the estimated child risk is below 1E-06, only the estimated adult fish consumption risk is evaluated further. For the estimated adult fish ingestion cancer risk of 5.3E-06, the chemical-specific contributions are:

Arsenic – 0.05%

BaP – 37.5%
Indeno[1,2,3cd]pyrene – 4.2%
Benzo[a]anthracene – 8.4%
Benzo[b]fluoranthene – 4.4%
Other PAHs – 0.7%

PCBs – 15.4%

Dioxin/Furan Congeners – 7.4%

Pesticides – 21.9%

7.4.1.5 Dermal Absorption

Estimated cancer risk due to dermal absorption of contaminants is well below 1E-06 in the Northside/Southside neighborhood zone (and in all other neighborhood zones) (Table 6-17; Table 6-18).

Chemical-specific contribution to estimated cancer risk due to dermal absorption is dominated by PAH constituents (85 percent), dioxin/furan congeners (7.6 percent), arsenic (6 percent), and PCBs (0.7 percent). Other organic constituents contribute the remainder.

7.4.2 Local Student

Local area students attending school in the vicinity of the CDF are assumed to be potentially exposed to chemical contaminants through a combination of three modeled exposure pathways (inhalation, soil ingestion, and dermal absorption). These are the combination of contaminant exposure pathways expected for routine school attendance and outdoor student activities (e.g., recreation, sports practice). The part of the Study Area selected as the school zone corresponds to the location of Central High School and West Side Junior High School in East Chicago. These are the schools located in nearest proximity to the CDF. Estimated cancer risks summarized by individual exposure pathway are listed in Table 6-21.

The only individual exposure pathway showing an estimated cancer risk above 1E-06 is inhalation, which exhibited an estimated risk level of 1.3E-06.

All estimated risk for the inhalation pathway is contributed by the sum of two contaminants: naphthalene, which contributes the risk due to volatile emissions; and hexavalent chromium (Cr+6), which contributes risk as a contaminant carried in particle matter.

For the estimated student inhalation cancer risk of 1.3E-06: 1.1E-06 (85 percent) is contributed by naphthalene, and 2.1E-07 (15 percent) is contributed by hexavalent chromium.

For the other exposure pathways applicable to students (i.e., soil ingestion, dermal absorption), the chemical contaminants predicted to contribute most significantly to a given pathway exhibit a pattern very similar to the pattern observed for the Local Area Resident (as summarized above).

7.5 Summary and Significance of Estimated Hazard Index Results

7.5.1 Local Area Resident

Local area residents living in the vicinity of the CDF are assumed to be potentially exposed to chemical contaminants through a combination of five modeled exposure pathways. Estimated HI results summarized by individual exposure pathway are listed in the following Tables: 6-15, 6-16, 6-19, and 6-20.

Local adult residents estimated to have the highest HI results are those assumed to consume fish obtained from Lake George (Table 6-15). For those individuals, the total (additive) HI does not exceed the “requires further action” level (i.e., 1.0) in any residential zone.

Local child residents estimated to have the highest HI results are those assumed to consume fish obtained from Lake George (Table 6-16). For those individuals, the total (additive) HI does not exceed the “requires further action” level (i.e., 1.0) in any residential zone.

Estimated total HI results were found to be highest in the Northside/Southside and Robertsdale zones for both adult and child residents. The estimated HI results for these two zones are described further below for the three exposure pathways which contributed most significantly to the HI: inhalation, home garden produce consumption and fish consumption. The chemical contaminants predicted to contribute most significantly to each pathway are summarized below.

7.5.1.1 Inhalation

The estimated HI for inhalation was found to be the highest in the Robertsdale zone. The estimated inhalation HI for an adult and child is 0.191 (Table 6-15; Table 6-16). Essentially all the inhalation HI is contributed by two constituents: naphthalene, which contributes the inhalation hazard due organic volatile emissions; and elemental mercury, which contributes to the inhalation hazard as a volatile inorganic emission. The relative contributions to the HI are naphthalene (93.4 percent) and mercury (6.6 percent).

7.5.1.2 Home Garden Consumption

The estimated HI due to consumption of garden grown produce is highest for the Northside/Southside zone. The total HI values for the adult and child resident are 0.0399 and 0.0558, respectively (Table 6-15; Table 6-16). The contribution of specific chemicals to these risks is summarized in Appendix 7-1.

For the estimated adult garden produce HI of 0.0399, the chemical-specific contributions are:

Manganese – 18.5%
Arsenic – 9.2%
Chromium (+6) – 7.4%
Antimony – 5.8%
Cadmium – 2.1%
Zinc – 5.6%
Other inorganics – 2.5%

PCBs – 47.5%

All PAHs and Pesticides – 1.4%

For the estimated child garden produce HI of 0.0558, the chemical-specific contributions are:

Manganese – 18.2%
Arsenic – 9.2%
Chromium (+6) – 7.4%
Antimony – 5.9%
Cadmium – 2.1%
Zinc – 5.6%
Other inorganics – 2.5%

PCBs – 47.7%

All PAHs and Pesticides – 1.1%

7.5.1.3 Fish Consumption

The estimated HI values due to consumption of fish harvested from Lake George for the adult and child resident at Northside/Southside are 0.0738 and 0.0479, respectively (Table 6-15; Table 6-16).

For consumption of fish harvested from Lake George by an adult or child, essentially all of the HI is contributed by the presence of methylmercury in fish tissues. As explained earlier, the explanation for this result is that methylmercury can form in watersheds and water bodies by conversion of inorganic mercury to methylmercury due to a combination of biological and chemical transformation processes. The methymercury formed in water bodies has a high capacity for uptake and bioaccumulation into fish. Inorganic mercury is deposited onto watersheds and water bodies primarily in the form of oxidized mercury species (e.g., Hg +2), such a mercuric chloride.

7.5.2 Local Student

Local area students attending school in the vicinity of the CDF are assumed to be potentially exposed to chemical contaminants through a combination of three modeled exposure pathways (inhalation, soil ingestion, and dermal absorption). These are the combination of contaminant exposure pathways expected for routine school attendance and outdoor student activities (e.g., recreation, sports practice). The part of the Study Area selected as the school zone corresponds to the location of Central High School and East Side Junior High School in East Chicago. These are the schools located in nearest proximity to the CDF. Estimated HI results summarized by individual exposure pathway are listed in Table 6-21.

No individual exposure pathway has an estimated HI value above 0.2. The predominant pathway contributing to the HI is the inhalation pathway, which showed a HI value of 0.158 (Table 6-21). This pathway contributed about 93 percent of the total HI estimate. The chemical constituents contributing to the HI are the following:

Naphthalene – 80%
Mercury – 5.6%
Manganese – 12.5%

Naphthalene contributes to inhalation hazard as a volatile emission; manganese contributes to inhalation HI as a contaminant carried in particle matter; elemental mercury contributes to the inhalation hazard as a volatile inorganic emission.

7.6 Early Lifestage Differences in Contaminant Exposure and Toxicity

Section 6.4.7 presented a limited evaluation of potential early lifestage differences in human health susceptibility and exposure for many contaminants included in the SRA. The section addresses USEPA risk assessment guidance and methods for both toxicity and exposure assessment. Although the SRA uses information from sources other than USEPA, those sources were not evaluated in the early lifestage discussion. USEPA's approach to noncancer effects assessment has long considered developmental toxicity; a recent review concluded that additional uncertainty factors for early life susceptibility were considered unnecessary in most cases (Section 6.4.7.4). However, as discussed in Section 6.4.7.7, recent information on PCB developmental neurotoxicity was not included in the SRA. Recently updated guidance for carcinogen risk assessment includes supplemental guidance for early lifestage considerations, although the longstanding use of low-dose linear extrapolation is also thought to provide public health conservatism (Section 6.4.7.3). Toxicity information updates are needed and pending for some agents in USEPA's IRIS database, as shown in "IRIS Track" (Section 6.4.7.4). Several guidance documents address potential lifestage exposure variation, and quantitative exposure assessment input variable recommendations are available (Section 6.4.7.2). Thus, potential early lifestage differences in both contaminant exposure and toxicity are reflected in the SRA.

7.7 Criteria for Determining the Significance of Lead Emissions

As described in Section 6.1.4.4, exposure and health effects from lead emissions represent a special case that cannot be characterized in terms of a cancer risk or HI. This is because USEPA and other scientific organizations do not currently have an acceptable RfD or RfC for lead. The primary reason is that a threshold level for exposure to lead has not been established. In addition, based on findings that neurobehavioral effects have been observed in children with blood lead levels below those that have caused carcinogenic effects in laboratory animals, a CSF has also not been derived. Consequently, USEPA has relied on the neurological effects observed in children as the sensitive endpoint for evaluating lead toxicity. The Agency has developed the *Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children* (USEPA 1994g). This model evaluates potential risks based on predicted blood lead levels associated with exposure to lead. The IEUBK model integrates several assumptions about the complex exposure pattern and physiological handling of lead by the body, and it has been validated at several sites at which lead exposure data and human blood lead levels are available.

A computerized version of the IEUBK model has been developed that predicts blood lead levels and distributions for children ages zero to seven years. The IEUBK computer model does not predict potential blood lead levels in adults. USEPA has also developed an interim approach for assessing risks associated with adult exposures to lead in soil. This interim model is intended for assessing adult lead risks associated with nonresidential (i.e., industrial) exposure scenarios. However, the weight of available evidence strongly suggests children are more susceptible to lead exposures than adults because of higher soil ingestion rates and greater absorption by the gut, in addition to nutritional variables and lower body weight.

7.8 Summary and Significance of Estimated Lead Emissions

For the SRA, the ISCST3 Model coupled with the IRAP model provided the following results on the estimated lead emissions for each residential zone and the school zone (Table 6-22): (1) estimates of the average and maximum predicted increases in soil lead concentration during the expected operating life of the CDF, and (2) an estimate of the highest predicted increase in lead air concentration during the operating life of the CDF.

USEPA's IEUBK Model was used to evaluate whether lead emissions from the CDF could have a significant impact on the predicted blood lead level of children assumed to reside in the vicinity of the CDF. The IEUBK Model was used to evaluate children who were assumed to live in each local neighborhood selected for evaluation within the risk assessment Study Area. The required inputs to the IEUBK Model are described in Section 6.3.5.9 and listed in Table 6.7. The site-specific inputs to the IEUBK Model include the following quantitative values:

1) A background ambient air concentration of lead that applies before the CDF begins operating. For obtaining a site-specific value, ambient air monitoring data reported at a

monitoring station located at East Chicago Central High School was evaluated. From these data, the highest quarterly ambient air lead concentration was determined for the time period from April 2002 - December 2005. This value was determined to be 0.035 $\mu g/m^3$.

2) A background soil lead concentration that applies before the CDF begins operating. Site-specific data on lead (or other contaminants of interest) within East Chicago soils that could be used for determining a valid site-specific background level of lead in soil were not available at the time the SRA was developed. Consequently, the IEUBK Model recommends using a default background level of 200 mg/kg (200 ppm) for use the analysis. This is considered a reasonably conservative (i.e., reasonably high) value to apply in the absence of site-specific data (USEPA 2001a).

3) The incremental increase in soil lead due to CDF operation. For each residential zone, the IEUBK Model was run using the maximum incremental increase in soil lead predicted by the ISCST3/IRAP modeling as given in Table 6-22. The maximum incremental increase corresponds to the conservative assumption that a child's exposure to soil does not begin until after the deposition of lead from the CDF is complete. The deposition of lead is assumed to be complete when no further addition of IHSC sediments occurs to the CDF (i.e., after 30 years of operation).

4) The incremental increase in the ambient air concentration of lead due to CDF operation. For each residential zone, the IEUBK Model was run using the maximum predicted incremental increase in ambient air lead concentration predicted by the ISCST3/IRAP modeling as given in Table 6-22.

The IEUBK Model generates two primary output predictions of interest to the general user:

1) A probability distribution curve which determines the geometric mean blood lead concentration for a population of children each exposed to lead under a specific exposure scenario (e.g., a fixed set of lead environmental levels and intake exposure factors).

2) The probability of exceeding the specified blood lead level of concern. In this case, the blood lead level of concern is the CDC reference exposure level of 10 µg/dL. This probability may be interpreted as the percentage of children at the same specific exposure scenario who are expected to exceed the level of concern.

The IEUBK Model was run for each residential neighborhood scenario using the corresponding input values described above. The results are summarized in Table 6-23.

As a starting point, IEUBK Model was used to evaluate the potential impact of lead in soil and ambient air for the "Background" exposure case (i.e., the situation that applies before the operation of the CDF begins). For this situation, the IEUBK Model estimates an expected mean blood lead level of 3.36 µg/dL with approximately 1.0 percent (0.97 percent) of the child population predicted to have a blood lead level above the health-based target value of 10 µg/dL. Both of these values are within the range of acceptable blood lead criteria.

Then the IEUBK Model was used to evaluate the potential impact of lead emissions after operation of the CDF as an <u>addition</u> to the starting background exposure case. The results indicated that a significant addition to the background was predicted only for the Northside/

Southside neighborhood zone. For this zone, the predicted blood lead level compared to the background exposure increased from 3.36 µg/dL to 3.60 µg/dL and the percentage of the child population predicted to have a blood level above 10 µg/dL increased from 1.0 percent to 1.4 percent (1.39 percent). Both of these values for the Northside-Southside neighborhood zone are within the range of acceptable blood lead criteria. Based on these results, no further analysis of lead emission from the CDF was conducted using the IEUBK Model.

It should noted that if the IEUBK model is run using the standard recommended default values (which generally represent national averages, or "typical" values), the model predicts that no more than 5 percent of children exposed to a lead concentration in soil of approximately 400 mg/kg would have lead concentrations in blood exceeding 10 µg/dL. In theory, this means that if lead emissions to ambient air from single facility resulted in a residential soil lead concentration of 400 mg/kg, then blood lead levels above the acceptable range would not be predicted and no adverse health effects would be expected. In practice, however, background lead emissions at a given location could be deposited onto soil from a number of different sources (e.g., automobiles, trucks, power plants, metallurgical plants). For this reason, USEPA-OSW has recommended that operation of any single hazardous waste combustion unit should not be allowed to cause more than a 100 mg/kg increase in the soil lead concentration in the vicinity of a combustion facility (USEPA 1994). The 100 mg/kg recommended limit for the soil lead increase for a single facility is designed as an allowance to increase the likelihood that the total local soil lead level will not exceed 400 mg/kg in the vicinity of the facility because of other local background emissions of lead.

It is recognized that the CDF is not a hazardous waste combustion facility and will not be regulated as a combustion facility. However, as a further evaluation of the potential significance of lead emissions from the CDF, the rationale used by the USEPA-OSW to evaluate lead emissions from combustion facilities could be applied to the predicted long-term lead emissions from the CDF. In the vicinity of the CDF at locations where current and/or future human occupancy is expected, the school zone is the part of the Study Area predicted to have the highest long-term increase in soil concentration due to operation of the CDF. The predicted highest average increase in soil lead concentration within the school zone during the operating life of the CDF is 65 mg/kg, and the predicted maximum increase in soil lead concentration within the school zone after operation of the CDF is completed is 110 mg/kg. (In the SRA, the School Zone is not evaluated by the IEUBK Model since children in the age range with highest sensitivity to lead exposure [infancy to age seven years] are not expected to live, attend school, or spend significant amounts of time in the School Zone).

7.9 Margin of Exposure Evaluation for Dioxin Intake

Most chemical compounds for which RfDs are derived are not widely distributed and/or persistent in the environment. Therefore, background exposures are generally very low and not taken into account in a risk assessment. USEPA's draft "Dioxin Reassessment" documents (USEPA 2000, 2003a) concluded that it would be inappropriate to develop a reference dose for dioxins. This is because dioxins are persistent compounds in the environment and because pre-existing background exposures to dioxins are not necessarily low compared to incremental dioxin exposures arising from a single source under investigation. Therefore, the draft Dioxin Reassessment concluded that it would not be appropriate to use the reference dose approach in evaluating incremental exposures to dioxins.

As an alternative, the USEPA Office of Research and Development has recommended using a MOE approach. This is an approach for estimating if a specific incremental exposure dose to dioxin is significant compared to the expected background exposure dose (USEPA 2000, 2003a, 2005c). To apply this approach, one determines the ratio of the estimated daily dose of dioxins from a particular source (in this case, intake of dioxin emissions from the CDF) compared to the average daily background intake of dioxins expected for the individual or population subgroup under study. The ratio of this incremental dose to the background dose represents the margin of exposure to dioxins. A low ratio indicates that the incremental source under investigation does not contribute a significant addition to the expected background exposure to dioxin.

In the SRA, the MOE approach for dioxins is applied to two population groups:

1) Breast-feeding infants (up to one year old) who may receive dioxin intake from breast milk.

2) Local adult residents who may receive dioxin intake from a number of sources. In general, intake from the diet is the primary background exposure route for dioxin intake.

7.9.1 Breast-Feeding Infant

Infants that are breast-fed may be exposed to chemical contaminants via breast milk if the mother has been exposed to contaminants which are capable of undergoing transport and accumulation in breast milk. The potential for exposure is significant for dioxin-like compounds which are highly lipophilic and tend to accumulate in tissues with increased fatty deposits (e.g., breast tissue) and to accumulate in the lipid portion of breast milk. USEPA's Dioxin Reassessment (USEPA 2000, 2003a) and other guidance have developed procedures and algorithms for estimating the concentration of dioxin congeners in mother's milk and an ADD for the breast-feeding infant.

The Dioxin Reassessment reviewed and summarized a study in which dioxin levels were measured in the breast milk of 42 U.S. women (Schecter et al. 1992). This study found an average dioxin concentration of 16 ppt in the lipid portion of breast milk (expressed as dioxin-TEQ based on the 2,3,7,8-TCDD congener).

The 16 ppt dioxin-TEQ average breast milk lipid concentration has been used as the starting point to calculate an expected background infant ADD_{inf} value by using reasonable exposure factors for breast milk consumption and an equation that relates the breast milk concentration to an intake dose (Section 6.3.5.8). The calculated value was found to range from 50-60 pg/kg-day of dioxin-TEQ based on slight differences in intake parameters (USEPA 1998b, 1999b).

For applying the MOE approach in the SRA, the value of 50 pg/kg-day dioxin-TEQ was adopted in this SRA as the reference background ADD_{infant} for the breast-feeding infant. The next step is to calculate estimates of the incremental ADD_{infant} due to dioxin congener emissions from the CDF. To make these estimates, the IRAP Model combined the information on dioxin congener emission rates, air dispersion/deposition modeling, and fate and transport modeling in order to calculate dioxin congener values for mother's breast milk lipid concentration (Section 6.3.4.5) and the corresponding dioxin congener ADD_{infant} value (Section 6.3.5.8). The estimates were made for infants assumed to reside in each residential zone in the Study Area for the CDF.

IRAP calculates individual dioxin congener ADD_{infant} values. These are converted to dioxin-TEQ ADD_{infant} values for use in the MOE comparison. The dioxin congener ADD_{infant} values and conversion to dioxin-TEQ values are shown in Appendix 6-6.

The dioxin-TEQ ADD_{infant} values and results of applying the MOE approach are shown in Table 6-24. The results are presented for a breast-feeding infant of a woman assumed to be an Adult Fisher who resides in a Neighborhood Zone in the Study Area.

The results of the analysis showed that no estimated MOE in the Study Area exceeded a value of 0.006. These results are interpreted to mean that predicted average dioxin-TEQ ADD_{infant} values are more than 100-fold lower than the expected dioxin-TEQ ADD_{infant} background exposure to dioxin congeners in breast milk based on currently available background data (USEPA 1998, 2000, 2003a, 2005c). Consequently, no further evaluation is conducted in the SRA.

7.9.2 Local Adult Resident

Dioxin-like chemicals are persistent in the environment and can accumulate in biological tissues, particularly in the lipid fraction of animal tissues and processed foods from animal sources. This includes foods such as raw and processed meats, fish, eggs, milk, and other dairy products. Consequently, the major route of human exposure is through ingestion of lipid-containing foods that retain minute concentrations of dioxin-like compounds. This results in relatively widespread exposure of the general population. Available data indicate that daily intakes have been reduced since the 1970s and that, as of the mid-1990s, U.S. adult daily intakes of dioxin-like chemicals average in the range of 1 to 3 pg dioxin-TEQ/kg-day for adults (based on a 70 kg average adult body weight).

One approach that the Agency has taken to evaluate whether dioxins emitted from a specific source are likely to cause significant noncancer health effects is to compare exposures estimated to result from the source's emissions with national average background exposure levels for these compounds (1 to 3 pg dioxin-TEQ/Kg-day for adults). If exposures due to the facility's emissions during the exposure duration of concern are low compared to background exposures, then the emissions are not expected to cause noncancer effects. Currently, USEPA guidance for risk assessment recommends conducting a comparison of estimated exposures to dioxins from a specific facility's emissions (during the time duration of concern) to the low end of the national average background exposure level, namely 1 pg dioxin-TEQ/kg-day for adults (USEPA 1998b, 2005c).

For the SRA, the IRAP Model was used to calculate individual dioxin congener ADD_{adult} values. These were converted to dioxin-TEQ ADD_{adult} values for use in the MOE comparison. The dioxin congener ADD_{adult} values and conversion to dioxin-TEQ ADD values are shown in Appendix 6-7.

The dioxin-TEQ ADD_{adult} values and the results of applying the MOE approach are shown in Table 6-25. The results are presented for a local resident who is assumed to be an Adult Fisher and who resides in a Neighborhood Zone in the Study Area.

The results of the analysis showed that no estimated MOE in the Study Area exceeded a value of 0.008. These results are interpreted to mean that predicted average dioxin-TEQ ADD_{adult} values from the combination of ingestion pathways evaluated in the SRA are at least 100-fold lower than the expected dioxin-TEQ ADD_{adult} background exposure to dioxin congeners in the U.S. diet based on currently available background data (USEPA 1998, 2000, 2003a, 2005c). Consequently, no further evaluation is conducted in the SRA.

7.10 Summary and Significance of Short-Term Inhalation Exposure to CDF Emissions

In this SRA and in other assessments of air emissions, long-term or "chronic" exposure will be the primary health risk concern contributing to potential exposure for a given chemical contaminant. This assumption is valid when the potential site-specific exposure is expected to occur over multiple years. This assumption is valid for the SRA since potential releases from the CDF could occur over many years of operation. This situation is evaluated in the SRA by using annual average emission rates of chemical contaminants as an input for the air dispersion modeling to estimate long-term chronic inhalation exposure and long-term deposition rates of chemical contaminants to soil and water bodies.

However, it is recognized that fluctuations (i.e., "peaks" and "valleys") in the actual air concentration of a given chemical contaminant could occur over shorter time frames within the annual average due to variations in meteorological conditions (e.g., wind speed, temperature, cloud cover, precipitation rates). As explained in previously in Section 5, the ISCST3 air dispersion model can utilize meteorological data corresponding to short-time (e.g., hours, days) variations in weather to estimate the highest expected one-hour or one-day average. These results are useful for evaluating the predicted short-term air concentration levels of chemical contaminants, and the corresponding potential inhalation health risks attributable to acute (short-term) duration periods. To evaluate the potential for adverse health effects due to short-term air concentration levels of contaminants, USEPA and other organizations have developed air concentration levels intended to provide protection for the general population from the acute effects of many commonly encountered air contaminants. These air concentration levels are commonly referred to as AIEC or ERPGs (Section 6.1.6). The SRA uses these air concentration guidelines for comparison to the short-term air concentration levels predicted by the ISCST3 Model.

Particulate matter is regarded as an additional contaminant of concern because of the range of health effects attributable to exposure to particulate matter, especially to particulate matter in the respirable size range of PM10. In the SRA, particulate matter emissions from the CDF are evaluated using the WEPS erosion model combined with site-specific weather data (e.g., wind direction, wind speed, precipitation rates, temperature) for available time scales as short as one hour and 24 hours. The site-specific WEPS Model for the SRA predicted that particulate emissions could be expected to occur primarily as episodic events that require a threshold wind speed to be achieved before particles can become airborne and be transported outside the CDF. Because of the predicted episodic nature of PM emissions, short-term fluctuations (peaks and valleys) in air concentrations of PM would be expected over time frames of a few hours to a few days depending on the duration of the threshold wind speed. The WEPS Model emissions of particulate matter were combined with the ISCST3 Model of particulate transport to estimate short-term air concentrations of particulate matter as respirable PM10. The estimated short-term air concentration levels of PM10 are compared to published regulatory concentration levels or limits for evaluating the health and environmental significance of PM10.

7.10.1 Chemical Contaminants

As explained in previous sections, the COCs for the SRA are modeled as three distinct phases in which contaminants could be partitioned for air transport after release from the CDF. These phases are: volatile components (assumed to be naphthalene); metals, which could be emitted as particles; and chemical constituents bound to particles (SVOCs).

The procedures to evaluate short-term air concentrations of chemical contaminant emissions from the CDF are outlined in detail in Section 6.4. The ISCST3 air dispersion model operated in the acute mode was combined with the IRAP software analysis to calculate the chemical-specific concentrations corresponding to each contaminant found in the three contaminant phases. The resulting IRAP output files were scanned to find the highest predicted one-hour contaminant air concentration within each receptor zone of interest.

The primary results of the evaluation may be summarized as follows:

- The highest predicted naphthalene concentration in each area of interest is shown in Table 6-26. The highest one-hour air concentration for naphthalene was predicted to occur within the School Zone (103 $\mu g/m^3$). As explained previously, naphthalene was used as the surrogate chemical contaminant to represent the entire modeled annual emission of volatile contaminants for evaluating chronic exposure. As shown in the table of Acute Inhalation Exposure Criteria (AIEC) (Table 6-2), naphthalene was found to possess the lowest published AIEC value corresponding to a one-hour exposure period compared to the other chemical contaminants in IHSC sediments that could be expected to be emitted exclusively as vapor phase contaminants (See the TEEL-1 value for naphthalene compared to the values for benzene, toluene, ethylbenzene, and xylene.) Consequently, it was considered valid and conservative to evaluate the short-term inhalation of volatiles by using naphthalene alone.

  Table 6-26 also shows the "Acute Inhalation Hazard Quotient" calculated by comparing the predicted highest one-hour naphthalene air concentration with the TEEL-1 value:

  $$\text{Acute Inhalation Hazard Quotient} = \frac{\text{Highest Predicted one-hour Air Concentration}}{\text{TEEL-1 Concentration}}$$

  The highest Acute Inhalation Hazard Quotient for naphthalene was found in the School Zone (0.0013). Since the calculated acute HQ values for naphthalene were found to be well below 1 in each area of interest, no further evaluation was conducted for the SRA.

- For chemical contaminants expected to be released from the CDF as particulates and particulate-bound contaminants, the highest predicted one-hour air concentrations for all contaminants occurred within the school zone. This observation is consistent with the results of the combined WEPS Model/ISCST3 Model which showed that the highest predicted particle phase air transport would occur predominantly in a southerly direction from the CDF.

  The highest predicted one-hour air concentration for each contaminant in the school zone (including naphthalene) is shown in Table 6-27. This table also shows the Acute Inhalation Hazard Quotients calculated by comparing the one-hour air concentration of each contaminant to its corresponding TEEL-1 value. The sum of the individual Acute Inhalation Hazard Quotients is expressed as an Acute Inhalation Hazard Index value at the bottom of Table 6-27. The calculated Acute Inhalation Hazard Index Value for the highest predicted one-hour air concentration due to the combination of all CDF contaminants is 0.113 at the School Zone.

  Table 6-28 shows the Acute Inhalation Hazard Index values estimated for each area of interest for comparison to the school zone. This table also lists the contaminants which made the highest contribution to the Hazard Index. Since Acute Inhalation Hazard Index values for the highest predicted one-hour air concentration due to the combination of all CDF contaminants is significantly lower than 1.0 in each zone of interest, no further evaluation was conducted for the SRA.

7.10.1.1 Particulate Matter

For PM10, the applicable ambient air quality standards and limits for short-term inhalation exposure are based on an averaging time of 24 hours. Consequently, the evaluation of short-term inhalation exposure to respirable particulate matter in the SRA is based on an assumed 24-hour exposure period.

The procedures to evaluate short-term air concentrations of particulate emissions from the CDF are outlined in detail in Section 6.4.

The result of applying these procedures to evaluate short-term ambient air concentrations yielded values corresponding to the "Maximum 24-hour Average PM10 Concentration" within each Study Area zone of interest for the SRA.

The results of the evaluation are listed below in Table 6-29 as the "Maximum 24-Hour Average PM10 Concentration" within each Study Area zone of interest. To provide a useful context for evaluating the significance of the results, the table also shows a comparison of the results with the following values:

1) Primary NAAQS for PM10 and PM2.5 are limits set to protect public health including the health of sensitive subpopulations such as asthmatics, children, and the elderly. The 24-hour ambient air limit for PM10 is 150 µg/m^3; the 24-hour ambient air limit for PM2.5 is 35 µg/m^3. It should be noted that compliance with the Primary Standards is normally evaluated for a designated geographic "attainment area." Evidence that the attainment area meets the Primary Standards is obtained by collecting and analyzing air monitoring data for PM10 and PM2.5 at specific monitoring stations located within the attainment area. Air monitoring results for PM10 and PM2.5 within an attainment area will represent measured PM concentrations from a combination of sources including point sources and area sources. Obviously, the CDF is not likely to represent the only source of PM emissions in the vicinity of East Chicago. But it is useful to compare the highest predicted 24-hour PM10 concentrations from the CDF with health based limits.

2) PSD from Particulate Matter is an additional requirement which limits the amount of further air quality degradation allowable from emissions caused by major new sources. For attainment areas which already meet NAAQS, the "PSD increment" means that a major new emission source is only allowed to increase a pollutant's ambient concentration up to a certain level above the concentration that exists on a specific baseline date. The maximum allowable increase in concentration is the PSD increment. Three classes of PSD increments have been promulgated. Class I increments apply to sensitive environmental preservation areas, such as national parks. Class II increments apply to areas of normal or average concern, such as areas with established commercial and industrial operations. Class III increments apply to the remaining areas. The Study Area for the CDF is a Class II area. Consequently, the PSD increment or the maximum allowable increase in concentration of PM10 for a 24-hour period would be 30 µg/m^3 if a major new source were added to the Study Area. This value is being used in the SRA for comparison purposes only, and not as a test to determine if the PSD increment applies to any existing facility in the Study Area. (According to USEPA regulations, the

PSD increment requirement applies only to a major new pollution source—e.g., a facility/operation that could emit greater than 100 TPY of PM10. The Indiana Harbor CDF is not such a facility because its particulate matter emission limit is currently set by State regulation not to exceed 25 TPY. Therefore, the PSD increment is not an additional compliance limit that applies to the CDF).

Table 6-29 shows that the predicted maximum 24-hour average PM10 concentration for CDF emissions in each zone of interest within the Study Area is well below the Primary health-based 24-hour NAAQS limit for PM10 and PM2.5. For example, the maximum 24-hour average PM10 concentrations for the School Zone and the Northside-Southside zone are 3.6 $\mu g/m^3$ and 1.8 $\mu g/m^3$, respectively. These values should be compared to the 24-hour NAAQS limits of 150 $\mu g/m^3$ for PM10 and 35 $\mu g/m^3$ for PM2.5. Finally, the maximum 24-hour average PM10 concentration in each zone of interest within the Study Area is below the 24-hour PSD increment (30 $\mu g/m^3$) that would apply to the CDF Study Area. Based on these results, no further evaluation of short-term particulate matter concentrations was conducted for the SRA.

7.11 Conclusions

The SRA is a multi-step modeling exercise that consists of a combination of several procedures and methodologies used to derive quantitative estimates of health risks from potential exposure to chemical contaminants released from the CDF. These procedures and methodologies are summarized in Section 3 and described in detail in Sections 4 through 6. These Sections present the major assumptions and parameter selections that were made to conduct the modeling and to introduce appropriate conservatism into the analysis. Some of the major modeling assumptions that are important for evaluating the outcome of the analysis and for drawing conclusions based on the results of the SRA are presented below:

1) The CDF is expected to have a 30-year operating life. This means that IHSC sediments will be added to the CDF every year for 30 years until additions end, and the CDF is capped. Various methods were investigated for conducting chemical contaminant emission estimates from the CDF based on the use of: (1) assumed sediment input rates to the CDF, and (2) theoretical models for predicting volatile chemical contaminant and particulate emission rates. These assumptions for sediment input rates and theoretical emission models were determined to be too uncertain and complex to use for quantitative analysis in the SRA. As a substitute for the complex theoretical emissions model, the SRA relied on the established regulatory compliance limits for emissions from the CDF as the starting point for defining chemical contaminant emission rates from the CDF. Based on the State of Indiana air emission regulations imposed on operation of the CDF, emission rates of volatile contaminants and particulate matter used in the CDF were each assumed to be at the regulatory limit of 25 TPY. Consequently, the health risk analysis conducted in the SRA is based on chemical emission rates corresponding to the regulatory compliance limits that apply to the CDF.

2) Because of the uncertainty and complexity of using theoretical models to develop chemical-specific emission rates for volatile contaminants in IHSC sediments, the SRA uses naphthalene as the single chemical-contaminant to represent total volatile chemical emissions at the 25 TPY limit. Naphthalene was selected because of its relative toxic potency for the inhalation route of exposure (both for inhalation cancer risk and inhalation toxic hazard) compared to other volatile chemicals known to be present in IHSC sediments. Consequently, inhalation cancer risk and noncancer hazard based on

naphthalene as the sole volatile chemical emission should overestimate actual inhalation risks and hazards due to volatile emissions from the CDF.

3) To enhance the site-specific application of the SRA, information on population demographics and human activities in the vicinity of the CDF was used to define and map geographic "Zones of Interest" for modeling contaminant exposure and risk in the vicinity of the CDF. Five zones of interest were identified that correspond to specific residential neighborhoods, and one additional zone was identified where the primary concern was potential exposure in a school setting. In each of these zones, exposure scenarios were developed that identify the major potential pathways of exposure to contaminants. For individuals living or spending time in these zones, the assumption is that every individual is exposed to contaminants by each applicable exposure pathway. This model for "individual" exposure is a generally conservative model because the collective population may include individuals who do not experience contaminant exposure by a given pathway. (For example, a specific residential zone may include many individuals who do not consume vegetables grown in a home garden or consume fish harvested from a local water body).

4) For chemical contaminant releases that actually occur from the CDF, a wide range or distribution of actual contaminant exposure dose/intake levels would be possible within the population in the vicinity of the CDF. The distribution of exposure will be due mainly to variability in the contaminant concentrations levels (i.e., contaminant variability by location) and the variability in human exposure factors and behaviors (e.g., variability in body weight, ingestion rate, exposure duration). Because of resource and time constraints, an analysis of the full range of exposure distribution in the vicinity of the CDF is beyond the scope of the SRA. Consequently, a simplified approach to modeling or estimating contaminant exposure was adopted for the SRA which is realistic and also protective in nature. The approach is the application of the RME concept. The RME is the highest exposure that is reasonably expected to occur under the exposure scenario that applies to a given situation. The RME concept was developed within the USEPA Superfund remediation program where the goal is to protect an individual at the "high end" level of exposure, but not at the highest possible level of exposure that could be envisioned (USEPA 2004b). The RME is meant to represent an exposure level at the high end but within the realistic range of exposure. In practice, the RME estimate for a specific exposure pathway or scenario is constructed by setting one or more sensitive exposure factors to their near-maximum values and employing other factors at their known or expected average/mean values (USEPA 1992a).

5) To enhance the likelihood that the SRA would serve as an RME or high-end estimate of potential contaminant exposure, the following methodology was applied:

(a) For estimating chemical intake for each exposure pathway, at least one high-end exposure factor was selected, and in some cases, multiple high-end exposure factors were selected. Typical exposure factors set at high-end values include: exposure duration (years), exposure frequency (days/year), and consumption/ingestion rate (mg/day)

(b) For a specific exposure scenario, each individual located in a Zone of Interest was assumed to be exposed to chemical contaminants by each pathway of exposure (as described in [3] above)

(c) For estimating exposure in a specific zone of interest, the modeled individual was assumed to live (residential zone) or conduct activities (school zone) at the location corresponding to the highest combination of risk and hazard calculated for the combination of exposure pathways that apply within a boundary zone. The results for this location are referred to as "highest-combined exposure pathway risk" estimate for the boundary zone.

Based on the application of SRA modeling methodology described above and the results of the SRA risk and hazard analysis presented in Section 6.4 and Section 7.3 through 7.9, the following conclusions and recommendations are offered:

1) For all Zones of Interest (residential neighborhoods and school zone), no total (additive) cancer risk for an adult or child exposure scenario is estimated to be at or above the level of 1×10^{-4} (1E-04; 1 in 10,000) that USEPA generally regards as a level "requiring further action." In a number of Zones of Interest, the estimated cancer risk for several exposure pathways for adult and child exposure are below the level of 1×10^{-6} (1E-06; 1 in 1,000,000) that USEPA generally regards as a level with "no further concern." For the exposure scenarios that include consumption of garden produce and local fish, all residential zones had total cancer risk for adult exposure estimated to be in the range of 1×10^{-6} to 1×10^{-4} (1E-06 to 1E-04), with the highest estimated risk at a level of 1.4×10^{-5}. For the exposure scenarios that include consumption of garden produce and local fish, four residential zones had total cancer risk for child exposure estimated to be in the range of 1×10^{-6} to 1×10^{-4} (1E-06 to 1E-04), with the highest estimated risk at a level of 4.5×10^{-6} . For an exposure scenario displaying estimated cancer risk in the range of 1×10^{-6} to 1×10^{-4}, USEPA may determine that the risk is acceptable without further action or may decide that further action is warranted, including further analysis of risk and/or recommendations to ensure that the emission source is subject to appropriate monitoring and controls. Based on the conservatism of the methodology and exposure assumptions applied in the SRA, a reasonable conclusion is that cancer risk estimates based on chemical contaminant emissions at the regulatory compliance limit (25 TPY of volatiles and 25 TPY of particulates) would be regarded by USEPA as acceptable and adequately protective. However, the SRA could be regarded as a one-time screening level analysis or "snapshot" in time of estimated cancer risks based on operation of the CDF at the regulatory compliance limit. Consequently, a reasonable recommendation is that a continuing monitoring and contaminant emission modeling program should be put in place for the operation of the CDF. Many of the necessary features of the on-going modeling/monitoring program are currently spelled out in the existing State of Indiana Air Emission Registration that applies to operation of the CDF. The primary objective of the on-going modeling/monitoring program would be to demonstrate that the contaminant emission limits continue to be complied with on an annual basis.

2) For all Zones of Interest (residential and school zone), no HI for an adult or child exposure scenario is estimated to be at or above the level of 1.0 that USEPA generally regards as a level "requiring further action." Additional conservatism is included in the estimation of HI in the SRA because these estimates are additive or screening level estimates of HI. This means that estimated HQs for individual chemical contaminants were summed together to generate a HI that disregards the probability of significant differences in the mechanism of action of target organ endpoints between chemicals. Based on the conservatism of the methodology and exposure assumptions applied in the SRA, a reasonable conclusion is that HI estimates based on chemical contaminant emissions at the regulatory compliance limit (25 TPY of volatiles and 25 TPY of

particulates) would be regarded by USEPA as acceptable and adequately protective. To ensure that the estimate of HI remains protective during actual operation of the CDF, the recommendations made above in (1) for a continuing monitoring program at the CDF would be advisable.

3) Potential adverse health risks for exposure to lead cannot be evaluated through a cancer risk or noncancer hazard estimate. Consequently, USEPA uses an uptake-exposure model (IEUBK Model) that correlates the estimated blood lead concentration resulting from several sources of lead intake to a blood lead concentration which is considered to be below a health based level of concern for young children, using the CDC target guidelines for child lead exposure. Children in the age range of infancy to age seven are known to be the most sensitive group for experiencing the potential adverse neurological and developmental effects of lead exposure.

   In the SRA, the IUEBK Model was applied to evaluate the potential significance of lead exposure due to CDF emissions within each residential zone. Based on application of a reasonable combination of site-specific input parameters and default input parameters derived from USEPA guidance, the IEUBK Model results indicate that predicted increases of blood lead levels for young children due to lead emissions from the CDF would not be significant enough to reach a level of health concern in any residential zone. Only one zone (Northside-Southside) showed a predicted increase in blood lead levels due to CDF emissions compared to the background case for to lead. Consequently, no adverse health effects for lead exposure are expected from CDF emissions based on operation of the CDF at the regulatory compliance limit for particulate matter.

   To apply the IEUBK Model, two input parameters are needed to represent the background conditions for lead in the vicinity of the CDF. These values are: a background ambient air lead concentration and a background soil lead concentration. Site-specific background values are used whenever possible to increase the prediction accuracy of the IEUBK Model.

   To derive a site-specific background ambient air concentration for lead, the USACE historical database for ambient air monitoring of lead was reviewed (https://web.ead.anl.gov/inharbor/data/). The database contains recorded monitoring results for several environmental parameters at 5 monitoring stations located around the CDF construction site. The station at East Chicago High School is located in closest proximity to the School Zone and most residential zones evaluated in the SRA. Based on all reported data for the air monitor located at East Chicago High School for the time period April 2002 to October 2005, the highest quarterly mean ambient air concentration of lead was determined to be 0.035 $\mu g/m^3$. This value was selected for use as the site-specific background ambient air lead concentration.

   For development of a site-specific background soil lead concentration, no published data could be located for East Chicago soils that could be used for deriving a valid site-specific background level of lead in soil. Consequently, the IEUBK Model recommends using a default background level of 200 mg/kg (200 ppm) for use the analysis. This is considered a reasonably conservative (i.e., reasonably high) value to apply in the absence of site-specific data (USEPA 2001a). Therefore, a site-specific background input level for lead in soils which would be representative of the East Chicago area or specific neighborhood zones remains uncertain.

To provide a further evaluation of the potential significance of lead emissions from the CDF and the resulting deposition of lead to local soils in the vicinity of the CDF, the rationale used by the USEPA-OSW to evaluate lead emissions from combustion facilities could be applied to the predicted long-term lead emissions from the CDF. For example, USEPA-OSW has recommended that operation of any single hazardous waste combustion unit should not be allowed to cause more than a 100 mg/kg increase in the soil lead concentration in the vicinity of a combustion facility (USEPA 1994d). The 100 mg/kg recommended limit for the soil lead increase for a single facility is designed as an allowance to increase the likelihood that the total local soil lead level will not exceed 400 mg/kg in the vicinity of the facility because of other local background emissions of lead. (The concentration of 400 mg/kg is the level at which concentrations of lead in soil begin to be a health concern for childhood lead exposure).

It is recognized that the CDF is not a hazardous waste combustion facility and will not be regulated as a combustion facility. However, as a further evaluation of the potential significance of lead emissions from the CDF, the rationale used by USEPA-OSW to evaluate lead emissions from combustion facilities could be applied to the predicted long-term lead emissions from the CDF.

In the vicinity of the CDF at locations where current and/or future human occupancy is expected, Northside-Southside zone and the school zone are the parts of the Study Area predicted to have the highest long-term increases in soil lead concentration due to operation of the CDF. The predicted maximum increase in soil lead concentration in the Northside-Southside zone is 27.1 mg/kg, the predicted average increase in soil lead concentration at the school zone during the operating life of the CDF is 31.4 mg/kg, and the predicted maximum increase in soil lead concentration at the school after operation of the CDF is completed is 58.7 mg/kg. These could be regarded as significant long-term increases to the local background level of lead since the starting local background level is assumed to be 200 mg/kg before disposal of sediments to the CDF begins. Consequently, a number of reasonable recommendations could be made.

(a) The predicted long-term increases of 58.7 mg/kg at the school zone and 27.1 mg/kg in the Northside-Southside zone are based on annual particulate emissions of 25 TPY. The contaminant emission modeling/monitoring program described in (1) above should be used to determine if actual annual total particulate emissions at the limit of 25 TPY are expected during the early years of CDF operation. If the modeling/monitoring program demonstrates that total annual particulate emissions well below 25 TPY (e.g., 5 -10 TPY) are observed, concerns about long-term lead emission and deposition rates would become less significant.

(b) On the other hand, if total annual emissions of particulate matter are not demonstrated to be significantly less than 25 TPY, additional reasonable follow up actions should be put in place, such as plans to: (1) conduct soil sampling/analysis for lead in the Northside-Southside zone and the school zone in order to establish site-specific background levels of lead; (2) conduct periodic soil sampling/analysis for lead in the same zones during operation of the CDF in order to determine if significant increases in soil lead levels are observed; and (3) if significant increases are observed and the pattern of increases points to the

CDF as the emission source, then initiate mitigation measures to reduce particulate matter emissions from the CDF.